Exploring Telepresence in Virtual Worlds

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Exploring Telepresence in Virtual Worlds

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Virtual worlds, as the computer-based simulated environments incorporating various representations of real-world elements, have great potential to not only transform the structures and operation modes of various industries but also change the way people work, do business, learn, play, and communicate. However, the existing sharp distinctions between virtual worlds and the real world also bring critical challenges. To address these challenges, the concept of telepresence—the user's feeling of 'being there' in the virtual environments—is adopted as it is considered a direct and essential consequence of a virtual world's reality. To cultivate this feeling, it is essential to understand what factors can lead to telepresence. However, some literature gaps on telepresence antecedents impede the understanding of telepresence antecedents and affect the adoption of the telepresence construct in the design of virtual worlds. To address these issues, this study explores the concept of telepresence in the context of virtual worlds. Specifically, by adopting means-end chain (MEC) theory, the study aims to investigate the antecedents of telepresence; to reveal the inter-relationships among these antecedents by building a hierarchical structure; and to develop an innovative approach for user segmentation to understand in-depth individual differences in perceiving telepresence. To achieve these objectives, the laddering interview technique was adopted to collect qualitative data from 25 participants. Analysis of the data identified 21 antecedents of telepresence. Based on their inter-relationships, a hierarchical structure was developed to capture the process of cultivating telepresence. Moreover, three types of users with distinctive paths leading to telepresence were classified. This study contributes to both the virtual world research and the telepresence literature and develops a new and meaningful user segmentation method. Finally, this study provides sufficient information and helpful guidelines to practitioners on the design and improvement of virtual worlds for a better user experience.

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List of Abbreviations

AR	Augmented reality
CMC	Computer-mediated communication
HVM	Hierarchical value map
IPQ	Igroup Presence Questionnaire
IS	Information systems
IT	information technology
ITQ	Immersion Tendency Questionnaire
JAIS	*Journal of the Association for Information Systems*
MEC	Means–end chain
MISQ	*Management Information Systems Quarterly*
PAT	Person-artefact-task
SIM	Summary implication matrix
SOPI	Sense of Presence Inventory
SPQ	Spatial Presence Questionnaire
SUS	Steed-Usoh-Slater
UMC	User-medium-content
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VR	Virtual reality
VW	Virtual world

Abstract

Virtual worlds (VWs), as computer-based simulated environments incorporating various representations of real-world elements, have extended our daily lives from offline to online. With the ability to overcome the geographical and temporal limitations of the real world, VWs have great potential to not only transform the structures and operation modes of various industries but also completely change the way people work, do business, learn, play and communicate. However, the existing sharp distinctions between VWs and the real world impede user experience and bring critical challenges for the design of VWs. To address this issue, the concept of telepresence—the user's feeling of 'being there' in the virtual environment—is adopted as it is considered a direct and essential consequence of a VW's reality. To cultivate great telepresence in VWs, it is essential to understand what factors can lead to telepresence. However, gaps in the literature on telepresence antecedents were found during a literature review undertaken as part of the current study; this challenges the understanding of telepresence antecedents and affects the adoption of the telepresence construct in the design of VWs.

To address these challenges, this study explores the concept of telepresence in the context of VWs. Specifically, by adopting means–end chain (MEC) theory, the study aims to investigate the antecedents of telepresence; to reveal the inter-relationships among these antecedents by building a hierarchical structure; and to develop an innovative approach for user segmentation to understand in-depth individual differences in perceiving telepresence.

To achieve these objectives, the laddering interview technique was adopted to collect qualitative data from 25 participants. Analysis of the data identified 21 antecedents of telepresence in the context of VWs. Based on the inter-relationships among the identified constructs a hierarchical structure was developed to capture the process of cultivating telepresence. Moreover, three types of VW users with distinctive paths leading to telepresence experience were classified.

By innovatively adopting telepresence to address issues around VWs in an exploratory way and utilising a relatively new approach in the discipline, this study not only contributes to both VW research and the telepresence literature, but also develops a new

and meaningful segmentation method for user typology. The generalised techniques and consequences from this study, which can be applied in other related contexts, also benefit information systems research. Finally, this study provides sufficient information and helpful guidelines to practitioners on the design and improvement of VWs for a better user experience.

Chapter 1: Introduction

Telepresence, as the user's feeling of 'being there' in the mediated environment (Minsky, 1980), has become one of the most essential constructs for understanding user experience in technology-mediated environments and thus has become a critical criterion to evaluate the success of information systems (IS) (Nah et al., 2011;Ettis, 2013). Although the importance of telepresence in improving user experience is well recognised, the telepresence literature falls short of exploring the factors leading to telepresence and the underlying mechanisms that cultivate telepresence within environments created by IS (Choi et al., 2016;Liu and Uang, 2016). Specifically focusing on the context of virtual worlds (VWs), which have dramatic effects on both online and offline life, the current study explores telepresence antecedents; develops the hierarchical structure of telepresence antecedents to reveal the underlying mechanisms; and establishes novel user segmentation based on individual mechanisms of perceiving telepresence to address the literature gaps in telepresence research. This chapter begins with an introduction to the study background; it then presents the rationale for the study, the research objectives and the corresponding research questions. Finally, the research significance is emphasised and the organisation of the thesis is outlined.

1.1 Background to the Study

VWs are broadly defined as computer-based simulated environments incorporating various representations of real-world elements, which extend our daily life from offline to online (Jarvenpaa et al., 2008). Derived from this definition adopted in the current study, although VWs have been considered as an antonym of the real world, the inherent purpose of VWs is to simulate the real world. Aiming to supplement or replace a wide range of features of the real world, VWs have diverse applications, such as virtual offices for online working (Chandra et al., 2012), virtual malls for online shopping (Goel and Prokopec, 2009;Hassouneh and Brengman, 2011;Cheon, 2013), virtual classrooms and tours for online learning (Oliver and Carr, 2009;Callaghan et al., 2013;Englund, 2017) and virtual multiplayer platforms for online gaming (Rodrigues et al., 2012;Billieux et al., 2013) and online socialising (Pinkwart and Olivier, 2009;Munn, 2012;Sharma et al., 2013). While horizontally extending their applications to cover every possible part of daily life, VWs also vertically upgrade themselves by constantly integrating emerging advanced technologies into their design. Some promising technologies, such as virtual reality (VR)—a computer technology using equipment similar to headsets to create realistic sensations for users—have been tentatively applied in VWs (Mine et al., 2015;Peng and Tian, 2017).

Despite the rapid growth and significance of VWs, this type of IS are still considered at its ‘trigger’ phase, meaning that people use them for fun and novel experience rather than for practical supplementation or replacement of the real world (Castronova et al., 2009;Goel et al., 2013). The reason for this failure to achieve the original goal of VWs lies mainly in the fact that there are sharp distinctions between the current VWs and the real world (Chaturvedi et al., 2011;Freina et al., 2016). The challenge of realness in VWs affects their acceptability and popularity and consequently hinders their development. Thus, to address this challenge, it has been suggested that VWs should be designed to be as real as possible to provide users a feeling of ‘being in’ the created environment (Animesh et al., 2011). To this end, telepresence, which refers to the user’s subjective feeling of ‘being there’ in the mediated/virtual environment (Minsky, 1980;Suh and Chang, 2006), is of direct relevance.

The construct of telepresence was introduced to indicate the sense of being physically present at a remote location when a user is interacting with remote control systems (Minsky, 1980). The adoption of telepresence has since extended from the original context of teleoperators to a wide range of contexts ranging from traditional media to ultra-realistic simulated systems (Kim and Biocca, 1997;Suh and Chang, 2006;Nah et al., 2011). According to telepresence studies in different contexts, telepresence has been regarded as a key concept to describe the user’s ‘perceptual illusion of being present in a mediated environment, while they are in reality physically present in another place’ (Suh and Lee, 2005, p.675), which reflects the realness of the environment created by the IS (Lombard et al., 2011;Haans and Ijsselsteijn, 2012;Faiola et al., 2013). Moreover, improving the user’s telepresence experience has been acknowledged to further produce some positive consequences such as increased learning (Kim and Biocca, 1997;Suh and Lee, 2005), better task performance (Witmer and Singer, 1998;Kaber et al., 2000), positive affect (Klein, 2003;Grigorovici and Constantin, 2004) and superior persuasion effects (Nelson et al., 2006). Therefore, adopting the construct of telepresence in VWs not only addresses its challenges regarding realness but predicts the success of this type of IS.

1.2 Research Rationale

When considering the significance of telepresence on types of IS, especially VWs, it is essential to understand what factors can lead to telepresence (Kim and Biocca, 1997;Klein, 2003;Nah et al., 2011). The investigation of telepresence antecedents not only provides valuable information on understanding the dynamic process of telepresence but also offers practical contributions by incorporating the identified factors in the design of IS, which is the fundamental purpose for adopting the construct of telepresence in these contexts. However, according to the literature, studies on telepresence antecedents are still too few and are no sufficiently clear to provide a comprehensive and thorough understanding of what factors lead to telepresence. Some literature gaps on telepresence antecedents were found during the literature review that not only impede the understanding of telepresence theory but also affect the adoption of the telepresence construct in the design of IS; for example, VWs for better user experience. Specifically, there are three main challenges involved in the understanding of telepresence antecedents.

First, according to the literature review, understanding of the content of telepresence antecedents remains limited and problematic. There are two major limitations with existing knowledge of telepresence antecedents: the investigation scope and clarity. The first limitation derives from the influence of the classical model of telepresence antecedents proposed by Steuer (1992). In the model, Steuer (1992) identifies two main factors that lead to telepresence from the technological perspective. According to Steuer (1992), the two main telepresence antecedents are vividness, which refers to 'the ability of a technology to produce a sensorial rich mediated environment' (p. 82) and interactivity, which indicates 'the degree to which users of a medium can influence the form or content of the mediated environment' (p. 83). Steuer (1992)'s model of telepresence antecedents has greatly influenced later studies by restricting the investigation scope to the technology-only aspect (Nah et al., 2011;Ou et al., 2014). Because of the lack of a comprehensive and balanced view for exploring telepresence antecedents, some of the significant factors leading to telepresence are easily ignored in research. This further affects the construction of research models and the creation of IS, such as VWs, for the design. The other literature gap with respect to telepresence antecedents is due to the diverse contexts in which telepresence has been applied, as telepresence is regarded as a product of all media (Bracken and Skalski, 2010). The contexts in various research areas have yielded a large amount of terms for telepresence antecedents. Thus, the literature is quite complicated and it is difficult to integrate all of the factors from different contexts into an applicable model because some of them are context-specific, some are ambiguous and some are interchangeable (IJsselsteijn et al., 2000;Liu and Shrum, 2002;McMillan and Hwang, 2002;Skadberg and Kimmel, 2004;Nelson et al., 2006). Without an overarching model, the identification of telepresence antecedents remains disordered, confusing and illogical. Thus, a well-formed model for arranging the factors leading to telepresence is deemed to be of immense value for comprehensively and clearly understanding telepresence antecedents.

Second, based on the literature review, the hierarchical structure of telepresence antecedents is unclear. This challenge derives from the oversimplification of the current understanding of the relationships between causal factors and telepresence. Investigations of telepresence antecedents have remained at a relatively superficial level by focusing only on the influences of interface features on telepresence (Suh and Chang, 2006;Nah et al., 2011). As these investigations have been based on specific media, the generalisation and applicability of their findings are limited. A deeper exploration of the inner mechanism of the relationships is required to understand how existing telepresence antecedents at a lower level influence telepresence through factors at higher levels. Thus, a hierarchical structure of telepresence antecedents facilitates unfolding the ‘black box’ of the process of cultivating telepresence, which provides solid theoretical foundations for researchers and practitioners to adapt findings to their studies and designs within different contexts.

Finally, according to the literature review, although the influence of individual differences on perceiving telepresence has been acknowledged by researchers (Bystrom et al., 1999;Nelson et al., 2006;Cho et al., 2015;Stavropoulos et al., 2017), little knowledge on this feature can be gleaned from the literature. To explain the well-accepted but unclear telepresence phenomenon that in the same mediated environment different users may produce different degrees of telepresence (IJsselsteijn et al., 2000), the perspective of user segmentation is adopted in the current study. Meanwhile, from the perspective of the context of VWs, to achieve successful design and operation, a clear understanding of current user typologies is vital. By identifying user segments, VW designers can specifically customise their designs to their target group of users and/or offer optional and tailored functions to different user types. However, according to the literature review, limited attention has been paid to user segmentation in the context of VWs. Further, although studies on user segmentation in similar contexts may provide some reference information, most user typologies have been based on factors that depend on specific systems/technologies, such as a user's ability and motivation to use the specific systems/technologies or consequent use behaviours and final usage. Accordingly, these existing user typologies have a system-specific basis. Thus, generalisation and applicability is relatively limited for existing user typologies and there is little reference information for use in the current study in the context of VWs. From the perspective of telepresence research, an understanding of how users perceive telepresence experience is used to represent the inner mechanism of user experience, which is the basis for establishing innovative user segmentation. The new user segmentation in VWs is expected to provide more generalised and applicable information for future user segmentation studies.

To summarise, there are three major challenges in understanding telepresence antecedents that have hindered the adoption of telepresence in IS, especially for addressing the challenge of VWs in the current study. These challenges have motivated the researcher to conduct an exploratory and extensive study on telepresence in VWs, which led to the following research aims and questions.

1.3 Research Aims and Questions

Based on the discussion above, this study focuses on the construct of telepresence in VWs to address practical issues with VWs and to fill literature gaps that are impeding the adoption of telepresence in this context. Therefore, the research aim is to understand telepresence in an exploratory way in VWs by identifying antecedents of telepresence, interpreting the hierarchical structures of the identified constructs and developing appropriate user segmentation for the context of VWs.

To achieve the research aim, three major research objectives are formulated:

- Research objective (RO) 1: To understand the antecedents of telepresence in the context of VWs.
    - *Research Question (RQ) 1: What are the antecedents of telepresence in the context of VWs?*

- RO2: To understand the hierarchical structure of telepresence antecedents in the context of VWs.
  - *RQ2: What is the hierarchical structure of the identified telepresence antecedents in the context of VWs?*
  - *RQ3: What is the relative importance of the telepresence antecedents?*
- RO3: To understand user segmentation and the hierarchical structure of telepresence antecedents for each group of users in the context of VWs.
  - *RQ4: Are there any distinct types of users based on their mechanisms of perceiving telepresence in the context of VWs?*
  - *RQ5: If yes, what are the similarities and differences between the hierarchical structures of telepresence antecedents for these groups of users in the context of VWs?*

1.4 Research Significance

The significance of the current research has both theoretical and practical features. Theoretically, the study is among the first to investigate VWs from the perspective of telepresence using an exploratory approach. Highlighting the significant role of telepresence in VWs, the study utilises a qualitative method to explore possible factors leading to telepresence and that contribute to the success of VWs by providing better user experience. Through this new perspective, abundant and valuable information is provided, which is expected to generate many innovative insights for future studies in the context of VWs. From the perspective of telepresence research, although telepresence has been considered an essential construct to understand the user experience in various contexts, current knowledge on the cultivation of telepresence remains limited and somewhat confusing. This study addresses gaps in the telepresence literature by exploring the antecedents of the construct and accordingly developing hierarchical structures to investigate the inner mechanisms for better understanding and higher generalisation. Thus, the study adds to and clarifies current knowledge on telepresence, which facilitates further development and application of the construct. Finally, previous studies on user segmentation were criticised on the basis of flexibility and generality in that the user typologies were context-specific depending on the systems used. Thus, this study develops an innovative way to classify users based on their inner mechanisms of user experience, specifically their mechanisms of perceiving telepresence experience. This new method is expected to overcome the limitations of segmentation research with respect to generalisation and applicability and help future researchers more comprehensively and thoroughly to understand users in various contexts. Moreover, the study develops a hierarchical structure for each group of users to describe user segments more concretely and vividly. Thus, this study is among the first to investigate user typologies in the context of VWs, and to classify users based on their inner nature with reference to their mechanisms of user experience.

With respect to practice, the study is significant in helping designers and operators of VWs to survive intense competition with others and in maintaining the stability and prosperity of the VW ecosystem as a whole. By providing abundant information on the antecedents of telepresence as well as the hierarchical structure of the constructs, the study facilitates practitioners to better understand the key to VWs involving better user experience, especially from the perspective of telepresence. The study's findings will help practitioners to not only understand what factors can influence telepresence, but also to interpret how to cultivate telepresence via the paths leading to telepresence. With the hierarchical structure of telepresence antecedents, practitioners can flexibly adapt the study findings to the design of specific VWs and even other types of systems. Additionally, the innovative user segmentation in the study provides new insights for practitioners to understand and target distinct types of users. This is helpful for attracting and retaining more users to VWs by offering a customised user experience to specific groups of users. The hierarchical structure for each group helps with the depiction of distinct types of users. With a better understanding of users, practitioners can develop cost-effective strategies for design and operation to successfully satisfy their target users in VWs. Thus, the findings of the study are expected to lead to improved design and market investigation for VWs to address current challenges, which would promote the acceptability and popularity of VWs in diverse contexts. Improved VWs that provide a better telepresence experience are more likely to realise their original goal of supplementing or replacing various features of real life, which would completely change the way people work, shop, learn, play and socialise.

1.5 Organisation of the Thesis

This thesis is structured as follows:

- Chapter 1: Introduction. This chapter provides an overall view of the research background and explains the rationale for the study. The research aims and questions are outlined based on the rationale and then the theoretical and practical significance of the study are discussed.
- Chapter 2: Literature Review. This chapter presents a review of relevant literature to the study. It begins with an understanding of the core construct of telepresence and then introduces the research context of VWs. The core construct and context are then linked by arguing that telepresence can be regarded as the most appropriate solution to the challenges of VWs. Accordingly, a further review on telepresence antecedents is presented and the challenges in understanding telepresence antecedents are discussed. Finally, the theoretical foundation for the study is presented.
- Chapter 3: Research Methodology. This chapter introduces the research methodology employed in the study. It begins with a discussion of the research approach and then describes the specific study artefact for collecting the data. The technique and process for data collection are illustrated, followed by an introduction to the data analysis method.
- Chapter 4: Research Results. This chapter presents the research results based on the data analysis. First, the results for the content analysis to answer RQ1 are illustrated. The hierarchical structure presenting the relationships among the identified constructs are then discussed to address RQ2 and RQ3. Finally, the results of the cluster analysis are presented to address RQ4 and RQ5.
- Chapter 5: Discussion. This chapter discusses the research results to explore the main findings of the study.
- Chapter 6 Conclusion. This chapter concludes the thesis by discussing the theoretical and practical implications of the study as well as the research limitations and directions for future studies.

Chapter 2: Literature Review

2.1 Introduction

As outlined in Chapter 1, the major aim of this study is to understand the telepresence construct in VWs by utilising an exploratory approach. To achieve this aim, three specific objectives for the study are to identify telepresence antecedents; develop a hierarchical structure of telepresence antecedents; and establish user segmentation based on users' mechanisms of perceiving telepresence. This chapter reviews the literature relevant to the current research topic for two main reasons: to link the literature to the current study and provide a theoretical reference point for better understanding of the research topic; and to explain the motivation behind the specific objectives by identifying gaps in the literature. Thus, this chapter begins by thoroughly explaining the core concept of the study—telepresence. To provide a comprehensive insight into this concept, Section 2.2 explicates telepresence within a wide range of research contexts and further summarises the importance of telepresence to explain why the construct has been considered as key to the study of user experiences in various contexts. Section 2.3 then introduces current research context—VWs. In this section, the context of VWs is investigated with respect to both its background and present research progress. Based on this, current challenges in the design of VWs are discussed in Section 2.4, linking this with the telepresence concept as the core solution through improved user experience. Regarding the adoption of the telepresence concept into solving challenges in the design of VWs, the core consideration is what factors lead to telepresence, to provide practical guidelines for design. Thus, Section 2.5 focuses on further investigating telepresence antecedents based on previous studies within various research contexts to offer a theoretical reference for this core consideration. The review of the literature on telepresence antecedents identifies some significant relevant literature gaps, which forms Section 2.6 on discussing the major challenges to understanding telepresence antecedents in VWs. Finally, MEC theory is introduced as the theoretical foundation to guide the study's approach to addressing the challenges discussed and as the theoretical basis for data collection and data analysis in the study.

2.2 Understanding the Core Construct of Telepresence

As telepresence is the core construct in the current study, a thorough understanding of concept is a prerequisite for conducting the study. Thus, in this section, the telepresence concept is first explicated by outlining definitions within various contexts that capture the essence of the concept; investigating current terminology to identify relevant literature for further review; distinguishing telepresence from similar concepts to clarify its uniqueness; and reviewing current measurement of telepresence. Second, the importance of telepresence is emphasised mainly based on the consequences of this construct within different research contexts. Thus, this section facilitates understanding of the core construct, telepresence, and reinforces explanations of why telepresence has been regarded as key in studying the user experience in diverse research contexts.

2.2.1 Telepresence Explicated

In this subsection, previous definitions of the telepresence concept within various contexts are illustrated. Through synthesising these definitions, the essence of telepresence is extracted to provide an overall meaning for this concept. The alternative terms used interchangeably for telepresence in the literature are then investigated, which helps in identifying studies related to telepresence for further literature review and provides hints for understanding some basic features of this concept. Additionally, a conceptual comparison between telepresence and similar, easily confused concepts—such as presence, social presence, immersion and flow—is made to clarify the uniqueness of the telepresence concept, which cannot be replaced by similar constructs used in relevant studies. Finally, the current measurement of telepresence is reviewed to investigate how to judge the existence and degrees of telepresence feeling for further explication of this concept.

2.2.1.1 Definitions of Telepresence

The term telepresence was coined by Marvin Minsky in his classic 1980 paper on remote control technology (Minsky, 1980). In his paper, telepresence was defined as a person's sense of being physically present at a remote location through interaction with the human–computer interface. He explained that the sense of telepresence is what users receive via the proper teleoperation technology through their actions and the subsequent perceptual feedback.

Table 2-1: Selected definitions of telepresence

Author	Context	Definition
Minsky (1980)	Teleoperator	A person's sense of being physically present at a remote location through interaction with the human–computer interface
Steuer (1992)	VR	'The experience of presence in an environment by means of a communication medium' (p. 76)
Held (1992)	General	A sense of being present in a mediated environment
Kim and Biocca (1997)	Television	The psychological phenomenon whereby a user is 'phenomenally transferred to a mediated environment, resulting from low accessibility to the unmediated information and high accessibility to the mediated information' (p. 4)
Draper et al. (1998)	Synthetic environment	'The perception of presence within a physically remote or simulated site' (p. 354)
Shih (1998)	Cyberspace	A sense of being present in a virtual store where users can browse and shop as in a brick-and-mortar store
Coyle and Thorson (2001)	Marketing websites	'The simulated perception of direct experience' mediated by a communication technology, which occurs 'when the perception mediated by the technology takes precedence over the unmediated perception' (p. 66)
Klein (2003)	Computer-mediated environment	'A sense of presence in a remote environment' (p. 41)
Suh and Lee (2005)	VR	A user's perceptual illusion of being present and highly engaged in a mediated environment, while the user is physically present in another place
Fiore et al. (2005)	Retailing website	'The sense of being transported to another location or the sense of being in a mediated space other than where the physical body is located' (p. 41)
Nelson et al. (2006)	Computer game	'The presence of being present or "transported" inside a virtual mediated environment' (p. 88)
Song et al. (2007)	Retailing website	'A mental state where the user feels immersed in a virtual environment; real world stimuli are blocked out and the virtual environment captivates the senses' (p. 557)
Phang and Kankanhalli (2009)	VWs	'The illusion or sensation of being physically present in the environment simulated by the medium' (p. 2)

Author	Context	Definition
Kwon and Wen (2010)	Social network service	‘A sort of feeling that a user is present in a virtual environment’; that users feel like ‘they are located remotely from where they currently are’ (p. 257)
Ning Shen and Khalifa (2012)	Retailing website	‘The sense of being located somewhere, describing an immersive experience induced by a wet site’ (p. 401)
Bellman et al. (2014)	Advergame and television	‘The feeling of “being there” in a mediated environment, and forgetting that you are actually sitting in front of a PC or a TV’ (p. 277)
Coxon et al. (2016)	VR	A feeling of being spatially located in a digital environment created by VR technology

Although in Minsky’s (1980) study telepresence was limited to the specific context of teleoperators, later research applied this construct to various contexts because of increasing research interest in this construct and the argument that telepresence is the product of all media, to varying degrees (Biocca et al., 1995;Reeves and Nass, 1996;Suh and Chang, 2006;Bracken and Skalski, 2010). For instance, telepresence can be perceived by a novel reader when they feel like they are inside an imaged scene narrated by the novel (Andringa, 1996). Similarly, a user wearing a head-mounted display that captures their entire perceptual field also can develop a feeling of telepresence—that they are actually inside a place that may not even exist in the real world (Hecht and Reiner, 2006). Thus, the construct of telepresence has been adopted in various mediated experiences, such as reading novels (Gerrig, 1993;Andringa, 1996), watching television (Kim and Biocca, 1997), communicating remotely (Muhlbach et al., 1995;Khalifa and Shen, 2004), online advertising (Li et al., 2002;Hopkins et al., 2004;Keng and Lin, 2006), online shopping (Suh and Chang, 2006;Nah et al., 2011), online learning (Fowler and Mayes, 1997;Giraldo et al., 2010;Faiola et al., 2013), online gaming (Nelson et al., 2006), interactions between humans and robots (artificial intelligence) (Tsui et al., 2011;Escolano et al., 2012) and experiencing VR (Steuer, 1992;Satava, 1997;Riva, 2007). This wide range of applications of telepresence has boosted the popularity and development of the construct. However, it has also resulted in a variety of definitions of telepresence in different contexts, with no consensus. Table 2-1 presents the definitions of the telepresence concept in various research contexts.

Although definitions of telepresence vary among contexts, the essence of the concept and elimination of the influence of contexts can be extracted by synthesising the definitions and descriptions of telepresence. Accordingly, the essence of telepresence emphasises the feeling of 'transportation' from users' physical surroundings to the mediated environment: as stated by (Kim and Biocca, 1997), telepresence is a feeling of being 'phenomenally transferred to a mediated environment' (p. 4). Thus, for the telepresence concept, two types of environments are involved: the physical environment that surrounds a user and the mediated environment that is generated by the media (Suh and Lee, 2005). According to Held (1992), the mediated environment can refer to either a real environment such as a remote space viewed via a video camera, or a virtual environment such as a 3D online gaming platform. Through the interaction between the user and the media, a feeling of telepresence is cultivated, which involves competition for the user's attention between stimuli from the physical and the mediated environments (Nah et al., 2011). Kim and Biocca (1997) described this competition by saying that telepresence is induced, 'resulting from low accessibility to the unmediated information and high accessibility to the mediated information' (p. 4). Similarly, Nah et al. (2011) argued that telepresence represents such a phenomenon that a user's perception of the physical surroundings is reduced when their attention is focused on the experience in the mediated environment; thus all irrelevant thoughts are screened out. Based on these description, telepresence can be considered as a 'moment-by-moment' feeling that is limited to only one environment at a time (Gerrig, 1993). Thus, when the physical environment is blocked out, the mediated environment captivates users' sense that they have departed from the physical environment in which they are present and arrived at the mediated environment generated by the media (Kim and Biocca, 1997;Qiu and Benbasat, 2005). Many researchers have used the phrase of 'being there' or 'being present' to describe the result of this process of transportation and define the telepresence concept. For instance, Bellman et al. (2014) defined telepresence as 'the feeling of 'being there' in a mediated environment' (p. 277). Suh and Lee (2005) regarded telepresence as a user's perceptual illusion of being present and highly engaged in a mediated environment, while the user being physically present in another place.

Figure 2-1 depicts the essence of the telepresence concept as discussed. Through the interaction between users and media, when a user's attention is totally absorbed by the mediated environment created by the media, they have a feeling of 'being there' in the mediated environment and forgetting that they are physically located in another place. In the figure, computers are used as an example to represent the media; however, it is notable that telepresence is a product of all media, from traditional media to advanced media with cutting-edge equipment (Biocca et al., 1995;Reeves and Nass, 1996;Suh and Chang, 2006;Bracken and Skalski, 2010).

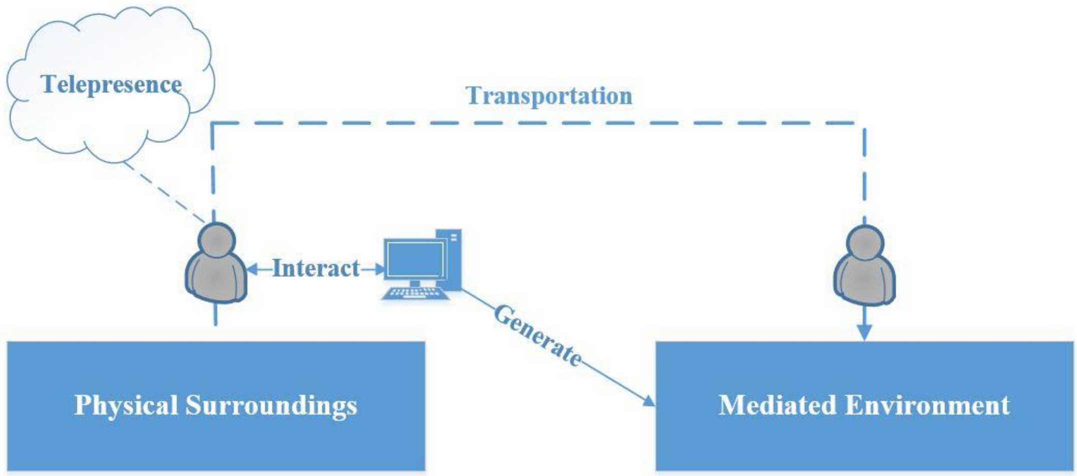

Figure 2-1: The essence of the telepresence concept

Source: author

The review of telepresence definitions used in previous studies proves a general background to the essence of this concept. In the following subsection, alternative terms of telepresence are investigated based on the argument that the telepresence literature lacks unified terminology and that a better understanding of this concept should be based on the comprehension of all possible substitute terms (Lee, 2004a). Further, a review of alternative terms for telepresence helps to identify telepresence studies for the literature review and to avoid overlooking any significant research.

2.2.1.2 The Terminology of Telepresence

In prior studies, the term telepresence was often interchangeably used with presence, virtual presence, mediated presence, physical presence and personal presence. The lack of unified terminology complicates communication among scholars from diverse fields, such as industrial engineering (e.g., Retik et al., 2002), communication (e.g., Biocca and Levy, 2013), business (e.g., Hoffman and Novak, 1996;Klein, 2003), computer science (e.g., Minsky, 1980;Sheridan, 1995), education (e.g., Fowler and Mayes, 1997;Kwon et al., 2010) and psychology (e.g., Suh and Chang, 2006;Stavropoulos et al., 2013). In Table 2-2, commonly used alternative terms are reviewed to provide valuable information for understanding the terminology of telepresence and for identifying related telepresence studies in the literature.

According to Table 2-2, the various terms express the same meaning of the telepresence concept, which emphasises that it is a feeling of ‘being there’ in the mediated environment. Studies in different contexts have used different terms to highlight their various concerns. For instance, virtual presence specifically indicates the feeling of ‘being there’ in the virtual environment generated by VR technologies (Sheridan, 1992). Physical presence is always used in comparisons with social presence in studies that contain both constructs in their research model (Cho et al., 2015). Although some researchers have stated that using different terms according to different contexts can provide specific understanding of the construct, the existing diverse terms are more likely to cause unnecessary confusion in future studies trying to understand the construct and identify related studies for a literature review. To eliminate any confusion, the current study argues that the term of telepresence works best to represent the concept referring to a feeling of ‘being there’ in mediated environments as it is one of the most commonly used terms in the literature, is general enough to represent the feeling in all media and is distinctive enough from similar constructs.

Table 2-2: A summary of terminology used for telepresence

Term	Definition	References	Motivation to Use/Coin
Telepresence	The user's sense of 'being there' in the virtual environment	(Minsky, 1980); (Held, 1992); (Kim and Biocca, 1997); (Suh and Chang, 2006); (Faiola et al., 2013)	To emphasise the sense of transportation to a space created by technology
Presence	The user's sense of 'being there' in the virtual environment	(Slater and Usoh, 1993); (Zahorik and Jenison, 1998); (Riva et al., 2003)	To be adapted as a shorten version of 'telepresence' when the journal Presence was founded in 1991
Virtual presence	The feeling of presence in a virtual environment	(Sheridan, 1992); (Sheridan, 1994); (Sallnäs et al., 2000); (Blair et al., 2005)	To refer to telepresence caused by VR technologies
Mediated presence	The user's mediated perception of an environment in which they are being transported via technologies	(Biocca et al., 2001b); (Gorini et al., 2011); (Villi and Stocchetti, 2011); (Waterworth and Waterworth, 2010)	To confine telepresence strictly to the realm of mediated perception by communication scholars
Physical presence	The user's sense of physically being at the cyberplace rather than the physical place	(Biocca, 1997); (IJsselsteijn et al., 2001); (Weaver et al., 2006)	To emphasise competition between the physical environment and cyberspace for user's attention to feel telepresence
Personal presence	The subjective sense of a user that they feel like they are in the VW	(Heeter, 1992); (Romano et al., 1998); (Blake et al., 2000)	To highlight that telepresence is a user's subjective feeling

Specifically, there are several reasons for selecting the term telepresence in this study to represent the construct based on comparisons with alternative terms. First, according to the literature, telepresence and presence are the terms used most to illustrate the feeling of 'being there' in a remote/virtual environment (Lombard and Jones, 2007). Although the term presence has been used by many studies as the shortened version of telepresence, it has also been employed as a broader concept defined as 'a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of technology in the experience' (Lombard and Snyder-Duch, 2001, p.58). With this definition, the construct of presence has been widely used to indicate the perception of un-mediation, which contains not only telepresence but other types of presence such as social presence and co-presence (Lee, 2004a;Bulu, 2012). Thus, to avoid confusing and ambiguous research results, the term presence should be first excluded.

Second, other terms (e.g., virtual presence, mediated presence, physical presence and personal presence) have been coined or used either to specify the technological domain or to emphasise one specific aspect of the definition (Sheridan, 1992;Weaver et al., 2006;Gorini et al., 2011). In contrast, telepresence is a more general term that has been applied to various contexts and can be employed in the analysis of future mediums or technologies whose domains have not yet been determined (Bracken and Skalski, 2010).

Finally, telepresence was the first term coined by Minsky (1980) to refer to the feeling of being in a remote/virtual environment and moreover, the etymon 'tele' (i.e., at a distance; far away) indicates the focus of the feeling that is the illusion of transportation from the physical to the remote/virtual environment (Kisswani, 2010). Thus, the etymon 'tele' reflects the essence of the concept and precisely represents this kind of feeling with its literal meaning, thus clearly distinguishing it from similar constructs.

Although the term telepresence has absolute superiority to represent the concerned construct, the investigation and comparison of alternative terms also provides some hints for better understanding of the construct. Accordingly, considering the use of alterative terms together with various definitions, some fundamental features to depict the construct of telepresence are identified. First, all definitions agree that telepresence is a personal subjective feeling rather than an objective measurement of the media. The term 'personal presence' includes the word 'personal' to emphasise this feature (Heeter, 1992;Blake et al., 2000). Second, the physical feature of telepresence is highlighted by definitions in different forms of expression. For instance, IJsselsteijn et al. (2000) classified presence with a broader meaning into two types—physical and social—where the physical type refers to telepresence. Some studies have used the term 'physical presence' to represent this feeling and to stress this feature (Biocca, 1997;Weaver et al., 2006). Moreover, other researchers have employed the relevant phrases in their definitions to indicate the physical feature of telepresence, such as ‘physically present’ (Minsky, 1980;Suh and Lee, 2005), ‘phenomenally transferred’ (Kim and Biocca, 1997), ‘physical environment/surroundings’ (Nah et al., 2011), ‘being there’ (Slater and Usoh, 1993;IJsselsteijn et al., 2001) or ‘being transported’ (Biocca et al., 2001b). Finally, the necessity of the mediated environment and the mediated experience created by the media to induce telepresence has been emphasised. Some studies directly used the phrase ‘mediated environment’ in their definitions to highlight the essential role of media or related technologies (Kim and Biocca, 1997;Coyle and Thorson, 2001;Bellman et al., 2014). Other definitions adopted the description ‘virtual environment’ to distinguish the mediated environment created by some specific media or technologies (Shih, 1998;Nelson et al., 2006;Song et al., 2007). The term ‘mediated presence’ and ‘virtual presence’ are used to highlight this mediated feature of telepresence (Blair et al., 2005;Waterworth and Waterworth, 2010). Figure 2-2 illustrates these features of the telepresence construct as discussed.

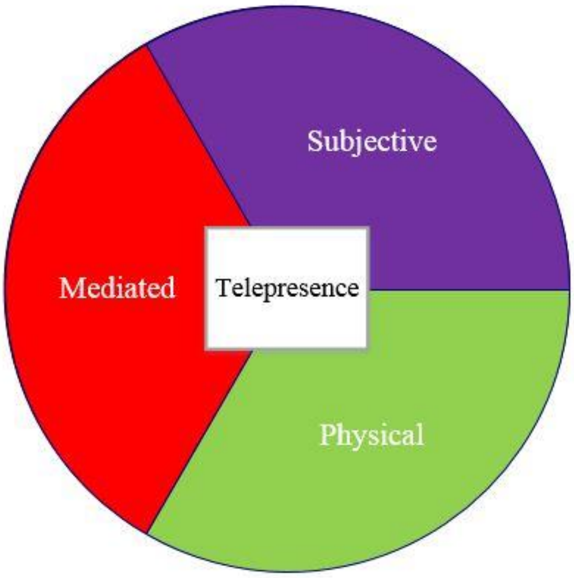

Figure 2-2: Fundamental features of the telepresence concept

Source: author

This subsection reviews terminology used for telepresence; based on this, the term telepresence is regarded as the most appropriate to represent the core construct in this study. The list of alternative terms also provides a reference for further searches and review of relevant studies to avoid overlooking any significant research on the telepresence construct. Accordingly, telepresence-related studies are identified and reviewed (see Appendix A). Moreover, by investigating alternative terms and definitions of this construct, three fundamental features of telepresence are identified to further depict this concept. These features also facilitate distinguishing telepresence from similar concepts, which may cause confusion in the literature. Thus, the following subsection compares telepresence with similar concepts to distinguish the construct and highlight its uniqueness.

2.2.1.3 Comparison between Telepresence and Similar Concepts

According to previous studies, concepts such as presence, social presence, flow and immersion, are similar to the construct of telepresence; researchers state that these concepts are closely associated with telepresence and use them together in their research models (Skadberg and Kimmel, 2004;Teoh and Cyril, 2008;Nah et al., 2011;Bulu, 2012). Further, some researchers alternatively use them to represent telepresence in their research by arguing that they express the same meaning of telepresence (Dede, 1995;Pettey et al., 2010;Gorini et al., 2011). However, without a clear distinction between telepresence and similar concepts, relevant studies may lead to ambiguous understanding of telepresence and confusing research results related to the telepresence concept. Thus, to avoid this issue, this subsection presents a one-to-one comparison of telepresence with each of these similar concepts, which identifies the significant differences between them.

2.2.1.3.1 Telepresence *v*. Presence (Specific *v*. General)

In previous studies, the concepts of telepresence and presence have been used interchangeably because some authors employed presence as the shortened version of telepresence, as discussed in Section 2.2.1.2 (e.g., Lombard and Snyder-Duch, 2001;Floridi, 2005;Riva, 2009). However, the concept of presence has also been widely used to represent a broader meaning, which refer to the user's 'perceptual illusion of non-mediation' (Lombard and Ditton, 1997). As a broader concept, presence emphasises that a person fails to perceive the existence of a medium in the mediated environment and responds as if the medium did not exist (Bulu, 2012). Presence consists of two main types—telepresence from the physical perspective and social presence from the social perspective—that indicate a feeling of being together and communicating with someone (IJsselsteijn et al., 2000). Thus, the construct of presence contains telepresence rather than being equal to telepresence (Nowak and Biocca, 2003;Cho et al., 2015). According to this comparison, presence is a broader concept to indicate the feeling of non-mediation whereas telepresence is more specific with respect to physical features, referring to the feeling of being in a mediated environment.

2.2.1.3.2 Telepresence *v*. Social Presence (Physical *v*. Social)

As mentioned above, presence consists of two main types: telepresence and social presence (IJsselsteijn et al., 2000). Comparing these two concepts, telepresence focuses on physical features that highlight the feeling of transportation of users from their physical surroundings to mediated environments (Khalifa and Shen, 2004). When users have the feeling of telepresence, they feel that they are 'being there' in a mediated environment. However, social presence emphasises social features that highlight interpersonal relationships via media (Lombard and Ditton, 1997). When users have the feeling of social presence, they fell that they are 'being together' with others in a mediated environment and thus they regard the media as sociable, warm, sensitive, personal or intimate (Ning Shen and Khalifa, 2008). Therefore, telepresence and social presence are two distinct concepts, which indicate different feelings based on different perspectives.

2.2.1.3.3 Telepresence *v*. Immersion (Subjective *v*. Objective)

Some researchers have regarded telepresence and immersion as essentially the same thing and have used the two terms interchangeably (Bracken and Skalski, 2010). However, although perceptual and psychological immersion can describe part of the telepresence experience, it cannot cover the whole meaning of telepresence to replace this construct (Bowman and McMahan, 2007). Further, according to Slater and Wilbur (1997) and Draper et al. (1998), the concept of immersion as adopted in academic studies, especially those of virtual environments, normally refers to the physical properties of the media technology (Slater, 2003). More specifically, it indicates the objectively measurable properties of a medium, which are defined as the 'extent to which computer displays are capable of delivering an inclusive, extensive, surrounding, and vivid illusion of reality to the senses of the VE [virtual environment] participant' (Slater and Wilbur, 1997, p. 604). In comparison, telepresence refers to a user's subjective psychological response to a medium. Therefore, telepresence and immersion are logically separable. It is argued in the literature that immersion is objective and measurable because a medium's level of immersion depends only on its rendering software and sensory display technology, whereas telepresence is subjective. Related to the experience of 'being there', different users can have different levels of telepresence within the same medium (Slater and Wilbur, 1997;Draper et al., 1998).

2.2.1.3.4 Telepresence *v*. Flow (Medium-oriented *v*. Task-oriented)

Flow is defined as the mental state of operation in which a person performing an activity is fully immersed and has a feeling of energised focus, full involvement and enjoyment in the process of the activity (Csikszentmihalyi and Csikzentmihaly, 1991). According to the literature, telepresence and flow have usually been regarded as associated concepts in some research models to investigate the user experience (Faiola et al., 2013;Stavropoulos et al., 2013). There is ongoing debate on the relationship between telepresence and flow (Finneran and Zhang, 2005;Nah et al., 2011). Although the two concepts share some commonalities as they are both the users' subjective mental state, there is one significant difference between them, which is an emphasis on the objects that immerse users. It has been acknowledged that flow occurs when a person is participating in a task for its own sake and the person wants to repeat the task constantly as they feel the task is so satisfying (Csikszentmihalyi, 1988;Finneran and Zhang, 2003). Thus, the emphasis of the flow concept is the task that immerses the user. However, based on current understanding of the telepresence concept, it highlights the role of the media that generates the mediated environment in which users feel that they are physically present, just as Scoresby and Shelton (2011) argued that telepresence is 'determined by how the environment assists or distracts the individuals' (p. 231). Thus, telepresence is a medium-oriented concept in which the cultivation of telepresence is based on the premise of the existence of a medium, whereas flow is a task-oriented concept in which the occurrence of flow is based on the premise of the existence of a task.

Figure 2-3 summarises distinctions identified via the one-to-one comparison between telepresence and similar concepts, which demonstrate its uniqueness and irreplaceability. At the same time, it confirms the core features of telepresence identified in Section 2.2.1.2.

The above subsections facilitate an understanding of the telepresence concept by synthesising its definitions within different contexts and investigating the terminology to identify its fundamental features as well as distinguishing telepresence from similar concepts. To further explicate the telepresence concept, the following subsection focuses on the concrete interpretation of telepresence from the perspectives of both users and researchers by investigating how telepresence is measured.

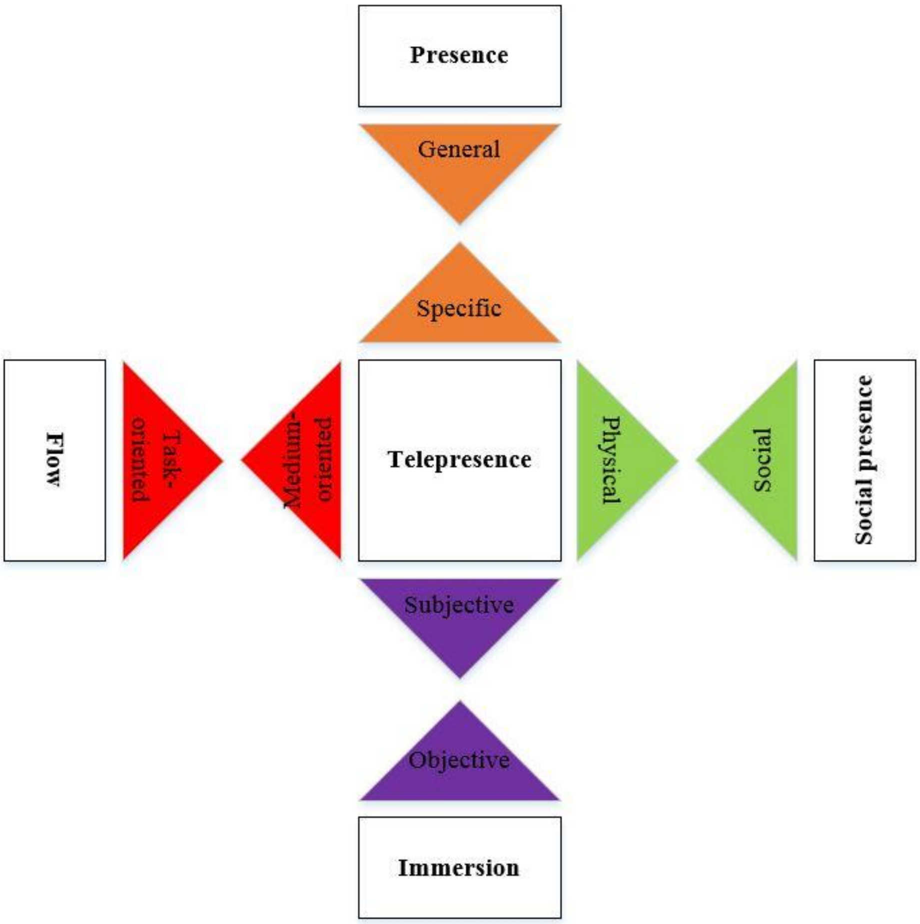

Figure 2-3: One-to-one comparison between telepresence and similar concepts

Source: author

2.2.1.4 The Measurement of the Telepresence Construct

To further explicate the concept of telepresence, it is important to understand methods for judging whether a feeling of telepresence has been induced by the media and to what extent. This consideration involves the measurement of this concept. Based on the literature, there are two main ways to measure telepresence: objective measures and subjective measures (IJsselsteijn et al., 2000).

2.2.1.4.1 Objective Measurement of Telepresence

The design of objective measurement was based on the *behavioural realism* approach and the basic principle that ‘the more simular a display becomes to the environment it mimics, the more the observer will respond to the display in the same way that he/she would respond to the environment itself’ (Freeman et al., 2000, p. 151). Taking an extreme example, if the medium can fully mimic the real environment, users are very likely to feel they are present in the mediated environment as it will be perceptually indistinguishable from the real environment, and thus their responses to the medium should be equivalent to those to the real environment (Hendrix and Barfield, 1995). Based on this premise, objective measures used for measuring the sense of telepresence include postural responses, physiological measures and dual task measures (IJsselsteijn et al., 2000).

Specifically, some researchers have proposed that the automatic postural adjustments of users can be recorded via a magnetic tracking device to indicate their experience of telepresence. The use of postural responses for telepresence measurement is based on the premise that when users feel present in the mediated environment, they are likely to experience self-movement (Ohmi, 1998;Freeman et al., 2000).

With respect to physiological measures, some indicators, such as blood pressure, heart rate, muscle tension and skin conductance have been adopted (Schloerb, 1995;Riley et al., 2004). Within the behavioural realism paradigm, a user’s feeling of telepresence is detected when the results of these measures are similar to their physiological responses to the real environment (Wiederhold et al., 1997).

With dual task measures, researchers have assumed that the allocation of attentional resources plays a significant role in telepresence (Draper et al., 1998;Witmer and Singer, 1998). Thus, users are provided with two tasks: the primary task is in the mediated environment and the secondary task is in their physical surroundings. When they are having a feeling of telepresence, more attention is allocated to the primary task, and fewer attentional resources are left for the secondary task. Thus, signals to represent attentional resources allocated to the secondary task, such as secondary reaction times or the extent to which information is processed, are used to measure telepresence (Barfield and Weghorst, 1993).

These objective measures have been criticised because they lack sufficient evidence to be directly correlated with telepresence (Prothero et al., 1995;IJsselsteijn et al., 2000). Sheridan (1992) argued that ‘telepresence is a subjective sensation, much like mental workload, and it is a mental model—it is not so amenable to objective definition and measurement’ (p. 209). It has been suggested that more extensive studies are needed to investigate correlations between these measures and telepresence to provide a more reliable objective measurement (Riley et al., 2004;Aracil et al., 2007;Biocca, 2015). Thus, currently, objective measures can only corroborate subjective measures of telepresence to some extent.

2.2.1.4.2 Subjective Measurement of Telepresence

As telepresence is primarily a user’s subjective feeling, subjective methods have been widely accepted and adopted in most relevant studies to measure telepresence (Suh and Chang, 2006;Mollen and Wilson, 2010;Nah et al., 2011;Pelet et al., 2017), and have been regarded as the essential basic measurement (Sheridan, 1992). Thus, post-test questionnaires and rating scales have been developed to measure telepresence as it has been suggested that post-test self-reports of telepresence experience ‘do not disrupt the media experience and are easy to administer’ (IJsselsteijn et al., 2000, p.522). Commonly accepted questionnaires regarding telepresence are summarised in Table 2-3. It is notable that as discussed in Section 2.2.1.2, some alternative terms exist in the literature so the review of telepresence studies was not limited to the term telepresence. Further, to ensure the reviewed questionnaires are focused on telepresence rather than similar concepts, such as presence, and with a broader meaning, definitions of the construct in each study were also checked and these are included in Table 2-3.

Reviewing studies using prominent telepresence questionnaires facilitates an understanding of the conceptualisation and interpretation of the telepresence concept. For instance, Slater et al. (1994) required respondents to answer several questions after exposing them to a virtual environment, based on the ‘transportation’ nature of telepresence. Considering that telepresence is a uni-dimensional concept, three themes were used to represent this dimension with an emphasis on transportation: first, the users feel they are there; second, the extent to which the virtual environment becomes the dominant reality for the users; third, the users regard the virtual environment as a ‘place’ they had visited rather than just a set of images. Finally, six questions form the SUS

Questionnaire, which is one of the most widely used short questionnaires for measuring telepresence experience (Schuemie et al., 2001). Kim and Biocca (1997) constructed a questionnaire with eight items, based on two dimensions they proposed to specify the ‘transportation’ nature of telepresence: *departure*, which refers to the feeling of not being present at the physical surrounding; and *arrival*, which indicates the feeling of being in the mediated environment. Schubert et al., 2001) developed their IPQ based on the literature, which generated a 75-item questionnaire. Responses to the questionnaires were obtained from 246 participants and according to the results of factor analysis, eight factors were identified, three of which were concerned with the telepresence concept and five of which were regarded as immersion-related factors. The three telepresence factors are *spatial presence*, which refers to the relationship between the virtual environment as a space and the users; *involvement*, which is the users’ awareness devoted to the virtual environment; and *judgement of reality*, which refers to the sense of reality attributed to the virtual environment. Different from the above telepresence questionnaires, which were based on an understanding of the telepresence concept itself. Witmer et al. (2005) developed the ITQ based on their theory of immersion and involvement (Witmer and Singer, 1998). In this questionnaire, they selected four major categories of telepresence determinants to measure telepresence: *control factors* (the amount of control the user had in the virtual environment); *sensory factors* (the quality, number, and consistency of sensory displays); *distraction factors* (the extent of distraction by the physical surroundings); and *realism factors* (the degree of realism of the virtual environment).

Some telepresence questionnaires have a large number of items. For example, Lessiter et al. (2001) proposed the Sense of Presence Inventory (SOPI) to measure telepresence via 44 items that were argued to be applicable to all media contexts. Vorderer et al. (2004) developed the Spatial Presence Questionnaire (SPQ) with 103 items to measure telepresence in the context of virtual environments. This type of measurement has been used in studies focusing on the telepresence construct, especially those utilising laboratory experiment approach to achieve their research goals (Baus and Bouchard, 2017). However, for reasons of simplicity and convenience, most telepresence studies have measured the construct in their research model by selecting several items from the existing questionnaires rather than directly adopting all their items (e.g., Venkatesh and Johnson, 2002;Fiore et al., 2005;Song et al., 2007;Campbell et al., 2010;Guo et al., 2015;Kim and Hyun, 2016;Ho et al., 2017).

The literature review on telepresence measurement shows that there are several major components to objectively or subjectively reporting sensations of telepresence. This information facilitates further explication of the concept of telepresence by discussing what happens to users and what users perceive during the experience of telepresence. With a better understood the concept of telepresence, the importance of this construct is discussed in the following subsection to explain why researchers and practitioners regard it as a core construct in their studies and design.

2.2.2 The Importance of the Telepresence Construct

The concept of telepresence was explicated in previous sections. According to the literature, researchers argue that this construct is an important indicator of evaluating user experience in all media (Shih, 1998;Klein, 2003;Qiu and Benbasat, 2005) and have commonly adopted telepresence in various contexts (Keng and Lin, 2006;Kwon and Wen, 2010;Kim and Hyun, 2016). The emphasis on the construct of telepresence in the literature is mainly derived from the consequences of the construct in different contexts (Keng and Lin, 2006;Haans and Ijsselsteijn, 2012;Faiola et al., 2013). Table 2-4 summarises the telepresence consequences identified in previous studies.

Table 2-3: A summary of telepresence questionnaires

Author	Questionnaire Name	Context	Term/Definition of Telepresence	Method	Factors	Items
Slater et al. (1994)	Steed-Usoh-Slater (SUS) Questionnaire	Immersive virtual environments/ VR	Presence: the subject's sense of 'being there'	Experiment	Uni-dimensional (transportation)	6
Kim and Biocca (1997)	-	Television	Telepresence: the sense of being transported to a mediated environment	Experiment	-Arrival -Departure	8
Barfield et al. (1998)	Presence & Realism Questionnaire (PRQ)	Virtual environment	Presence: the participant's feeling or sense of 'being there' in the virtual environment	Experiment	-Sense of spatial presence -Engagement of senses -Perceived fidelity of the interaction between the user and the virtual environment	18
Witmer and Singer (1998)	Presence Questionnaire (PQ)	Mediated environment	Presence: the subjective experience of being in one place or environment, even when one is physically situated in another	Survey	-Labelled involvement -Adaptation/immersion -Sensory fidelity -Interaction quality	32
Lombard et al. (2000)	Temple Presence Inventory (TPI)	Mediated environment	Telepresence/presence: a perception of users in a different location via feedback systems that allow them to 'see and feel what is happening' there	Survey	-Spatial presence -Para-social interaction -Passive interpersonal presence -Active interpersonal	42

Author	Questionnaire Name	Context	Term/Definition of Telepresence	Method	Factors	Items
					-Engagement -Social richness -Social realism -Perceptual realism	
Biocca et al. (2001b)	-	Virtual environment	Presence: illusion of presence in virtual environments	Experiment	-Spatial presence -Tactile engagement -Sensory presence	18
Schubert et al. (2001)	Igroup Presence Questionnaire (IPQ)	Virtual environment	Presence: a sense of being in the virtual environment	Survey	-Spatial presence -Involvement -Judgement of reality	14
Lessiter et al. (2001)	ITC Sense of Presence Inventory (ITC-SOPI)	Mediated environment	Presence: a user's subjective sensation of 'being there' in a scene depicted by a medium	Survey	-Sense of physical space -Engagement -Ecological validity -Negative effects	44
Vorderer et al. (2004)	Means–end Chain Spatial Presence Questionnaire (MEC-SPQ)	Virtual environment	Spatial presence: a sense of 'being there' in the virtual environment	Survey	-Process factors (attention allocation, spatial situation model, spatial presence) -Spatial presence-related factors (self-location and possible actions) -States-and-actions-related factors (cognitive	103

Author	Questionnaire Name	Context	Term/Definition of Telepresence	Method	Factors	Items
					involvement and suspension of disbelief) -User-related factors (domain specific interest, visual spatial imagery, and absorption)	
Witmer et al. (2005)	Immersion Tendency Questionnaire (ITQ)	Mediated environment	Presence: psychological state of 'being there' mediated by an environment that engages our senses, captures our attention, and fosters our active involvement	Survey	-Control factors -Sensory factors -Distraction factors -Realism factors	32

Table 2-4: A summary of telepresence consequences

Author	Context	Method	Telepresence Consequence
Sheridan (1992)	Virtual environment	Conceptual	Training efficiency Task performance
Muhlbach et al. (1995)	Videoconferencing technology	Experiment	Satisfaction Acceptance
Kim and Biocca (1997)	Television	Experiment	Memory Persuasion
Witmer and Singer (1998)	Virtual environment	Experiment	Learning Performance
Shih (1998)	Cyberspace	Conceptual	Immersion Time spent Positive affective feelings Probability of repeat visits
Lombard and Snyder-Duch (2001)	Interactive digital media	Conceptual	Enjoyment Persuasion Primary goals of advertising
Venkatesh and Johnson (2002)	Telecommuting systems	Survey	Extrinsic motivation Intrinsic motivation System usage
Fiore et al. (2005)	Retailing website	Experiment	Experiential value Instrumental value Attitude towards the online retailer Willingness to purchase from the online retailer Willingness to patronise the online retailer
Qiu and Benbasat (2005)	Retailing website	Experiment	Perceived usefulness Attitudes towards a website Intention to revisit
Suh and Lee (2005)	VR	Experiment	Knowledge Attitude Purchase intention
Keng and Lin (2006)	Advertising website	Experiment	Recall Recognition
Suh and Chang (2006)	VR	Experiment	Product knowledge Attitudes

Author	Context	Method	Telepresence Consequence
			Purchase intention
Song et al. (2007)	Retailing website	Survey	Fantasy Shopping enjoyment Willingness to purchase Willingness to patronise
Phang and Kankanhalli (2009)	VWs	Survey	Social norm Concentration Enjoyment Learning outcome
Kwon and Wen (2010)	Social network service	Online survey	Perceived ease of use Perceived encouragement
Zaman et al. (2010)	Instant messaging technology	Online survey	Flow Positive affect Exploratory behaviour Perceived expected creativity
Nah et al. (2011)	VWs	Experiment	Enjoyment Brand equity Behavioural intention
Ning Shen and Khalifa (2012)	Retailing website	Experiment	Arousal Pleasure Buying impulse Impulse buying
Kim (2015)	Social commerce site	Survey	Usefulness Enjoyment Participation intention
Peng and Ke (2015)	3D VWs	Experiment	Perceived authenticity Perceived trustworthiness Purchase intention
Cho et al. (2015)	3D VWs	Experiment	Situational interest Perceived achievement
Choi et al. (2016)	Marketing website	Online survey	Utilitarian performance Hedonic performance
Makowski et al. (2017)	2D/3D movie	Online survey	Factual memory
Ho et al. (2017)	Exergames	Survey	Game enjoyment Mood experience Attitude towards exergaming Performance for future gameplay

As a key way to understand the user experience ranging from traditional media to the ultra-realistic simulated environment (Kim and Biocca, 1997;Kaber et al., 2000;Nelson et al., 2006), telepresence has different effects in various contexts. According to Table 2-4, the consequences of telepresence can be classified into four main areas: memory, persuasion, emotional responses and task performance.

2.2.2.1 The Effects of Telepresence on Memory

Researchers have argued that telepresence can improve users' memory for mediated content (Kim, 1996;Ditton, 1997). For instance, in Kim and Biocca's (1997) study on the infomercial on television, they found a significant correlation between telepresence and factual memory: as the degree of telepresence perceived by the viewer increases, the amount of information from the television processed by the viewer also increases, which consequently influences the viewer's memory (Gerrig, 1993;Kim and Biocca, 1997). Similarly, Li et al. (2002) conducted a study on 3D advertising and found that telepresence has an influence on information processing in that it can affect the process by which the user perceives and memorises product knowledge. They concluded that telepresence can affect memory by influencing how comprehensively users learn about products from the perspective of consumer learning. Other researchers have also demonstrated the influence of telepresence on memory-related constructs, such as user learning, product knowledge, factual memory, subject recall and recognition (Witmer and Singer, 1998;Keng and Lin, 2006;Suh and Chang, 2006;Makowski et al., 2017). One prominent explanation for the relationship between telepresence and memory refers to the direct/indirect experience contained in the meaning of telepresence (Nelson et al., 2006). Based on Lombard's (1995) definition, telepresence indicates the perception of a relatively direct experience through a medium, which means users who feel present in a mediated environment perceive their experience as first-hand and direct. Further, Kempf and Smith (1998) claimed that direct experiences that involve multiple sensory channels and provide users with multiple stimuli can increase users' memory. Many researchers have supported the argument that the direct experience leads to better memory than dose the indirect experience (Fazio and Zanna, 1981;Mooy and Robben, 2002;Makowski et al., 2017). Telepresence has been considered to indicate a simulation of direct experience whereby users perceive that the virtual environment can provide the necessary cognitive and sensory input equivalent to that of the more concrete real environment, which influences users' memory for the input information (Fiore et al., 2005). In other words, the higher the degree of telepresence, the more real the user's experience seems to be, which then generates a more cognitive elaboration of the content associated with memory.

2.2.2.2 The Effects of Telepresence on Persuasion

Another important influence of telepresence is related to users' intentions and behaviours. For example, Kim and Biocca (1997) identified that telepresence has persuasive effects on users in the context of advertising via television by showing that participants reporting higher telepresence expressed more confidence in their brand selection. Similarly, Klein's (2003) study demonstrated a persuasive influence of telepresence on consumers' beliefs and attitudes towards unfamiliar brands in a computer-mediated environment. Thus, studies on telepresence have confirmed a positive relationship between telepresence and persuasion in a variety of contexts (Grigorovici and Constantin, 2004;Nelson et al., 2006). Similar to the influence of telepresence on memory, support for the persuasive effects of telepresence can be derived from research on how direct experiences influence persuasion (Fazio and Zanna, 1981;Millar and Millar, 1996). Such studies have found that direct, first-hand experience gives the user a chance to develop an attitude about the experience and to hold that attitude with greater confidence based on their experience (Kim and Biocca, 1997). Compared to indirect experience, beliefs and attitudes formed from direct experience are much stronger and more persistent (Mao and Palvia, 2008). When a user experiences telepresence, it is assumed that they are more likely to consider their experience in the mediated environment as first-hand or direct (Lombard, 1995). Accordingly, as with direct experience, the sense of telepresence is expected to have persuasive effects on users (Klein, 2003). Thus, the higher the telepresence, the more real the experience of the mediated environment will seem, which leads to users' higher intensity of beliefs, attitudes and confidence.

2.2.2.3 The Effects of Telepresence on Emotional Responses

It has been argued that telepresence also has effects on emotional response and that a mediated experience with high telepresence can evoke similar emotions to a real experience (Schuemie et al., 2001;Lee, 2004b). For instance, Barfield and Weghorst (1993) developed a conceptual model for investigating telepresence in the virtual environment and observed a relationship between telepresence and enjoyment. Similarly, in Heeter's (1995) study on a VR entertainment system, respondents who had a sense of telepresence reported significantly greater enjoyment. In addition to positive emotional responses, studies have found that telepresence can also lead to negative emotions according to the particular context (Slater, 1999;Schuemie et al., 2000). For instance, Regenbrecht et al. (1998) investigated the relationship between telepresence and fear of height in a virtual environment and found that telepresence is the best predictor of fear in this context. North et al. (1998) studied the treatment of phobias and reported a relationship between telepresence and fear of public speaking by illustrating that telepresence tended to amplify participants' emotional responses. Thus, unlike the similar concept of flow—which is regarded as an optimal state always leading to positive emotions (Csikszentmihalyi, 1988;Csikszentmihalyi and Csikzentmihaly, 1991)—with respect to telepresence, some researchers argue that whether the produced emotion is positive or negative is mainly determined by the simulated environment; telepresence only influences the degree of this emotional experience (Schuemie et al., 2000). However, other researchers support that the feeling of telepresence itself to some extent has already satisfied users' needs during the process of using the media, which elicits positive emotions such as enjoyment and pleasure, and consequent responses such as positive evaluation of the media and the experience (Zaman et al., 2010;Nah et al., 2011;Ho et al., 2017).

2.2.2.4 The Effects of Telepresence on Task Performance

Studies have also found that a media that can evoke a high degree of telepresence and facilitate completion of tasks in a more effective and efficient way (Thornson et al., 2009). Telepresence has been considered an important construct to predict task performance, especially human information processing and its subsequent performance (Biocca, 1997;Lombard and Ditton, 1997). For instance, Witmer and Singer (1998) argued that users in a virtual environment who experience a strong sense of telepresence do better on the task via media. Welch (1999) explained the relationship between telepresence and task performance by illustrating that telepresence means that the virtual environment seems more like the real world to users, as they are familiar with it and thus work more efficiently on the task. Kaber et al. (2000) conducted an experiment through a VR interface and confirmed a positive relationship between telepresence and users' performance via teleoperators. Generally, the influence of telepresence on task performance indicates that the increased telepresence in a mediated environment can lead to more meaningful understanding and more active participation: as Witmer and Singer

(1998) stated in their study ‘it would be very surprising indeed if positive relationships between (tele)presence and performance were not found’ (p. 238).

The consequences of telepresence for the various features discussed above indicate that it is a significant construct for studying the user experience in various mediated environments. Cultivating this feeling enhances the possibility of great performance and success of the media (Riva, 2007). Thus, for many types of media, designers have established telepresence as a major goal to achieve (Mollen and Wilson, 2010;Kim and Hyun, 2016).

2.2.3 Summary

This section was mainly focused on investigating the concept of telepresence as the core construct of the current study. First, the understanding of the telepresence concept is gradually deepened by summarising its definitions and terminology, comparing it with similar concepts and investigating its measurement. Additionally, the consequences of telepresence were discussed to illustrate the importance of this construct and to explain why telepresence is regarded in the literature as the core construct for studying user experience. With a better understanding of the core construct having been established, the following section reviews the literature related to the context of the current study, that is, VWs.

2.3 Understanding the Context of Virtual Worlds

The previous section provided a thorough explanation of the core construct of the current study—the telepresence concept. This section focuses on understanding the research context, which is VWs. It begins with definitions of VWs to briefly introduce the context, which is followed by a summary of common characteristics to further depict it. The current applications and significance of VWs are then illustrated. Finally, the literature on this context is summarised to establish the research focus and trends in this context.

2.3.1 The Definitions and Common Characteristics of Virtual Worlds

VWs are broadly defined as computer-based simulated environments incorporating various representations of real-world elements, which extend our daily life from offline to online (Jarvenpaa et al., 2008). With the rapid development of information technology (IT) and the popularity of high-speed Internet access, VWs have experienced a dramatic evolution (Dionisio and Gilbert, 2013) and are expected to become more widely adopted (Davis et al., 2009). VWs are considered as one of the most promising emerging technological breakthroughs and have received considerable attention, which causes individuals to increasingly participate in these simulated environments (Bainbridge, 2007). As applied to diverse aspects of daily life, different VWs have distinct forms and features. Thus, there is no uniformly accepted definition for the term VWs: different researchers have provided different definitions of VWs according to the context (see Table 2-5). The table illustrates that some common features are shared among the descriptions. Thus, a further review is conducted to investigate the features summarised from prior studies in various contexts (see Table 2-6).

To identify common characteristics of VWs for further description of this context, the features of VWs discussed in studies with different contexts are synthesised as follows to depict VWs in a relatively broad sense.

2.3.1.1 Simulated Environment

With the aim of duplicating our daily lives from offline to online, VWs are always described using the term ‘simulated’, indicating that VWs aim to simulate the real world to achieve that goal. A simulated environment is designed to be similar to the real physical world and the location of a user within the simulated environment is often described as ‘being in the world’.

Table 2-5: A summary of selected definitions of virtual worlds

Authors	Context	Definition
Phillips and Rodden (2001)	E-collaboration	A virtual environment where users can interact with objects and other users
Dickey (2005b)	E-learning	‘A networked desktop virtual reality in which users move and interact in simulated 3D spaces’
Bainbridge (2007)	General	‘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’ (p. 472)
Jarvenpaa et al. (2008)	General	Computer-based simulated environments incorporating various representations of real-world elements, which extend our daily life from offline to online

Bell (2008)	General	Persistent online computer-generated environments where people in remote physical locations, represented as avatars, can interact simultaneously within the network-based simulated environments
Castronova et al. (2009)	E-commerce	Computer-generated physical spaces, represented graphically in 3D that can be experienced by many users
Kaplan and Haenlein (2010)	Social media	‘Computer-based simulated environments inhabited by three-dimensional avatars’ (p. 60)
Bosch-Sijtsema and Sivunen (2013)	E-collaboration	3D digital space where multiple users can navigate, manipulate virtual objects and interact with others
Merchant et al. (2014)	E-learning	Virtual environments that provide the illusion of being in a virtual space in which digital representation of users can interact with the virtual objects and/or other users
Antonio et al. (2016)	E-learning	Immersive environments that offer resources to simulate real environments and provide high interactivity

Table 2-6: A summary of selected studies on the features of virtual worlds

Authors	Context	Features	Explanation
Whitelock et al. (1996)	E-learning	Representational fidelity	Can be subdivided into technical fidelity (the degree to which the technology delivers realistic renderings, colours, textures, motion, etc.), representational familiarity (the extent to which the simulated environment is familiar to users) and representational reality (the extent to which the world is possible)
		Immediacy of control	Refers to the human–computer interaction and response in a VW
		Presence	Refers to telepresence where VWs offer an awareness of space found in real-life spaces giving a sense of being there
Brna (1999)	E-learning	Representational fidelity	As above
		Immediacy of control	As above
		Presence	As above
		Social fidelity	Can be subdivided into social familiarity (the extent to which the simulated social environment is familiar to user) and social reality (the extent to which the social world is believable)
		Immediacy of discourse	Refers to human–human communication in a VW
		Social presence	Refers to an awareness of co-existence of other participants found in real-life spaces giving a sense of being together with others
Book (2004)	Online gaming	Shared space	Allows multiple users to participate at the same time
		Graphic user interface	Depicts space visually, ranging in style from 2D cartoon imagery to more immersive 3D environments

Authors	Context	Features	Explanation
		Immediacy	Refers to the interaction that occurs in real time in a VW
		Interactivity	Allows interaction and communication among users as well as between users and the environment by altering, developing, building or submitting user-generated content
		Persistence	Indicates that the existence continues regardless of whether individual users are logged in
Dickey (2005a)	E-learning	Illusion of 3D space	Refers to a 3D graphical interface
		Avatars	Indicates that the avatars serve not only as the visual representation of a user, but also the viewpoint into the 3D environment
		Interactive chat environment	Indicates human–human communication and interaction in a VW
Bell (2008)		Synchronous	Refers to the interaction as synchronous
		Persistent	Indicates that the user has a sense that the VW continues to exist and function without their participation
		Network of people	Indicates that a VW can be regarded as an ecosystem in which users interact with the environment
		Represented as avatars	Indicates that avatars can be shown in diverse forms to interact with the environment
		Facilitated by networked computers	Indicates that networked computers allow the scale of VWs to expand past horizons of imagination; that people can have the experience without physically being there
Gilbert (2011)		3D	Refers to the 3D graphical interface and integrated audio for contemporary VWs

Authors	Context	Features	Explanation
		Massively multi-user remote interactivity	Refers to the simultaneous interactivity among multiple users in remote physical places
		Persistent	Indicates that the VW should continue to operate even when a personal user is not connected
		Immersive	Indicates that users in a VW have a sense of ‘being in’ the digital environment rather than being outside of it, thereby intensifying their psychological immersion
		User-generated activities	Indicates that an advanced VW should have user-created activities by providing in-world tools for content creation

2.3.1.2 Facilitation by Networked Computers

VWs are computer-generated environments; to allow them to be reached by users they are placed in a network of computers. Thus, a popular descriptor of this essential characteristic in the definitions of VWs is 'online', which indicates that users from different physical places can have a similar experience of some features of real life via a networked computer.

2.3.1.3 Real Time

The real-time characteristic of VWs means that actions and interactions of users are performed synchronously. It also emphasises that unlike simulations, in which many hours may pass in a matter of minutes, the actions in VWs occur according to the time constraints in the real world to make the virtual environment as similar as possible to the real one.

2.3.1.4 Interactivity

VWs allow manipulation and navigation. Manipulation refers to modification of the virtual environment in a direct way. Navigation refers to functions to perceive and/or change the location in the virtual environment. In VWs, users interact with the environment and the objects in it in real time; they have the support and freedom to interact naturally as they would in the real world. For instance, when viewing an object in a VW, the user can virtually move the object to look at its back; just as such an interaction would occur in the real world.

2.3.1.5 Avatars

Avatars in VWs provide representations of users within the virtual environment and can be used to interact with the environment. The forms of avatars are various: they can be viewpoints, text-descripted figures or 2D/3D graphic figures.

2.3.1.5 Immersion

The virtual environment created by VWs is perceived and interacted with from a single locus of the user, which is impossible to partially control from the outside. Thus, when users interact in the virtual environment, they perceive information and take actions from their own perspective, which enables them to be immersed in the virtual environment to some degree.

Considering definitions of VWs within different contexts as well as the highlighted common characteristics shared by various VWs, VWs can be interpreted as computer-generated virtual environments aiming to simulate the real world. Users, represented by avatars, can interact synchronously in created virtual environments and this allows them to move their daily life from offline to online. Thus, this definition synthesises the fundamental features of VWs and is used throughout this thesis to provide a broader and more specific understanding of the research context.

2.3.2 Current Applications and the Significance of Virtual Worlds

VWs create diverse types of virtual environments to simulate different features of the real world for people in different physical places to experience, which extends their daily life from offline to online (Bainbridge, 2007). By overcoming the geographical and temporal limitations of offline life, VWs have great potential to totally change the way people learn, work, play and do business (Warburton, 2009;Pearce et al., 2011;Reeves and Read, 2013). Thus, the significance of VWs is reflected in the contexts in which they have been applied, which are discussed below.

2.3.2.1 Education

VWs are considered as one of the most useful tools in online learning (Baker et al., 2009). As learning is generally classified into two types—formal learning and information learning—VWs benefit both by presenting them from offline to online. Formal learning is defined as learning in an 'institutionalized, chronologically graded and hierarchically structured educational system' (Coombs and Ahmed, 1974, p.8), which includes classroom instruction and workshops. The offline way of this type of learning requires students and teachers to be in the same physical classroom, VWs overcome regional barriers by gathering together students and teachers from different physical places in the same created VW, which provides students with a sense of being in a virtual classroom and engages them with learning (Childress and Braswell, 2006). Thus, for formal learning, VWs have been used to make the whole educational process more convenient for both students and teachers, especially those living in remote districts or who are disabled and cannot join a physical classroom (Harris and Rea, 2009). Moreover, as VWs are simulated environments, it is more cost effective to use VWs to simulate projects and training; thus, teaching faculties can make substantial savings with respect to purchasing experimental instruments and hiring of trainers but can still offer similar or even better learning opportunities to students (Bainbridge, 2007).

Figure 2-4: An example of the application of virtual worlds in formal learning

Source: Nguyen (2014)

Informal learning is interpreted as any learning that is not formal learning; it is learning from experience or daily life activities involving work, family or leisure (Colardyn and Bjornavold, 2004). Informal learning is acknowledged as an essential element of education for learners at all ages (Malcolm et al., 2003). It has been argued that compared to formal learning, informal learning usually occurs in places outside of schools, such as museums and exhibition centres (Chen et al., 2012). There is a growing trend for the ‘informal consumption, creation, communication and sharing of knowledge’ via information technologies, which enables users to learn from their virtual experiences at home (Selwyn, 2007). Specifically, VWs, as one product of information technologies, provide diverse virtual experiences to learners in remote physical places through a network of computers by simulating corresponding parts of experiences from the real world (Faiola et al., 2013). Thus, the learning process is based on the experience of VWs—the more authentic are the VWs presented, the more real the experiences are perceived by learners and the better the learning outcomes expected.

Figure 2-5: An example of the applications of virtual worlds in informal learning

Source: Romey (2015)

2.3.2.2 Collaboration

Based on the identification of common characteristics of VWs in Section 2.3.1, VWs are facilitated by networked computers, which can provide real-time interactions with both the created virtual environment and others in remote places (Novak et al., 2014). Thus, VWs can build a shared working platform for employees in different physical places to collaborate and co-create for completing actual tasks (Kohler et al., 2011). VWs, especially these with built-in functions for users to create virtual objects, facilitate joint product development activities in which employees can design and revise a virtual representation of the product in the same virtual place to simplify the design process and to increase work efficiency (Prahalad and Ramaswamy, 2004;Ondrejka, 2007). Such a work place in VWs is capable of psychologically bonding employees in distant places by making them feel like they are together in the same place, which has been proved to increase employees' engagement with the work and consequent work performance (Reeves and Read, 2009).

Figure 2-6: An example of the applications of virtual worlds in collaboration

Source: AIAInstitue (2011)

2.3.2.3 Entertainment

VWs applied to entertainment are more likely to highlight the experiential nature of virtual environments that provide simulated virtual experiences of specific offline activities for pleasure and delight (Dunstan et al., 2006). This application requires adoption of the most cutting-edge technologies, such as VR and augmented reality (AR), in VWs to provide multiple sensory stimulation to users as the virtual experience is the only means to entertain them (Shin, 2009). By utilising VWs, users can experience diverse kinds of entertainment activities even though they are staying indoors to save money and energy, which makes pleasure and relaxation easier to achieve than ever before.

Figure 2-7: An example of the applications of virtual worlds in entertainment

Source: CEEKAR (2014)

2.3.2.4 Business

The potential of VWs as a commercial and marketing tool is extremely attractive and compelling; they provide an innovative mode for business (Nah et al., 2011). Unlike ordinary e-commerce modes, VWs create a new way for customers to be immersed in created shopping environments to experience products just as they do in the real world (Demirkan and Spohrer, 2014). Innovations by VWs in business are expected to totally revolutionise the current situation of both online and offline business. Compared with traditional online e-commerce platforms, VWs improve users' product experience and shopping experience by providing a more realistic and thorough user experience, which enhances customers' evaluation of a product and purchase intention (Barnes and Mattsson, 2008;Park et al., 2008). Further, VWs address geographical and temporal constraints by providing an offline shopping mall in which customers can conveniently have a similar shopping experience as in a physical mall (Dawson et al., 2010). With its potential to supplement and/or replace offline business, the existence and further development of VWs for business purposes is also expected to dramatically influence offline business.

Figure 2-8: An example of the applications of virtual worlds in business

Source: Graziani (2016)

According to the above discussion of the applications of VWs, they have been gradually changing individual daily life by transferring various aspects of life from offline to online. The real world provides abundant sources to be simulated by VWs, which in turn change the real world by offering information and experience to users (McGonigal, 2016). For instance, some users can experience education in VWs and that knowledge transfers to the real world and is applied in real life. Some users might be interested in the places they virtually visit in VWs and be motivated to physically travel to these places for further exploration. By providing a more realistic user experience, VWs blur the boundary between people’s offline and online lives, which is expected to completely alter the way people learn, work, play and do business (Dionisio et al., 2013).

2.3.3 Research Significance and Current Study Trends in Virtual Worlds

The previous subsection investigated the practical significance of VWs based on various applications and this subsection focuses on the research significance of VWs and the literature in this context. From an academic perspective, VWs are a relatively novel research context for researchers to test theories from the real world or to develop new theories in created virtual environments (Schlosser, 2003). Specifically, as a relatively innovative type of IS that is distinctive from existing others, the question of whether conclusions from other contexts are applicable to this new context raises has attracted the interest and attention of researchers (Levinson and Christensen, 2003). Further, as VWs provide innovative ways for people to learn, work, play and do business, how people behave and respond in VWs is extremely valuable for providing novel insights into user psychology and behaviour studies and may lead to new findings in this context (Castronova et al., 2009;Harris and Rea, 2009). Additionally, VWs introduce an innovative way to conduct research, especially experimental studies (Winsberg, 2003). This is due to the simulated nature of VWs where the virtual environments created are as close as possible to the real world, which facilitates observation of user behaviours (Fiedler et al., 2011). In that sense, VWs are not only a tool to deliver information for teaching and training but also a way to conduct experiments in virtual labs for creation and innovation that can recruit a large number of participants in various areas and at lower cost (Bainbridge, 2007).

Specifically in the IS discipline, there has been a recent growing interest in VWs, according both practical and academic significance to this context (Schultze and Orlikowski, 2010). Many top-ranked IS journals have published special issues dedicated to topics within the specific context of VWs. For instance, *Management Information Systems Quarterly* (MISQ) published a special issue on VWs in 2011 and *Journal of the Association for Information Systems* (JAIS) published one in 2012. IS researchers have emphasised the opportunities provided by VWs for conducting IS-related studies (Bray and Konsynski, 2007;Hansen et al., 2008;Ives and Junglas, 2008) and have suggested research agendas for understanding the novel capabilities of VWs (Mennecke et al., 2008;Davis et al., 2009;Messinger et al., 2009).

On this basis, a literature review is conducted to investigate the most current studies in top-ranked IS journals (see Table 2-7). Based on this investigation, there are three main current study trends on VWs in the IS discipline: (1) studies focusing on the design and development of VWs (Chaturvedi et al., 2011;Roquilly, 2011;Suh et al., 2011;Junglas et al., 2013;Zahedi et al., 2016); (2) studies investigating the effects of VWs from various perspectives (Animesh et al., 2011;Nah et al., 2011;Venkatesh and Windeler, 2012;Yang et al., 2012;Ketter et al., 2016); and (3) studies testing or exploring related research topics/theories developed in the real world (Berente et al., 2011;Roquilly, 2011;Nardon and Aten, 2012;Chesney et al., 2014;Zhou et al., 2015).

Table 2-7: A summary of selected studies on virtual worlds in the information systems literature

Authors	Context	Focus	Theory	Method	Conclusion	Contribution
Schultze et al. (2008) (CAIS)	A combined context of online learning, online working and online playing	Extension of applications for VWs	-	Conceptual	VWs have blurred the boundaries between work and play and between virtuality and reality	Highlighting the importance of VWs and proposing future resolutions to address issues on learning, working and playing in VWs
Davis et al. (2009) (JAIS)	General	Conceptual model for VW research	-	Conceptual	Develops a conceptual model for research in VWs on five key constructs: VWs themselves; people/avatars; technology capabilities; behaviours; and outcomes	Guiding future studies
Schultze and Orlikowski (2010) (ISR)	General	Research commentary	-	Conceptual	The authors propose that a performative perspective may be particularly useful to develop new theories and new methods in VW research	Advising new perspective for future studies
Chaturvedi et al. (2011) (MISQ)	General	Proposed design principles for VWs	IS design theory	Conceptual	VWs comprise a new class of IS whose design requires a combination of analytical, empirical and computational approaches	Extending the design science paradigm by developing a set of design principles applicable to VWs

Authors	Context	Focus	Theory	Method	Conclusion	Contribution
Wasko et al. (2011) (MISQ)	General	Updated introduction of the current situation of VWs	-	Conceptual	There is a requirement to explore the promise, potential and problems associated with VWs to make theories and research reflect the emerging reality of contemporary organisations and societies	Emphasising significance and providing future directions for VW research
Kohler et al. (2011) (MISQ)	Online collaboration	Design of co-creation systems in VWs	-	Action research	Creates a co-creation system that fits the VW context	Providing future designers and researchers a useful framework to leverage VWs for co-creation
Nah et al. (2011) (MISQ)	Online marketing	Comparison of 2D and 3D VWs for enhancing brand equity	Flow theory; brand equity theory	Experiment	Although the 3D VW environment has the potential to increase brand equity by offering an immersive and enjoyable virtual product experience, the rich environment can also be a distraction	Providing a theoretical foundation for explaining users' experience with 2D *v*. 3D VW branding sites and providing insights to practitioners for designing 3D VW sites to enhance brand equity and intentions through user engagement
Animesh et al. (2011) (MISQ)	Online shopping	Dynamics that govern the purchase of	Stimulus-organism-	Web-based survey	The technological and spatial environments in VWs influence participants'	Recognising the need to integrate technological

Authors	Context	Focus	Theory	Method	Conclusion	Contribution
		virtual goods in VWs	response (S-O-R) model		virtual experiences and consequently affects their responses	and non-technological aspects of VW research
Suh et al. (2011) (MISQ)	General	Avatars	-	Experiment	The more closely an avatar assembles its user, the more likely the user is to have positive attitudes towards the avatar, which consequently positively influences their intentions to use the avatar	Providing advice on avatar design in VWs and suggesting that utilisation of avatars may be a new business opportunity likely to thrive in VWs
Yang et al. (2012) (ISR)	E-business	Market value of VW business	Real options theory	Event study	The market positively reacts to VW initiatives with respect to four key characteristics: interpretive flexibility; divisibility; strategic importance; and exploitable absorptive capacity	One of the first studies to employ a real options perspective to examine the value of VWs for actual business
Venkatesh and Windeler (2012) (JAIS)	Online collaboration	Benefits of VWs for team collaboration	-	Comparative field study	Use of VWs positively influences technology use and team cohesion and performance	Laying an important foundation for discourse about the value of VWs for team collaboration

Authors	Context	Focus	Theory	Method	Conclusion	Contribution
Nardon and Aten (2012) (JAIS)	Online collaboration	Judgements on the value of VWs	-	Interpretive	An individual's assessment of a technology varies according to their interpretation and mental categorisation of the technology. There are three mental categories of interpretation of VWs: VWs as a medium; VWs as places; and VWs as an extension of reality	Contributing particularly to the acceptance of VWs but also more generally to the understanding of technology acceptance
Junglas et al. (2013) (JAIS)	General	Effects of sociability on technology acceptance of VWs	Technology acceptance theories	Survey	Sociability affects enjoyment, which predicts intentions to use VWs	Highlighting social components of the usage of VWs
Chesney et al. (2014) (CAIS)	Online community	Friendship in VWs	Theories of homophily, heterophily and propinquity	Experiment	There are three main determinants of friendship in VWs: the similarity of avatar appearance; the distance between avatars; and the talkativeness of avatars	Contributing to studies on interactions in VWs

Authors	Context	Focus	Theory	Method	Conclusion	Contribution
Zhou et al. (2015) (EJIS)	Online community	Effects of cultural values in VWs	-	Online survey	Indulgence weakens the effect of utilitarian value but strengthens the effect of hedonic value on affective commitment; individualism weakens the effect of rational capital on affective commitment and consequently on continuance intention	Providing valuable insights for VW design and research so that cultural differences can be considered
Ketter et al. (2016) (MISQ)	Online collaboration	Application of VWs to address societal challenges	-	Case study	It is evident of the efficacy of VWs for addressing societal challenges through the community's contributions	Highlighting the importance of VWs to collaboration for addressing societal challenges
Zahedi et al. (2016) (JMIS)	Online medical care	Application of VWs to build an augmented virtual doctor's office	Media naturalness theory and technology acceptance theories	Experiment	How design features influence outcomes and users' positive evaluations of the design and use of VWs	Providing guidelines for the design of VWs for online medical care
Nambisan et al. (2017) (MISQ)	General	Discussion of digital innovation	-	Conceptual	Suggestions for novel theorising on digital innovation management	Offering a foundation for reinventing innovation management research in VW

Compared to other types of IS, VWs are a relatively innovative context with the specific purpose of simulating the real world; thus, more effort is required to explore them. Considering the practical and theoretical significance of VWs as outlined above, studying them in context is expected to provide more valuable and meaningful insights. As the technologies employed in VWs are constantly advancing, VWs have great potential to extend their influence in people's daily lives, which also offers fruitful new research topics.

2.3.4 Summary

This section focused on the context of the current study; that is, VWs. First, VWs were depicted by reviewing their definitions and common characteristics. Then, the practical significance of VWs was presented by describing current applications of VWs. The research significance of this context was also discussed and current study trends on this context in the IS discipline were summarised. After understanding both the core construct and the context of the current study, the following section links the core construct with the context, supported by the literature.

2.4 Linking the Construct with the Context—Telepresence as a Solution for the Challenges of Virtual Worlds

Previous sections on the core construct of telepresence and the research context of VWs have provided a good understanding of these concepts. In this section, further investigation of relevant studies is made to link the construct with the context. Specifically, based on the literature review on the context of VWs, current challenges to design are discussed further. To address these challenges, the construct of telepresence is adopted as an effective solution, with respect to the fundamental features and the significance of the construct discussed at the beginning of this chapter.

According to the literature review in Section 2.3, VWs have great potential to transform our offline daily life to a more convenient online life. However, it has been argued that current VWs have not achieved their original design purpose of completely simulating the real world (Goel et al., 2013). Thus, many users have tried different applications of VWs for fun, regarding them as refreshing online experiences rather than seriously considering their practical use. This raises the issue of user participation and retention of

VWs (Dass and Dabbagh, 2016). Users have argued that although VWs overcome the regional limitations of the real world and have the potential to bring more convenience to daily life, this is at the cost of losing the benefits of realness (Zhang et al., 2014). Therefore, it has been suggested that the perceived realness of current VWs remains a critical challenge to the design and is expected to be a major direction for future improvements to VWs (Chaturvedi et al., 2011;Boellstorff, 2015;Freina et al., 2016). Although some cutting-edge technologies such as VR and AR recently have tentatively been adopted, the distinction between VWs and the real world is still seen as dramatically sharp (Mine et al., 2015;Peng and Tian, 2017). Without a proper solution to this challenge, the development of VWs may remain at a very elementary stage for a long time such that the various applications of VWs will not play a practical role to supplement and/or replace aspects of real life as expected (Ketter et al., 2016).

Regarding this challenge, the construct of telepresence has been utilised in research to describe the perception of the realism of a user's mediated experience, which reflects the distinction between the mediated world and the real world (Shih, 1998;Klein, 2003;Shin, 2006;Haans and Ijsselsteijn, 2012). It has been argued that telepresence depends on how accurately the computer-mediated experience simulates the real-world experience (Shih, 1998). Specifically, when the mediated environment feels as close as possible to the real environment, users consider elements such as objects and people in the mediated environment as real and unmediated, and react directly to the elements as if they are physically present in the mediated environment (Nah et al., 2011;Faiola et al., 2013). Thus, telepresence is regarded as a key indicator of how closely a mediated environment simulates the real world (Pelet et al., 2017). Specifically, in the current context, telepresence is appropriate for solving challenges with VWs. Moreover, as illustrated in Section 2.2.2, a mediated environment that can cultivate a higher degree of telepresence is more likely to produce positive outcomes in various ways based on consequences of the telepresence feeling. Schmeil et al. (2012) described an ideal VW focusing on the feeling of telepresence as providing:

> a space in which users can move freely, interact intuitively with all kinds of objects, recognize familiar people, and communicate in a natural manner with others—all in a realistic setting that evokes a feeling of really being in the virtual world (p. 837).

Therefore, the construct of telepresence not only addresses the challenges with VWs but ensures the success of VWs, which is one of the most appropriate and essential construct for this context.

Meanwhile, from the perspective of telepresence research, VWs are also an appropriate context to study for this construct. Compared to other types of IS, VWs place more emphasis on design with an inherent realistic nature, which is more likely to produce a feeling of telepresence. Studies have directly confirmed that one of the major design goals of VWs is to build a virtual environment that can cultivate a higher degree of telepresence (Slater et al., 1994;Jäkälä and Pekkola, 2007;Mennecke et al., 2008). Similarly, Kock (2008) stated that a VW should be designed to replicate elements of the real world with practical applications in mind and induce people to become immersed in it to experience the feeling of telepresence. Accordingly, VWs can provide abundant and valuable information as a context to study the telepresence construct, which is one of the most appropriate and essential contexts for studying this construct.

This section linked the core construct of telepresence with the context of VWs by outlining current challenges in the design of VWs and arguing that telepresence is the core solution to these challenges by showing that telepresence and VWs are appropriate for each other. To address challenges in adopting telepresence in VWs, the most relevant and practical consideration is what factors lead to telepresence. Information on telepresence antecedents is expected to feed into guidelines for the design of VWs and accordingly solve the discussed challenges. Thus, the following section presents a literature review specifically on understanding telepresence antecedents in various contexts.

2.5 Understanding Factors Leading to Telepresence

Acknowledging the importance of the telepresence construct for studying not only VWs but also other IS, it is essential to answer the question ‘What factors lead to telepresence?’ Understanding of telepresence antecedents facilitates cultivating telepresence, which leads to the positive outcomes brought by telepresence. Researchers and practitioners can benefit from information on telepresence antecedents to provide a better user experience and promote the success of relevant IS, especially for VWs. Thus, in this section, the studies on telepresence antecedents are reviewed. The investigation is not limited to the context of VWs; rather, to provide a comprehensive and thorough insight into the factors leading to telepresence, studies within various contexts are reviewed. Table 2-8 summarises telepresence antecedents in the literature within a variety of contexts.

Table 2-8: A summary of telepresence antecedents in selected studies

Author	**Context**	**Method**	**Telepresence Antecedents**
Steuer (1992)	VR	Conceptual	Vividness -breadth -depth Interactivity -speed -range -mapping
Sheridan (1992)	Virtual environment	Conceptual	Extent of sensory information Control of relation between sensors and environment Ability to modify environment
Muhlbach et al. (1995)	Videoconferencing technology	Experiment	Stereoscopy
Hoffman and Novak (1996)	Computer-mediated environment	Conceptual	Network navigation Vividness Interactivity Process characteristics Involvement Focused attention
Witmer and Singer (1998)	Virtual environment	Experiment	(Only conceptually proposed) Control factors Sensory factors Distraction Factors Realism factors
Shih (1998)	Cyberspace	Conceptual	Vividness Interactivity
Huang and Alessi (1999)	VR	Conceptual	User’s mental health conditions -depression -anxiety -psychotic disorders
Bystrom et al. (1999)	Virtual environment	Conceptual	Suspension of disbelief

Author	Context	Method	Telepresence Antecedents
IJsselsteijn et al. (2000)	VR	Conceptual	The extent and fidelity of sensory information The match between sensors and the display User characteristics Content factors
Coyle and Thorson (2001)	Marketing website	Experiment	Vividness Interactivity
Lombard and Snyder-Duch (2001)	Interactive digital media	Conceptual	Medium form variables Content variables User variables
Klein (2003)	Computer-mediated environment	Experiment	Media richness User control
Skadberg and Kimmel (2004)	Human–computer interaction	Survey	Attractiveness of website design Interactivity
Suh and Chang (2006)	VR	Experiment	User interfaces -multiple-picture -video-clip -VR
Nelson et al. (2006)	Computer game	Experiment	Game liking
Phang and Kankanhalli (2009)	VWs	Survey	3D realism
(Mollen and Wilson, 2010)	Virtual store	Conceptual	Operator environment Perceived interactivity
Campbell et al. (2010)	Advertising website	Experiment	Interactivity Involvement
Nah et al. (2011)	VWs	Experiment	2D/3D virtualisations
Haans and Ijsselsteijn (2012)	Virtual environment	Conceptual	Embodiment
Ning Shen and Khalifa (2012)	Retailing website	Experiment	Vividness Interactivity

Author	Context	Method	Telepresence Antecedents
Rodríguez-Ardura and Martínez-López (2014)	Digital media	Literature Review	Mental imagery
Ou et al. (2014)	Computer-mediated communication (CMC)	Longitudinal field study	Effective use of CMC tools
Kim (2015)	Social commerce site	Survey	Vividness
Peng and Ke (2015)	3D VWs	Experiment	Immersion
Cho et al. (2015)	3D VWs	Experiment	User’s age User’s epistemological beliefs
Kim and Hyun (2016)	AR	Survey	System quality Information quality
Choi et al. (2016)	Marketing website	Online survey	Informativeness Entertainment
Coxon et al. (2016)	VR	Experiment	Imagery
Liu and Uang (2016)	Virtual store	Experiment	Depth perception cues Visual display modes Cybersickness
Lim et al. (2017)	Television	Online survey	Loneliness Gratification shopping motivation
Makowski et al. (2017)	2D/3D movie	Online survey	Emotion experience
Baus and Bouchard (2017)	VR	Experiment	Odours
Stavropoulos et al. (2017)	Virtual environment	Longitudinal field study	Anxiety symptoms in real life Openness to experience

This subsection begins by introducing Steuer's (1992) classical model of telepresence antecedents, which has been broadly accepted and used in telepresence research. After highlighting the importance of Steuer's (1992) model in the telepresence literature, other possible factors leading to telepresence in the literature are summarised to provide a comprehensive understanding of telepresence antecedents.

2.5.1 Steuer's Classical Model of Telepresence Antecedents

The classical paper exploring the antecedents of telepresence is Steuer's (1992) conceptual study on defining VR, which has fundamentally influenced later studies (Klein, 2003;Mollen and Wilson, 2010). Steuer (1992) aimed to develop a new and variable-based definition of VR that can be employed to classify VR according to different media; the concept of telepresence was used as a key to the definition. In Steuer's study, telepresence was defined as 'the extent to which one feels present in the mediated environment, rather than in the unmediated physical environment' (p.78). Based on that, VR is defined as 'a real or simulated environment in which a perceiver experiences telepresence' (p.79). To further understand telepresence, Steuer conceptually identified two main technological constructs that contribute to telepresence: vividness and interactivity (see Figure 2-9). Vividness refers to 'the ability of a technology to produce a sensorial rich mediated environment' (p. 82) and interactivity refers to 'the degree to which users of a medium can influence the form or content of the mediated environment' (p. 83).

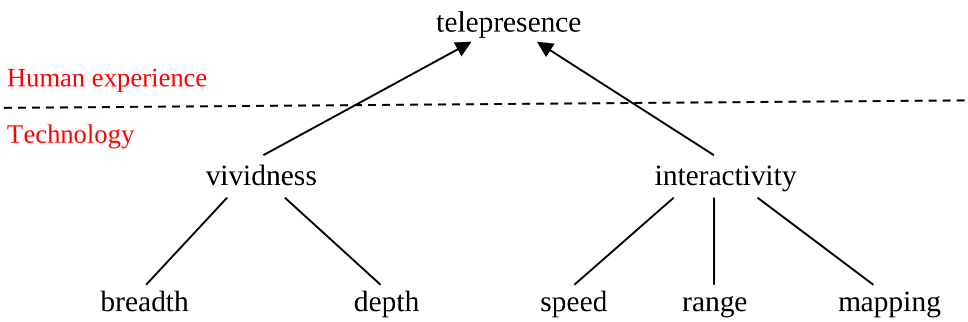

Figure 2-9: Steuer's (1992) classical model of telepresence antecedents

In Steuer's (1992) model, vividness, as the sensory richness of a mediated environment, mainly contains two dimensions: sensory breadth and depth. *Sensory breadth* indicates the number of different sensory channels that a medium utilises (Steuer, 1992), which refers to the ability of the medium to present information across senses: the basic orienting sense, the auditory sense, the visual sense, the touch sense and the taste–smell sense (Gibson, 1966). *Sensory depth* indicates the quality of information within each channel and thus, an image/audio with greater depth can be generally perceived as having higher resolution/quality than one of less depth. Different media can have different degrees of sensory breadth and depth, which indicates different extents of vividness (Li et al., 2001;Nah et al., 2011). For instance, high-definition televisions exhibit greater depth than do ordinary colour televisions (Suh and Chang, 2006). However, researchers have argued that in designing media systems, the depth of sensory channels has been always sacrificed in simulations of the real world because no currently available auditory or visual recording systems match the capabilities of the human auditory and visual system (Hendrix and Barfield, 1995).

The other antecedent of telepresence proposed by Steuer (1992) is interactivity, which refers to the extent to which users can modify the form and content of a mediated environment in real time. The definition of interactivity here is distinct from the normal definition, which is related to interpersonal communication and frequently applied by communication researchers (Rafaeli, 1988;Blattberg and Deighton, 1996). As a significant determinant of telepresence, the interactivity in Steuer's (1992) research is 'a stimulus-driven variable, and is determined by the technological structure of the medium' (p.86). According to Steuer (1992), the construct has three major dimensions: speed, range, and mapping. *Speed* indicates the rate at which input can be assimilated into the mediated environment; thus, the real-time interaction represents the highest degree for this dimension. *Range* indicates the number of possibilities for manipulation at any given time (e.g., number of clickable areas); in other words, the more parameters that can be modified, the greater the range of interactivity of a medium. *Mapping* indicates the ability of a medium to map its controls to the changes in the mediated environment in a natural and predictable manner, which refers to the way in which human actions are connected to actions within a mediated environment (Norman, 1990). Therefore, at one extreme mapping can be totally unrelated to the function performed and at the other extreme, completely natural.

The proposition of Steuer's (1992) model on telepresence antecedents is based on the argument that telepresence depends on how closely the mediated experience simulates the real world (Shih, 1998). Specifically, telepresence is determined by how closely the quantity and quality of simulated sensory channels and simulated ability to interact with the mediated environment approximate interaction with the real environment (Fiore et al., 2005). Steuer (1992) labelled the determinants as ‘vividness’ and ‘interactivity’ respectively, which were considered to describe the technological features of the media. Later studies have empirically demonstrated that vividness and interactivity can lead to telepresence (Coyle and Thorson, 2001;Hyun et al., 2009;Liu and Shrum, 2009). Steuer’s (1992) study provided the seminal model of telepresence antecedents adopted in many later studies as an essential reference to build research models containing the construct of telepresence (Hopkins et al., 2004).

2.5.2 Other Telepresence Antecedents in the Literature

As a significant construct to study user-mediated experience, telepresence has been applied to a wide range of contexts (see Table 2-8). Accordingly, telepresence antecedents in the literature can be classified into three major trends: 1) acceptance and modification of the classical model; 2) combinations of media capabilities; and 3) exploration of factors from perspectives other than media.

First, many studies accepted and modified Steuer’s (1992) classical model containing vividness and interactivity as telepresence antecedents in their research models. Some directly adopted the classical model (Shih, 1998;Coyle and Thorson, 2001;Keng and Lin, 2006;Ning Shen and Khalifa, 2012) whereas some replaced some constructs or corresponding dimensions with other terms according to their specific contexts (Sheridan, 1992;IJsselsteijn et al., 2000;Klein, 2003;Skadberg and Kimmel, 2004). For instance, Klein (2003) interpreted the classical model in the context of a computer-mediated environment and proposed two new terms to replace vividness and interactivity: media richness and user control. Klein argued that the original term of vividness was also used in marketing research but with a different meaning (see, Kisielius and Sternthal, 1986); to avoid confusion, he selected the term media richness. Similarly, he used the term user control rather than interactivity to emphasise that this construct refers to human–computer interactions. In Skadberg and Kimmel’s (2004) study of the user experience of browsing a website, they specified the term of vividness with the term of attractiveness of website design based on the specific context. Although researchers may select alternative terms to represent the constructs in the classical model according to different contexts, this kind of model on telepresence antecedents expresses the same meanings as Steuer's (1992) classical model.

The second trend of telepresence antecedents is based on a consideration of combining media capabilities such as vividness and interactivity into different forms of media or technologies (Suh and Chang, 2006). This type of study focused on investigating and/or comparing the influences of different types of media, indicating different levels of vividness and interactivity, on telepresence. For example, Nah et al. (2011) compared the effects of the 2D and 3D VW environment on telepresence. They argued that a 3D VW environment provides a greater number of sensory stimulations than does a 2D VW environment. The sensory stimulations contain the traditional sensory channels such as vision and audition and may also include the sense of movements and haptic feedback to simulate real sensations (Park et al., 2008). Further, Nah et al. (2011) assumed that users in a 3D VW environment are more likely to feel that they are directly interacting and navigating in the virtual environment, indicating a higher level of vividness and interactivity, which is positively connected to the increased feeling of telepresence based on Steuer's (1992) classical model. Considering that a 3D VW may more closely resemble the real environment, they argued that users' feeling of telepresence is higher in a 3D VW than in a 2D VW. Similarly, Suh and Chang (2006) compared the influences of three types of user interfaces: multiple pictures, video clips and VR. They found that VR interface produces the highest telepresence, as it represents a higher level of vividness and interactivity. This type of study of telepresence antecedents does not involve concrete degrees of vividness and interactivity. However, arguments regarding the influence of factors related to specific media, technologies or interfaces leading to telepresence are also based on Steuer's (1992) classical model, indicating that different factors contain different levels of vividness and interactivity. Despite the differing perspectives utilised to investigate telepresence antecedents in the above two trends, both explore technological factors, influenced by the argument proposed by Steuer's (1992) classical model on telepresence antecedents.

Distinguished from the above two trends in telepresence antecedents, the third trend in telepresence antecedents in the literature attempts to explore factors leading to telepresence in new ways. Among this kind of telepresence antecedents, studies have proposed new conceptual ways for future research to investigate the factors leading to telepresence. For instance, Witmer and Singer (1998) suggested four features of telepresence antecedents: sensory factors, control factors, distraction factors and realism factors. Among these features, sensory factors and control factors are to some extent consistent with the vividness and interactivity proposed in Steuer's (1992) classical model. Distraction factors and realism factors were newly proposed by Witmer and Singer (1998) as they regarded these two features as closely associated with competition between the physical surroundings and the mediated environments for users' attention, which finally leads to telepresence. Similarly, Draper et al. (1998) conducted a literature review on telepresence; based on the results they recommended the investigation of telepresence antecedents via both a technological approach and a psychological approach. The technological approach they proposed agreed with Steuer's (1992) classical model while the psychological approach was proposed based on the consideration that as telepresence is a subjective feeling, perceptions of it may involve psychological phenomena that should not be ignored. Although these studies on telepresence antecedents have identified some new ways of exploring factors leading to telepresence, such propositions were based on researchers' understanding of telepresence and the process of cultivating telepresence.

For the third trend in existing telepresence antecedents, studies have identified specific factors from some new perspectives rather than that of technology only. For instance, Bystrom et al.'s (1999) conceptual model for investigating virtual environments proposed users' suspension of disbelief as a factor leading to telepresence, which highlights the significance of the user perspective for exploring telepresence antecedents. Similarly, Nelson et al. (2006) argued that a user's enjoyment of a game can influence telepresence in models for studying brand placements in online games that also investigate user-related factors leading to telepresence. In addition to these user-related factors, studies have found that some abstract constructs involving the process of people using media can also affect the feeling of telepresence (Hoffman and Novak, 1996;Haans and Ijsselsteijn, 2012;Peng and Ke, 2015;Choi et al., 2016;Kim and Hyun, 2016). For instance, Hoffman and Novak (1996) conceptually presented a preliminary process model for network navigation in a hypermedia environment. In the model, as one important construct, telepresence is directly influenced by three factors: vividness, interactivity and focused attention. The first two factors were adopted from Steuer's (1992) classical model while the construct of focused attention was newly proposed by arguing that when users centre their attention on the limited mediated environment rather than their physical surroundings, telepresence feeling is cultivated. Further, according to Hoffman and

Novak's (1996) process model, the three telepresence antecedents are also influenced by other factors. Specifically, network navigation influences interactivity and vividness, which further leads to telepresence. Network navigation also influences process characteristics such as extrinsic motivation and intrinsic motivation, which further affect involvement, and finally lead to telepresence through focused attention. Although the development of the process model is based only on the researchers' interpretation of a relevant phenomenon, Hoffman and Novak's (1996) study raised the possibility that there may be some inter-relationships between the factors leading to telepresence.

The third trend in existing telepresence antecedents is consistent with the previous argument that as telepresence experience resides in individual consciousness and occurs when users interact with the IS, consideration of telepresence antecedents should be based on multiple features (Lombard and Ditton, 1997;Sacau et al., 2008). However, the features that should be considered for identifying telepresence antecedents varied according to the researchers' perspectives (Witmer and Singer, 1998;IJsselsteijn et al., 2000;Lombard and Snyder-Duch, 2001).

2.5.3 Summary

This section reviewed telepresence antecedents in the literature that are expected to facilitate addressing current issues regarding realness of VWs. The section began by illustrating the classical and most influential model of telepresence antecedents, and then analysed existing telepresence antecedents by identifying three major trends. Based on the literature review, the following section—section 2.6 illustrates the major literature limitations with respect to telepresence antecedents and argues that these gaps have impeded the comprehensive and thorough understanding of what factors lead to telepresence, which further cause challenges in adopting telepresence in VWs to resolve the issues outlined in Section 2.4.

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2.6 Challenges to Understanding Telepresence Antecedents

Based on previous sections of the literature review, the concept of telepresence, referring to a user's feeling of 'being there' in mediated environments has been regarded as a core construct to study user experience in mediated environments. Because of its role in investigating user-mediated experience, as well as the consequences of this concept contributing to the success of the media, the construct of telepresence is adopted to the context of VWs to resolve current design issues by arguing that the construct and the context are appropriate to each other. To provide practical guidelines for the design of VWs focusing on the telepresence construct, an additional literature review is presented specifically on telepresence antecedents in various contexts to provide valuable insights. However, literature gaps on telepresence antecedents were found during the review, which not only impede comprehensive and thorough understanding of what factors lead to telepresence in the general context but also affect the adoption of telepresence construct in the specific context of VWs to resolve current issues. Specifically, there are three main challenges involving the understanding of telepresence antecedents based on literature gaps with respect to understanding the content of telepresence antecedents, the hierarchical structure of telepresence antecedents, and individual differences in perceiving telepresence from the perspective of user segmentation.

2.6.1 Understanding the Content of Telepresence Antecedents

As outlined in previous sections, identifying what factors lead to telepresence is significant both for researchers to develop research models containing the construct of telepresence and practitioners to guide their design of relevant media for a better user experience (Kim and Biocca, 1997;Klein, 2003;Nah et al., 2011). However, according to the literature review, there remain some significant literature gaps, which impede understanding of the content of telepresence antecedents.

To begin with, the current study's scope for exploring telepresence antecedents is relatively narrow, mainly influenced by Steuer's (1992) classical model of telepresence antecedents. As Steuer (1992) argued, the two major constructs contributing to telepresence in his model are both technological factors; most later studies investigating telepresence antecedents either directly adopted his model or combined and/or modified the technological constructs he proposed. Thus, according to the literature review, most existing telepresence antecedents are related to the technologies as many researchers only explored factors leading to telepresence from a technological perspective (Kim and Biocca, 1997;Klein, 2003;Fiore et al., 2005;Suh and Chang, 2006;Phang and Kankanhalli, 2009;Nah et al., 2011;Kim, 2015;North and North, 2016). However, it has been argued that telepresence, as a user's feeling of 'being there' in the mediated environment when they interact with the media is a much more complicated construct to investigate, the cultivation of which may contain a combined function of all possible components rather than technology only (IJsselsteijn et al., 2000). Overemphasising one particular component may cause imbalanced research results when exploring telepresence antecedents, which may lead researchers to ignore important factors leading to telepresence. The missing information on these factors impedes a comprehensive understanding of telepresence antecedents, and it is impossible to make full use of telepresence constructs to address the current issues.

Additionally, as mentioned in Section 2.5, although a few studies have proposed new ways to explore telepresence antecedents, these are based on an understanding of the process of cultivating telepresence that may lack sufficient theoretical or empirical support. For instance, Draper et al. (1998) stated that there are two major approaches to investigating telepresence antecedents: one is the traditional technological approach and the other is the psychological approach, as the feeling of telepresence may arise from a series of psychological phenomena. Witmer and Singer (1998) proposed four conceptual factors leading to telepresence: sensory factors, control factors, distraction factors and realism factors. However, ways of exploring telepresence antecedents proposed by previous studies were only conceptually introduced; the in-depth logic for these propositions and whether they can cover all possible factors leading to telepresence is questionable (Cho et al., 2015). Meanwhile, although other studies have not identified new features, they have investigated specific new factors leading to telepresence that belong to the new features, such as suspension of disbelief (Bystrom et al., 1999), game liking (Nelson et al., 2006), embodiment (Haans and Ijsselsteijn, 2012), immersion (Peng and Ke, 2015), system and information quality (Kim and Hyun, 2016) and emotion experience (Makowski et al., 2017). These kinds of studies also provide some hints that for telepresence antecedents, the investigation scope should not be limited to technological features; some other new features are also worthy of exploration. However, these new factors were identified specifically in relation to particular contexts, and thus were too scattered to be utilised to investigate telepresence in different contexts. Without a comprehensive view of possible factors leading to telepresence, it is difficult to synthesise existing telepresence antecedents in various research contexts for a better understanding of what factors lead to telepresence. Thus, a comprehensive exploration of potential telepresence antecedents is required to narrow this literature gap, which is also expected to broaden the investigation scope of studies on telepresence antecedents.

For existing telepresence antecedents identified in previous studies, the clarity of the constructs remains an issue for the relevant literature. This problem is due to the nature of telepresence as a product of all media, which has been applied to studies within a wide range of contexts (Bracken and Skalski, 2010). The diverse contexts in distinct disciplines produce a large number of terms for representing existing factors leading to telepresence. Taking the constructs of vividness and interactivity for example, in Steuer's (1992) model, these two telepresence antecedents represent the influences of sensory stimulation and human–computer interaction on telepresence, containing different dimensions. Instead of directly adopting Steuer's (1992) model, many later studies emerged or split some dimensions of constructs and adopted new terms to describe them according to different contexts (IJsselsteijn et al., 2000;Klein, 2003;Liu and Uang, 2016;Baus and Bouchard, 2017). For instance, IJsselsteijn et al. (2000) proposed two technological factors leading to telepresence in the context of VR: the extent and fidelity of sensory information; and the match between the sensor and the display. The former construct represents the original construct of vividness whereas the latter only indicates the mapping dimension of the construct of interactivity. In Klein's (2003) study, he replaced vividness and interactivity with the terms media richness and user control in the context of computer-mediated environments. In addition, a few studies picked only one specific perspective involving the two original constructs to deepen understanding. For instance, Liu and Uang (2016) discussed the influence of one specific sensory stimulation—visual stimulation—on telepresence based on the construct of vividness in the classical model. Their study identified two factors from this perspective, which are depth perception cues and visual display modes. Baus and Bouchard (2017) specifically investigated the influence of odours and olfactory stimulation on telepresence in the context of VR. For this kind of telepresence antecedents, although some describe the same aspect, different terms may be used in different contexts. Moreover, different terms in different studies may be raised from different levels that some were from the level of constructs and some were from the level of the dimensions/components of the constructs. Accordingly, confusion and ambiguity exist regarding the factors leading to telepresence in various research contexts. Thus, despite a considerable number of studies of telepresence antecedents, it is still difficult to combine the current knowledge in a coherent framework for an overall consideration to provide a clear understanding of what factors lead to telepresence.

To summarise, with respect to the literature on telepresence antecedents, the investigation scope for exploring factors is relatively narrow. Although a few studies have noted this issue, the proposition of possible ways of investigating factors leading to telepresence by these studies varies according to researchers' interpretations of the concept. Additionally, the identification of telepresence antecedents among the new features is constrained to specific research contexts to which the generality of the findings in relevant studies is limited. Further, as the construct of telepresence is a product of all media, it has been applied in a wide range of contexts. Thus, many terms for telepresence antecedents have been introduced to the literature at different levels in different contexts, which has produced a relatively confusing and ambiguous understanding. This lack of a comprehensive and clear understanding of what factors lead to telepresence makes it quite difficult to combine and synthesise existing telepresence antecedents from previous studies to either develop theoretical research models containing telepresence or design IS in practice for an improved telepresence experience. An exploratory investigation of telepresence antecedents is required to broaden the investigation scope and complete and clarify existing knowledge. The findings based on such an investigation are expected to narrow the literature gap on telepresence antecedents, specifically considering the context of VWs. They are also expected to address current issues by providing a better telepresence experience. The challenge of understanding the content of telepresence antecedents raises the first question for the current study:

- *RQ 1: What are the antecedents of telepresence in the context of VWs?*

2.6.2 Understanding the Hierarchical Structure of Telepresence Antecedents

Based on the literature review, the hierarchical structure of telepresence antecedents is unclear. A few studies have identified some inter-relationships between factors leading to telepresence, which has revealed that different telepresence antecedents may be at different hierarchical levels and may be related to each other. However, only limited knowledge is available in the literature to form a relatively comprehensive understanding of the mechanisms for how telepresence is cultivated in mediated environments. For instance, Bhatt (2004) found that the vividness of a website can influence telepresence through the user's engagement, which presents a chain from vividness to engagement to telepresence. Similarly, the process model proposed by Hoffman and Novak (1996) to investigate the influences of network navigation showed that network navigation influences telepresence via two paths: network navigation→content characteristics (interactivity and vividness)→telepresence; and network navigation→process characteristics→involvement→focused attention →telepresence. Although Hoffman and Novak (1996) proposed the paths leading to telepresence only as part of their process model, this still demonstrated that telepresence is gradually cultivated through a mental process. Other studies have confirmed this argument by identifying some relatively abstract constructs that could be influenced by other concrete factors as telepresence antecedents, such as involvement (Campbell et al., 2010), embodiment (Haans and Ijsselsteijn, 2012), immersion (Peng and Ke, 2015), system and information quality (Kim and Hyun, 2016) and emotion experience (Makowski et al., 2017). These studies confirm that different hierarchical levels and inter-relationships exist among telepresence antecedents.

However, based on the literature review, limited studies have focused on investigating the process of cultivating telepresence and only a few relationships regarding telepresence antecedents have been identified (Hoffman and Novak, 1996;Bhatt, 2004). Thus, knowledge is not sufficient to build a comprehensive understanding of the underlying mechanisms cultivating telepresence. The relationship between technological features and telepresence is a 'black box'. Without such understanding of how telepresence is cultivated, findings on telepresence antecedents are constrained by specific contexts in the literature and cannot be flexibly applied to other contexts. Thus, the generalisation and applicability of telepresence studies are limited. For instance, in studies that generally investigated the influence of specific systems/technologies on telepresence (Muhlbach et al., 1995;Fiore et al., 2005) or compared this influence (Suh and Chang, 2006;Nah et al., 2011;Bellman et al., 2014;North and North, 2016), findings were only restrained in the relationships between the specific systems/technologies and telepresence. Thus, it is not clear which features influence telepresence and why different systems/technologies can produce different degrees of telepresence. Thus, for this kind of study, findings on telepresence antecedents are only restrained with respect to the specific systems/technologies and further application of these findings in other contexts may lead to questionable research results.

Therefore, to thoroughly understand telepresence antecedents and to make the findings more applicable in a broad range of contexts for future studies, studying the hierarchical structure of telepresence antecedents is necessary. Understanding the hierarchical structure of telepresence antecedents facilitates opening the ‘black box’ of the process for cultivating telepresence. This is expected to provide abundant information to supplement current knowledge on telepresence antecedents. Further, with such a hierarchical structure means it is more flexible and easy for researchers and practitioners to adapt findings to their studies and designs in different research contexts. To this end, MEC theory can shed light on the hierarchical structure of telepresence antecedents as it has been widely used in understanding how people’s perception/evaluation/motivation is gradually produced (Grunert et al., 2001;Costa et al., 2004;Vorderer et al., 2004;Xiao et al., 2017). For instance, Xiao et al. (2017) developed a hierarchical structure of consumer goals for online group buying based on MEC theory. Guo et al. (2012) adopted MEC theory as a perspective to investigate how student technology use motivations can be represented as a set of inter-related and hierarchically organised elements. Fu and Wu (2010) adopted MEC theory to understand how the user’s cognition is formed based on advertising pages. Thus, to understand the hierarchical structure of telepresence antecedents, which refers to an understanding of how users’ perception of telepresence is cultivated, MEC theory can be adopted as the theoretical foundation, as is introduced in Section 2.7.

2.6.3 Understanding Individual Differences in Perceiving Telepresence Based on User Segmentation

Regarding subjective features of telepresence (IJsselsteijn et al., 2000), most telepresence studies have acknowledged that the experience of telepresence differs between individuals (Coxon et al., 2016). However, in the literature on telepresence antecedents, compared with technological factors only a few studies have investigated the influences of individual differences on perceiving telepresence feeling (Bystrom et al., 1999;Nelson et al., 2006;Cho et al., 2015;Stavropoulos et al., 2017). According to these studies, telepresence is closely associated with some individuals’ characteristics, such as suspension of disbelief (Bystrom et al., 1999), immersive tendencies (Schubert et al., 2001;Bulu, 2012) and intrinsic motivation (Lim et al., 2017). It has been argued that users may experience different levels of telepresence in the same virtual environment in different ways (Schubert et al., 2001). For instance, when Welch et al. (1996) investigated the importance of interactivity to the experience of telepresence, they found that people who can actively interact with the virtual environment may have a higher degree of telepresence than individuals who are mere passive observers. Based on these arguments, there is a possibility that there may be different types of people with respect to perceiving telepresence. Considering user segmentation in terms of perceiving telepresence will explore additional reasons for the well-accepted phenomenon involving telepresence that in the same mediated environment, different users may experience different degrees of telepresence (IJsselsteijn et al., 2000).

Thus, a further review was conducted on studies of user segmentation, specifically in the context of IS. It has been argued that user segmentation is important for both practitioners and researchers in IS (Miller and Melton, 2017). By identifying user typologies, practitioners can specifically recognise a target group of users and customise the design of IS by providing optional and tailored features and functions to achieve the success of systems in a more cost-effective way (Brandtzæg et al., 2011). For researchers, understanding user segmentation in IS provides supplementary information for understanding user experience, user psychology and behaviours (Meyen et al., 2010;Hassouneh and Brengman, 2014). Table 2-9 presents selected user segmentations in IS.

Table 2-9: A summary of selected studies on user segmentation in information systems

Author	Context	Segmentation Basis	Number of Segments	User Type
Modahl (1999)	E-commerce	Ability to acquire technology	3	Innovators and first adopters Majority adopters Sidelined citizens
Prensky (2001)	Digital technology	Familiarity with technology	2	Digital natives Digital immigrants
Sheehan (2002)	Internet	Information privacy concerns	4	Unconcerned Internet users Circumspect Internet users

Author	Context	Segmentation Basis	Number of Segments	User Type
				Wary c users Alarmed Internet users
Keng Kau et al. (2003)	E-commerce	Online buying behaviour	6	On-off shoppers Comparison shoppers Traditional shoppers Dual shoppers E-laggards Information surfers
Rohm and Swaminathan (2004)	E-commerce	Online shopping motivations	4	Balanced buyers Convenience shoppers Store-oriented shoppers Variety seekers
Brengman et al. (2005)	E-commerce	Web usage	3	Business users Suspicious learners Tentative shoppers
Barnes et al. (2007)	E-commerce	Online buying behaviour	3	Risk-averse doubters Open-minded online shoppers Reserved information-seekers
Meyen et al. (2010)	Internet	Internet usage	7	The virtuosi The professionals The addicts The aficionados The companions The cautious The affiliated
Brandtzæg et al. (2011)	Internet	Internet usage	5	Non-users Sporadic users Entertainment users Instrumental users Advanced users
Oyedele and Minor (2011)	3D VWs	User behaviour	3	Virtual sceptics E-virtualists Virtual-centrists
White and Le Cornu (2011)	Internet	Engagement with the Internet	2	Visitors Residents

Author	Context	Segmentation Basis	Number of Segments	User Type
Hassouneh and Brengman (2014)	Social VWs	Motivation	7	Role-players Relationship seekers Manipulators Achievement seekers Friendship seekers Uninvolved Escapists
Rosa et al. (2016)	Immersive VR environment	Gaming lifestyle	3	PC gamers Console gamers Non-gamers

According to Table 2-9, there are major bases for user segmentation in IS, such as user abilities (Modahl, 1999;Prensky, 2001), user motivations (Rohm and Swaminathan, 2004;Hassouneh and Brengman, 2014), online user behaviours (Keng Kau et al., 2003;Barnes et al., 2007;Oyedele and Minor, 2011) and final usage of IS (Meyen et al., 2010;Brandtzæg et al., 2011). Among these bases, user abilities and user motivations predict a different user experience with IS for different types of users whereas online user behaviours and final usage of IS reveal the final consequences of user experiences with the IS (Oyedele and Minor, 2011;Hassouneh and Brengman, 2014). It has been argued on the inflexibility of existing user segmentation by previous studies that the majority of user typologies is limited to specific contexts and cannot be applied to other contexts (Prensky, 2009;Brandtzæg, 2010;White and Le Cornu, 2011). The features of user abilities and user motivations may vary according to different types of IS and based on which produce different consequences of using these IS. Thus, types of IS also determine the corresponding user segmentation, which reduces the generality and flexibility of segmentation results. Specifically, for the current context of VWs, relatively few studies have been conducted to classify users in VWs. Oyedele and Minor (2011) developed a customer typology for 3D VWs by grouping users based on their use behaviours with 3D VWs. Hassouneh and Brengman (2014) classified users in social VWs based on their different motivations. Considering criticism of the flexibility of existing user segmentations and the diversity of VW applications (each of which may have distinctive design purposes as well as features and functions to achieve its purposes) it is inappropriate to apply any previous user typologies to the specific application of VWs.

Some studies have suggested that employing user experience as the basis for segmenting users can to some extent address issues of the flexibility and generality of existing user segmentation (White and Le Cornu, 2011). User experience is regarded as the mediator connecting the features of IS and user behaviours, which can reflect users' inner mechanisms of producing certain perceptions and/or behaviours when using IS (Harris and Weistroffer, 2009). White and Le Cornu (2011) classified Internet users into two groups based on their engagement with the Internet: visitors and residents. They argued that the visitor–resident continuum accounts for users behaving in different ways when using IS, but is considered a wider and more accurate representation of individual differences. Thus, a user segmentation based on user experience is more likely to reduce the limitations of specific contexts and concentrate on revealing individual differences based on different inner mechanisms of producing certain perceptions and/or behaviours.

In the current study, as discussed in Section 2.2, telepresence experience is one significant type of user experience. Based on that discussion, telepresence antecedents in hierarchical levels reflect users' inner mechanisms of cultivating telepresence. Considering the discussion on understanding individual differences on perceiving telepresence, it is argued in the current study that a user segmentation based on mechanisms of perceiving telepresence can both resolve issues in existing user segmentation research and enhance understanding of telepresence theory.

Further, to conduct user segmentation on users' inner mechanisms of perceiving telepresence, MEC theory can facilitate selection of appropriate factors for the segmentation. According to MEC theory, inter-related factors can be classified into different hierarchical levels based on their positions in the hierarchical structure (Gutman, 1982). Factors at the medium level, which links the lower and higher levels, are regarded as the core constructs to explain the mechanisms of different chains of related factors in the hierarchical structure (Grunert et al., 2001). Thus, classifying users based on these factors is expected to produce a distinct hierarchical structure of telepresence antecedents that represent distinctive mechanisms of perceiving telepresence.

2.6.4 Summary

The three major challenges in understanding telepresence antecedents are presented in this section, involving understanding the content and hierarchical structure of telepresence antecedents and understanding individual differences of perceiving telepresence from the perspective of user segmentation. Specifically, to understand the hierarchical structure of telepresence antecedents, MEC theory is introduced as a theoretical foundation, as illustrated in the following section.

2.7 Theoretical Foundation

As mentioned above, to address challenges, MEC theory is adopted as the theoretical foundation for the current study. Thus, this section is focused on outlining this theory. MEC theory originated in Simon's (1957) study on decision making to investigate how a decision is made to achieve an ultimate goal. In the process of decision making, MECs are regarded as hierarchies of goals indicating potential actions that need to be done to reach the ultimate goal (Gutman, 1997). This theory has been widely applied in various contexts to understand how people evaluate objects/experiences by relating a consumer's object/experience knowledge to their self-knowledge (Gutman, 1982;Grunert et al., 2001;Wagstaff et al., 2001;Mort and Rose, 2004;Fu and Wu, 2010;Jung and Kang, 2010). It has been argued that MEC theory is particularly suitable to investigate people's underlying mechanisms of goals, values, perceptions and behaviours in different contexts (Veludo-de-Oliveira et al., 2006). Taking the context of marketing as an example, Gutman (1982) provided a clear definition on MEC:

> Means are objects or activities in which people engage (running, reading). Ends are valued states of being such as happiness, security, and accomplishment. A means–end chain is a model that seeks to explain how a product or service selection facilitates the achievement of desired end states (Gutman, 1982, p.60).

The central principle of MEC theory has been interpreted as being that structures related to formulating a perception are stored in people's memory, which forms a chain of hierarchically connected constructs within different hierarchical levels (Zeithaml, 1988;Klenosky et al., 1999;Grunert et al., 2001). In different contexts, different terms are used to describe these hierarchical levels. For instance, in studies using MEC theory to understand product preference, the hierarchical levels are attributes, consequences and values (Costa et al., 2004). Attributes indicate the physical features of products. Consequences refer to perceived benefits based on these attributes. Values are regarded as the ultimate factors that directly influence consumer preference for products. The three hierarchical levels are connected in sequences to form a chain, which facilitates a thorough understanding consumers' product preferences (Costa et al., 2004). In the context of IS, MEC theory has been adopted to understand the process for how a user's cognition/perception is cultivated using IS and technologies (Gengler et al., 1995;Fu and Wu, 2010). For this kind of context, there are three basic hierarchical levels: givens, means and ends (Kanungo et al., 1999;Kanungo, 2009;Anantatmula, 2010;Guo et al., 2011). Givens are the independent or influencing factors that have a significant influence on the factors above them in the hierarchical structure. They can be considered as the input or trigger of the chain to explain or affect the experience or behaviour in IS (Kanungo, 2009). Means are the linkage or relay factors, which have a role in strongly linking other factors in the hierarchical structure. Any factors leading to them have further consequences so understanding on this level represents an interpretation of the mechanisms of the linking relationships (Iyer and Sagheer, 2009). Ends are the dependent or result factors, which are the ultimate outcomes of the influence of other factors in the hierarchical structure. The understanding of this level provides insights into how users finally respond to the IS (Guo et al., 2011).

The current study focuses on the construct of telepresence in the context of VWs, which belongs to IS research. The hierarchical levels of givens, means and ends can be adopted to arrange identified telepresence antecedents. The three levels play distinct roles in the complex process of cultivating telepresence: factors at the level of givens can be regarded as the original triggers that activate related factors to the ends of the paths that finally lead to telepresence; the factors at the level of means can be considered as the mediators between the givens–ends relationship; and the factors at the level of ends are the terminals of the paths and have relatively immediate relationships with the core construct of the current study—telepresence. This hierarchical structure with three different levels—givens, means and ends—is capable of facilitating an exploration and understanding the underlying mechanisms of how telepresence is cultivated.

To form the MECs, the most commonly used methodology is the laddering technique (Grunert and Grunert, 1995). This is a specific interview technique developed by Hinkle (1965) in the field of clinical psychology to construct the structures of belief in an in-depth and systematic way. The technique has since been applied in a wide range of areas including marketing, IS and organisational management to elicit hierarchical constructs (ladders) or MECs (Rugg et al., 2002;Veludo-de-Oliveira et al., 2006;Schultze and Avital, 2011). The set of ladders built by various MECs is a hierarchical value map (HVM), which presents the hierarchical structure of all related constructs at different levels (Grunert and Grunert, 1995). As a tree-like graph, a HVM provides thorough insight into individual perceptions by illustrating the main perceived connections among the distinct hierarchical levels (Veludo-de-Oliveira et al., 2006).

This study adopts MEC theory as a theoretical foundation for investigating the hierarchical structure of telepresence antecedents by regarding users' experience of telepresence as the ultimate end. To achieve this ultimate end, the study attempts to explore factors at different hierarchical levels sequentially to form the chains that finally lead to telepresence. Accordingly, the laddering interview technique is applied to collect interview data from participants' perspectives; by analysing these data, a hierarchical structure is developed to present the results for thorough interpretation.

As the theoretical foundation for the current study, MEC theory is expected to guide the understanding of the hierarchical structure of telepresence antecedents. In addition, as discussed above, the hierarchical structure developed from data analysis can be used as a foundation to classify VW users based on their different mechanisms of perceiving telepresence. Accordingly, the adoption of MEC theory is suitable for addressing the following research questions:

- *RQ2: What is the hierarchical structure of the identified telepresence antecedents in the context of VWs?*
- *RQ3: What is the relative importance of the telepresence antecedents?*
- *RQ4: Are there any distinct type of users based on their mechanisms of perceiving telepresence in the context of VWs?*
- *RQ5: If yes, what are the similarities and differences between their hierarchical structures of telepresence antecedents for these groups of users in the context of VWs?*

2.8 Chapter Summary

This on first explicated the core construct of telepresence and then introduced the context of VWs. The chapter then linked this construct with the context by arguing that telepresence can be regarded as the solution to the challenge of VWs. Accordingly, a further review on telepresence antecedents was presented and the challenges of understanding telepresence antecedents was discussed. Finally, MEC theory as the theoretical foundation for the current study was presented.

Chapter 3: Research Methodology

3.1 Introduction

Chapter 1 briefly introduced the study by describing the research background, rationale, questions and significance. Chapter 2 then linked the study to existing research via literature review to provide insights and identify literature gaps for the current study. This chapter presents the research methodology, of which essential features are the general outline and specific details for how the study was conducted. Beginning with a discussion of the research paradigm and approach of the study, this chapter introduces the study artefact to conduct the research. Further, the specific techniques and procedures for collecting data in both the pilot study and the main study are presented, followed by an illustration of the data analysis approach. Figure 3-1 depicts the major parts of this chapter.

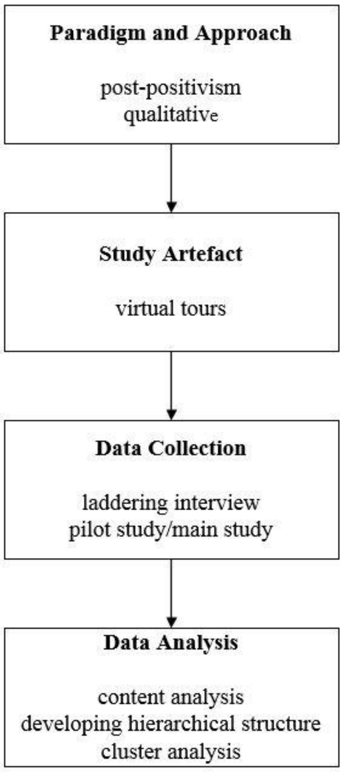


Figure 3-1: Major sections of Chapter 3

3.2 The Research Paradigm and Approach

This section discusses the research paradigm and the research approach used in the study, as the foundation guiding the research design. To investigate related paradigms and approaches, and considering the nature of the study, a post-positivism paradigm and qualitative approach are taken by the study, as outlined in the following subsections.

3.2.1 The Research Paradigm

A research paradigm is defined as a 'set of interrelated assumptions about the world which provides a philosophical and conceptual framework for the organized study of that world' (Filstead, 1979, p.34). Research paradigms provide researchers with philosophical assumptions on the research and help them to select appropriate methodological procedures for the research (Denzin and Lincoln, 2000;Ponterotto, 2005).

It has been acknowledged that research paradigms have three main dimensions to be characterised: ontology, epistemology and methodology (Guba and Lincoln, 1994). Ontology refers to the nature of reality and addresses the question 'What is reality?' (Guba, 1990). Epistemology indicates the nature of knowledge, which reveals the relationships between subjects and researchers to answer the question 'What and how can we know reality?' (Orlikowski and Baroudi, 1991;Bunge, 2012). Methodology is related to the analysis of methods applied to the investigation of subjects by collecting and analysing data, and deals with the question 'What procedure can we use to acquire knowledge?' (Kumar and Phrommathed, 2005). These three dimensions of a research paradigm are shown in Figure 3-2.

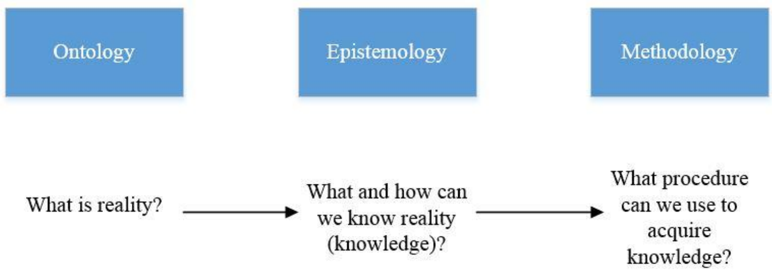


Figure 3-2: The relationships between ontology, epistemology and methodology

According to the literature, ontology and epistemology provide insights into how knowledge is viewed and how researchers relate themselves to the knowledge, while the methodology is the procedure used by researchers to obtain that knowledge (Hirschheim and Klein, 1992). Thus, by encompassing ontology, epistemology and methodology, a research paradigm reflects a researcher's world view including their understanding of 'the nature of the world, the individual's place in it, and the range of possible relationships to that world and its parts' (Guba and Lincoln, 1994, p.107). These fundamental philosophical assumptions are critical for a study to ensure that it is valid and the selected research method is suitable for it (Orlikowski and Baroudi, 1991).

Different paradigms are adopted to guide and conceptualise research (Denzin and Lincoln, 2000;Ponterotto, 2005). From a philosophical perspective, there are four main research paradigms that inherently reflect our beliefs of the world in which we live: positivism, interpretivism, post-positivism and critical paradigm (Lather, 1986;Blanche et al., 2006). These four paradigms have been commonly applied in a wide range of research areas including sociology, psychology, management and IS (Gephart, 1999;Krauss, 2005;Mackenzie and Knipe, 2006;Peffers et al., 2007). It has been suggested that to select a research paradigm appropriate for a specific study, the researcher needs to review and compare potential paradigms to find the most interpretable and comprehensive one (Ponterotto, 2005).

Positivism is defined as 'a form of philosophical realism adhering closely to the hypothetico-deductive method' (Ponterotto, 2005, p.128), which focuses on verifying prior hypotheses presented as quantitative propositions and/or mathematical formulae to explain and predict phenomena (Burrell and Morgan, 1979;Guba and Lincoln, 1994;Ponterotto, 2005). Ontologically, positivists assume that reality exists objectively and can be measured using properties independently from the researcher (Henning et al., 2004). Epistemologically, positivists believe that the knowledge can verify or falsify theories and researchers should adopt a distant, non-interactive posture to pursue generalisation (Walsham, 1995b). Methodologically, as positivists adopt an independent position, which requires them to collect empirical evidence objectively, quantitative methods are appropriate for them to acquire knowledge (Adams et al., 2005). Methodological procedures normally include the development of a model based on a phenomenon's description, presentation of corresponding hypotheses, the conduct of a quantitative study to collect data, statistical verification of the hypotheses and finally interpretation of the statistical results (Cacioppo et al., 2004). Positivism has been broadly adopted by researchers in IS, and still dominates empirical research in IS (Chen and Hirschheim, 2004). However, some researchers have criticised this paradigm, arguing that it ignores the social context and thus fails to explain the meanings of humans and their behaviours, as their behaviours may not always follow the same specific social law (Neuman and Robson, 2014). Moreover, as positivism is adopted to verify a model or theory based on existing studies, it may not be appropriate for in-depth exploratory research (Klein and Myers, 1999).

Interpretivism assumes that multiple and equally valid realities exist in the world, which is in contrast to positivism's belief that there is a single external reality (Schwandt, 1994). The distinction of interpretivism from positivism is based on interpretivists' assumption that reality is constructed in the mind of the individual, and highlights the interaction between the researcher and the objects of investigation on interpreting (Hansen, 2004). Specifically, via this interaction, researchers 'understand, explain, and demystify social reality through the eyes of different participants' (Cohen et al., 2007, p.19). Ontologically, interpretivists believe that reality is subjective and socially constructed through human interaction (Chen and Hirschheim, 2004). Epistemologically, interpretivists assume that knowledge depends on thinking and reasoning humans and thus is based on acts of interpretation by researchers without any previous assumptions (Gephart, 1999). Methodologically, interpretivists implement subjective measurement and qualitative methodologies. It has been argued that the interpretivist approach is appropriate for studies attempting to obtain a more thorough understanding of phenomena in cultural and/or natural settings from the participant's point of view (Orlikowski and Baroudi, 1991). In IS research, interpretivism represents one strand and is increasingly attracting more research interest (Walsham, 1995a;Goldkuhl, 2012). Nevertheless, the interpretivist approach has also been criticised because of generalisation of unverified results and the viewpoint for investigations being too subjective (Tushnet, 1983;Williams, 2000).

Post-positivism was derived from a critique of some aspects of the positivist stance (Ponterotto, 2005). While positivists acknowledge that reality is objective and comprehensible, post-positivists support that the objective reality is imperfectly comprehensible (Lincoln et al., 2011). Additionally, whereas positivists state that researchers hold an independent position with respect to the subjects, post-positivists regard that the observation of subjects can be affected by the theories, background, knowledge and values of the researcher (Robson, 1993). Post-positivism has been considered as a paradigm that 'recognizes the flaws in classic positivism and acknowledges social construction, but also assumes that knowledge can best be gained through search for regularities and causal relationships among components of the social world' (Poole, 2009, p.584). Ontologically, post-positivists assume that reality exists but cannot be comprehensively understood by researchers because of their imperfect sensory and intellectual mechanisms (Fischer, 1998). Epistemologically, post-positivists support modified subjectivism by arguing that as a regulatory ideal, objectivity can only be approximated by humans (Johnson and Onwuegbuzie, 2004). Methodologically, post-positivists emphasise ‘critical multiplism’ by executing a pluralistic approach to the integration of quantitative and qualitative methods (Posey et al., 2013). As post-positivism is regarded as amending some of the criticisms of both positivism and interpretivism (Smith, 2006), IS researchers have adopted it to provide rich and precise insights into the meanings of IT to users (Guba, 1990;Poole, 2009)

Critical paradigms depend on critical theory for disrupting and challenging the status quo (Kincheloe and McLaren, 2002), which has been defined as ‘one of emancipation and transformation, one in which the researcher’s proactive values are central to the task, purpose, and methods of research’ (Ponterotto, 2005, p.129). Ontologically, critical theorists support that reality is based on people in society and is constructed through media, institutions and society (Guba and Lincoln, 1994). Epistemologically, critical theorists accept that knowledge is derived from power rather than the truth, ‘determined by the social and positional power of the advocates of that knowledge’ (Cohen et al., 2007, p. 32). Methodologically, critical theorists take a transformative position to initiate changes in practices and social relationships (Cecez-Kecmanovic, 2011). Critical research is described in the IS community as ‘socially critical research, which challenges established social conditions and institutions and oppressive forms of control, often enabled and supported by IS, which prevent the realization of humane, just and free organizations and society’ (Cecez-Kecmanovic, 2011, p.442). Thus, IS critical researchers always occupy explicit ethical and value positions to challenge the prevailing views of IS in society for transforming and disrupting the current social order (Klein, 1999;Cecez-Kecmanovic, 2011). Despite the long history of critical theory, studies that have applied a critical paradigm remain limited compared to those adopting the above three paradigms (Klein, 2009). The critical paradigm has been criticised on the basis of two main factors. One stems from the diversity of ideologies contained by it, which prompts researchers to argue that the level of critical theory is insufficient to encompass all the ideologies that belong to the critical paradigm (Guba and Lincoln, 1994). The second criticism argues that there is no distinctive methodological identified for this paradigm as methods for both positivists and interpretivists have been adopted to conduct research with the critical paradigm (Cecez-Kecmanovic, 2011).

Based on the above discussion of the four major research paradigms, Table 3-1 summarises the comparison between them within three philosophical dimensions: ontology, epistemology and methodology (Guba and Lincoln, 1994).

Table 3-1: Analysis of research paradigms from a philosophical perspective

Paradigms	Ontology	Epistemology	Methodology
Positivism	Naïve realism—‘real’ reality but apprehendable	Dualist/objectivist; findings true	Experimental/manipulative; verification of hypotheses; chiefly quantitative methods
Interpretivism	Relativism—local and specific constructed realities	Transactional/subjectivist; created findings	Hermeneutical/dialectical
Post-positivism	Critical realism—‘real’ reality but only imperfectly and probabilistically apprehendable	Modified dualist/objectivist; critical tradition/community; findings probably true	Modified experimental/manipulative; critical multiplism; falsification of hypotheses; may include qualitative methods
Critical	Historical realism—virtual reality shaped by social, political, cultural, economic, ethnic	Transactional/subjectivist; value-mediated findings	Dialogic/dialectical

Source: Guba and Lincoln (1994)

After comparing the four major research paradigms discussed above, the current study finally selected the post-positivist perspective to address the research questions. The reasons for the selection are twofold. First, the study supports the view of ‘approximately reality’ to state that the reality is objective but imperfectly comprehensible (Guba, 1990;Clark, 1998), which is consistent with the ontological assumption of post-positivism. Specifically, the current study aims to explore telepresence antecedents and their hierarchical structure in VWs; thus, the literature on both the construct of telepresence and the context of VWs provides some insights to understanding this pre-existing phenomenon. However, the literature review revealed that existing knowledge on this topic is sufficient in neither amount nor clarity to address the research questions and practical issues. Besides modifying some pre-identified factors, some new knowledge is expected to emerge from the current study for supplementing and improving relevant understanding of this topic. Additionally, from the methodological perspective, this study is of an exploratory nature rather than for the verification of developed hypotheses. This is associated with post-positivism's advantages with respect to the formation and verification of knowledge, which are providing more meaningful data and enhancing content validity (Gruner and Homburg, 2000;Kock et al., 2008;Guo et al., 2010). Therefore, the study takes post-positivism as its research paradigm, which is considered the most appropriate for the study.

3.2.2 The Research Approach

Based on the nature of the research topic and the corresponding research questions, research approaches can be generally classified into two categories: a qualitative approach and a quantitative approach (Neuman, 2002). Qualitative research is defined as 'exploratory, inductive, unstructured, open-ended, naturalistic, and free-flowing research that results in qualitative data' and quantitative research is defined as 'confirmatory, deductive, structured, closed-ended, controlled, and linear research that results in quantitative data' (Johnson and Turner, 2003, p.297). These two distinctive research approaches have different focuses in that the former highlights the importance of observations and words in presenting reality and/or depicting human beings in natural situations, whereas the latter emphasises the significance of numbers to reveal opinions and concepts (Amaratunga et al., 2002).

Debate over the relative superiority of qualitative and quantitative research is ongoing (Creswell, 2013). It has been argued that the two types have different virtues and the choice of a research approach should be based on the research situation (Yin, 1994;Goulding, 2002). To provide insights into the decision, researchers have compared qualitative and quantitative research from different perspectives (Trochim and Donnelly, 2001;Amaratunga et al., 2002;Creswell and Poth, 2017) (see Table 3-2).

Table 3-2: Comparison of qualitative and quantitative research

	Qualitative research	Quantitative research
Purpose	-To understand underlying reasons and motivations -To provide insights into the setting of a problem, generating ideas and/or hypotheses for later quantitative research -To uncover prevalent trends in thought and opinion	-To quantify data and generalise results from a sample to the population of interest -To measure the incidence of various views and opinions in a chosen sample -Sometimes followed by qualitative research, which is used to explore some findings further
Features	-Inquiry from the inside -An attempt to take account of differences between people -Aimed at flexibility and lack of structure, to allow theory and concepts to proceed in tandem -The results are said to be, through theoretical generalisation, 'deep, rich and meaningful' -Inductive—where propositions may develop not only from practice or a literature review, but also from ideas themselves -An approach to the study of the social world that seeks to describe and analyse the culture and behaviour of humans and their groups from the point of view of those being studied	-Inquiry from the outside -Underpinned by a completely different set of epistemological foundations from those in qualitative research -Involves the following of various states of scientific research -The results are said to be 'hard generalisable data'
Strengths	-Data-gathering methods seen more as natural than artificial -Ability to examine change processes over time -Ability to understand people's meaning -Ability to adjust to new issues and ideas as they emerge -Contribute to theory generation	-They can provide wide coverage of a range of situations -They can be fast and economical -Where statistics are aggregated from large samples, they may be of considerable relevance to policy decisions
Weakness	-Data collection can be tedious and require more resources -Analysis and interpretation of data may be more difficult	-The methods used tend to be rather inflexible and artificial -They are not very effective in understanding process or the

	Qualitative research	Quantitative research
	-Harder to control the pace, progress and end-points of the research process -Policy makers may give low credibility to results from a qualitative approach	significance that people attach to actions -They are not very helpful in generating theories -Because they focus on what is, or what has been recently, they make it hard for policy makers to infer what changes and actions should take place in the future

Source: Trochim and Donnelly (2001); Amaratunga et al. (2002); Creswell and Poth (2017)

Based on this comparison, a quantitative approach is suitable for research aiming to explain a phenomenon by developing casual relationships between constructs and testing corresponding hypotheses whereas a qualitative approach is appropriate for research attempting to explore a phenomenon that previous knowledge cannot explain (Creswell, 2013). Considering the situation of the current study, a qualitative approach is taken. The reasons for adopting a qualitative approach are twofold. First, based on the literature review in Chapter 2, the identified literature gaps require the application of the telepresence construct in the context of VWs as current knowledge on both telepresence and VWs is neither sufficient nor clear enough to provide an understanding of this specific phenomenon. As the major goal of qualitative research is to describe, clarify and explore a phenomenon, it is appropriate to provide abundant and valuable insights in the current study to address existing knowledge gaps (Guba and Lincoln, 1994;Ponterotto, 2002). Second, specifically considering the research objectives of this study—which are to explore telepresence antecedents and develop a hierarchical model of these factors in VWs—a qualitative approach can facilitate the achievement of these objectives with its exploratory nature to identify new factors and models that have not been identified in previous studies (Henning et al., 2004;Ridder and Hoon, 2009). Therefore, this study takes a qualitative approach as its research approach, as it is considered the most appropriate for the study.

3.3 The Study Artefact

As reviewed in Chapter 2, the context of VWs is a broad concept with the major purpose of simulating various features of the real world (Jarvenpaa et al., 2008). To achieve this purpose, there are diverse applications of VWs in education, collaboration, entertainment and business. To implement a study in this broad context, a specific study artefact is needed for the respondents to provide relevant and concrete information for the researcher to interpret (Peffers et al., 2007). Thus, the study artefact of virtual tours, defined as the simulation of an existing location for visiting and learning (Okada et al., 2001), is selected for the current study, based on the overall consideration of its representativeness of the context, practicability and suitability for the current study, as outlined in the following.

With respect to representativeness, virtual tours have been regarded as a typical representation of virtual informal learning environments (Tuthill and Klemm, 2002;Roussou, 2004;De Freitas et al., 2010), which refers to the educational aspect of VW applications as introduced in Section 2.3.2. It has been argued that informal learning, which indicates learning from experience, usually occurs in various places outside schools, such as museums and cultural heritage sites that can be simulated by virtual tours (Chen et al., 2012). According to (Pérez et al., 2010), in terms of education, culture and heritage education is a significant representation of informal learning, which can be digitally implemented by virtual tours. By adopting advanced technologies such as 3D modelling, panoramic techniques and VR techniques, a fully immersive VW can be created for a virtual tour to provide learners with innovative approaches to informal learning by experiencing and interacting with simulated museums and cultural heritage sites (De Freitas et al., 2010;Chen et al., 2012). Additionally, the representativeness of virtual tours in the context of VWs can be confirmed by their design purpose; VWs attempt to simulate every feature of the real world while virtual tours aim to simulate a museum or cultural heritage site for visiting and learning, which represents one specific aspect of experience in the real world (Okada et al., 2001;Jarvenpaa et al., 2008). Thus, virtual tours can be regarded as a proper study artefact to represent the research context of VWs for implementing the current study.

With respect to practicability, virtual tours, as a typical representation of VWs in the field of informal learning to simulate sites of interest, can contribute to both online knowledge and culture diffusion and the digital preservation of culture and heritage. Virtual tours create virtual environments in which users can be immersed to learn through observing and participating (Paradise and Rogoff, 2009). As one type of VWs, this also overcomes the regional limitations of real tours in that users can virtually visit simulated sites even if they are physically at remote places (Chittaro et al., 2004). Further, because of the simulated nature of VWs, virtual tours digitally preserve not only architecture and cultural relics but also visiting experiences from tourists' perspectives, which are expected to provide abundant and valuable information for culture preservation (Stanco et al., 2011). Moreover, as an alternative approach to tourism, virtual tours to some extent relieve pressure on physical places that may be caused by the volume of visitors. A well-known example of a virtual tour is the project Google Arts & Culture (https://www.google.com/culturalinstitute/beta/), which was launched on 1 February 2011 by Google. It has simulated thousands of the world's greatest museums and heritage sites using Google's Street View technology and with the cooperation of the museums and heritage sites (e.g., see Figure 3-3). Via Google Arts & Culture, users can virtually visit museums and cultural heritage sites to gain relevant knowledge and culture by 'walking' through the created virtual environments. Also, detailed information about the museums and cultural heritage sites, such as the layout of an exhibition and physical and contextual information about the architecture and artworks is also retained in virtual tours. Thus, considering this degree of practicability, the study artefact of a virtual tour is selected here to represent the context of VWs, which is expected to make additional specific contributions to both informal learning and culture preservation.

Figure 3-3: An example of a virtual tour

Some researchers have suggested that the context of virtual tours is suitable to investigate the construct of telepresence. Qiu and Benbasat (2005) argued that as telepresence indicates the concept of transporting users to remote physical places, it is particularly appropriate to study 'the immersive experience of a tour of virtual museums' (p. 337). Similarly, Choi et al. (2016) proposed that 'virtual tours of art exhibits, museums, and tourist destinations on the t' well illustrate the concept of telepresence (p. 48). The suitability of virtual tours for studying telepresence is mostly due to the design purpose of virtual tours, which is to simulate an existing location for visiting and learning and give users the feeling of being at the location (Okada et al., 2001). When users feel like they are physically being in the location that they are virtually visiting through a virtual tour, they have the feeling of telepresence. Thus, telepresence is a significant construct for the design of virtual tours, which also are likely to cultivate a feeling of telepresence and thus are suitable for the current study and its focus on the telepresence construct.

Considering their representativeness, practicability and suitability, virtual tours were selected as the study artefact for the current study. Further, it was decided to implement the study in China, for three main reasons. First, as an ancient civilisation with a history of more than 5,000 years, Chinese culture has associated with it a very large number of heritage sites and museums. By 2016, the number of registered museums in China had exceeded 5,000 and visitor volumes had exceeded 800 million. There are thousands of cultural heritage sites all over China. In the list of United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Sites, China has 52 heritage sites, ranking it second in the world (UNESCO, 2017). Thus, China has abundant resources and the demand for development of virtual tours of its existing museums and heritage sites to disseminate culture, relieve the pressure from the large visitor volume and preserve these places. Second, air pollution issues in China have gained great attention, which has influenced the undertaking of various outdoor activities by residents (Guo et al., 2016). Tourism is one of the more affected aspects as visitors must be physically present in the places they are visiting. In this sense, virtual tours can be regarded as one of the most appropriate solutions to issue because users can visit their destinations despite remaining indoors, by using computers. Thus, investigation of virtual tours in China makes a practical and valuable contribution. Finally, most of the famous museums in other countries have cooperated with Google Art & Culture, which produces virtual tours in the same format by using Google’s Street View technology. However, due to policy restrictions, museums and cultural heritage sites in China have decided to design virtual tours to meet their own requirements, and have created them in various formats and with different functions. Thus, the elements of Chinese virtual tours are more diverse, making them more appropriate for a study aiming to explore a greater range of possible constructs.

3.4 The Research Procedure

Based on the discussion in Section 3.2, a qualitative approach that uses interview to collect data is adopted in the study for two reasons. First, the research questions are based on ‘what’ questions attempting to identify possible factors leading to telepresence in VWs but the literature is insufficient to answer these. As a qualitative approach is of an exploratory nature, it is appropriate to address such questions using this approach. Second, the concept of telepresence is defined as the user’s subjective perception so the interview method will facilitate interpretation of related topics from the participant perspective.

Thus, adopting a qualitative approach, the major research procedures are:

- select an appropriate interview technique
- design the interview procedure
- conduct a pilot study and refine the interview design
- collect the main data
- analyse the data
- interpret the results.

Specifically, the selected interview technique is presented first, based on which the interview procedure in the current study is introduced. Following the designed interview procedure, a pilot study was conducted, according to which the design was refined. The data for the main study were then collected. Following data analysis, the results of the current study were interpreted and discussed. The following sections detail the research methods used in the study, including the data collection technique, the conduct of the pilot study, details of data collection and data analysis.

3.5 Data Collection Technique

As the major objectives of the study are to investigate the antecedents of telepresence and to develop a hierarchical structure of telepresence antecedents, a specific interview technique is required to not only explore telepresence antecedents but also identify the inter-relationships among the antecedents to enable building of the hierarchical structure. To achieve these goals, the laddering interview technique is of direct relevance as it is an in-depth, one-on-one interview technique used to develop an understanding of how users translate the separate constructs of a phenomenon into meaningful relations among them, following MEC theory (Reynolds and Gutman, 1988). Thus, laddering is selected to conduct the current study. This section focuses on the introduction of the laddering interview technique and the design of the associated interview procedure.

Laddering is ‘a technique that allows the researcher, together with the participant, to explore the rationale for, the meanings of, and the relationships between different constructs’ (Curtis et al., 2008, p.44). The ladder refers to a tool for researchers to reach richer information from the participants. By asking ‘how’, ‘why’ and ‘what’ questions about an elicited construct, this technique allows the researcher to understand both the broader context and the deeper meaning of an idea (Reynolds and Gutman, 1988).

Although the laddering interview technique was originally developed in clinical psychology study to understand patients’ core values and beliefs (Hinkle, 1965), as a simple and systematic way of establishing an individual’s core set of constructs on how they view the world, it has been adapted to other fields (Grunert and Grunert, 1995;Rugg et al., 2002;Roininen et al., 2006;Amatulli and Guido, 2011). In IS research, it has been widely accepted and used to derive a rich collection of perceptions about IS including systems features, why participants would want to use such features and the values and goals of system use (Tuunanen et al., 2006;Curtis et al., 2008;Tuunanen et al., 2010).

Laddering is a semi-structured qualitative method using a series of directed probes, typified by ‘why’ and ‘how’ questions, aiming to form sets of linkages between the key identified constructs at different hierarchical levels (Reynolds and Gutman, 1988). The open-ended response format of the technique contributes to its exploratory nature, which allows a level of freedom for participants to provide data via interview and for researchers to understand the data through the process of data analysis. Based on data collected during laddering interviews, a set of ladders or chains are formed and combined into association networks or hierarchical structures. A sample ladder is presented in Figure 3-4, which shows partial data collected from a respondent in a salty-snack study, beginning with the basic distinction between types of snack chips (Reynolds and Gutman, 1988).

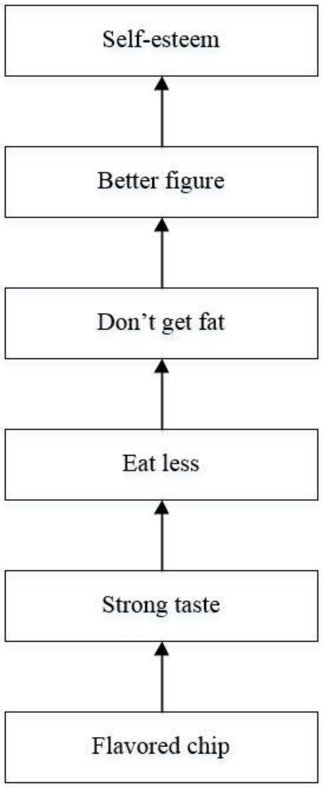


Figure 3-4: A sample of a ladder obtained in a laddering interview

Source: Reynolds and Gutman (1988)

According to the sample ladder, the basic distinction between types of snack chips, elicited by the respondent is ‘flavored chip’. The respondent perceived that a flavoured chip has a strong taste, which enables them to eat fewer chips and thus they do not get fat from eating them. As a result, they can retain a better figure, which directly leads to improved self-esteem. The chain was gradually built based on a series of ‘why’ and ‘how’ questions and corresponding answers in an interview between the researcher and the respondent. It can be seen from the chain that by utilising the laddering interview technique, the constructs were sequentially elicited by the researcher from the product’s attributes, ending with the personal motivations explaining the selection of the specific product (Reynolds and Gutman, 1988).

The adoption of the laddering interview technique can facilitate the achievement of the current research objectives, which focus on not only exploring telepresence antecedents but also developing the hierarchical structure of these antecedents. Considering the exploratory nature of the current study, this interview technique is the most suitable as it can provide further and better insights into participants’ understanding of some constructs

(Phythian and King, 1992). Specifically, by offering information on the different chains of factors identified from the interview, laddering can provide not only the content of the factors but also the inter-relationships between these factors and based on these relationships can build a synthesised hierarchical structure (Rugg et al., 2002). Laddering requires participants to logically reveal their inner mental mechanisms of the perception/motivation/evaluation from their own perspective (Grunert et al., 2001;Roininen et al., 2006). Thus, as telepresence is a complicated subjective feeling, laddering is suitable for studying it and exploring users' inner mechanisms of perceiving a telepresence feeling. Therefore, using laddering for interviews in the current study can address the proposed research questions involving the telepresence construct and solve identified practical issues with the context of VWs.

To perform laddering, the researcher uses a set of standard questions to move sideways, upwards or downwards from a starting point, which is also called 'elicited distinction' (Reynolds and Gutman, 1988). Accordingly, there are two major steps in laddering: eliciting distinctions and obtaining ladders, as follows.

3.5.1 Eliciting Distinctions

The laddering interview technique begins with eliciting distinctions made by participants regarding perceived meaningful differences between elements. The elements here indicate the objects of attention within the domain of investigation while the distinctions elicited are normally the attributes of the elements as the foundation for further laddering (Zanoli and Naspetti, 2002). Taking the sample ladder in Figure 3-4 as an example, the elicited distinction was identified as 'flavored chip', which is placed at the bottom of the ladder (Reynolds and Gutman, 1988). Based on this distinction, further questions were asked to build up the ladder and finally form the ladder in Figure 3-4. However, according to the literature, an elicited distinction can occur at any position on the ladder, based on which the ladder can be developed upwards or downwards (Reynolds and Gutman, 1984;Grunert and Grunert, 1995). Further considering Figure 3-4, the distinction elicited by the respondent can be 'eat less' when they first evaluate one specific element of a snack chip. Based on this distinction, the researcher can then move downwards by asking why the respondent wishes to eat less of this type of snack chip to further identify the factors of 'strong taste' and 'flavored chip' or move upwards by asking how 'eat less' can further influence their evaluation of the snack chip to gradually explore the factors of ‘don’t get fat’, ‘better figure’ and ‘self-esteem’.

The elicitation procedure is significant in the laddering interview as it determines the entire ladder to be extracted from the interview as a starting point (Reynolds and Gutman, 1988). Five main techniques have been widely employed in laddering studies: direct elicitation, free sorting, picking from an attribute list, ranking and triad sorting (Reynolds and Gutman, 1988;Botschen and Hemetsberger, 1998). Table 3-3 presents these five elicitation techniques, briefly introduces each procedure with an example, and discusses its strengths and weakness.

Table 3-3: Elicitation techniques for laddering study

Elicitation Technique	**Procedure**	**Example**	**Strength**	**Weakness**
Direct elicitation	Participants are asked directly to list specific types of an element's attributes.	Background: A list of mobile phone brands is provided: Siemens, Philips, Nokia, Ericsson, Apple, Motorola and Samsung. *Interviewer: What is the most important attribute for you in choosing a mobile phone from these brands?* *Interviewee: Long standby time is the most important attribute that I consider when choosing among these brands. I always travel around different cities for business. If the standby time for a mobile phone is short, it's very inconvenient.* <u>Distinction elicited: Standby time</u>	Stronger focus on idiosyncratic and intrinsically relevant attributes	While generating more relevant abstract attributes, distinctions elicited may have low discriminative and predictive abilities
Free sorting	Participants are required to divide a set of elements into groups that can consist of as many or as few elements as the participants organise. Participants are then asked to describe why elements are placed together and how they differ from other groups of elements.	Background: A list of mobile phone brands is provided: Siemens, Philips, Nokia, Ericsson, Apple, Motorola and Samsung. *Interviewer: Can you group these mobile phone brands based on your own opinion?*	Attributes created are more concrete than those from other techniques and have better discriminative abilities	Attributes created are regarded as less important than those generated by other techniques

Elicitation Technique	Procedure	Example	Strength	Weakness
		Interviewee: Group1: Nokia, Philips; Group 2: Motorola, Samsung, Siemens; Group 3: Ericsson *Interviewer: How are the brands in each group alike, and how do they differ from the brands in the other groups?* *Interviewee: Brands in group 1 have long standby time, but the appearance is not as good as other brands. Brands in group 2 have a beautiful appearance, but the physical quality is not good enough. Brands in group 3 have better keyboard arrangement.* <u>Distinction elicited: Standby time, appearance, keyboard arrangement</u>		
Picking from an attribute list	Participants are required to choose attributes that are significant to them from a list of attributes provided by a researcher. The attributes offered can be created by using a focus group or can be based on the relevant literature.	None	Clear research goals and structure	Attributes created have less predictive ability; researchers' knowledge may influence participants
Ranking	Participants are asked to rank elements according to preference,	Background: A list of mobile phone brands is provided: Siemens, Philips,	Higher predictive ability than other techniques	Generates fewer attributes than other

Elicitation Technique	Procedure	Example	Strength	Weakness
	and to state the reason for the ranking.	Nokia, Ericsson, Motorola and Samsung. *Interviewer: Can you rank these brands according to your preference?* *Interviewee: 1) Nokia, 2) Motorola, 3) Siemens, 4) Samsung, 5) Ericsson, 6) Philips.* *Interviewer: Why do you like the first brand more than the second one?* *Interviewee: Nokia has long standby time compared to Motorola. I don't need to recharge it every day.* *Interviewer: Why do you like Motorola more than Siemens?* *Interviewee: Many people are using Motorola and recommending it to me. It has a brand reputation, and it is easy to access after-sale service.* *Interviewer: Why do you like Siemens more than Samsung?* *Interviewee: Because…* Distinction elicited: Standby time, reputation, easy access to after-sale service		techniques; time consuming

Elicitation Technique	Procedure	Example	Strength	Weakness
Triad sorting	Three elements (a triad) are randomly selected from the pool. For each triad, the participant is asked to identify a way that two elements are similar yet different from the third. After obtaining the attributes, the three cards are returned to the pool and participants are asked to select another three cards; the procedure is repeated until either no new distinctions can be elicited from a triad, or the participant becomes noticeably tired.	Background: A few cards are prepared, each printed with a car brand name. *Interviewer: There are no right or wrong answers. Choose three cards from the pool and take a moment to think about the three cars on the respective cards. (Lincoln Continental, Mustang, Cadillac are chosen by interviewee).* *Interviewer: Specifically, I want you to tell me some important ways in which two of the three chosen cars are the same, and thereby different from the third.* *Interviewee: First is about the different car makers: Lincoln Continental and Mustang are made by Ford, while Cadillac is made by General Motors. Second regards price: Lincoln Continental and Cadillac are luxury cars while Mustang is an economy car. (The three cards are returned to the pool and another three cards selected. This process is repeated.)* <u>Distinction elicited: Car maker and price</u>	Attains more concrete attributes; the generated attributes have better discriminative and predictive abilities	Generates irrelevant attributes

Source: Reynolds and Gutman (1988); Grunert et al. (2001)

Different techniques may lead to different sets of distinctions and thus to different ladders (Grunert et al., 2001). Meanwhile, there is no a priori way to determine which technique might be the most suitable for a specific study based only on the literature (Reynolds and Gutman, 1988). Thus, to select the appropriate elicitation technique, the situation of the specific study should first be considered to include or exclude some of the techniques (Corbridge et al., 1994). Additionally, a pilot study may be needed to test potential elicitation techniques and enable final selection to ensure the quality of the main data collection (Billé, 2010). In the current study, as there are significant literature gaps that challenge understanding of telepresence antecedents, no comprehensive and clear attribute list can be provided. Thus, the technique of picking from a list of attributes was excluded. Additionally, as free and triad sorting have similar strengths and weaknesses, only one was chosen for consideration. Accordingly, direct elicitation, ranking and triad sorting were selected for the pilot study to examine their suitability for the main data collection.

3.5.2 Obtaining Ladders

Based on elicited distinctions, researchers further extend the 'ladder' by asking a set of questions to move upwards or downwards from the starting one. By using an open-ended response format, a participant's answer can form a path that links the key constructs. When one ladder is completed, the interviewer turns to the next salient attribute for distinction elicitation and the laddering process is repeated. Laddering provides valuable insights by enabling respondents to reflect on the perceptions behind their experience through developing chains of inter-related attributes (Reynolds and Gutman, 1988). Thus, based on the exploratory nature of the current study, the laddering procedure identified factors leading to telepresence as well as the paths for these factors to form the whole hierarchical structure. To explicate the process of obtaining ladders, a sample interview of a study on user evaluation on mobile phones is provided here:

> **Interviewer:** You indicated that appearance is the most important attribute for you when choosing a mobile phone: why is that? (<u>Elicited distinction: appearance).</u>
>
> **Interviewee:** The mobile phone is not so important for me, it is a like an accessory for a girl. I like those with a beautiful appearance and colour, which fits my own taste.

Interviewer: Then suppose you were using one without a beautiful appearance: how would you feel?

Interviewee: I would wish to explain promptly to others, 'this is not mine…' (Factor: personal status; Ladder: appearance→personal status).

Interviewer: Why is that?

Interviewee: I think I am kind of afraid of others saying 'it's so ugly'. I care about other people's opinions. When I buy something, I always ask others, 'how do you feel about it?' (Factor: how others view the interviewee; Ladder: appearance→personal status→how others view the interviewee).

Interviewer: Why do you care about others' opinions?

Interviewee: I like socialising. I wish to be recognized by others in my friendship circle (Factor: maintenance of the respect from others; Ladder: appearance→personal status→how others view the interviewee→maintenance of the respect of others).

In this sample of a laddering interview about selection of a mobile phone the researcher began from an already elicited distinction—the appearance of the phones—to ask why this factor is important to the interviewee. When the interviewee provided an answer indicating the factor of personal status, the researcher asked 'why' questions to identify factors relating to how others might view the interviewee and about maintaining the respect of others. In this way, using a series of questions based on the interviewee's answers, a chain was formed regarding why the respondent selected a particular mobile phone: the appearance of the phone→personal status→how others view the interviewee→maintenance of the respect of others.

3.5.3 Summary

This section introduced the procedure followed in the laddering interview technique adopted in this study as the data collection technique. The elements are different virtual tours as the study artefact introduced in Section 3.3. The factors/constructs/attributes are telepresence antecedents and the elicited distinctions are telepresence antecedents, which are regarded as the starting points for the ladders. The ladders/chains refer to the relationships among telepresence antecedents, which finally are synthesised to reveal the mechanisms for how a feeling of telepresence is gradually cultivated in respondents' minds. Table 3-4 summarises the basic terms used in the laddering interview technique (Reynolds and Gutman, 1988) and links them to the current study.

Table 3-4: Terminology of the laddering technique used in the current study

Term	Definition	Application in the Study
Elements	The objects of attention within the domain of investigation	Virtual tour platforms
Factors/Constructs/Attributes	The research participant's interpretation based on the elements	Telepresence antecedents
Elicited distinctions	The perceived meaningful differences among different elements, which are used as the starting points for laddering	The elicited telepresence antecedents as the starting points for laddering
Ladders/Chains	The paths linking the factors/constructs based on the identified relationships between them	The paths of telepresence antecedents to reveal how telepresence is cultivated

In accordance with the major procedures of laddering interview, the study adapted the interview design to achieve the research objectives. First, before conducting the interview, it was arranged for participants to experience the elements; that is, different virtual tours. This is due to arguments made in previous studies that as telepresence is a subjective and moment-to-moment feeling, experiencing this feeling immediately before an interview rather than recalling a previous relevant experience can elicit more precise and rich information from a participant's perspective (Suh and Chang, 2006;Nah et al., 2011). Second, the current study adopted a suggestion of Whyte and Bytheway (1996) regarding element selection for the laddering interview: besides some specific elements, respondents can be asked to identify elements that they consider the best and/or worst to supplement a list of elements. This refinement of element selection can reduce limitations due to the researcher's selection of elements for participants and to summarising and comparing, to identify distinctions and constraints in the selected elements (Crudge and Johnson, 2004), which is expected to elicit more comprehensive distinctions for the laddering process. Thus, in the current study, four selected virtual tours were provided for participants to experience before their interview. Additionally, participants were asked to describe two extra virtual tours they imagined the worst and best in terms of cultivating a telepresence feeling. Thus, in total, six elements—including four provided by the researcher and two by the participant—were used in the laddering interview for the current study to elicit factors leading to telepresence; this is consistent with the suggested number of elements for laddering interview in previous studies (Hunter, 1997;Wansink, 2003)

The interview procedure for the current study is presented in Figure 3-5:

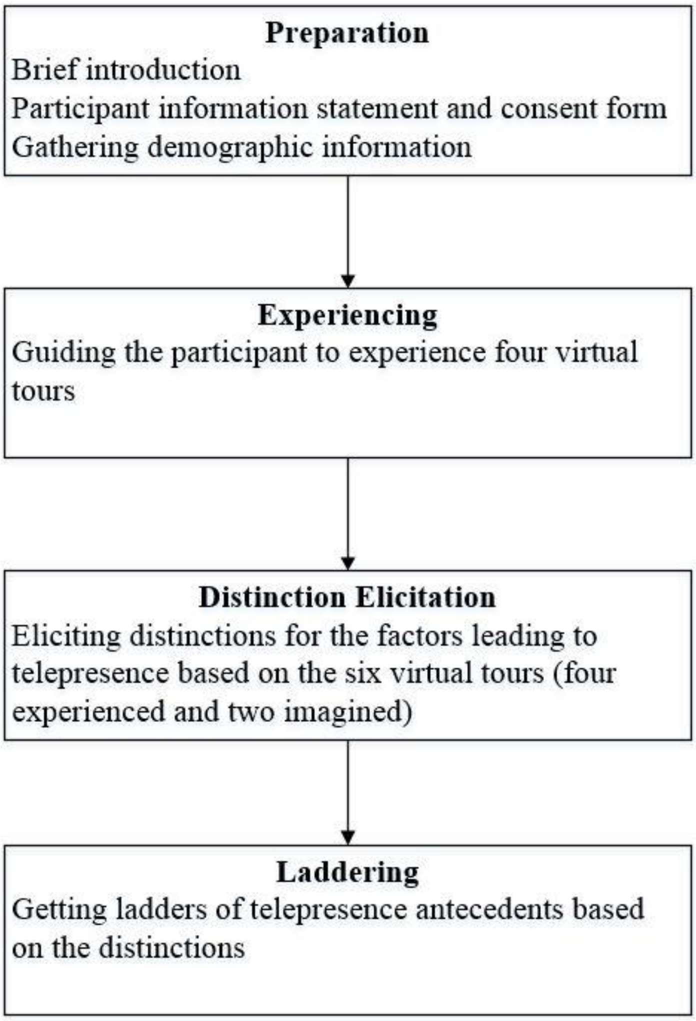


Figure 3-5: Proposed interview procedure

In this section, laddering interview as the data collection technique in the current study was described by explaining the reasons for selecting this technique, introducing the two major steps in the laddering interview and refining interview procedures for the current study.

3.6 Pilot Study

The selected laddering interview technique and the refined interview procedure were discussed in the previous section, leading into the data collection and analysis methods now discussed. In addition, as mentioned in Section 3.5.1, distinction elicitation techniques must be tested to select the most appropriate one for the main data collection. Thus, a pilot study was added before the main data collection. Table 3-5 presents the major procedures for the conduct of the current study, including three phases: the pilot study, main data collection and data analysis.

Table 3-5: Overview of the major procedures to conduct the study

Phase	Purpose	Procedure	Proposed Outcome
P1. Pilot study	To refine the interview procedure; specifically to select the appropriate elicitation technique for laddering in the study	-Pilot interviews using different elicitation techniques -Analysing and comparing to select the elicitation technique and to refine the data collection design	An appropriate method for the main data collection
P2. Main data collection	To collect data for the main study	Laddering interview: (1) eliciting relevant attributes (2) building the ladders	A series of interview data
P3. Data analysis	(1) To identify telepresence antecedents (2) To develop a hierarchical structure of telepresence antecedents (3) To conduct user segmentation	(1) Content analysis (2) Developing the hierarchical structural model (3) Cluster analysis	Telepresence antecedents, hierarchical structure of telepresence antecedents and user segmentation in VWs

This section focuses on presenting the conduct of the pilot study aimed at selecting the most appropriate distinction elicitation technique and refining the interview design. It has been argued that undertaking a pilot study with a relatively small sample before the main study can help a researcher to assess potential techniques and enable better choices as well as to correct any flaws in interview design exposed in the pilot study (Richins, 1983). To conduct the pilot study, a sample of nine college students was used. In the following subsections, the objectives, design, findings and conclusion of the pilot study are presented.

3.6.1 Objectives of the Pilot Study

As mentioned in Section 3.5.1, there is a range of distinction elicitation techniques that can be used in the laddering interview. It has been suggested that the researcher should select from among these techniques according to the specific situation of their study (Reynolds and Gutman, 1988). Thus, it was necessary to test potential elicitation techniques and select the most appropriate one for the current study. Moreover, flaws in the interview design may be exposed in the process of interview, which can then be resolved in advance to avoid the same issues occurring during the main data collection. Thus, the major objectives of the pilot study were to:

- test the proposed three elicitation techniques (direct elicitation, ranking and triad sorting) and choose the most appropriate for the main data collection
- identify potential problems in the interview procedure and accordingly refine the design.

3.6.2 Design of the Pilot Study

The pilot study followed the proposed interview procedures, which includes four main steps:

1) preparing and gathering demographic information
2) guiding the participants to experience the virtual tours
3) eliciting distinctions
4) building ladders.

In the first step, the researcher briefly introduced the study to the participant and then explained the Participant Information Statement and Consent Form as per ethical considerations. When the participant signed the consent form to agree to participate in the interview, a survey was used to collect the participant's demographic information such as gender, age, education, occupation and income. The collected demographic information was used to check the sample selection and coverage and to facilitate the description of the research results for user segmentation. A copy of the survey is provided in Appendix B.

In the second step, the participant was required to experience the virtual tours because as telepresence is a subjective and moment-to-moment feeling, experiencing the feeling immediately before interview can provide more precise and rich information on this construct (Nah et al., 2011). The virtual tours for experience are introduced in Section 3.7.2.

The third step involves eliciting distinctions as the starting points for the laddering process. As discussed in Section 3.5.1, five major elicitation techniques have been widely used in previous studies: direct elicitation, free sorting, picking from an attribute list, ranking and triad sorting. Without sufficient literature support, a comprehensive and clear list of attributes as telepresence antecedents cannot be prepared. Thus, the technique of picking from an attribute list was excluded from the current study. Free sorting and triad sorting involve similar procedures and have similar strengths and weaknesses; thus, only one (triad sorting) was selected as the potential elicitation technique for the current study. Therefore, for the current study, three distinction elicitation techniques were tested in the pilot study: direct elicitation, ranking and triad sorting.

The final step is related to probing the ladders based on the distinctions identified in the third step. A series of ‘why’ and ‘how’ questions were asked to obtain information on both telepresence antecedents and the relationships among them. Based on the factors leading to telepresence and the relationships, several chains were gradually built to explain how the participant perceived the feeling of telepresence in the virtual tours.

3.6.3 Findings of the Pilot Study

According to the pilot study design, nine interviews were conducted. As the first objective of the pilot study was to test potential elicitation techniques, the nine participants were randomly arranged into three groups corresponding to the three potential elicitation techniques (direct elicitation, ranking and triad sorting) so each group had three participants. The only difference among the three groups was that during distinction elicitation, a different technique was adopted for each group. Additionally, after the interviews, participants were asked to provide their opinions and suggestions regarding the interview. The distinctions elicited by different techniques during the pilot study are presented in Table 3-6.

Table 3-6: Distinctions elicited by the three elicitation techniques in the pilot study

Direct Elicitation	***n* = 3**	**Ranking**	***n* = 3**	**Triad sorting**	***n* = 3**
3D image	2	Picture quality	2	Texture of the 3D modelling object	2
Background music	2	Sound quality	1	Abundance of exhibition content	1
Brightness of the pictures	1	Arrow guide	1	Arrow guide	2
Ease of operation	1	Free choices of route	1	Control of avatar	1
Avatar	2	Comfortable feeling	1	Rhythm of the background music	1
Content type	1	Tool bar	1	Comfortable feeling	1
Viewing details	1	Ease of operation	1	Coherence of pictures	2
Environmental setting	1	Loading speed	1	Directional navigation	1
		Map	1	First-person perspective	1
		Feeling of engagement	1	Indoor and outdoor scene	1
		Location awareness	1	Loading speed	1
				Motion sensing	1
				Tool bar	1
				Virtual guide	1
				Visual angle	1
				Map	1
				Picture quality	2

Based on observations made during the interviews and comparison of the results, it was decided that triad sorting is the most appropriate technique for the current study to elicit distinctions for laddering, for three main reasons.

First, when comparing the distinctions identified by different techniques, it was found that the three potential elicitation techniques generated different numbers of distinctions. The distinctions provided by participants via direct elicitation were limited to the interface features; thus, there were fewer of them. However, by comparing the elements in different triads, the triad sorting group noticed more detailed factors leading to telepresence, which generated the largest number of elicitations involving a wide range of factors.

Second, the ranking technique reduced the expected effects of two elements imagined the best and the worst. When participants in the ranking group were asked to rank the elements, it was observed that as the best and the worst virtual tours had been set the position at the start and the end, the participants indeed only compared the four virtual tours they experienced in advance, ignoring the imagined two to elicit the distinctions.

Finally, the triad sorting group provided higher evaluations in their comments and feedback than did the other two groups. Two of the three participants in this group expressed that they thought the technique helped them to notice more details about their virtual tour experiences for eliciting distinctions.

Therefore, triad sorting was considered the most suitable distinction elicitation technique for the current study. Reynolds and Gutman's (1998) suggested that at least two techniques should be used to ensure no key distinction is overlooked. Comparison of the distinctions identified by the three techniques showed that the ranking technique produced a higher degree of content overlap with the triad sorting technique than did direct elicitation. Thus, the latter was adopted as the second elicitation technique in the study.

These findings regarding the distinctions identified by the three techniques achieved the first objective of the pilot study, which was to test the proposed three elicitation techniques and choose the most appropriate for the main data collection. With respect to the second objective, to identify potential problems in the interview procedure and accordingly refine the design, two major issues were identified during the process of interviews. First, when answering 'why' questions probing about telepresence antecedents, some participants mixed up factors leading to telepresence with those leading to successful systems, especially when the ladders were long and contained many linked factors. To address this issue, the interviewer must ask 'what' and 'why' questions emphasising the ‘leading to telepresence’ part, both at the beginning for distinction elicitation and during laddering. Specifically, at the beginning of the interview, the interviewer should emphasise that all the questions are focused on the feeling of telepresence. When eliciting a distinction, the interviewer should use questions highlighting telepresence antecedents, such as ‘What factors lead to the feeling of telepresence?’ or ‘What factors lead to different degrees of telepresence in different virtual tours?’ Further, when laddering based on the distinctions, instead of using the simple word ‘why’ or ‘how’, the interviewer should repeat the complete question each time—for example, ‘Why do you think this factor can lead to telepresence?’ —to remind participants that their answers should be focused on the telepresence antecedents. Second, during the process of laddering, it was observed that participants felt a lack of confidence or became impatient when continually being asked to answer repeated ‘why’ and ‘how’ questions. Some participants provided feedback and comments after interviews on this point, asking whether their answers were not sufficiently clear given that the interviewer continued to ask ‘why’ and ‘how’ questions. To address this issue, the interviewer should explain to the participants at the beginning of interviews that the repeated ‘why’ and ‘how’ questions are part of the research process based on the specific interview technique.

3.6.4 Conclusions from the Pilot Study

Based on the findings of the pilot study, including results from the comparison of the distinctions identified by different elicitation techniques and the comments and feedback provided by the participants after the interviews, the interview design was accordingly refined.

First, based on the distinctions identified by the three potential elicitation techniques, triad sorting was considered the most suitable technique for the current study. In addition, based on Reynolds and Gutman ‘s (1988) suggestion that at least two distinct methods are required for the elicitation of distinctions to ensure no key constructs are overlooked, direct elicitation was selected as the supplement. Thus, for the main data collection, triad sorting was first used to elicit distinctions for laddering. After completion of the whole process including distinction elicitation and laddering using triad sorting, the direct elicitation technique was then used to elicit other new distinction for laddering as a supplement. These two elicitation techniques are expected to provide abundant information for the study by generating a large number of distinctions for further laddering.

In addition, based on two major issues found during the pilot study, the researcher paid more attention to the details of how to conduct interviews. Further explanation of the questions and interview method was added to guide and remind the participants of the whole process of interviews.

In addition, open-ended questions about users' opinions on the design and experience of virtual tours were added to the end of the interviews based on the feedback from the participants, which is expected to provide the researcher with a better understanding of the research artefact and context and thus facilitate interpretation of the final results from the data analysis. The added questions were:

1) Do you have any previous virtual tour experience? If so, please briefly describe it. What was your purpose of experiencing it?
2) What are the advantages and disadvantages of virtual tours, compared to real tours?
3) Do you intend to experience other virtual tours by yourself in the future? If so, what is your purpose of using them? If not, why don't you want to use them?
4) For the current virtual tours, which feature would you like to see improved?
5) For future virtual tours, can you describe your ideal one, regardless of current technological limitations?

3.7 Main Data Collection

The results from the pilot study confirmed the appropriateness of using the laddering interview technique for the current study. Two elicitation techniques (triad sorting and direct elicitation) were selected after comparing the distinctions by different techniques in the pilot study. In addition, the interview design was refined based on participant feedback from the pilot study. The main data collection followed the refined interview design. In this section, details of the main data collection are provided, including an introduction to the research participants, description of the elements—virtual tours—and explication of the interview procedure.

3.7.1 Research Participants

As mentioned in Section 3.5, the current study design requires participants to experience the elements—virtual tours—and then be immediately interviewed on their telepresence experience on the virtual tours they have just taken. Thus, instead of asking them to recall previous relevant experiences, participants were interviewed directly after the experience. Accordingly, there was no specific requirement for participants to have previous experience of virtual tours; the only criterion for research participants was that they were at least 18 years of age. To recruit participants, the snowballing technique was adopted. The researcher contacted acquaintances and asked them to reach out to their personal networks to identify potential participants. To ensure that there was no possibility of coercion, the researcher allowed her contact details to be passed on to potential participants, allowing them to contact the researcher if they were willing to participate. After gathering a list of all potential participants (including names and email addresses), an invitation email was sent to each. Further contact was made to book an appointment time for interview with each potential participant. According to the literature, for laddering interview via the triad sorting technique, a pool of 15–25 participants is adequate to draw out constructs to address research questions (Tan and Hunter, 2002). In total, 25 participants were interviewed between July 2016 and September 2016 in China. Table 3-7 presents demographic information about the participants. Among the 25 participants, there were 12 males and 13 females and the gender ratio was equal. Most participants were young: 52% were aged 25–30 years; 20% were 19–24; and 20% were 31–35. In terms of education, 12% of the participants had a college degree; 64%, a bachelor degree; and 20%, a master degree or above. For monthly income, 28% earned 5,001–8,000 Yuan (~725–1,160 USD) per month; and 24% earned 3,001–5,000 Yuan (~425–724 USD) per month.

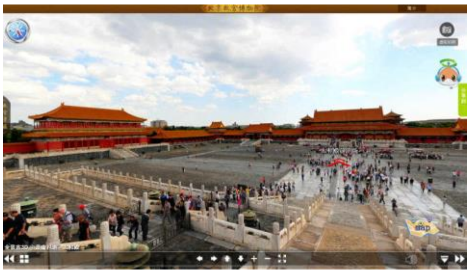
Table 3-7: Demographic information from participants (*n* = 25)

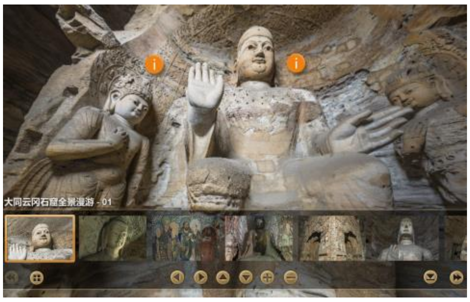
	Number	**Percentage**
Gender		
Male	12	48%
Female	13	52%
Age (years)		
19–24	5	20%
25–30	13	52%
31–35	5	20%
36–40	1	4%
>40	1	4%
Education		
High school	1	4%
Some college/Diploma	3	12%
Bachelor degree	16	64%
Master degree or above	5	20%
Occupation		
Student	4	16%
Sales person	4	16%
Administrative	4	16%
Human resources	1	4%
Accountant	3	12%
Clerk	4	16%
Research and development	3	12%
Teacher	1	4%
Consultant	1	4%
Monthly salary (Yuan)		
<1000	2	8%
1,000–3,000	3	12%
3,001–5,000	6	24%
5,001–8,000	7	28%
8,001–10,000	3	12%
>10,000	4	16%

3.7.2 Virtual Tours Experienced by Participants

As telepresence is the user's subjective and instant feeling, participants were asked to experience the study artefact—virtual tours—immediately before the interview, which allowed them to report their perception of telepresence rather than recalling any previous experience they may have. To select among available virtual tours, the researcher experienced more than 20 such tours and chose six that met the following criteria: 1) each had obvious differences from others so that comparing them would elicit more comprehensive information; 2) and the tour was presented in Chinese. A description of each of the chosen tours is provided in Table 3-8. All of the VWs were selected from public-access official websites of well-known places of interest or from well-accepted online touring platforms in China.

Table 3-8: Description of selected virtual tours for experiencing

Virtual Tour	Sample Screenshot	Description
Quanjingke.com http://www.quanjingke.com/		Quanjingke.com is the largest tourism-related VR producer in China, with 60,000+ panoramic pictures and VR videos from all over the country. On Quanjingke.com, users can view the panoramic pictures through adjusting view angle via operating the mouse or keyboard. The corresponding auditory narration is also with each presented picture.
The Forbidden City—360° Panoramic Virtual Tour http://www.dpm.org.cn/360overallview/		This virtual tour is from the official website of the Forbidden City and presents a 360° view of significant palace architecture and cultural relic exhibitions to make users feel like they are being in the places. On this website, users can virtually explore some inner space of the palace architecture and

Virtual Tour	Sample Screenshot	Description
		closely view the exhibition by clicking on it.
Baidu Baike Digital Museums http://baike.baidu.com/museum/		This platform involves cooperation between Baidu.com and many well-known museums in China. Users can use the platform to view cultural relics and through clicking on some relics, the Baike pages pop up to show the basic knowledge related to the relics.
Hunan Provincial Museum http://www.hnmuseum.com/hnmuseum/whatson/e_exhibitions/mwd/index.html		The Hunan Provincial Museum is an outstanding representation of provincial museums with respect to the development of virtual tours. Its online virtual showroom has clear audio explanations and virtual tours that provide informative knowledge for users.
National Art Museum of China http://www.namoc.org/en/exhibitions/online/		This platform offers users several virtual tours of exhibitions with different themes displaying modern and contemporary artistic works in China. During the virtual tours, users can access high-resolution images of the artworks in the museum.
3D Digital Lama Temple http://3dly.net/lama/		This system was developed via the SuperPolo Platform using the 3D modelling technique. It provides a digital simulation of the Lama Temple in a 3D virtual environment. In the 3D system, users can control the avatar to move around

Virtual Tour	Sample Screenshot	Description
		for exploring the Lama Temple.

From the pool of virtual tours, four were randomly selected for the participants to experience before the interview. As discussed in Section 3.5, to reduce limitations that may arise as a result of the selection of virtual tours for experiencing or due to current technological constraints in virtual tour design, two extra imagined virtual tours were added to supplement the elements; these were the worst and best virtual tours from the participants' perspective in terms of inducing telepresence. Specifically, after experiencing all the four randomly selected virtual tours, the researcher briefly introduced the meaning of telepresence—the feeling of 'being there' in the virtual environment. Then the participants were required to imagine two virtual tours, which would lead to the lowest and highest degree of telepresence from their own perspectives. The imagination of the two virtual tours could be based on but not constrained by the four experienced virtual tours. Then the participants were asked to depict the two imagined virtual tours in details, including the description of their features, functions, and experiences. Thus, through this process, some attributes related to influencing telepresence which are contained in the experienced virtual tours might be highlighted while some attributes which are not included in the experienced virtual tours could be supplemented in the study. As a result, the supplementation with these two additional virtual tours is expected to generate more distinctions than the four experienced virtual tours alone.

3.7.3 Interview Procedure

The conduct of the interviews for the main data collection followed the procedure refined as a result of the on the pilot study (see Section 3.6). Figure 3-6 summarises the refined interview procedure in a more intuitive way.

As depicted in the figure, there are five major stages in the interview procedure: preparation, virtual tour experiencing, eliciting distinctions, laddering and ending. These are described below.

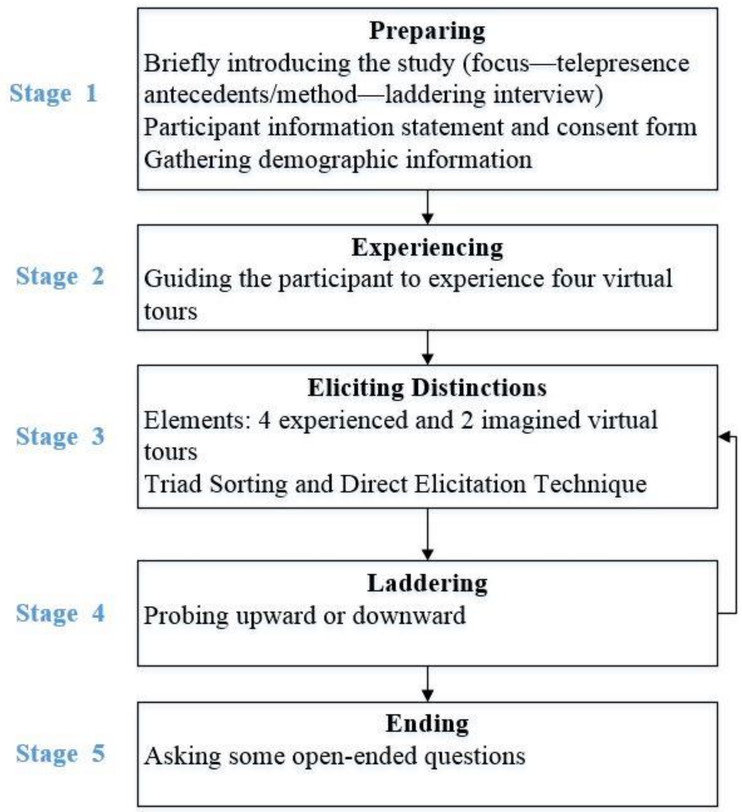


Figure 3-6: Refined interview procedure

3.7.3.1 Stage 1

In the first stage, the researcher first briefly introduced the current study to the participant. As discussed in Section 3.6, based on feedback from the participants in the pilot study, to guide and facilitate the interviews the researcher briefly introduced the concept of telepresence, the focus of the study (telepresence antecedents), and the method of interviewing (laddering). The researcher then handed the Participant Information Statement and Consent Form to the participant for reading and signing. The researcher explained the details in these documents if required by a participant. In addition, participants were promised protection of their privacy and were informed that audio recording of the interviews was required for further data analysis. Moreover, participants were informed that they had the right to decline recording and thus terminate their participation at any time. When a participant consented to participate in the interview, their signature was obtained on the consent form. The researcher then asked the participant to complete a demographic information survey designed to collect basic demographic information from participants, including gender, age, education level, occupation and monthly income.

3.7.3.2 Stage 2

In the second stage, before starting the one-to-one, face-to-face interview on telepresence antecedents in virtual tours, participants were required to experience four virtual tours. The reason for adding this step was discussed in Section 3.5. Briefly, as telepresence is a subjective and moment-to-moment feeling, interviewing participants immediately after their telepresence experience should provide more precise and rich information for further analysis. As introduced in Section 3.7.3, a pool of potential virtual tours for experiencing was formed. Participants were asked to randomly select four virtual tours from the pool for experiencing. As the virtual tours were all computer-based systems, a laptop with a mouse and headphones was provided for participants to experience the four selected virtual tours. They were told that there was no time limitation for them to experience each tour and that when they had experienced them, they could freely operate the systems by doing whatever they wanted just as they would usually do online. Participants were told that they could terminate each virtual tour if they wanted and continue to experience the next until all four VWs had been experienced. For this stage, the total time spent by participants on experiencing the four selected virtual tours ranged from 40 to 80 minutes.

3.7.3.3 Stages 3 and 4

After experiencing the four virtual tours, the one-to-one, face-to-face interview began and was recorded using a digital audio recorder. As discussed in Section 3.5, to supplement the four experienced virtual tours, participants were required to imagine two additional virtual tours that from their perspective were the worst and best virtual tours in terms of inducing telepresence. They were then asked to briefly describe the two imagined virtual tours, such as what did they look like and what major functions did they have. The titles of the six virtual tours (four experienced and two imagined tours) were then written separately on cards by the researcher.

According to the results of the pilot study described in Section 3.6, the triad sorting and direct elicitation techniques were used in stage 3 to elicit distinctions. The results from the pilot study showed that triad sorting can generate the largest number of factors leading to telepresence; thus, it was considered the main method for eliciting distinctions and was used to begin the laddering interview. Accordingly, the cards containing the titles of the six virtual tours as elements were turned over with the blank side upwards so that the participant would not know which card represented which virtual tour. The participant was then asked to pick three cards, and the researcher informed them which three tours they had selected. For each of the three cards (a triad), the participant was asked 'How are these two virtual tours similar and yet different from the third in terms of inducing telepresence?' and 'What factors cause this classification?' When a participant answered the question about classifying the three virtual tours, the two cards representing the virtual tours in one group were physically separated from the third according to their classification, which may help them to further explain the reasons for the classification. For each classification, the participant was asked to provide several words or phrases to describe the similarities and contrasts between the factors leading to telepresence until they could not identify any new factors. Then, for the same triad, the participant was asked about other ways to classify the three virtual tours so that two of them are similar and yet different from the third in terms of inducing telepresence, and what factors led to their decision. The classification process terminated when there were no more new ways to classify the three selected virtual tours. One round of triad sorting was then complete and the participant was asked to repeat the procedures by again randomly choosing three cards from among the six. After several rounds of triad sorting, when the participant could not identify any new distinctions from the newly generated triads and classifications—that is, theoretical saturation had been reached—the triad sorting was terminated. The technique of direct elicitation was then used as the supplement. After finishing the triad sorting process, the participant was asked to consider the six virtual tours together and directly identify new distinctions regarding the factors leading to telepresence to ensure no key constructs had been overlooked.

In the interviews, stage 4 of laddering ran in parallel to stage 3. When a distinction was elicited from stage 3 using triad sorting or direct elicitation techniques, further 'why' and 'how' questions were asked to obtain the ladders of telepresence antecedents. Based on the pilot study results and feedback, rather than simply asking 'why' or 'how', the interviewer repeated the complete question each time—for example, 'Why do you think this factor can lead to telepresence?' or 'How does this factor lead to telepresence'—to emphasise the focus on exploring factors leading to telepresence.

3.7.3.4 Stage 5

In the final stage, the following open-ended questions were asked, including the questions added based on the feedback of the pilot study and some questions to finalize the interview:

1) Do you have any previous virtual tour experience? If so, please briefly describe it. What was your purpose of experiencing it?
2) What are the advantages and disadvantages of virtual tours, compared to real tours?
3) Do you intend to experience other virtual tours by yourself in the future? If so, what is your purpose of using them? If not, why don't you want to use them?
4) For the current virtual tours, which feature would you like to see improved?
5) For future virtual tours, can you describe your ideal one, regardless of current technological limitations?
6) Do you have any supplementary information on virtual tours?
7) Do you have any supplementary comments on the interview?

The interviews lasted approximately 90–165 minutes, including 10–15 minutes for introducing the study and completing the survey, 40–80 minutes for experiencing the virtual tours and 40–70 minutes for asking and answering questions.

3.8 Ethical Considerations

Ethics approval was obtained on 16 June 2016 (No. HC16319) before data collection was undertaken for the pilot study and main study (see Appendix C). Participants were provided with a Participation Information Statement and Consent Form before interviews and were ensured that they would remain anonymous. Participants were also notified that they could review the findings summary and provide feedback if they wished. All participants and the researcher signed a consent form for both the pilot study and main study.

3.9 Data Analysis

The data analysis process was conducted in parallel with data collection, and thus began immediately after the first interview, which is expected to facilitate proper documentation. Specifically, there were three main stages in the data analysis: content analysis, development of the model of hierarchical structure and cluster analysis (see Figure 3-7). The details of each stage are illustrated in the following subsections.

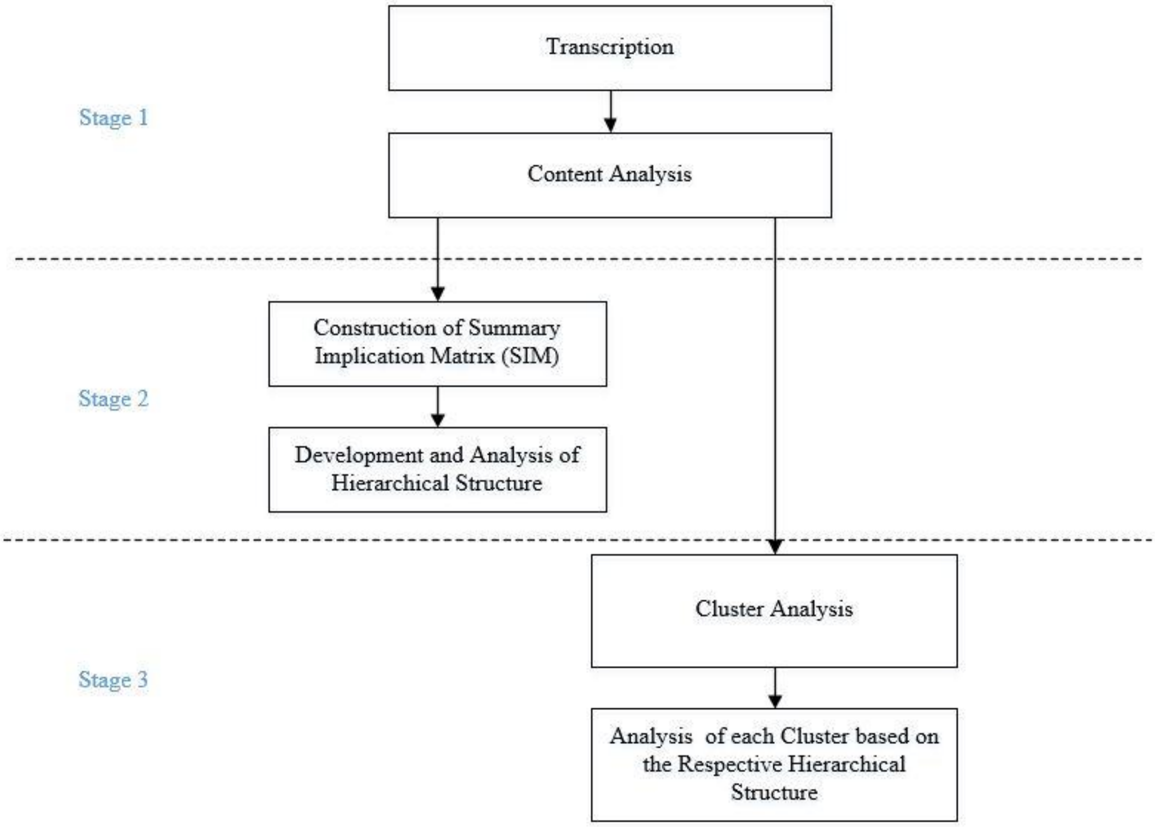


Figure 3-7: The procedure for data analysis

3.9.1 Transcription

As the interview data were collected in the form of audio recordings to provide complete information, verbatim transcription of the interviews was critical for documentation and further analysis to ensure the accuracy, validity and reliability of the study (Oliver et al., 2005). According to previous suggestions regarding transcription (Dortins, 2002;McLellan et al., 2003;Creswell, 2013), the researcher began the transcription by herself shortly after completion of the first interview. Thus, during the process of transcription, the researcher was able to immerse herself in the interview data to become familiar with, and develop a preliminary understanding of the content. Moreover, undertaking transcription shortly after completion of interviews can facilitate recall by the researcher of many instant memories from the interviews to capture any missing information and to highlight the key content, which may be helpful for further analysis

(Denzin and Lincoln, 2000). Approximately 122 hours was spent on the transcription process in total.

Following transcription of an interview, the transcript was incorporated into NVivo 11, which is qualitative data analysis computer software produced by QSR International. It has been acknowledged that this software facilitated the analysis of qualitative data and the production of professional results, which enhances research quality (AlYahmady and Alabri, 2013). Bazeley and Jackson (2013) suggested five major tasks for NVivo in data analysis: organising various forms of unstructured information; managing ideas by sorting data into categories; querying data for answering specific questions; creating relationships among conceptual data; and formulating reports on related data analysis. Thus, NVivo is regarded as ideal software to assist researchers to analyse qualitative data, and is expected to produce more reliable results (Gibbs, 2002).

3.9.2 Content Analysis

To analyse the transcribed data, content analysis was conducted as the first step. Defined as ‘a research technique for making replicable and valid inferences from data to their context’ (Krippendorff, 1980, p.21), content analysis was adopted in this study to classify unstructured data systematically into specific categories, to identify both the constructs and the relationships among them (Neuendorf, 2016). For this study, the content analysis began with coding to generate categories. The categories were then classified into hierarchical levels for further analysis of hierarchical structure. Finally, validity and reliability based on the content analysis was examined.

3.9.2.1 Coding

The core of data analysis begins with coding, which is utilised to reduce and analyse qualitative data (Saldaña, 2015). The major function of coding is to convert abundant unstructured data into an ordered and meaningful format (Marshall and Rossman, 2014). Through the process of coding, a researcher can categorise data representing different factors and relationships among factors into chunks with relevant quotes representing particular parts of the content to illustrate the major meanings and relationships relating to the research questions and to facilitate further analysis (Pandit, 1996;Bauer, 2000). Figure 3-8 shows the basic steps in the ongoing coding process, which are described further below.

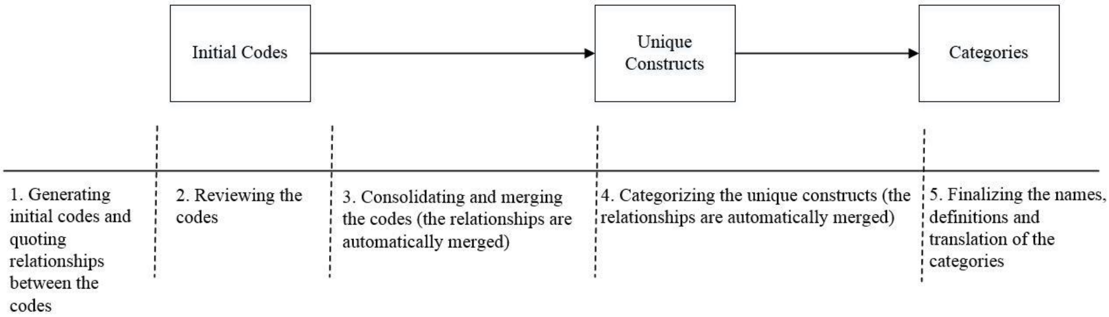


Figure 3-8: Coding procedure

First, initial codes are identified directly based on words and/or sentences used in interviews. Through the repeated verbatim reading of the transcripts, initial codes were generated along with the corresponding relationships among the codes. Thus, both the initial codes and relationships were coded to the related words and/or sentences via NVivo. An example of this coding procedure is given in Table 3-9. It has been suggested that at the first step, researchers should generate as many initial codes as possible to ensure that there are no missing significant codes (Braun and Clarke, 2006). In this step, for the first two interviews, two coders worked independently on the coding process and then their coding results were compared to calculate inter-coder reliability in terms of Krippendorff 's (1980) alpha value, to evaluate whether the researcher's way of coding was logical and reliable (Hayes and Krippendorff, 2007;De Swert, 2012). To calculate inter-coder reliability, the SPSS software was adopted and a SPSS macro developed by Hayes (2005) (http://www.afhayes.com/spss-sas-and-mplus-macros-and-code.html) was used to facilitate the calculation. Following the specific procedure in Hayes's (2005) study, Krippendorff's alpha value was calculated to show the inter-coder reliability.

The second step involves revising initial codes based on the rereading of transcripts. This is a process of adding missing information, deleting outliers and modifying misunderstandings through reviewing the initial codes and the corresponding relationships among them. The major purpose of this step is to recheck the results from the first step and correct any possible errors to ensure completeness and validity of the primary analysis results (Saldaña, 2015).

Table 3-9: A sample of coding

Quotation in Transcript	Initial Code	Relationships
Participant: This virtual tour (360° Panoramic Virtual Tour) provides clearer pictures and this is one of the reasons why I felt a comparatively high sense of telepresence in this environment.	Clear picture	Clear picture ↓ Sufficient information ↓ Form a holistic view ↓ Engagement Telepresence antecedents ↓ Telepresence
Interviewer: Could you explain why this factor led to your feeling of telepresence? Participant: If the picture in the virtual environment is clear enough, when I zoomed in I could see more details of the objects in the picture. I mean the clearer picture offered me enough information of the objects or the places.	Sufficient information	
Interviewer: Why does providing enough information about the objects or places lead to telepresence? Participant: The information helped me build the place in my mind. I obtained information from different parts of the virtual environment and finally formed a holistic view of the whole place in my mind.	Form a holistic view	
Interviewer: Why does a holistic view lead to telepresence? Participant: Then I can completely engage myself in the place I built in my mind so consequently I felt being there in the virtual environment, which is a telepresence feeling.	Engagement	

The third step involves the process of consolidating and merging initial codes into unique constructs to express the core concepts in the data. The revised initial codes were checked based on their commonalities and those presenting common points were combined into one unique construct. This step consisted of two rounds of code merging. In the first round, initial codes expressing the same meaning were merged. For example, ‘clear picture’ and ‘high-resolution image’ are the same and were combined into the code of ‘image resolution’. Then, in the second round, the codes expressing different meanings but with clear connections to describe one specific idea were consolidated into a unique construct. For instance, ‘sufficient information’ and ‘information overload’ were mapped to the unique construct of ‘appropriate amount of information’. After the two rounds, the initial codes were merged into unique constructs and the identified relationships among these were automatically changed according to the merging of codes via the NVivo software. For example, the original relationship between ‘clear picture’ and ‘sufficient information’ was automatically changed to the linkage between ‘image resolution’ and ‘appropriate amount of information’ when the initial codes were merged into the unique constructs. Two researchers worked on this step of consolidating and emerging the codes based on the discussions in the relevant literature and finally all disagreements were addressed through discussion between the two researchers.

In the fourth step, the unique constructs were classified into a broader level of categories to represent more abstract ideas from the data. For this process, the study followed the procedure suggested by Jankowicz (2004). First, one unique construct is compared to the other; if they are similar, they are both allocated under a single category created to contain them. If they are different, they are placed into different categories. The remaining unique constructs are then compared with each existing category and allocated to the appropriate category, if such a category already exists. It is evident that if a new category is generated, repeated refining of previous categories and their unique constructs is required, including merge, splitting and reallocation. This process is ongoing until all unique constructs have been categorised. For this process, two researchers worked on categorisation of the unique constructs based on discussions in the relevant literature, particularly that on the measurement and description of potential categories. Finally, through discussion, the two researchers reached an agreement on the categories.

The final step is related to the finalising of results from the content analysis. It has been argued that content analysis is an iterative process in which small modifications are continuously made for more clarity during the whole process of data analysis (Padgett, 2016). As the identification and refinement of unique constructs and categories is based on the literature, a coding book to define and describe each construct and category was created at the beginning. With continuous modifications, the coding book was accordingly revised throughout the process of data analysis. The original transcripts of interviews were in Chinese and were not translated into English for coding to avoid the loss of any significant meaning during translation. At the beginning of the coding process, transcripts were coded in Chinese. When unique constructs were created, they were translated into English based on Brislin ‘s (1970) back-translation method to ensure accuracy and avoid bias. The first step in the translation process was that two bilingual experts with virtual tour experience were provided with the constructs generated in Chinese as well as sample quotations from the transcripts for each construct, and required to translate the constructs from Chinese to English. The provided sample quotations were used to ensure the accuracy and reliability of the translation results. The researcher then checked the translation results and used them to create the list of constructs in English. After that, the construct list in t was provided to two bilingual experts to translate back into Chinese. The translated Chinese list of constructs was compared with the original list of unique constructs identified in Chinese to ensure translation accuracy.

3.9.2.2 Classification of Categories into Hierarchical Levels

To facilitate further analysis of the hierarchical structure of telepresence antecedents, the identified categories were classified into three basic hierarchical levels: givens, means and ends. According to the literature (Kanungo et al., 1999;Kanungo, 2009;Anantatmula, 2010;Guo et al., 2011), 'givens' are independent or influencing factors that have a significant influence on the factors above them in a hierarchical structure. They can be considered as the input or trigger of the chain to explain or affect the experience or behaviour in IS (Kanungo, 2009). 'Means' are the linkage or relay factors, which take the role of strongly linking other factors in the hierarchical structure. Any factors leading to them have further consequences so an understanding of this level represents the interpretation of the mechanisms of the linking relationships (Iyer and Sagheer, 2009). 'Ends' are the dependent or result factors, which are the ultimate outcomes of the influence of other factors in the hierarchical structure. An understanding of this level provides insights into how users finally respond to the IS (Guo et al., 2011).

Two researchers worked on the classification process and agreement on the classification results was finally reached via discussion. Although the classification was made subjectively by the researchers, an index of 'abstractness' of each construct was utilised as a reference for the classification, which is expected to add more validity and reliability to the results. The index of abstractness was borrowed from the method of social network analysis (Scott, 2017), which has been adopted to indicate the likelihood that a specific construct is allocated to a hierarchical level (Pieters et al., 1995). The abstractness of a construct is calculated as the ratio of in-degree, to in-degree plus out-degree of the construct; it ranges from 0 to 1. The in-degree indicates the number of times a construct is the destination for other constructs, accumulated across participants and ladders; the out-degree is the number of times a construct is the origin of a relationship with others, accumulated across participants and ladders. Based on comparison of the abstractness of all constructs, a higher index means a greater likelihood that the construct is the destination rather than the origin. Thus, in a hierarchical structure, constructs with higher abstractness are more likely to be the 'ends' whereas those with lower abstractness are more likely to be the 'givens', which provided a reference for the classification of categories into hierarchical levels in this study.

3.9.2.3 Validity and Reliability

Validity refers to 'the extent to which a concept, conclusion or measurement is well-founded and corresponds accurately to reality' (Ekstrand et al., 2013, p.771) and reliability indicates the consistency of findings (Schmidt et al., 2000). It has been argued that both validity and reliability should be considered to ensure research quality (Merriam, 1995). Thus, several methods were used to ensure validity and reliability in this study.

To ensure validity of the study, two major features were considered: internal validity (accuracy of the results) and external validity (generalisability of the results) (Godwin et al., 2003). To ensure internal validity of the study, the whole process of data collection was anonymous and confidential: from the interview to the analysis stage, all participants and their interviews and transcripts were identified by unique identification codes. All participants were informed of the consent, confidentiality and protection arrangements for the data provided by them. This design built the trust of the participants, which encouraged them to provide accurate information during the interviews to achieve credibility in the study. As a result, no participants terminated their participation in the study. Additionally, after completion of the transcription, the researcher sent five participants the transcripts of their interviews for checking and reviewing. This step provided the participants chances to add or/and edit their transcripts when they felt some of their answers in the transcripts were incomplete or unclear. This step of member checking is expected to ensure accuracy and credibility to some extent. Further, a pilot study was conducted to check the validity of the research design. Revisions were made to improve the design and maintain internal validity.

With respect to external validity of the study, based on the fundamental information collected from participants, the sample for the study has relatively even distribution on the range of age, education, occupation and salary. Thus, the findings are general to be adopted in studies on other users. Moreover, the data analysis process was supported by relevant literature from various contexts; through this process it was found that some of the constructs identified are consistent with findings in other research contexts.

To ensure reliability, exceedingly careful attention was paid to consistency throughout the research process. For the data collection, semi-structured interviews were conducted and when the first interview was completed the corresponding transcription and analysis was begun in parallel with subsequent interviews. Thus, there was an ongoing inspection of data to maintain high consistency. Moreover, the laddering interview technique, which is regarded as a sound and reliable technique to provide deeper understanding of phenomena (Grunert et al., 2001;Wansink, 2003), was adopted to collect the data to ensure their reliability. For the transcription process, the researcher required five participants to check the transcript of their interviews and revise it to make sure the transcription process was reliable. Independent coders and researchers participated in the data analysis process to test and establish the reliability of the analysis results. Specifically, for the coding process, two coders worked separately on the first two transcripts and the coding results were then compared to calculate inter-coder reliability (Krippendorff, 1980;De Swert, 2012). Any disagreements in coding were then discussed and addressed and these discussions guided the following coding process. Similarly, two researchers worked on the consolidation and categorisation step and addressed disagreements through discussions to ensure reliability.

3.9.2.4 Summary of Content Analysis

In Section 3.9.2, the procedure for content analysis was introduced to outline how the data were coded and consolidated into unique constructs and categories and how the identified categories were classified into hierarchical levels. The validity and reliability of the results from the content analysis were discussed. In the following sections, the process to develop the hierarchical structure of telepresence antecedents is presented.

3.9.3 Constructing a Summary Implication Matrix

Based on the results of content analysis, the frequencies with which a relationship between identified categories was indicated, were utilised to construct a matrix known as a summary implication matrix (SIM) (Reynolds and Gutman, 1988). In a SIM, the number of times each category leads to others is shown. Thus, it is a square matrix. Taking matrix Z as an example, the element Z_{ij} reflects the number of times category *i* leads to category j, summed across participants. In a SIM, there are two types of linkages: direct linkages and indirect linkages (Reynolds and Gutman, 1988). In the same ladder, when two factors are directly connected the relationship between them is a direct linkage; when two factors are in the ladder but separated by one or more other factors the relationship between them is indirect linkage. For instance, in a ladder linking factor A to B to C to D, A to B is called a direct linkage whereas A to C is an indirect linkage. It has been suggested that both direct and indirect linkages should be considered to understand the importance of the path as a direct linkage that occurs as high frequency may also provide significant information (Reynolds and Gutman, 1988). Direct linkages aggregated across participants can be gleaned from the content analysis results in NVivo and indirect linkages can be calculated by drawing out the relationships mentioned by each participant (Xiao et al., 2017)

Table 3-10: A sample of a summary implication matrix

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	G19	G20	G21	G22	G23	G24	G25	G26	G27
G1			4					4	4	2		0:01		0:01	0:01	21:03	0:01			5:07	4		0:09	1:02	2:04		
G2	1		1									0:02	5		3	6:01	11:01		0:01	0:01	0:03		0:04				
G3	1			1				1	2	1		0:02	7			22	2		1:01	1:05			2:09	0:02	0:06		
G4	1											33	3		4	1:03	1	0:01	4	1	1:01		1:01	2:04	1:09	0:01	0:10
G5			1											37	0:01	0:02	3	2:01	0:01			18:09	2:07	0:25	2:11	0:07	0:10
G6												0:01	20	1	1				1	7	1:02	0:01		0:13		0:02	0:02
G7													5	0:01			6	1	1		3:02		1:01	0:04	1	0:01	
G8				1			1					4:15	4:01	0:01	27	9:01	6:01	0:02	1:02	2:04	1:02		3:05	1:05	2:01		0:03
G9												1				6:01				2:01			0:03	1:01	2:02		0:01
G10	1								1		2		4:01	0:01	1	14:01	1:01		0:02	21:02		1	0:01	3:06	2:06	0:01	0:02
G11							20						1:04	0:01		1	2:06	0:01	0:01	0:01	0:04		1:02	1:03	1:01	0:02	
G12														2		2			1					12:01	8		8
G13												2							1	1	9	1	1	13:02	0:02	3:02	3:01
G14																		0:01	1			12	2:01	14:05	6:02	7	7:02
G15				1								24	2:01	1:02		3		2	5	2	1		6:01	0:07		2:01	0:03
G16																	2		0:01	14			13:01	2:02	13:03		
G17												0:02			1			2	1:01				7				
G18																											1
G19														2											2	1	2
G20																1:01	1		1:01				5	7:01	3:01	1	2
G21																							1	7	1	2	2
G22														1		1							5	17	6:01		5:01
G23																									9		
G24																1							2		8		7
G25																											
G26																											
G27																									2		

Source: Xiao et al. (2017)

A sample of a SIM is shown in Table 3-10. In the square matrix, the indexes of the constructs are listed in the row and column headings. The number in each cell represents the frequency of linkages with direct linkages to the left of the colon and indirect linkages to the right. For example, the number 5:07 for G1 to G20 in the SIM means that five participants mentioned that G1 can directly lead to G20 and seven participants mentioned that G1 can indirectly lead to G20 through other constructs.

The SIM not only depicts the relationships among the identified constructs but also presents the frequencies of the relationships, which can be considered as the basis to develop a hierarchical model of the constructs for further and more direct interpretation of the analysis results.

3.9.4 Constructing the Hierarchical Structure

Based on the SIM, a hierarchical structure known as a HVM can be developed to directly present the inter-relationships among the identified constructs (Reynolds and Gutman, 1988). There are three major steps in this process. The first involves determination of a cut-off value to highlight the essential meanings of relationships. Second, a hierarchical structure is developed. Finally, the relative importance of constructs is calculated to identify significant factors at each hierarchical level.

3.9.4.1 Determination of the Cut-Off Value

It has been argued that a HVM containing all relationships showed in the SIM may become too complex for interpretation, in which case it cannot present the core meaning to the researcher (Leppard et al., 2004). Thus, a cut-off value can be used to remove the relationships below the value and create a simpler structure for improved understanding. However, if the value is so high that few linkages are included in the structure, significant information may be ignored. Thus, the cut-off value must be carefully selected to balance the sufficiency of the provided information and the simplicity and clarity of the HVM (Botschen and Hemetsberger, 1998).

To select an appropriate cut-off value for constructing a HVM, this study adopted as a reference the method of sensitivity analysis proposed by Pieters et al. (1995), which has been widely accepted in previous studies. This method involves a comparison of the percentages of ‘active cells’ and percentages of ‘active linkages’ at a given cut-off. Active cells are those with entries at or above the given cut-off level and active linkages are the connections presented in the active cells. Table 3-11 shows an example of the use of this method to select the cut-off value.

In Table 3-11, column 1 shows given cut-off levels from 1 to 5. Column 2 indicates the number of active cells at each given cut-off value. Column 3 provides the percentage of all active cells that can be represented by each given cut-off level. Column 4 shows the total number of connections in the active cells at each given cut-off value. Column 5 presents the percentage of all active linkages that can be presented by each given cut-off level. For example, at a cut-off value of 5, 23 cells are active, which represents 19.66% of all existing active cells; the total number of active linkages at this level is 185, which represents 55.56% of the all existing active linkages.

Table 3-11: A sample of sensitivity analysis for selecting the cut-off value

Cut-off Value	**No. of Active Cells**	**Percentages of Active Cells**	**No. of Active Linkages**	**Percentage of Active Linkages**
1	117	100.00	333	100.00
2	62	52.99	278	82.48
3	49	41.88	267	80.18
4	25	21.37	220	66.07
5	23	19.66	185	55.56

It has been suggested that a cut-off value should be chosen to account for two-thirds of all relationships (Reynolds and Gutman, 1988). Additionally, with reference to the sensitivity analysis results, researchers should consider selecting a cut-off value that balances parsimony and goodness of fit (Pieters et al., 1995). Thus, in the example mentioned above, based on Table 3-11, a cut-off level of four was considered an appropriate value such that the HVM created at this cut-off level represents 66.07% of all relationships by using only 21.37% of all active cells in the SIM.

3.9.4.2 Development of the Hierarchical Value Map

With an appropriate cut-off value, the hierarchical structure can then be constructed based on the SIM. It has been suggested that at the beginning of the construction, it is necessary to recognise five potential types of linkages to clarify the process of construction (Reynolds and Gutman, 1988). These five types are listed in Table 3-12.

Table 3-12: Five types of relationships

Type of Relationship	**Description**	**Notes**
Adjacent – Direct	Constructs mapped as adjacent have a high number of direct relationships	The most common type, which represents the standard basis typically used in construction
Non-adjacent – Direct	Constructs mapped as non-adjacent have a high number of direct relationships	Constructs characterised by many direct relationships—although plotted separately because another construct exists between them—with strong direct relationships with both constructs
Adjacent – Indirect	Adjacent constructs have a high number of indirect relationships but a low number of direct relationships	Constructs that have strong indirect relationships are placed in an adjacent way because of the lack of an element with strong direct relationships with them
Non-adjacent – Indirect	Non-adjacent constructs have a low, non-zero number of direct relationships but a high number of indirect relationships	N–I is easily characterised because it presents constructs with many more indirect relationships that are thus placed separately
Non-adjacent – Zero	Non-adjacent constructs have a low (or zero) number of indirect relationships	Although this is a type of relationship in which there can be few or no relationships between the two constructs, these can be placed in a non-adjacent way owing to the sequence of relationships

Source: Reynolds and Gutman (1988)

Based on Reynolds and Gutman ‘s (1988) guidelines, once the five major types of relationship are understood, the construction of chains should begin from the first row of the SIM to search for the first active cell that has a number equal or superior to the selected cut-off value. Once the cell is found, the relationship between the two constructs is built and the search process begins again by moving down to the row that corresponds with the column of the previously identified cell. This process is repeated iteratively and when the end of the chain is reached, it returns to the beginning to check whether there is any other important relationship in the inspected row of the SIM. After finishing inspection of the first row via this process, the next step is to move to the second row and repeat the process again till the whole hierarchical structure is built.

3.9.4.3 Calculation of Relative Importance

After drawing out the hierarchical structure of the identified constructs, the relative importance of each construct is investigated to identify the constructs occupying the most important positions in the structure (Reynolds and Gutman, 1988). It has been considered that for hierarchical structures, the constructs that are more frequently connected to other constructs are more significant and should receive more attention in the analysis (Pieters et al., 1995). Thus, centrality, which indicates the degree to which a construct holds a central role in the structure, is utilised to represent the relative importance of a construct (Xiao et al., 2017). Centrality of a construct is calculated as the ratio of in-degrees plus out-degrees of the construct, summed over all cell entries in the SIM, ranging from 0 to 1. The higher the centrality, the more frequently the construct is involved in a relationship with other constructs, and thus the more significant is the construct.

3.9.5 Cluster Analysis for User Segmentation

Cluster analysis is defined as a multivariate statistical tool to classify individuals or variables (Lawless and Kulikowich, 1996). The aim of cluster analysis is to 'form groups in such a way that objects in the same group are similar to each other, whereas objects in different groups are as dissimilar as possible' (Kaufman and Rousseeuw, 2009, p.1).

As clustering is based on a set of measured variables and there is no mechanism for distinguishing between relevant and irrelevant variables for clustering, the selection of variables for clustering is significant and must be considered carefully (Everitt and Dunn, 2001). Additionally, with respect to techniques for cluster analysis, three major types have been widely accepted and applied: hierarchical cluster analysis (Langfelder et al., 2007), k-means cluster analysis (Wagstaff et al., 2001) and two-step cluster analysis (Wagstaff et al., 2001). It has been argued that different types of cluster analysis are suitable for different studies (Kaufman and Rousseeuw, 2009). Specifically, hierarchical cluster analysis suits studies that aim to examine solutions with an increasing number of clusters for a small data set, which can be used to provide a sense of the possible number of clusters as well as the way they merge. K-means cluster analysis is suitable for classification with a given number of clusters for a moderately sized data set. The two-step procedure is appropriate for large data sets with a combination of continuous and categorical variables. With respect to the specific situation of the current study, as the sample is relatively small and the number of clusters is still unknown, the study selected hierarchical cluster analysis to provide a reference point for the possible number of clusters and k-means cluster analysis to classify the sample. These two selected types of cluster analysis are detailed below.

Hierarchical clustering is a widely used method for identifying homogeneous clusters based on measured variables by building a hierarchy of clusters (Rokach and Maimon, 2005). This method begins with each separate cluster and then merges the clusters sequentially; thus, the number of clusters at each step keeps reducing until only one cluster remains. The forming of clusters is based on the distances among objects. As a result, this method organises objects into a dendrogram, which is Cluster 3; this presents the way the clusters have been joined as well as the distance between clusters at the time of joining. K-means cluster analysis is the most frequently used classification technique among existing types of clustering methods (Kuo et al., 2002). K indicates the number of desired clusters and the purpose of k-means clustering is to classify the subjects into k clusters where each subject belongs to the cluster with the nearest mean. The main procedures for both hierarchical and k-means clustering as described in the literature are summarised in Table 3-13.

Table 3-13: Procedure for the two selected types of cluster analysis

Clustering	**Procedure**
Hierarchical cluster analysis	Calculate the distance between all initial clusters
	Merge the two most similar clusters and recalculate the distances
	Repeat the second step until all initial clusters finally are merged into one cluster
K-means cluster analysis	Select the initial cluster centres
	Assign each subject to its nearest cluster based on the distance to the centroid
	Find the centroids of the clusters that have been formed
	Recalculate the distance from each subject to each centroid and move the subjects not in the cluster to the nearest cluster
	Repeat the above process until the centroids remain relatively stable

3.10 Chapter Summary

This chapter described the research methodology and justified the selection of the research approach and the specific data collection and analysis methods. To address the research questions, a qualitative approach was adopted in this study. Accordingly, interview data were collected and analysed via content analysis; associated analysis methods to build a hierarchical structure were adopted and presented in this chapter. In the next chapter, the results from the data analysis are presented.

Chapter 4: Data Analysis and Results

4.1 Introduction

Following the procedures described in Chapter 3, the analysis results are presented in this chapter. In the content analysis, 21 telepresence antecedents were identified and these were classified into three hierarchical layers. The relationships among the 21 telepresence antecedents were then summarised in a SIM, based on which the hierarchical structure of the identified telepresence antecedents was constructed. The relative importance of constructs was also calculated to interpret the structure. The cluster analysis results are illustrated for the segmentation of the users and the comparison among clusters. Figure 4-1 depicts the structure of this chapter.

4.2 Content Analysis Results

The first objective of this study was to explore telepresence antecedents. To achieve this objective, this section aims to the answer the following research question:

RQ1: What are the antecedents of telepresence in the context of VWs?

To answer this question, content analysis was conducted via three main steps to generate the content analysis results: data reduction; categorisation; and further classification of telepresence antecedents into three hierarchical layers for further analysis. The results from each step are presented in the following subsections.

4.2.1 Data Reduction Results

Using NVivo 11, transcripts of the interviews were first reviewed to code the raw constructs and relationships. Then, to reduce the data to allow clear interpretation, the raw data were further refined to generate the unique constructs. Eighty unique constructs were identified for telepresence antecedents. Following data reduction, these unique constructs were further categorised at a broader level and 21 categories were finally generated through this process. Each step is now discussed in detail.

In the first step, the transcripts of 25 interviews were initially coded by being reviewed sentence by sentence. To further explore the structure of constructs, the relationships among constructs identified in each interview were also coded in NVivo 11. Consequently, 264 raw constructs and 619 relationships were identified for telepresence antecedents.

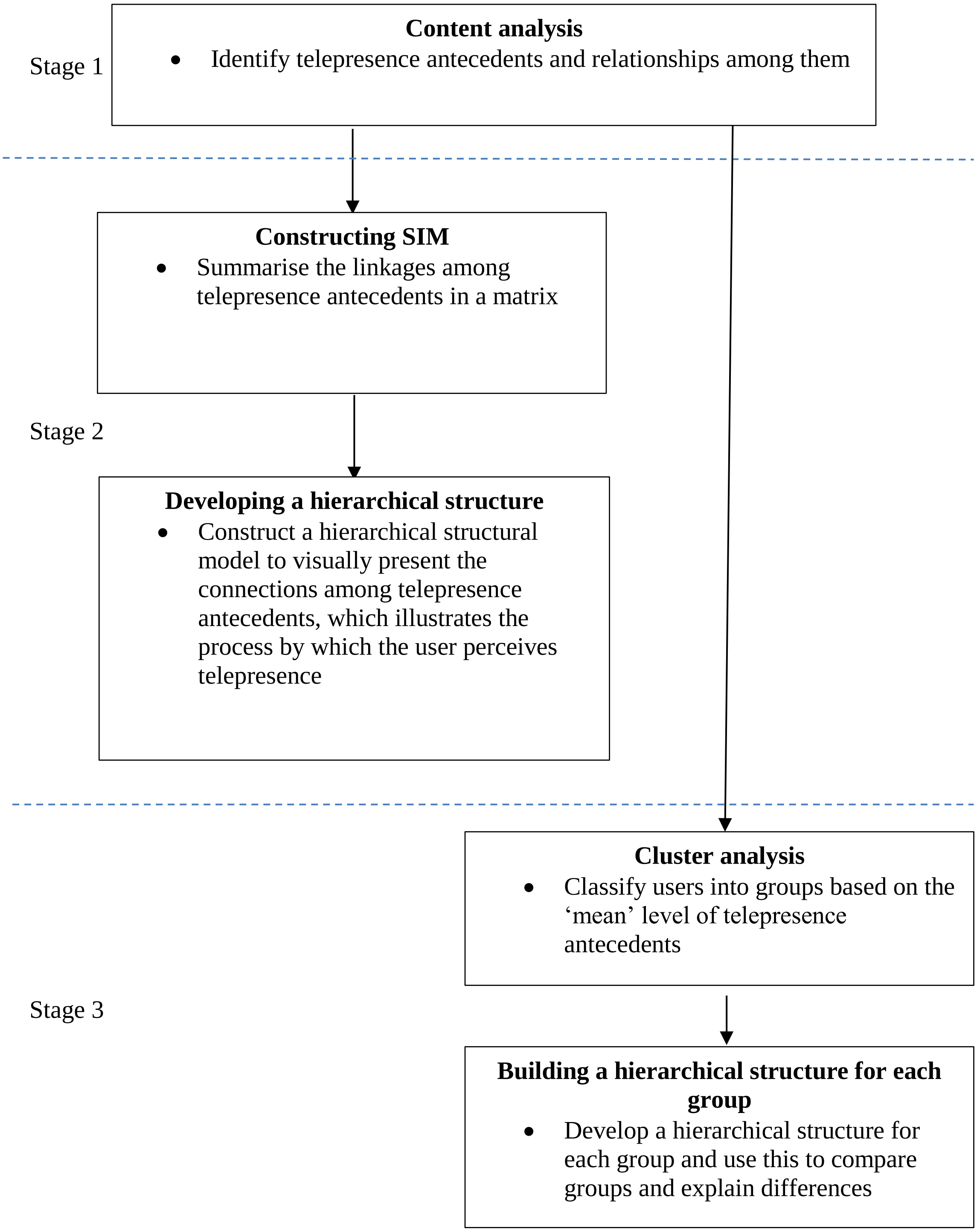


Figure 4-1: Chapter 4 structure

In the second step, the identified raw constructs and transcripts were reviewed for refinement. First, some content of the transcripts was reallocated to more appropriate raw constructs. For example, the coded content for the raw structure of ‘unexpected issue’ (e.g., ‘I came across a problem that the webpage of this virtual tour automatically shut down for no reason. This sudden problem immediately disturbed my feeling of telepresence’ [Interviewee No. 23]; ‘When I clicked the button the picture of this item should have popped up but nothing happened, which actually affected my sense of telepresence’ [Interviewee No.8]) was reallocated to the raw structure of ‘error-free’. After this process, all raw constructs were again reviewed and those expressing the same meanings were further merged. For instance, the nodes of ‘focus’ and ‘concentration’ were merged into the node of ‘focused attention’. After the merging step, the constructs expressing different meanings but with close connections were combined into a unique construct. For example, the constructs of ‘intention to use the virtual tour’, ‘intention to explore in the virtual environment’, and ‘intention to immerse in the virtual environment’ were mapped to the newly created unique construct ‘approach tendencies’. By utilising NVivo 11 for the process of merging the nodes (constructs), the relationships among nodes were automatically consolidated by the analysis software. Thus, after the data reduction process for telepresence antecedents, the 264 raw constructs were reduced to 80 unique constructs and the 619 relationships were finally reduced to 270 relationships. As the 80 unique constructs for telepresence antecedents were still too complicated to interpret, further consolidation of the results for telepresence antecedents was conducted by categorising the unique constructs, which is described next.

4.2.2 Categorisation of the Unique Constructs

To enable better interpretation of telepresence antecedents, the unique constructs derived from the data reduction were further classified into different categories. To make the categorisation results valid and reliable, a further literature review was conducted on related constructs and measurements in a variety of research fields including psychology, marketing, e-commerce and IS. Finally, 21 categories were generated after this categorisation. In addition, using the NVivo software, the 270 relationships among unique constructs were merged into 101 relationships among categories. Table 4-1 presents the results, including the categories of telepresence antecedent; the definition of each category; the unique constructs belonging to each category; the definition of each unique construct; and the frequency of categories and unique constructs.

Categorisation of the unique constructs was supported by the literature from previous studies and theory from various contexts. The construct of place profile was based on the construct of organisational profile (Shareef et al., 2008), describing the basic features of the place simulated by the virtual tour. The construct of atmospheric cues was borrowed from online retailing studies to indicate design features for creating an intended atmosphere (Davis et al., 2008). Thus, the cues related to the settings of virtual environment were included in this category. Unlike the atmospheric cues for establishing the atmosphere, visual content display and auditory content display refer to design features for displaying the major content of a place, such as the exhibition, architecture, culture or history, via visual and auditory channels, respectively (Frauenberger and Stockman, 2009;Deng and Poole, 2010). In addition to the visual and auditory channels identified as the major sensory stimulations for cultivating telepresence, multisensory co-stimulation reflects the combined effects from possible sensory channels on telepresence (Scalisi et al., 2006). Further, two specific function-related factors were compiled: spatial navigation, referring to the functions that navigate users in the virtual environment (Lind et al., 2013); and avatar characteristics, indicating the features of a virtual representation of the user in the virtual environment (Suh et al., 2011). Operational features describe a user's operation of the virtual tour (Laudon and Laudon, 2004). Interactivity was compiled based on the construct of interactivity from Steuer's (1992) classical model of telepresence antecedents. Information quality and system quality were categorised based on studies of the IS success model (Delone and McLean, 2003;Delone and Mclean, 2004;Petter and McLean, 2009).

Table 4-1: Telepresence antecedents identified in the content analysis and with reference to the literature

Index	Category and Unique Construct	*n* = 25	Description	Reference
1	**Place Profile**	21	The description of the place's features	
	• Place type	15	Refers to the type of the place simulated, such as museums (indoor scenes) or heritage sites (outdoor scenes)	
	• Place history	3	Describes whether the place has a long history	(Shareef et al., 2008)
	• Place background	12	Describes whether the place has a rich cultural background	
	• Place reputation	2	Describes whether the place is famous/known by many people	
2	**Atmospheric Cues**	21	Features relate to the settings of the virtual environment	
	• Lighting intensity	6	Refers to the image brightness of the virtual environment	
	• Colour	6	Describes whether the colour of the images of the virtual environment is vivid	(Sheng and Joginapelly, 2012;Zhang et al., 2016)
	• Background visitors	16	Describes whether other visitors can be perceived in the background of the virtual environment, in the form of a static human image or non-player character.	
	• Content matching of background music	8	Describes whether the background music in the virtual environment matches the cultural atmosphere of the place	

Index	Category and Unique Construct	*n* = 25	Description	Reference
	• Environmental sound	3	Describes whether the virtual environment provides a sound heard commonly in nature, such as a bird song, or a tree rustling sound	
3	**Visual Content Display**	25	Features of interface design to display the content in the virtual environment, which is related to visual stimuli	
	• Content display mode	21	Refers to the mode by which the content is provided, such as online texts and pictures, 360º real-scene panorama, 3D modelling or VR	
	• Image resolution	16	Refers to the clarity of the image to show the content details	
	• Consistency of image content	15	Describes whether when one image is switched to the next, the content transition is logical and coherent	(McIntyre, 2003;Hatcher and Aboudara, 2004;Kato et al., 2006;Deng and Poole, 2010;Hou et al., 2013)
	• Multiple visual angles	8	Describes whether the virtual tour provides multiple visual angles to view	
	• Naturalness of visual angle	9	Describes whether the visual angle provided by the virtual tour is as natural as the user's normal visual angle	
	• Visual distance	2	Refers to the perceived distance from the user's observation point to the focal objects in the virtual environment	
	• Field of view	5	Refers to the extent of the observable range of an environment that can be perceived by a user's eyes at a given moment	

Index	Category and Unique Construct	*n* = 25	Description	Reference
4	**Auditory Content Display**	9	Features of interactive design to display the content in the virtual environment, which is related to auditory stimuli	
	• Articulation of audio narration	2	Refers to the clarity of sound in the audio narration	(Malik and Lindahl, 2004;Frauenberger and Stockman, 2009;Clark et al., 2013)
	• Pace of audio narration	4	Refers to the speaking rate of the audio narrator	
	• Tone of voice of audio narration	6	Refers to the 'colouring' of the narrator's voice, such as whether the narrator sounds flat, bored, gentle or interesting	
5	**Multisensory Co-stimulation**	22	Refers to the co-stimulation from more than one sensory channel, which invokes more than one of a user's perception modalities	
	• Number of sensory outputs	14	Refers to the number of sensory channels that a medium utilises, including smell, temperature, touch, vibration and kinaesthetic sense	(Lombard and Ditton, 1997;Beeli et al., 2005;Scalisi et al., 2006)
	• Consistency of sensory outputs	20	Refers to the consistency of information in different sensory outputs; the information received through all provided channels describes the same objective world	
	• Synaesthesia	4	Refers to the involuntary physical experience of a cross-sensory linkage in which stimulation of one sensory pathway leads to automatic experiences in a second sensory pathway	

Index	Category and Unique Construct	*n* = 25	Description	Reference
6	**Spatial Navigation**	21	Describes the functions provided by a virtual tour for users to find their way around the virtual environment	(Theune et al., 2007;Lind et al., 2013)
	• Map	17	The virtual tour provides a map as a representation of the place showing physical features and routes	
	• Directional arrow	5	The virtual tour provides arrows in the virtual environment to indicate direction	
	• Planned route	15	The virtual tour provides a suggested route for the user visiting the place in the virtual environment	
	• Virtual guide	8	The virtual tour provides a virtual guide to simulate the real guide's functions to show the way to users	
7	**Avatar Characteristics**	10	The features of an avatar, which is a virtual representation of a user in the virtual environment	(Crawley, 2010;Suh et al., 2011)
	• Avatar’s person perspective	6	Describes whether the virtual tour provides the first-person perspective (the original point of view, as experienced during encoding) or the third-person perspective (an outsider’s point of view, as an onlooker) for the avatar	
	• Avatar similarity	6	Refers to the perceived similarity between the avatar's physical appearance and the user's physical appearance; the extent of an avatar's similarity is regarded as the degree of reflection of self-concept	
	• Avatar identification	2	Refers to the cognitive connection between an individual and an avatar, with the result being that the	

Index	Category and Unique Construct	***n* = 25**	Description	Reference
			individual regards the avatar as a substitute self or has such an illusion	
8	**Operational Features**	19	The characteristics of a user’s operation in the virtual environment	
	• Ease of operation	15	Refers to the degree to which a user regards that operating in the virtual environment is free of effort	(Segars and Grover, 1998;Laudon and Laudon, 2004)
	• Consistency of operation	15	Describes whether the operation in the virtual environment is coherent and fluent, without interruption	
9	**Interactivity**	25	Refers to the interactions that occur when users respond to the virtual environment	
	• Speed of interactivity	10	Indicates the rate at which input can be assimilated into the mediated environment	
	• Freedom of choice	20	Describes a user's opportunity and autonomy to perform an action selected from at least two available options provided by the virtual tour, unconstrained by external parties	(Steuer, 1992;Mollen and Wilson, 2010;Murray and Häubl, 2011)
	• Freedom of operation	21	Describes a user's opportunity and autonomy to operate freely in the virtual environment	
	• Mapping of interactivity	24	Indicates the ability of the virtual tour to map its controls to changes in the virtual environment in a natural and predictable manner	

Index	Category and Unique Construct	***n* = 25**	Description	Reference
10	**Information Quality**	24	The value perceived by a user of the output produced by the website information characteristics	
	• Appropriate amount	15	Refers to the extent to which the quantity or volume of available information is appropriate	
	• Accuracy	9	Refers to the extent to which information is correct, reliable and certified as free of errors	
	• Completeness	14	Refers to the extent to which information is of sufficient breadth, depth and scope for the task at hand	
	• Accessibility	3	Refers to the extent to which information is available or easily and quickly retrievable	(Wang and Strong, 1996;Lin, 2007)
	• Believability	4	Refers to the extent to which information is accepted or regarded as true, real and credible	
	• Value-added	11	Refers to the extent to which information is beneficial and provides advantages in use	
	• Ease of understanding	7	Refers to the extent to which information is clear without ambiguity and easily comprehended	
	• Representational consistency	6	Refers to the extent to which information is always presented in the same format and is compatible with previous information	
11	**System Quality**	16	Describes the evaluation of the virtual tour as an information system; refers to engineering-oriented performance characteristics	(Ahn et al., 2005)

Index	Category and Unique Construct	*n* = 25	Description	Reference
	• Functionality	4	Describes whether the virtual tour has good functionality relevant to the displayed content type	
	• Multimedia	6	Describes whether the virtual tour provides an appropriate multimedia presentation	
	• Error-free	9	Describes whether the virtual tour provides error-free content and operation	
	• Navigation to information	4	Describes whether the virtual tour provides easy navigation to information	
12	**User's Learning Profile**	19	Refers to the user's previous experience and knowledge related to the virtual tour experience	(Delone and McLean, 2003;Delone and Mclean, 2004;Limayem et al., 2007;Marquez et al., 2008)
	• User's previous online gaming experience	5	Refers to a user's experience with online gaming, which they can compare with the virtual tour experience	
	• User's previous online website browsing experience	4	Refers to a user's experience with traditional online website browsing, which they can compare with the virtual tour experience	
	• User's previous offline tour experience	5	Refers to a user's offline tour experience, which they can compare with the virtual tour experience	
	• User's previous knowledge on the place	12	Refers to knowledge of the place obtained by the user before the virtual tour experience	

Index	Category and Unique Construct	***n* = 25**	Description	Reference
	• User's offline tour habit	10	Refers to the extent to which people tend to perform behaviours automatically while visiting because of learning	
13	**User's Intrinsic Motivation**	22	Refers to a user's motivation to undertake a certain activity for its own sake: e.g., the activity is interesting, engaging or satisfying	
	• Satisfy curiosity about the place	17	Describes whether a user's motivation to experience the virtual tour is based on their interest in the place; by experiencing it they can satisfy their curiosity about the place	
	• Obtain knowledge	8	Describes whether a user's motivation to experience the virtual tour is to obtain knowledge related to the culture and history of the place.	(Lee et al., 2005;Lowry et al., 2012;Wu and Lu, 2013)
	• Desire to play and have fun	5	Describes whether a user's motivation to experience the virtual tour is to play in an innovative way and have fun during the experience	
	• Escape pressures in real life	2	Describes whether a user's motivation to experience the virtual tour is to escape real-life pressures; during the experience time they feel relaxed without considering real-life issues	
14	**User's Cognitive Abilities**	11	Individual differences in the ability to perform the information process tasks	(Ciulla, 1998;Yeo and Neal, 2004;Hibbeln et al., 2016)

Index	Category and Unique Construct	***n* = 25**	Description	Reference
	• Imagination	9	Refers to a user's ability to form new images and sensations that are not perceived through senses such as sight, hearing or other senses	
	• Attentional control	5	Refers to a user's capacity to choose what they pay attention to and what they ignore	
15	**User Intention**	19	Refers to the subjective possibility that a user would like to undertake a certain behaviour	(Fishbein and Ajzen, 1977;Herrington et al., 2003;Deng and Poole, 2010;Herrington et al., 2014)
	• Approach tendencies	16	Refers to a user's willingness to stay with or explore the website	
	• Willingness to suspend disbelief	11	Refers to a user's willingness to temporarily accept objects, events and people as believable while they are ordinarily seen as incredible	
16	**User's Virtual Tour Performance**	12	Describes a user's basic performance of their virtual tour experience	(Gelderman, 1998;Cho et al., 2002)
	• Length of the virtual tour experience	3	Refers to the time during which the user experiences the virtual tour	
	• Speed of the virtual tour experience	3	Refers to the rate at which the user experiences the virtual tour	
	• Degree of the virtual tour experience	3	Refers to the extent to which the user experiences the virtual tour	
	• Sequence of the virtual tour experience	6	Refers to the order of actions/movements in which the user experiences the virtual tour	

Index	Category and Unique Construct	*n* = 25	Description	Reference
17	**Affective Response**	22	Refers to the response that resides between a stimulus and a user, including affective states and affective evaluations of the stimulus	(Wang and Scheepers, 2012;Zhang, 2013;Stein et al., 2015)
	• Attitude towards the place	8	Refers to the degree to which a user likes/dislikes the place	
	• Attitude towards the virtual tour	6	Refers to a user's overall affective reaction to the virtual tour, which reflects the extent to which the user likes/dislikes the virtual tour	
	• Emotion	21	Refers to an affective state induced by or attributed to a specific stimulus	
18	**Cognitive Response**	22	Refers to a user’s thoughts and ideas evoked by the stimuli	(Artacho et al., 2010;Hopp, 2014;Brown et al., 2016)
	• Impression	12	Refers to the attribution a user makes of a place/object based on the received information	
	• Memory recall	9	Refers to the retrieval of specific information while recognition can be thought of as matching instant stimuli with previous memory	
	• Spatial layout awareness	17	Refers to the holistic perception of the locations of all the objects in the virtual environment	
	• Self-position awareness	7	Refers to the perception of the location of the observation point regarding its spatial relationship with other objects in the virtual environment	

Index	Category and Unique Construct	*n* = 25	Description	Reference
19	**Flow**	23	Refers to the state that occurs when a person is participating in an activity for its own sake and the person wants to constantly repeat the activity because the state is so enjoyable	(Soederberg Miller and Lachman, 2000;Pace, 2004;Reeve et al., 2004;Csikszentmihalyi, 2014)
	• Focused attention	20	Refers to a centring of attention on a limited stimulus, which brings a select amount of information into conscious awareness	
	• Sense of control	8	Refers to a user's belief that they feel able to affect their performance, or more specifically they are responsible for their outcomes because of their own efforts	
	• Engagement	19	Refers to the behavioural intensity and emotional quality of a person's active involvement during an activity in an environment	
20	**Appraisal**	25	Describes a user's evaluation of the consequences of the virtual tour experience	(Au et al., 2008;Beaudry and Pinsonneault, 2010;Lowry et al., 2015)
	• Expectation-disconfirmation	16	Describes the extent to which the virtual experience is evaluated as either exceeding or falling short of the user's expectations	
	• Needs fulfilment	23	Describes the extent to which the user's needs are fulfilled from using the virtual tour	
21	**Social Presence**	8	Refers to the warmth, sociability and feeling of human contact that can be brought from the website	(Biocca et al., 2001a;Ning Shen and Khalifa, 2008;Hess et al., 2009)

Index	Category and Unique Construct	*n* = 25	Description	Reference
	• Social awareness	6	Refers to the extent to which a user believes other social actors appear to exist and are able to react to the user in the virtual environment	
	• Behavioural interaction	2	Refers to the extent to which a user's behaviour affects and is affected by another social actor's behaviour	
	• Psychological involvement	3	Includes mutual understanding of the communication and emotional empathy between the actors	

The user's learning profile was based on studies investigating the influences of the user's previous experience and knowledge of their responses to IS (Senn, 1990;Lawrence and Low, 1993). Users' intrinsic motivation was categorised based on research on the effects of motivation on IS (Wu and Lu, 2013). The construct of users' cognitive abilities was compiled based on studies investigating individual differences in cognitive ability to perform related tasks in IS (Yeo and Neal, 2004). The construct of user intention was based on user behaviour research indicating the subjective possibility that a user would like to undertake a certain behaviour (Fishbein and Ajzen, 1977). A user's virtual tour performance was categorised to describe the basic features of the user's experience of a virtual tour (Cho et al., 2002).

Affective response and cognitive response were compiled based on studies on user responses that reside between the stimulus of an information system and a user from the perspective of affection and cognition, respectively (Artacho et al., 2010;Stein et al., 2015). The construct of flow was based on flow theory, which is a comparatively well-developed construct in the literature to which reference was made regarding the dimensions to conceptualise flow when labelling this antecedent, (Soederberg Miller and Lachman, 2000;Pace, 2004;Reeve et al., 2004;Csikszentmihalyi, 2014). Appraisal was based on Beaudry and Pinsonneault's (2010) study with respect to individual evaluations of the consequences of using IS. Social presence was compiled based on studies on social presence, which is also a relatively well-developed concept in the literature (Hess et al., 2009). Similarly, the dimensions to conceptualise social presence were used to label this antecedent (Ning Shen and Khalifa, 2008).

A further explication of the categories is provided in Section 5.2 as this is closely associated with further interpretation and discussion of the relevant results.

4.2.3 Inter-Coder Reliability

As introduced in Section 3.9, to ensure reliability in the current study, the first two transcripts were coded independently by two coders and cross-coder reliability was accordingly calculated as 83.6%, which is above the 80% acceptable inter-coder reliability level (Krippendorff, 1980;De Swert, 2012). In addition, two researchers were involved in the categorisation process. Based on semantic similarities and the relevant literature (Jankowicz, 2004), the unique constructs were finally categorised into 21 categories. The initial level of agreement between the two researchers' independently developed categories was 91.2%. The categories were further discussed by the two researchers until complete agreement was reached on all categories.

4.2.4 Hierarchical Classification Results for Telepresence Antecedents

Based on the analysis method introduced in Section 3.9, to further interpret the antecedents from a hierarchical perspective, the identified categories of telepresence antecedents were classified into hierarchical levels based on MEC theory as the theoretical foundation and the laddering interview as the data collection approach. Classifying the identified constructs into different hierarchical levels facilitates identification of the underlying mechanisms for how a feeling of telepresence is cultivated (Reynolds and Gutman, 1988). As the current study is among the first attempting to explore telepresence antecedents and classify them into different hierarchical layers, there is no literature for direct reference. However, as discussed in Section 3.9.2, the classification can be referred to the understanding of the hierarchical levels and the abstractness score for each category.

As outlined in Section 2.7 , the levels of givens, means and ends are adopted to represent the hierarchical levels based on MEC theory (Guo et al., 2012). According to the literature, 'givens' are the independent or influencing factors, which have a significant influence on the factors above them in the hierarchical structure. They can be considered as the input or trigger of the chain to explain or affect the experience or behaviour in IS (Kanungo, 2009). 'Means' are the linkage or relay factors, which play a role in strongly linking other factors in the hierarchical structure. Any factors leading to these have further consequences so understanding of this level represents an interpretation of the mechanisms of the linking relationships (Iyer and Sagheer, 2009). 'Ends' are the dependent or result factors that are the ultimate outcomes of the influence of other factors in the hierarchical structure. Understanding of this level provides insights into how users finally respond to the IS (Guo et al., 2011).

Table 4-2 presents the calculation results for the abstractness of each category as a reference for the classification, to decide the position of each construct in the hierarchical structure (Jung and Kang, 2010). As introduced in Section 3.9.2, out-degrees and in-degrees of the constructs are used to calculate abstractness. The out-degree of a construct indicates how many times the construct serves as the source of relationships leading to other constructs whereas the in-degree refers to the number of times the construct serves as the destination of relationships reached by other concepts (Pieters et al., 1995). The degree of abstractness is the ratio of in-degree over the sum of in-degree and out-degree of the construct. Ranging from 0 to 1, high abstractness indicates a strong possibility for the construct to be at the end of a relationship chain whereas low abstractness refers to a high potential for the construct to be at the start of a relationship chain.

Table 4-2: Abstractness of telepresence antecedents

Index	Categories	In-degree	Out-degree	Abstractness
1	Place Profile	0	16	0.000
3	Visual Content Display	0	39	0.000
4	Auditory Content Display	0	11	0.000
12	User's Learning Profile	1	31	0.031
2	Atmospheric Cues	1	25	0.038
7	Avatar Characteristics	1	12	0.077
5	Multisensory Co-stimulation	2	21	0.087
6	Spatial Navigation	3	30	0.091
14	User’s Cognitive Abilities	8	10	0.444
13	User's Intrinsic Motivation	16	17	0.485
11	System Quality	16	16	0.500
8	Operational Features	17	14	0.548
9	Interactivity	41	29	0.586
10	Information Quality	58	36	0.617
16	User’s Virtual Tour Performance	11	5	0.688
17	Affective Response	41	18	0.695
20	Appraisal	35	13	0.729
18	Cognitive Response	36	13	0.735
21	Social Presence	12	4	0.750
15	User Intention	38	7	0.844
19	Flow	33	3	0.917

According to Table 4-2, the abstractness for each of place profile, visual content display and auditory content display is 0, which indicates that no constructs lead to them. Their only role is as triggers to influence other factors; thus, they were allocated to the level of givens. In addition, some categories have relatively low abstractness (<0.1), compared to others (>0.4), such as user's learning profile (0.031), atmospheric cues (0.038), avatar characteristics (0.077), multisensory co-stimulation (0.087) and spatial navigation (0.091). Thus, these factors were also allocated to the level of givens. The factors belonging to the givens layer are either independent of the virtual tour systems (e.g., place profile and user's learning profile) or represent the design features of the virtual tour systems, such as sensory stimulation (e.g., visual content display, auditory content display and multisensory co-stimulation) and system settings or functions (e.g., atmospheric cues, avatar characteristics and spatial navigation). Therefore, they are all independent or influencing factors, the major role of which is as an input or trigger for chains influencing other factors.

Factors with moderate levels of abstractness (0.485–0.688) were then allocated to the level of means. There included user's intrinsic motivation (0.485), system quality (0.500), operational features (0.548), interactivity (0.586), information quality (0.617) and user's virtual tour performance (0.688). Some of these factors directly describe users' experiences of using the virtual tour systems, such as its operational features and the user's virtual tour performance. Some indicate users' perception of either the virtual tour systems or their virtual tour experiences, such as system quality, information quality and interactivity. Some are more likely to be based on a user's previous knowledge and experience, such as the user's intrinsic motivation. It can be concluded that the cultivation of these factors requires stimulation or influence by either the virtual tour system or users. Thus, they are at a higher level in the hierarchy than are factors from the givens layer. However, factors at the level of means are either direct consequences or further perceptions of the factors at the givens level, which may have further consequences at a higher level.

Finally, the remaining factors, most of which have higher abstractness (0.695–0.917), were allocated to the level of ends, including affective response (0.695), appraisal (0.729), cognitive response (0.735), social presence (0.750), user intention (0.844) and flow (0.917). It can be concluded that all these factors are further responses to the experience of using virtual tour systems and thus are at a higher position than the means level. In addition, the factors of user's cognitive abilities, which has relatively low abstractness (0.444), was also allocated to the level of ends. This is because arguments regarding the unique construct of attention control (as one dimension contained in the factor) suggest that this kind of cognitive ability does not remain stable and can be influenced by users' emotions (as one dimension of affective response) (Hibbeln et al., 2016). Thus, considering the relationship between affective response and the user's cognitive abilities, the latter factor should be included in the level of ends. The allocation of these factors to the level of ends is consistent with the argument that this level provides insights into how users finally respond to the IS.

The final classification results are presented in Figure 4-2.

4.2.5 Summary

The content analysis results were described in this section. To summarise, 21 categories of telepresence antecedents were identified in the content analysis. To understand the results in a hierarchical structure based on MEC theory and the laddering interview technique, the antecedents were classified into three hierarchical levels based on an understanding of each hierarchical level and the abstractness of each factor. In the following sections, to further investigate the relationships among telepresence antecedents within the three hierarchical layers, a SIM and corresponding hierarchical structure are created.

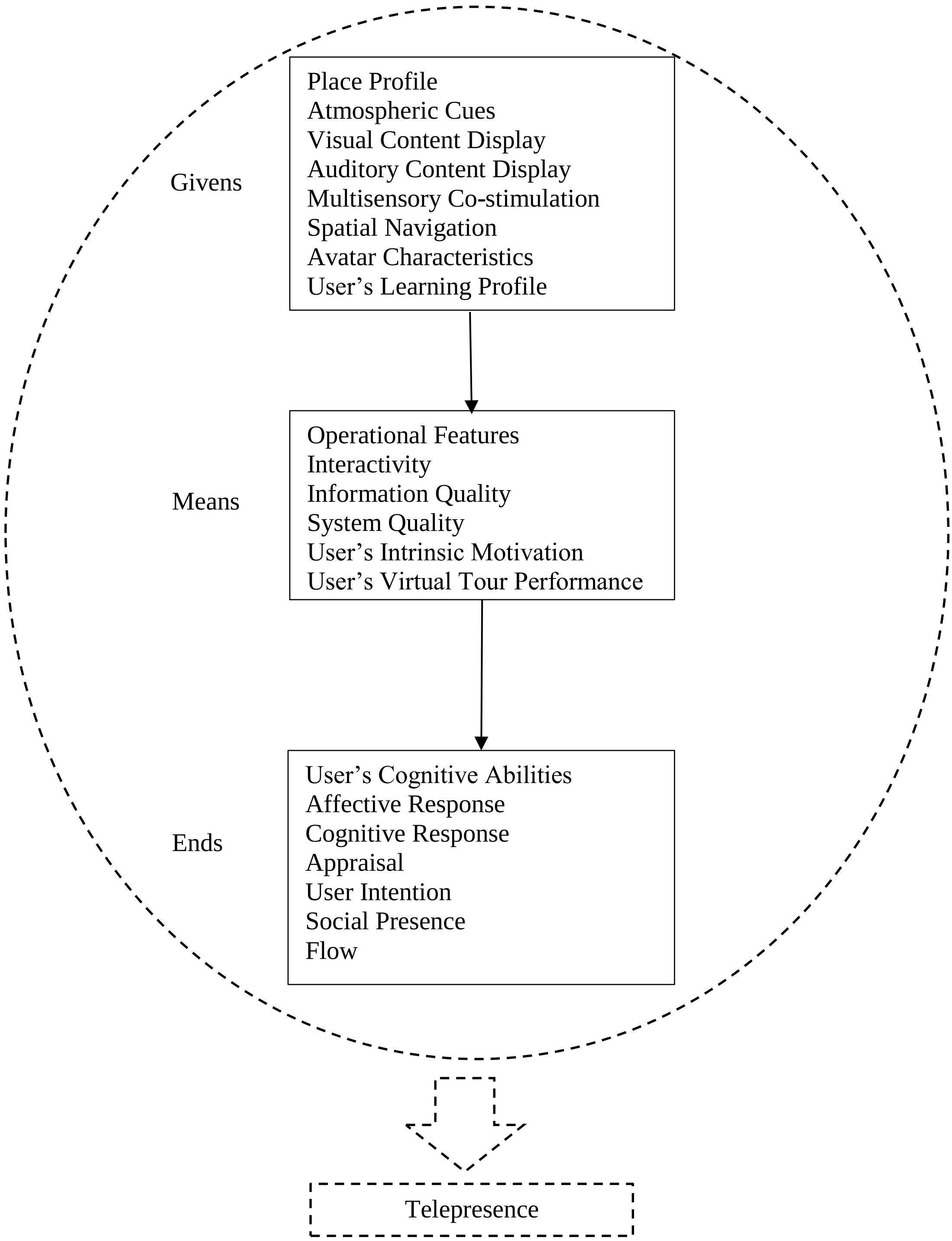


Figure 4-2: Hierarchical classification results for telepresence antecedents

4.3 Summary Implication Matrix

According to Chapter 3, which describes the research methodology, the SIM presents the linkages among categories. For the study, 370 direct linkages and 418 indirect linkages were summarised in the SIM. A 21 × 21-cell matrix was generated to depict the frequencies of the relationships among telepresence antecedents (see Table 4-3). The number in each cell indicates the frequency with which the antecedent in the row leads to the antecedent in the column for both the direct and indirect relationships. The frequency of the direct relationships is represented by the number to the left of the colon and the frequency of the indirect relationships is represented by the number to the right. For example, the number 9:02 in row 2 and column 17 indicates that a direct relationship from antecedent 02 (atmospheric cues) to antecedent 17 (affective response) was perceived nine times and an indirect relationship via other antecedents from 02 to 17 was perceived twice.

A SIM is regarded as the basis for developing a hierarchical structure of constructs to enable a thorough interpretation of the relationships among them. Thus, in the following section, a hierarchical structure is created based on the SIM.

4.4 Hierarchical Structure of Antecedents

The second objective of the study was to understand the hierarchical structure of the identified telepresence antecedents in the context of VWs. To achieve this objective, two research questions were expected to be addressed:

> *RQ2: What is the hierarchical structure of the identified telepresence antecedents in the context of VWs?*
>
> *RQ3: What is the relative importance of the telepresence antecedents?*

To address these research questions, a hierarchical structure is developed based on the SIM presented in Table 4-3.

Table 4-3: The summary implication matrix for telepresence antecedents

Category	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
01 place profile	0	0	0	0	0	0	0	0:01	0:01	10	0:01	1	5	0:01	0:08	0:01	0:03	0:09	0:05	0:07	0
02 atmospheric cues	0	0	0	0	1	0	0	0	0	2	0:01	0	0	0:03	0:09	0	9:02	1:02	1:06	0:05	11
03 visual content display	0	0	0	0	1	2	1	2	13	16:01	1:09	0	0:01	0:02	0:12	1:02	1:11	0:11	1:12	0:12	0:04
04 auditory content display	0	0	0	0	0	1	0	0	1	2:01	0	0	0:01	0:01	0:04	1:02	6	0:04	0:05	0:04	0
05 multisensory co-stimulation	0	0	0	0	0	0	0	0	9	10	0:06	0	0	0	0:05	0:02	0:03	0:07	0:06	2:08	0:03
06 spatial navigation	0	0	0	0	0	0	0	10	2:05	15:01	0:02	0	0	0	0:08	0:03	1:07	0:12	1:06	0:10	1
07 avatar characteristics	0	1	0	0	0	0	0	0	5	1	2:02	0	1	0:01	1:01	0:01	0:05	0:03	0:04	1:04	0:04
08 operational features	0	0	0	0	0	0	0	0	10	2	0:04	0	0	0	1:05	0:03	0:04	0:03	0:03	1:02	0:01
09 interactivity	0	0	0	0	0	0	0	0	0	0	13	0	0	0.02	7:01	4	1:07	0:01	2:04	2:05	0
10 information quality	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2:06	1	1:06	18	1:07	12:03	0
11 system quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0:02	0:02	0	6:02	2	0:02	8:02	0

Category	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
12 user's learning profile	0	0	0	0	0	0	0	5	1:02	0	0:03	0	9	1:01	3:04	2	1:02	7:01	0:06	2:03	0:01
13 user's intrinsic motivation	0	0	0	0	0	0	0	0	0	0	0	0	0	3:01	7:01	1:01	3:01	0:01	1:03	2:01	0
14 user’s cognitive abilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	7	0	0
15 user intention	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	1	6:01	0	0
16 user’s virtual tour performance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	5	0:03	0:03	0
17 affective response	0	0	0	0	0	0	0	0	0	0	0	0	0	4	10	0	0	0:01	2:05	2	0
18 cognitive response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1:01	0	2	0	7	3:01	0
19 flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0
20 appraisal	0	0	0	0	0	0	0	0	0	0	0	0	0	0:02	3:03	0	8	0	2:01	0	0
21 social presence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1:01	0	1	0:01	2:01	0	0

Table 4-4: Statistics for selecting a cut-off level

Cut-off Value	No. Active Cells	Percentage	No. of Active Linkages	Percentage
1	99	100.00%	370	100.00%
2	56	56.57%	327	88.38%
3	36	36.36%	287	77.57%
4	31	31.31%	272	73.51%
5	29	29.29%	264	71.35%
6	25	25.25%	244	65.95%
7	22	22.22%	226	61.08%

4.4.1 Cut-off Value Selection

As outlined in the discussion on research methodology in Chapter 3, a hierarchical structure showing all linkages presented in a SIM is too complex to understand. Thus, a cut-off level is required to ensure both simplicity to show essential meaning and integrity to retain significant linkages in the hierarchical structure.

To select an appropriate cut-off level for constructing the hierarchical structure, a sensitivity analysis method was adopted as a reference to show the active cells and active linkages at different cut-off levels (Pieters et al., 1995). The purpose of cut-off level selection is to present a large percentage of the linkages between constructs by a relatively small number of cells from a SIM. Table 4-4 shows the statistical results for cut-off values from 1 to 7. Taking a cut-off level of 5, for example, within this level there are 29 active cells in the SIM, occupying 29.29% of the total active cells. Meanwhile, these 29 active cells contain 264 active linkages, which represent 71.35% of the total active lineages. It can be seen from the table that increasing the cut-off value decreases the number of relationships considered for building the hierarchical structure.

It has been argued that the selected cut-off value should make the hierarchical structure cover two-thirds (66.67%) of all linkages in a SIM (Reynolds and Gutman, 1988). Accordingly, based on Table 4-4, the maximum cut-off value that should be chosen is 5. However, based on a comparison among possible hierarchical structures with different qualified cut-off values, a cut-off value of 4 was finally selected for the study, which covers 73.51% of all linkages and uses only 31.31% of the active cells in the SIM. This criterion for selection is consistent with Reynolds and Gutman's (1988) suggestion that the cut-off value should range from 3 to 5 and be based on each specific situation.

4.4.2 The Hierarchical Structure

With a selected cut-off value of 4, a hierarchical structure of telepresence antecedents was gradually developed based on the procedure outlined in Chapter 3. During the construction process, when two constructs were connected both directly and indirectly, the direct link was omitted from the structure to maintain simplicity. The resulting built hierarchical structure is presented in Figure 4-3. In the scheme, the arrowheads indicate the direction of the relationships between constructs, which in combination show the paths of factors leading to telepresence. The number attached to each line shows the frequency of the linkage, with the direct linkage frequency to the left of the colon and indirect linkage to the right. For example, the number 15:01 attached to the relationship between spatial navigation and information quality indicates that 15 participants mentioned that spatial navigation can directly lead to information quality and one participant mentioned that spatial navigation can indirectly lead to information quality.

To clearly present the hierarchical structure, based on previous advice (Gengler et al., 1995), the study used different colours to depict the distinct hierarchical levels, with white used for 'givens', grey for 'means' and black for 'ends'. Additionally, the strength of linkages was distinguished based on frequency and indicated by different thicknesses of arrows: weak relationships had four to eight associations, medium relationships had 9 to 13 associations and strong relationships had 14 or more associations. This way of presenting these relationships facilitates an easy and clear understanding of the hierarchical structure of telepresence antecedents.

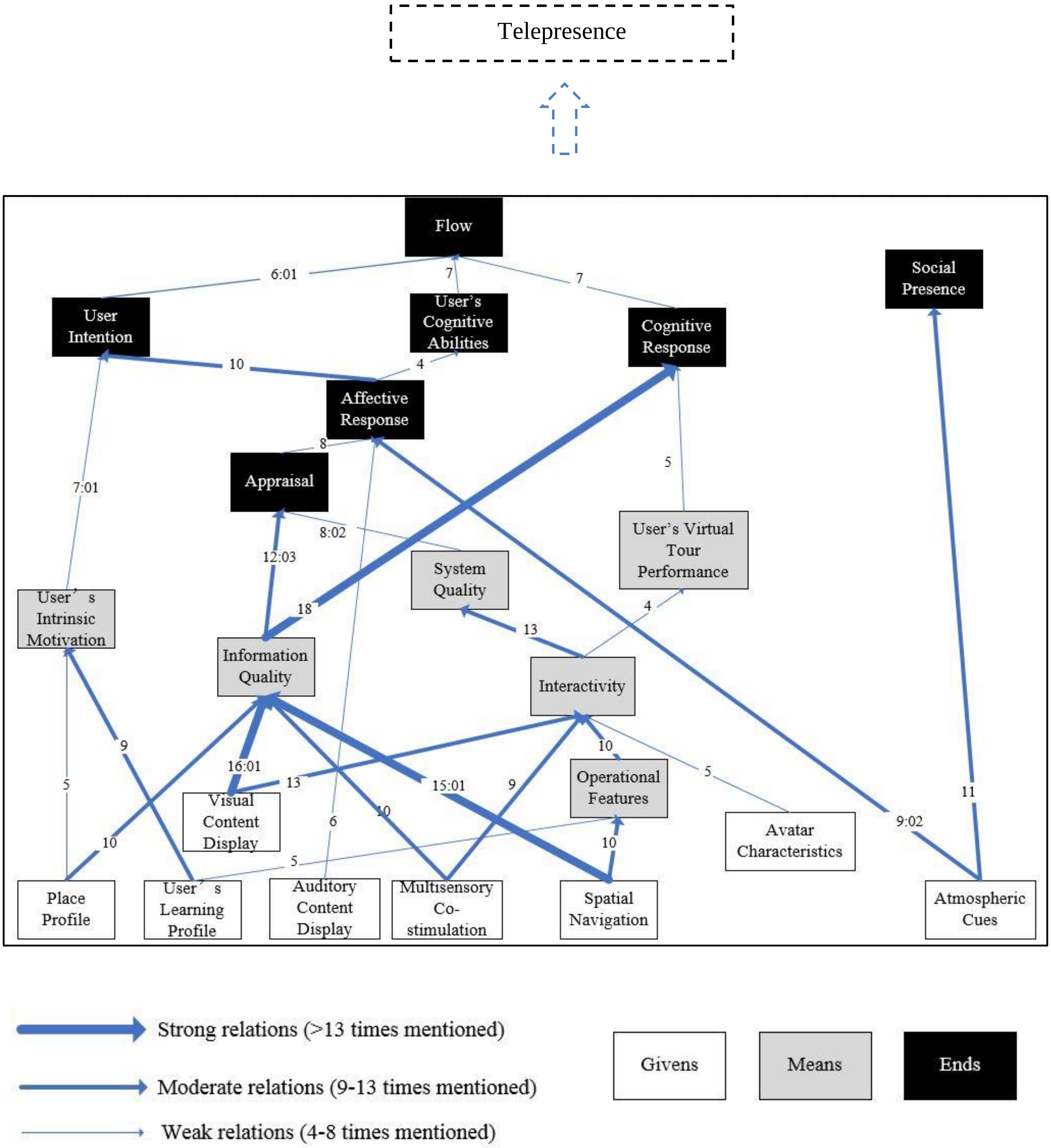


Figure 4-3: The hierarchical structure of telepresence antecedents

According to the hierarchical structure, beginning from the left side, both place profile and user's learning profile lead to user's intrinsic motivation, which further influences user intention and finally affects flow, which can directly lead to telepresence. One participant highlighted this chain:

> The Forbidden City is much more famous (**place profile**) … and around two years ago I visited there once so I was quite interested in this virtual tour (**user's learning profile**) … I was so curious about what extra cultural knowledge I can get from this virtual experience (**user's intrinsic motivation**) … Thus, I really wanted to carefully

> experience it for each detail (**user intention**), which made me totally focus on it (**flow**)… When my attention was completely in the virtual environment, I felt I was there (Interviewee No. 12).

The set of factors at the level of givens can influence the construct of information quality in the level of means, including place profile, visual content display, multisensory co-stimulation and spatial navigation. Among these givens, visual content display is the most significant with 16 participants mentioning the relationship between visual content display and information quality, which indicates that the visual channel is the most important sensory channel for users to obtain information from the virtual environment. Spatial navigation is the second most important construct influencing information quality in the structure, with 15 participants mentioning the linkage between spatial navigation and information quality. The information provided by this function is more related to spatial information as well as a holistic view to guide observations of the information in the virtual environment. Place profile and multisensory co-stimulation have the same frequency, leading to information quality, with 10 participants mentioning these relevant relationships. Information is connected to cognitive response directly and to affective response indirectly via appraisal. In comparison, the relationship between information quality and cognitive response is more important, with 18 participants mentioning this; it further influences flow and finally leads to telepresence. The path from information quality to affective response subsequently leads to flow and finally to telepresence via both user intention and user's cognitive abilities. One participant described a major chain in these paths, from visual content display to information quality to cognitive response and finally to flow as:

> For producing telepresence feeling, comparatively, Quanjingke is the best … because it provides high-resolution pictures (**visual content display**); thus when I zoomed in I could see a lot of details clearly (**information quality**) … Obtaining the details is very important for me because it reminded me of the memory of this place or relevant knowledge about it (**cognitive response**) … The resonation based on the memory recall forced me to focus on the virtual tour and engage myself in it (**flow**). As a result, I felt I was there in this virtual environment (Interview No. 23).

Similar to paths via information quality, a list of constructs influences the construct of interactivity, containing visual content display, multisensory co-stimulation, avatar characteristics, spatial navigation and user's learning profile. Among these factors, visual content display, multisensory co-stimulation and avatar characteristics are directly connected to interactivity; visual content display is the most important with 13 participants mentioning its relationship with interactivity. Spatial navigation and user's learning profile are indirectly connected to interactivity via operational features. Similarly, interactivity also influences both cognitive response and affective response, as does information. Specifically, interactivity affects cognitive response via user's virtual tour performance, and finally leads to telepresence via flow. The paths for the relationship between interactivity and affective are relatively complex. First, interactivity influences system quality and further affects appraisal, which is finally connected to affective response. Then, as explained in the above paths involving information quality, affective response influences flow via both user intention and user's cognitive abilities, which finally leads to telepresence. One participant provided a relatively long chain leading to telepresence in the interview, which belongs to the paths involving interactivity as discussed above:

> Quanjingke provides a well-designed map (**spatial navigation**) … Because the map has a corresponding icon for each building I could click these icons to be transferred to the buildings quickly, which facilitates my operation of the virtual tour (**operational features**) … When it is easy to operate it, I felt my interaction with the virtual tour was more natural, just like a real tour (**interactivity**) … Because the natural interaction means the system is well designed without errors (**system quality**) … I expected the virtual tour I experienced was a good one and it met my expectation (**appraisal**), which made me feel very satisfied (**affective response**) … When I felt satisfied or very happy or excited, I mean if I was really in a good mood, even if I knew it is not real, I was more likely to force myself to ignore the truth that it is not real and pretended that I was on a real tour (**user's cognitive abilities**) so I deeply engaged myself in it (**flow**) … When I engaged myself in it, I felt telepresence that I was really there in the virtual environment created by the virtual tour (Interview No. 9).

Two factors at the level of givens—auditory content display and atmospheric cues—have direct connections with constructs at the level of ends: For auditory content display, the only consequence is affective response while atmospheric cues influences both affective response and social presence. It is found that although auditory content display was designed to provide information to users in the same way as visual content display, its major influence on telepresence as perceived by users is directly through affective response rather than information quality. For atmospheric cues, with the purpose of building settings for the virtual tour, the construct not only directly influences the affective response but also is directly connected to social presence, which finally leads to telepresence. One participant described this direct relationship as:

> Compared to the Human Provincial Museum and Baike Museum, the virtual tour of Quanjingke has other visitors in the view of the created environment (**atmospheric cues**) … Although I knew they were not real users that I could interact with, I felt I was not visiting alone and I felt belonging to them (**social presence**) … Because I felt I was one of them and thus, I was in the virtual environment, that is the feeling of telepresence (Interviewee No. 4).

The hierarchical structure of telepresence antecedents was developed and described in this section. In the following section, to facilitate further interpretation of the hierarchical structure, the relative importance of the constructs at different hierarchical levels is calculated.

4.4.3 Relative Importance of Telepresence Antecedents

As outlined in Chapter 3, centrality was adopted to investigate the importance of the constructs in the hierarchical structure (see Table 4-5). Centrality is the ratio of the sum of in-degree and out-degree of a construct over the sum of all linkages in the SIM, which indicates how frequently an antecedent is related to other antecedents in the paths leading to telepresence (Pieters et al., 1995). Therefore, the higher the value for centrality, the more frequently the construct is involved in relationships with other constructs, and the more significant the position of the construct in the hierarchical structure.

As discussed in Section 4.2.4, the constructs at different hierarchical levels hold different hierarchical positions: givens, means, and ends serve respectively as triggers, bridges and destinations in the entire hierarchical structure. Thus, the relative importance of constructs is discussed here based on each level to identify important constructs at each level.

Table 4-5: Centrality of telepresence antecedents

Telepresence Antecedents	**Centrality**
Givens Layer	

Telepresence Antecedents	Centrality
Place Profile	0.043
Atmospheric Cues	0.070
Visual Content Display	0.105
Auditory Content Display	0.030
Multisensory Co-stimulation	0.062
Spatial Navigation	0.089
Avatar Characteristics	0.035
User's Learning Profile	0.086
Means Layer	
Operational Features	0.084
Interactivity	0.189
Information Quality	0.254
System Quality	0.086
User's Intrinsic Motivations	0.089
User’s Virtual Tour Performance	0.043
Ends Layer	
User’s Cognitive Abilities	0.049
User Intention	0.122
Affective Response	0.159
Cognitive Response	0.132
Flow	0.097
Appraisal	0.130
Social presence	0.043

At the level of givens, visual content display is the most important construct among the eight telepresence antecedents, having the highest centrality (0.105), followed by the construct of spatial navigation with centrality of 0.089 and then user’s learning profile with 0.086. As the factors in the lowest level of the structure, visual content display, spatial navigation and user’s learning profile are more frequently connected to factors at higher levels, showing that these three constructs are key factors at the level of givens, which influence the triggering of the process of telepresence cultivation. First, the importance of visual content display in the givens layer stresses again that vision is the most effective and efficient sensory channel to induce a feeling of telepresence as most information absorption occurs via the visual channel (Wang et al., 2010). Second, the significance of spatial navigation highlights its function of facilitating users to navigate and locate themselves in the VWs, as telepresence itself essentially refers to a spatially concerned feeling (Animesh et al., 2011). Third, user's learning profile is a user-related factor that is important at the level of givens, emphasising that a user's relevant knowledge and experience can also greatly influence their feeling of telepresence. In the overall consideration, this shows that among all the sensory-related factors, visual content display is the most significant factor and among all the identified website functions, spatial navigation is the most important one. Additionally, the importance of individual difference in influencing telepresence is highlighted by identifying user's learning profile as an important factor at this level.

At the level of means, information quality is the most significant construct among the six telepresence antecedents, with the highest centrality (0.254) and is followed by interactivity (0.189). Thus, as the level of means connects both the level of givens and the level of ends, information quality and interactivity occupy vital positions not only at this level but also in the whole hierarchical structure. As this level indicates the 'bridge' connecting the givens and ends in the structure, these two identified constructs can be regarded as two major ways to explain the mechanism of how telepresence is cultivated. These two major ways correspondingly represent the two main activities of users when they are using the VWs: information quality involves the activity that users receive, process, and respond to the information delivered by the virtual environment; and interactivity is related to human–computer interactions during the experience of VWs. For the first activity, users passively receive abundant provided information (Dukas, 1998). For the second activity, users actively interact with the virtual environment by operating and responding to the media (Shneiderman et al., 2016). The differences between these two main activities are obvious in that perceiving information is relatively passive whereas interacting is initiated by the user. However, the common feature shared by the two activities is also clear: they both occupy a user's attention and immerse them into the activities. This commonality may to some extent explain why the two major activities are both related to cultivating telepresence. As the feeling of telepresence involves the process of competition for cognitive accessibility between the virtual environment and the physical surroundings (Kim and Biocca, 1997), the two major activities may both absorb and retain users' cognitive accessibility while occupying their attention in the virtual environment only. Thus, the two ways can be regarded as the main mechanisms to explain the relationships between stimulation-related factors at the level of givens and response-related factors at the level of ends, which directly influence the core construct—telepresence.

At the level of ends, affective response is the most important construct among the seven telepresence antecedents, with the highest centrality of 0.159, followed by cognitive response with centrality of 0.132 and appraisal with centrality of 0.130. Thus, affective response, cognitive response and appraisal are more frequently connected to the lower levels, indicating these three constructs are key factors at the level of ends, which are the major consequences led by givens through means in the whole structure. The significant factors found at this level reveal major responses driven by the givens and mediated by the means. The identification of cognitive response and affective response is associated with previous arguments regarding the theory of the cognitive–affective processing system—that the stimulus can activate a set of the user's internal reactions, in both cognitive and affective ways (Mischel and Shoda, 1995). Accordingly, the two factors that involve users' responses to cognition and affection occupy important positions at the end part of the hierarchical structure. Appraisal, which refers to whether users' expectations or needs were satisfied during the virtual experience, is also an important telepresence antecedent at the level of ends. The identification of this factor indicates that the cultivation of telepresence is a challenging and demanding process that not only requires sufficient information and a proper atmosphere to immerse users but also needs to suppress any possible interference caused by expectation/need disconfirmation.

In addition, besides the relatively important constructs in each layer that are identified based on centrality, for the whole hierarchical structure, the position of flow and social presence is also important as the termination of the structure. These two factors are regarded as directly leading to telepresence, which indicates that the paths containing givens, means and/or ends influence telepresence through either flow or social presence. This to some extent explains the relationships between telepresence and the other two similar and closely associated concepts—flow and social presence. According to the literature, telepresence and flow are regarded as associated concepts to investigate user experience (Faiola et al., 2013;Stavropoulos et al., 2013). Studies that focus on a user's experience of flow argue that telepresence is either an antecedent or a dimension of flow (Finneran and Zhang, 2005;Nah et al., 2011). However, as the current study was conducted from a telepresence perspective, the developed hierarchical structure shows that flow can lead to telepresence. The major dimensions of flow, which are focused attention, sense of control and engagement, are unique constructs classified into the category in the current study that connects the former chains of telepresence antecedents and telepresence in the structure. Moreover, telepresence and social presence are considered as two basic types of presence that respectively indicate physical and social features of the conceptualisation of presence (IJsselsteijn et al., 2000). The current study links these two distinctive types of presence by stating that social presence can lead to telepresence.

Emphasising some significant telepresence antecedents from a hierarchical perspective provides rich and valuable information for understanding telepresence antecedents in a structured and logical way. Further investigation of important factors based on their relative importance can facilitate the improvement of VWs for an improved telepresence experience.

4.5 Segmentation Results

The final objective of the study was to understand different clusters of users based on their mechanisms of perceiving telepresence. To achieve this objective, two research questions were posed.

> *RQ4: Are there any distinct type of users based on their mechanisms of perceiving telepresence in the context of VWs?*
>
> *RQ5: If yes, what are the similarities and differences between their hierarchical structures of telepresence antecedents for these groups of users in the context of VWs?*

To address these questions, this section presents the results of cluster analysis along with the hierarchical structures for each group for further interpretation and comparison.

4.5.1 Cluster Analysis Results

To establish novel user segmentation in VWs based on their inner mechanisms of user experience, a cluster analysis was utilised, based on users' mechanisms of perceiving telepresence—specifically on the means-level telepresence antecedents—to distinguish the different ways of cultivating telepresence feeling.

To conduct the cluster analysis, a matrix of the six categories at the level of means as rows and the 25 participants as columns was generated. In the matrix, each cell presents the calculated relative percentage that a participant mentioned each category. For example, cognitive response has four unique constructs: impression, memory recall, spatial layout awareness and self-position awareness. For this category, if Interviewee No.1 mentioned two of the unique constructs and 25 unique constructs of different categories in total, the percentage of the category of cognitive response mentioned by this interviewee would be 2/25, or 8%. As introduced in Chapter 3, a two-stage clustering approach was followed based on the created matrix. In the first step, the hierarchical cluster method was used to provide a reference for the total number of clusters. Using squared Euclidean distance as the measure of similarity showed that classifying the users into three groups was more appropriate for generating optimal distinctions between clusters and provided more efficient cluster results. Following the guidelines of Aggarwal and Reddy’s (2013) study, k-means clustering was conducted, which finally generated three clusters. Table 4-6 presents the results of the k-means cluster analysis. The numbers in the cells of columns 2–4 indicate the cluster centroids for the three user segments and the last column shows the results of the variance analysis examining inter-cluster distinctions in the categories. This shows that the three groups of users are significantly different for the two means-level telepresence antecedents of interactivity and information quality. Figure 4-4 presents a graph of the means-level telepresence antecedents in the three groups of users to show the clustering results more directly.

Table 4-6: Cluster centroids from the k-means cluster analysis

	Cluster 1 (*n* = 10)	**Cluster 2 (*n* = 8)**	**Cluster 3 (*n* = 7)**	**F**
Operational Features	0.026	0.044	0.058	2.614
Interactivity	0.105	0.077	0.121	4.646*
Information Quality	0.083	0.143	0.035	42.373***
System Quality	0.020	0.044	0.023	2.542
User's Intrinsic Motivation	0.053	0.040	0.030	2.254
User's Virtual Tour Performance	0.016	0.011	0.037	2.694

***: p<0.01; ***: p<0.01; *: p<0.05

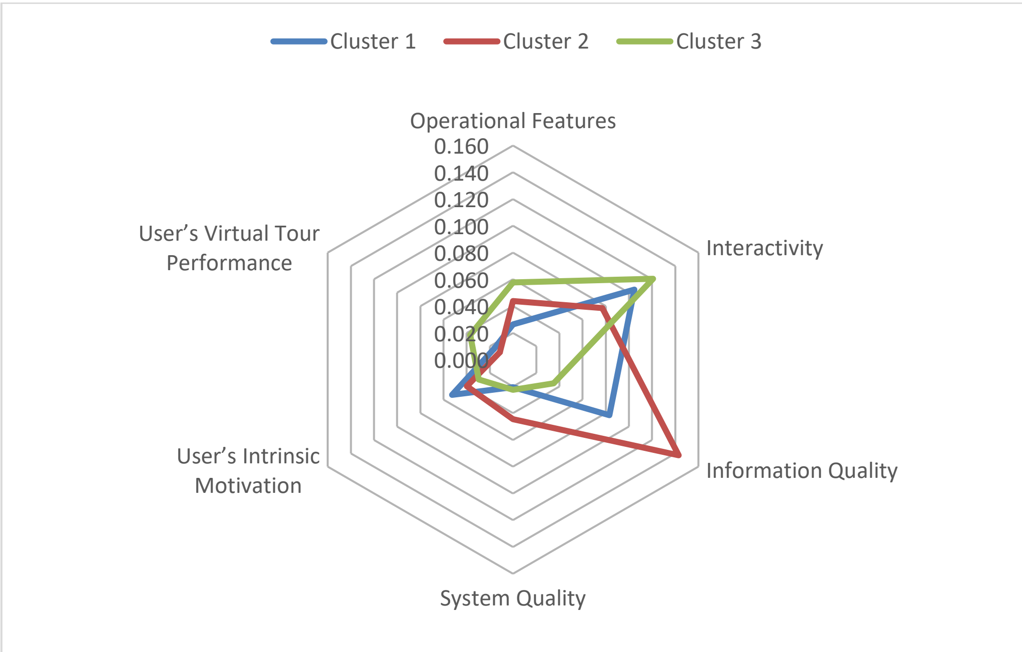


Figure 4-4: Radar diagram of the three clusters

To describe the clusters, Table 4-7 presents the demographic information for each group.

Table 4-7: Demographic information for the three clusters

	Cluster 1 (*n* = 10)		Cluster 2 (*n* = 8)		Cluster 3 (*n* = 7)	
	n	Percentage	*n*	Percentage	*n*	Percentage
Gender						
Male	6	60.00%	5	62.50%	1	14.29%
Female	4	40.00%	3	37.50%	6	85.71%
Age (years)						
19–24	2	20%	1	12.5%	2	28.57%
25–30	5	50%	5	62.5%	3	42.86%
31–35	2	20%	2	25.0%	1	14.29%
36–40	0	0%	0	0%	1	14.29%
>40	1	10%	0	0%	0	0%
Education						
High school	0	0%	0	0%	1	14.29%
Some college/Diploma	1	10.00%	1	12.50%	1	14.29%
Bachelor degree	8	80.00%	5	62.50%	3	42.86%
Master degree or above	1	10.00%	2	25.00%	2	28.57%
Occupation						
Student	1	10.00%	2	25.00%	1	14.29%
Sales person	3	30.00%	1	12.50%	0	0%
Administrative	2	20.00%	2	25.00%	0	0%
Human resource	1	10.00%	0	0%	0	0%
Accountant	1	10.00%	0	0.0%	2	28.57%
Clerk	2	20.00%	1	12.50%	1	14.29%
Research and development	0	0%	0	0%	3	42.86%
Teacher	0	0%	1	12.50%	0	0%
Consultant	0	0%	1	12.50%	0	0%
Monthly salary (Yuan)						
<1,000	1	10.0%	1	12.5%	0	0%
1,000–3,000	0	0%	1	12.5.0%	2	28.57%
3,001–5,000	3	30.00%	1	12.50%	2	28.57%
5,001–8,000	4	40.00%	2	25.00%	1	14.29%
8,001–10,000	1	10.00%	1	12.50%	1	14.29%

	Cluster 1 (*n* = 10)		**Cluster 2 (*n* = 8)**		**Cluster 3 (*n* = 7)**	
	n	Percentage	*n*	Percentage	*n*	Percentage
>10,000	1	10.00%	2	25.00%	1	14.29%

Cluster 1 contains the largest number of users, which are 40% of the total respondents. For this group, the scores on information quality and interactivity are approximately similar. In this group, 60% of respondents are males and 40% are females. Compared to the other two groups, Cluster 1 has the highest percentage of users with an educational level of bachelor degree (80%), occupation as sales person (30%) and monthly salary level of 5,001–8,000 Yuan (40%).

Cluster 2 has a sample size of eight, consisting of 32.0% of the total respondents. This group scores higher on the construct of information quality but lower on interactivity. In the group, 62.5% of the respondents are males and 37.5% are females. Compared to the other two clusters, Cluster 2 has the highest percentage of males, in the age range 25–30 (62.5%), with the occupation of student (25.0%), administrative (25.0%), teacher (12.5%) and consultant (12.5%), and a monthly salary of more than 10,000 Yuan (25.0%).

Cluster 3 has a sample size of seven, which is 28% of the total respondents. In contrast with Cluster 2, this group scores highly on the construct of interactivity but lower on information quality. In this group, it is obvious that the male to female ratio is quite imbalanced: 14.29% are males and 85.71%, females. With respect to occupation, Cluster 3 has the highest percentage of research and development staff. With the exception of the dramatic gender and occupation differences, the distributions of age, education and monthly salary in this group are comparatively even.

4.5.2 SIMs for the Three Clusters

To further interpret the similarity and differences among the three clusters, hierarchical structure for each group is required. As the basis for this, a SIM was created for each of the three clusters, and are presented in Tables 4-8–4-10.

Table 4-8: Summary implication matrix for Cluster 1

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
01 place profile	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0:04	0	0:01	0:03	0:01	0:01	0
02 atmospheric cues	0	0	0	0	1	0	0	0	0	1	0	0	0	0:02	0:04	0	6	0:01	0:03	0:01	5
03 visual content display	0	0	0	0	0	1	1	0	7	8	1:04	0	0	0:01	0:07	0:01	0:04	0:05	0:06	0:05	0:01
04 auditory content display	0	0	0	0	0	0	0	0	1	2	0	0	0	0:01	0:02	1:01	3	0:03	0:03	0:02	0
05 multisensory co-stimulation	0	0	0	0	0	0	0	0	5	4	0:03	0	0	0	0:02	0	0	0:02	0:03	1:02	0:02
06 spatial navigation	0	0	0	0	0	0	0	4	2:02	4:01	0:01	0	0	0	0:04	0:01	0:03	0:04	0:03	0:03	0
07 avatar characteristics	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0:01	0	0:01	0:01	0:01	0:01	0:01
08 operational features	0	0	0	0	0	0	0	0	3	1	0:01	0	0	0	0:03	0:01	0:02	0:01	0:01	1	0
09 interactivity	0	0	0	0	0	0	0	0	0	0	6	0	0	0:01	4	2	1:02	0	2:01	1:01	0
10 information quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1:03	0	1:02	7	0:05	4:01	0
11 system quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	0	0	2	0	0:01	3	0
12 user's learning profile	0	0	0	0	0	0	0	2	0:01	0	0:01	0	5	0	1:03	1	1:01	3:01	0:03	0:02	0
13 user's intrinsic motivation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0:01	0:01	1	2	0

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
14 user's cognitive abilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	5	0	0
15 user intention	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	1	2:01	0	0
16 user's virtual tour performance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0:01	0:01	0
17 affective response	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	0	0:01	2:01	0	0
18 cognitive response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1:01	0	1	0	4	1	0
19 flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
20 appraisal	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	0:02	0	3	0	1	0	0
21 social presence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1:01	0	1	0:01	1:01	0	0

Table 4-9: Summary implication matrix for Cluster 2

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
01 place profile	0	0	0	0	0	0	0	0	0	5	0	0	2	0	0:03	0:01	0:01	0:05	0:03	0:05	0
02 atmospheric cues	0	0	0	0	0	0	0	0	0	1	0:01	0	0	0	0:04	0	1:02	1:01	1:02	0:03	3
03 visual content display	0	0	0	0	0	1	0	1	3	5	0:02	0	0:01	0	0:05	0:01	1:05	0:05	1:03	0:05	0:01
04 auditory content display	0	0	0	0	0	1	0	0	0	0:01	0	0	0:01	0	0:02	0:01	2	0:01	0:02	0:01	0

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
05 multisensory co-stimulation	0	0	0	0	0	0	0	0	2	4	0:02	0	0	0	0:02	0:01	0:02	0:04	0:01	1:04	0
06 spatial navigation	0	0	0	0	0	0	0	2	0:01	7	0:01	0	0	0	0:04	0:01	1:03	0:05	1:02	0:06	1
07 avatar characteristics	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0:01	0	0	0:01	0:01
08 operational features	0	0	0	0	0	0	0	0	3	1	0:02	0	0	0	0:02	0:01	0:01	0:01	0:01	0:01	0:01
09 interactivity	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2:01	1	0:03	0	0	0:03	0
10 information quality	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1:02	1	0:03	8	1:01	7:01	0
11 system quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	0	1:01	2	0:01	4:01	0
12 user's learning profile	0	0	0	0	0	0	0	1	0	0	0	0	4	1:01	2:01	1	0:01	2	0:02	1:01	0
13 user's intrinsic motivation	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0:01	1	0	0:02	0	0
14 user’s cognitive abilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
15 user intention	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
16 user’s virtual tour performance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0:01	0:01	0
17 affective response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0:02	0	0

	01	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
18 cognitive response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0
19 flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
20 appraisal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1:01	0	3	0	0	0	0
21 social presence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4-10: Summary implication matrix for Cluster 3

	01	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
01 place profile	0	0	0	0	0	0	0	0:01	0:01	2	0:01	1	1	0:01	0:01	0	0:01	0:01	0:01	0:01	0
02 atmospheric cues	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	0:01	0	2	0	0:01	0:01	3
03 visual content display	0	0	0	0	1	0	0	1	3	3:01	0:03	0	0	0:01	0	1	0:02	0:01	0:03	0:02	0:02
04 auditory content display	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0:01	0
05 multisensory co-stimulation	0	0	0	0	0	0	0	0	2	2	0:01	0	0	0	0:01	0:01	0:01	0:01	0:02	0:02	0:01
06 spatial navigation	0	0	0	0	0	0	0	4	0:02	4	0	0	0	0	0	0:01	0:01	0:03	0:01	0:01	0
07 avatar characteristics	0	1	0	0	0	0	0	0	3	1	1:02	0	0	0:01	1	0:01	0:03	0:02	0:03	1:02	0:02

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
08 operational features	0	0	0	0	0	0	0	0	4	0	0:01	0	0	0	1	0:01	0:01	0:01	0:01	0:01	0
09 interactivity	0	0	0	0	0	0	0	0	0	0	3	0	0	0:01	1	1	0:02	0:01	0:03	1:01	0
10 information quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	0	0:01	3	0:01	1:01	0
11 system quality	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	0:01	0	3:01	0	0	1:01	0
12 user's learning profile	0	0	0	0	0	0	0	2	1:01	0	0:02	0	0	0	0	0	0	2	0:01	1	0:01
13 user's intrinsic motivation	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	1:01	1	2	0	0:01	0:01	0
14 user’s cognitive abilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
15 user intention	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
16 user’s virtual tour performance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	1	0:01	0:01	0
17 affective response	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0:02	2	0
18 cognitive response	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0:01	0
19 flow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 appraisal	0	0	0	0	0	0	0	0	0	0	0	0	0	0:01	2	0	2	0	1:01	0	0
21 social presence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

4.5.3 Hierarchical Structures for the Three Clusters

The procedure for constructing the hierarchical structures for telepresence antecedents for the three clusters was the same as the one used for all participants. Thus, the cut-off value was decided first; this was followed by development of the three hierarchical structures based on the SIMs and cut-off values. Finally, the centrality of constructs in each group was calculated to indicate the relative importance of telepresence antecedents for each group to aid further understanding of the hierarchical structures.

4.5.3.1 Selection of Cut-off Values for the Three Clusters

As the three clusters have different numbers of users and different amounts of relationships, different cut-off values were required to build the hierarchical structures for the three clusters. Table 4-11 presents the statistics used to decide the cut-off levels for the three clusters.

Table 4-11: Statistics for selecting cut-off levels for the three clusters

	Cluster 1 (*n* = 10)		**Cluster 2 (*n* = 8)**		**Cluster 3 (*n* = 7)**	
Cut-off value	Active cells	Active linkages	Active cells	Active linkages	Active cells	Active linkages
1	66 (100.00%)	159 (100.00%)	60 (100.00%)	124 (100.00%)	50 (100.00%)	87 (100.00%)
2	35 (53.03%)	128 (80.50%)	27 (45%)	**91 (73.39%)**	24 (48.00%)	**61 (70.11%)**
3	23 (34.85%)	**104 (65.41%)**	16 (26.67%)	69 (55.65%)	10 (20.00%)	33 (37.93%)
4	16 (24.24%)	83 (52.20%)	9 (15%)	48 (38.71%)	3 (6.00%)	12 (13.79%)

It has been argued that the selected cut-off value should make the hierarchical structure cover two-thirds (66.67%) of all linkages in the SIM (Reynolds and Gutman, 1988). Additionally, for specific segment comparisons, the cut-off value should meet three requirements to be deemed adequate (Boecker et al., 2008). The requirements are equivalence, representativeness and proportionality. Equivalence requires the information content of each cluster—represented by the percentage of active links at the cut-off level—to be similar. Representativeness requires the information content in each cluster to be sufficient to represent the cluster, which is consistent with the above requirement for covering at least two-thirds of all linkages. Proportionality requires a similar ratio of cluster size to corresponding cut-off level.

Following overall consideration of these requirements, the cut-off values for the three clusters were chosen as 3 for Cluster1 and 2 for each of Clusters 2 and 3. These selected cut-off values meet the requirement of representativeness to cover two-thirds of all linkages: for Cluster 1, 34.85% of active cells present 65.41% of information content; for Cluster 2, 45% of active cells present 73.38% of information content; and for Cluster 3, 48% of active cells present 70.11% of information content. Based on this, the percentage of information content is similar between clusters, which meets the requirement for equivalence. Moreover, the ratio of cluster size to cut-off level for each cluster is 3/10 (0.3) for Cluster 1, 2/8 (0.25) for Cluster 2 and 2/7 (0.29) for Cluster 3, which are sufficiently similar to meet the requirement for proportionality.

Thus, the selected cut-off values for the three clusters were appropriate for the cluster comparison of the hierarchical structure of each group. Using these cut-off values, the hierarchical structures of the telepresence antecedents for the three clusters were developed based on the SIMs, and are shown in the following subsection.

4.5.3.2 Hierarchical Structures for the Three Clusters

Figures 4-5–4-7 present the constructed hierarchical structure of telepresence antecedents for the three clusters.

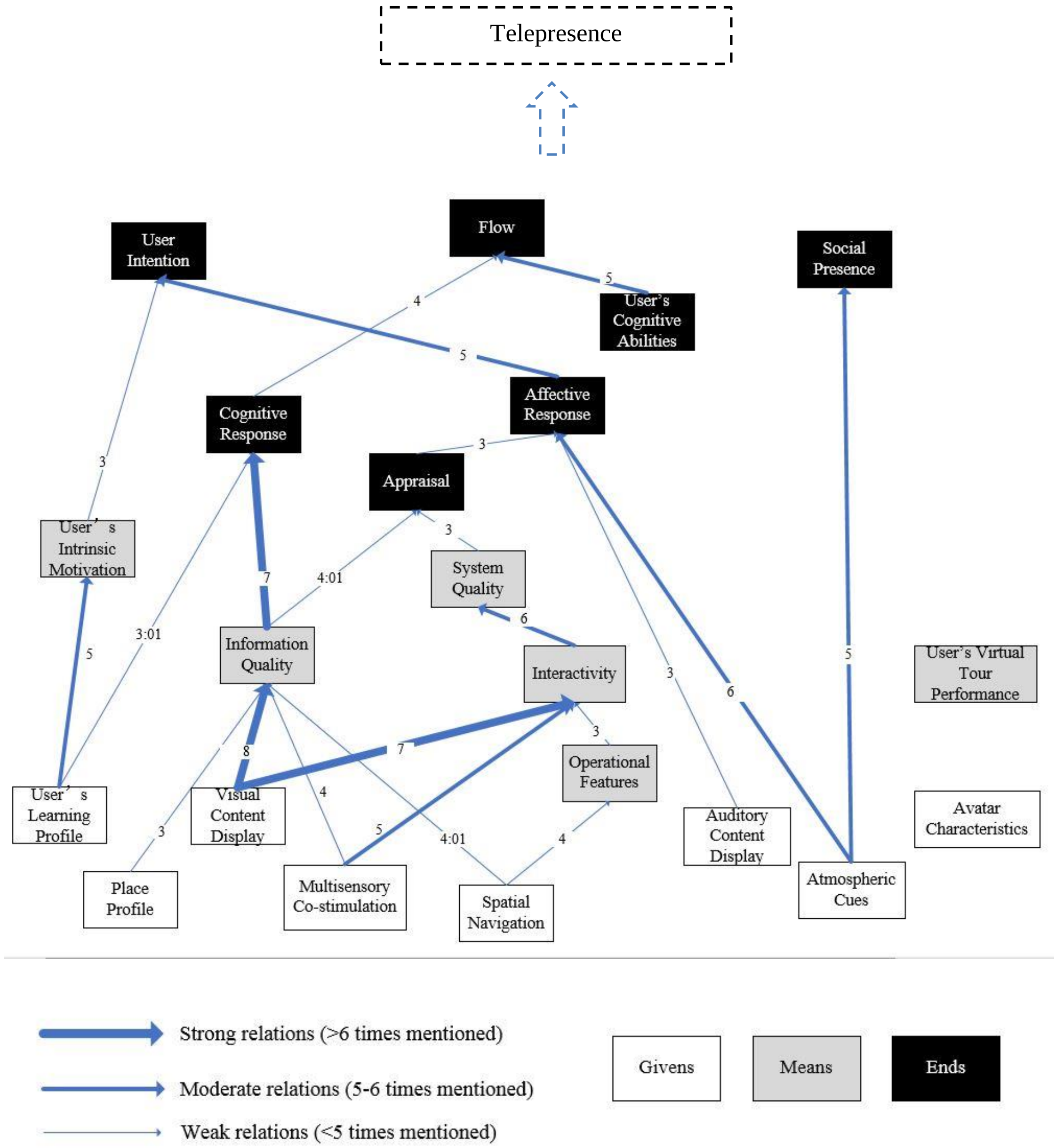


Figure 4-5: Hierarchical structure of telepresence antecedents for Cluster 1

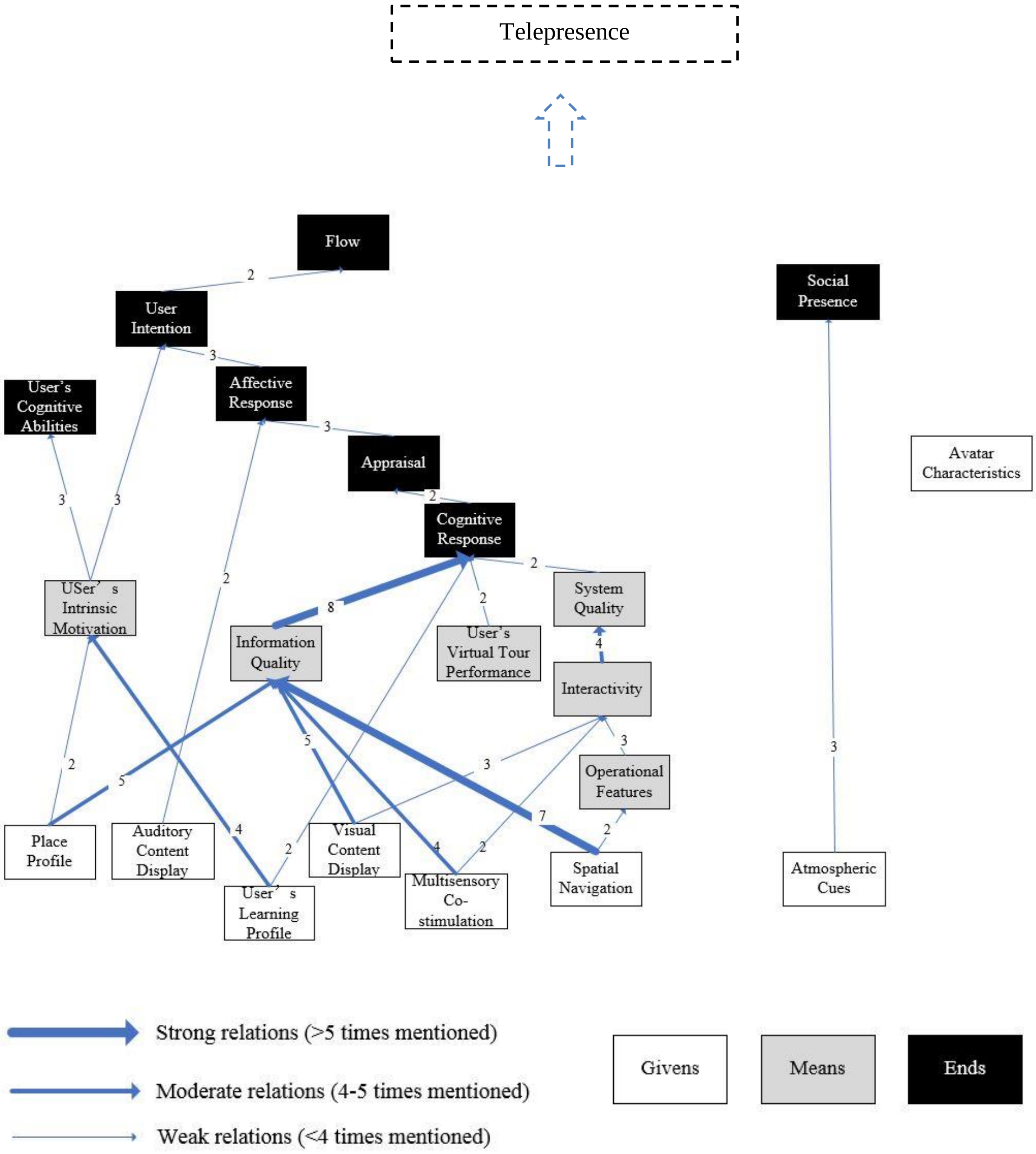


Figure 4-6: Hierarchical structure of telepresence antecedents for Cluster 2

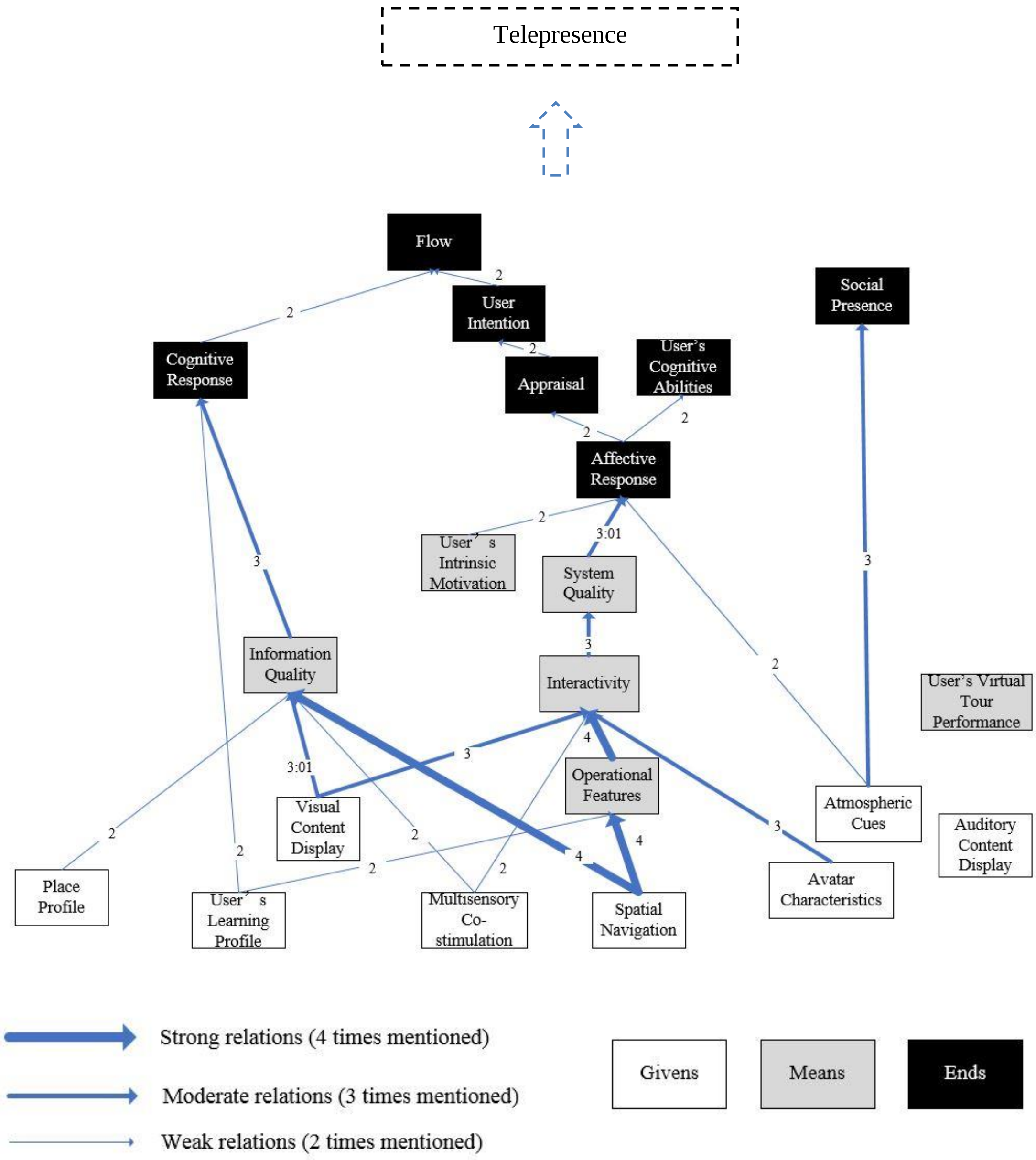


Figure 4-7: Hierarchical structure of telepresence antecedents for Cluster 3

Comparison of the hierarchical structures of the three clusters revealed that they have some significant similarities and distinctions. With respect to similarities, the three clusters share most of the telepresence antecedents in their hierarchical structures. Moreover, some basic connections are similar among the three hierarchical structures. For example, although they have different weights, four constructs at the level of givens lead to information quality at the level of means: place profile, visual content display, multisensory co-stimulation and spatial navigation. Among these four factors, visual content display and multisensory co-stimulation also lead to interactivity. Spatial navigation influences operational features, which further leads to system quality via interactivity. User’s learning profile directly leads to cognitive response. Atmospheric cues directly lead to social presence. Information quality directly leads to cognitive response. The similarities in some relationships in the hierarchical structures shared by the three clusters indicate that even for different types of users, some mechanisms are fixed and thus can be regarded as fundamental connections to facilitate understanding of the process of cultivating telepresence.

The identification of differences among clusters was based on the comparison of centrality to reveal different important constructs in hierarchical structures and on reviewing different relationships to identify distinctions in the mechanisms of perceiving telepresence. Thus, centrality of the constructs for the three clusters was calculated and the values are provided in Table 4-12.

According to Table 4-12, for the level of givens, the importance of visual content display is highlighted for all three clusters. Moreover, both Clusters 1 and 3 regarded this construct as the most significant factor in the givens layer. Clusters 1 and 2 share the construct of user’s learning profile as an important factor and Clusters 2 and 3 share the construct of spatial navigation as an important factor. Specifically, atmospheric cues are significant in the hierarchical structure of Cluster 1 and avatar characteristics are significant for Cluster 3.

At the level of means, all clusters share the significant constructs, being interactivity and information quality. However, centrality differs for these two factors across the three clusters. For Cluster 1, the centrality of interactivity is 0.220, which is similar to the centrality of information quality (0.226). For Cluster 2, the centrality of information quality (0.333) is much higher than the centrality of interactivity (0.127). For Cluster 3, the centrality of information quality (0.188) is notably lower than the centrality of interactivity (0.224).

At the level of ends, important factors in the hierarchical structure for Cluster 1 are affective response and cognitive response. The construct of appraisal is an important factor shared by Clusters 2 and 3. However, Cluster 2 emphasises cognitive response and Cluster 3 highlights affective response as a significant factor in the layer of ends.

Table 4-12: Centrality of telepresence antecedents in three clusters

	Centrality		
Telepresence Antecedents	Cluster 1	Cluster 2	Cluster 3
Givens Layer			
Place Profile	0.031	0.056	0.047
Atmospheric Cues	0.082	0.056	0.071
Visual Content Display	0.113	0.095	0.106
Auditory Content Display	0.044	0.024	0.012
Multisensory Co-stimulation	0.069	0.056	0.059
Spatial Navigation	0.069	0.111	0.094
Avatar Characteristics	0.019	0.016	0.094
User's Learning Profile	0.082	0.095	0.082
Means Layer			
Operational Features	0.069	0.063	0.141
Interactivity	0.220	0.127	0.224
Information Quality	0.226	0.333	0.188
System Quality	0.075	0.095	0.094
User's Intrinsic Motivation	0.088	0.111	0.059
User’s Virtual Tour Performance	0.038	0.048	0.047
Ends Layer			
User’s Cognitive Abilities	0.057	0.048	0.035
User Intention	0.126	0.119	0.118
Affective Response	0.176	0.111	0.200
Cognitive Response	0.138	0.143	0.106
Flow	0.119	0.079	0.082
Appraisal	0.107	0.151	0.141
Social Presence	0.050	0.032	0.047

Further, some distinctions in the paths leading to telepresence are evident. First, the weights for the relationships connecting the givens-level factors to information quality and interactivity differ across the three clusters. For Cluster 1, the weights for the relationships of givens to information quality and to interactivity are quite balanced. However, for Cluster 2, the relationship of givens to information quality is much stronger than for the relationship of givens to interactivity; for Cluster 3, the relationship of givens to information quality is much weaker than the relationship of givens to interactivity.

Second, from the perspective of ends, the positions of cognitive response and affective response are quite similar. User's learning profile in the givens layer and information quality in the means layer lead to cognitive response, which further influences flow. Appraisal in the ends layer, and auditory content display and atmospheric cues in the givens layer, lead to affective response, which further affects user intention. However, for the other two clusters, the mechanisms are distinctly different. In Cluster 2, cognitive response occupies the most central position in that it connects the majority of factors at lower levels and the majority of factors at the ends level. Information quality, user's virtual tour performance and system quality in the means layer, which are directly or indirectly connected to most factors in the givens layer, leads to cognitive response. Cognitive response further leads to appraisal and consequently influences a chain of ends. In Cluster 3, affective response occupies the most central position connecting majority of factors at lower levels and majority of factors at ends level. User's intrinsic motivation, system quality, and atmospheric cues directly lead to affective response. Affective response then further leads to user's cognitive abilities and appraisal, which consequently influences a chain of ends.

Third, some functions of specific factors differ among the three clusters. For example, for Clusters 1 and 2, user's learning profile leads to both user's intrinsic motivation and cognitive response, whereas for Cluster 3 this construct is directly connected to operational features and cognitive response. For Clusters 1 and 3, atmospheric cues lead to both affective and social presence, whereas for Cluster 2 this construct influences only social presence. Additionally, in Cluster 1, the function of appraisal is to influence affective response, which further leads to user intention. However, in Cluster 2, appraisal is a consequence of cognitive response, which further leads to affective response. This relationship between cognitive response and appraisal indicates that for this group of users, their expectations and needs with respect to virtual tours are more related to their cognitions. In contrast, in Cluster 3, appraisal is a consequence of affective response, which further leads to user intention. The relationship between affective response and appraisal indicates that for this group of users, their expectations and needs with respect to virtual tours are more related to their affections.

The differences presented above confirm that the three clusters identify distinctive groups of users in VW in terms of their mechanisms of perceiving telepresence.

4.6 Summary

This chapter presented the study results to address the proposed research questions. Twenty-one telepresence antecedents were identified based on the content analysis and were developed into a hierarchical structure to explain the inner mechanism of cultivating telepresence. Further, a cluster analysis was utilised to classify the users into three groups; accordingly, three hierarchical structures were built to interpret distinct mechanisms for different users to perceive a telepresence feeling. The following chapter discusses the major findings based on the research results.

Chapter 5: Discussion

5.1 Introduction

There were three research objectives of this study. First, the study attempted to provide a comprehensive, clear and structural set of factors leading to telepresence. The analysis identified 21 telepresence antecedents. Second, the study sought to further interpret factors contributing to telepresence by investigating the hierarchical structure of telepresence antecedents. Accordingly, the 21 identified antecedents were classified into three layers and a hierarchical structure of the relationships among the telepresence antecedents was built to facilitate interpretation of the mechanisms of how telepresence is cultivated. The third objective of this study was to classify users according to how they perceive telepresence, based on which the cluster analysis segmented three clusters of users. Corresponding hierarchical models for these groups of users were generated to explain individual differences in perceiving telepresence. The consequent major findings of this study are discussed from three perspectives: expanding the current understanding of telepresence antecedents; understanding the hierarchical structure of telepresence; and interpreting the segments of users.

5.2 Expanding the Current Understanding of Telepresence Antecedents

Because of its exploratory nature, the study provided abundant information for identifying comprehensive factors leading to telepresence, which is expected to expand the existing limited understanding of telepresence antecedents. There are three major outcomes of the exploration of factors cultivating telepresence in the study. First, the study deepens the interpretation of the prior classical model that has been commonly accepted and adopted in telepresence-related studies. Second, the study specifies significant design features for VWs that are closely related to telepresence. Last, the study broadens the overall perspective for considering what factors lead to telepresence by proposing a user-medium-content (UMC) model as an overarching framework. The major findings are discussed in the following subsections.

5.2.1 Deepening the Understanding of Steuer's Classical Model

As discussed in Chapter 2, most studies adopt the constructs proposed by Steuer's (1992) classical model as telepresence antecedents in their research models (Coyle and Thorson, 2001;Skadberg and Kimmel, 2004;Mollen and Wilson, 2010). Some of the telepresence antecedents identified in the current study are consistent with Steuer's (1992) model, thus providing empirical support for his argument. Further, as a qualitative study, its exploratory nature enables a deeper understanding of the classical model to produce additional findings on the original model that previous telepresence research has not provided. Thus, the findings in this respect are presented based on the major constructs of the classical model, which are 'vividness' and 'interactivity'.

5.2.1.1 Deepening the Understanding of 'Vividness'

According to the literature review, 'vividness', as 'the ability of a technology to produce a sensorially rich mediated environment' (Steuer, 1992, p.86), includes two main dimensions: the 'breadth' to indicate the number of different sensory channels and the 'depth' to indicate the resolution within each sensory channel. Thus, based on Steuer's (1992) proposition, researchers have argued that the more sensory channels a medium contains and the higher the resolution within each channel, the better the telepresence experience it can induce (Coyle and Thorson, 2001;Klein, 2003). From this perspective which provides a general consideration of all sensory channels, each sensory channel is supposed to have equal influence on telepresence. However, the current study found that different sensory stimulations have different significance for influencing telepresence. Two sensory stimulations were specifically identified here as telepresence antecedents: visual content display and auditory content display. Based on the frequency of these and the content mentioned by the participants, visual content display (25) that all participants mentioned as telepresence antecedents is much more significant than auditory content display (9) that only 9 out of 25 participants mentioned in leading to telepresence. One participant described the different influences of visual and auditory stimulations on telepresence in the following way:

> Vision is of course the most important stimulation to induce the feeling of telepresence while comparatively sound is not necessary because I could still have a strong telepresence feeling even if the virtual environment is mute (Interviewee No.1).

This finding is in agreement with some conclusions in the literature on cognitive science that different senses have different importance in influencing individual perceptions (Stein and Meredith, 1993;Calvert et al., 2004). Previous studies have explained this distinction by stating that individual perceptions are associated with individual information processing and thus the information absorption rates related to different senses lead to different degrees of perception (Selame et al., 1988;Wang et al., 2010;Sakat et al., 2012). According to these studies, 83.0% of information is absorbed through vision, 11.0% through hearing, 3.5% through smell, 1.5% through touch and 1.0% through taste. Data on information absorption rates may thus explain why this study found that the visual channel is much more important than the auditory channel in influencing telepresence and provides some hints for predicting the importance of other sensory channels that were not specifically mentioned by participants in the study.

Further with respect to 'vividness', the study also found that users emphasised the influence on telepresence of the quality ('depth') of existing sensory channels over the number ('breadth') of sensory channels, which was not mentioned by Steuer (1992) in his classical model. One participant argued that:

> Adding more sensory stimulations, like sense of touch or smell, could be ineffective for cultivating telepresence if the existing pictures are not clear enough (Interviewee No.14).

Additionally, the study revealed that besides the quality of each sensory channel, the consistency of existing sensory channels also has an important influence on telepresence as a unique construct—consistency of sensory outputs—was identified in the study. On participant mentioned this specific unique construct:

> Adding more sensory stimulations is better to provide a telepresence feeling; however, if the outputs from different (sensory) channels cannot match each other, the (telepresence) feeling can hardly be induced (Interviewee No.5).

In combination, the findings on the differing influence on telepresence of different sensory channels and the emphasis on the influence on telepresence of 'depth' over 'breadth', help further interpret Steuer's (1992) classical model. Thus, they eliminate confusion caused by the previous superficial understanding of the model. For instance, based on the classical model, it was argued that more sensory channels and higher resolution could improve the telepresence experience, which guided practitioners to improve system design by constantly updating the forms of systems and equipment for more sensory stimulation and higher quality. However, according to the findings from this study, blindly pursuing cutting-edge technologies to contain more sensory channels in created environments may be ineffective and inefficient for improving telepresence if the quality or consistency of the sensory channels is low. One participant referred to this consideration as:

> A VR experience platform with advanced and expensive equipment to achieve multisensory stimulations may hardly produce telepresence feeling if the visual, auditory and other sensory outputs are not coordinated (Interviewee No.7).

The finding here argues that increasing the number of sensory channels should be conditional on guaranteeing quality and consistency of the existing sensory channels. Moreover, instead of indiscriminately developing all sensory stimulations, the findings suggest that there are priorities for different sensory channels and vision is the most significant sensory channel for cultivating telepresence. Thus, the findings suggest that practitioners should cease blindly updating the technology in VW design and carefully consider an updating strategy focused on assuring the quality of each existing sensory channel. More generally, these findings are expected to help current practitioners reconsider the design of IS; many take it for granted that updating a system's design with advanced technologies, such as from 2D to 3D or from a single sensory stimulation to multisensory stimulations, will improve the user experience, particularly the feeling of telepresence (Nah et al., 2011;Morcillo et al., 2016).

5.2.1.2 Deepening the Understanding of 'Interactivity'

'Interactivity', as the other main construct of Steuer's (1992) classical model, refers to 'the degree to which users of a medium can influence the form or content of the mediated environment' (Steuer, 1992, p.83). The construct contains three dimensions in Steuer's (1992) study: 'speed', the rate at which input can be assimilated into the mediated environment, 'range', the number of possibilities for manipulation at any given time; and 'mapping', the ability of a medium to map its controls to changes in the mediated environment in a natural and predictable manner. The identified construct of 'interactivity' in the current study is in agreement with the one proposed by Steuer (1992), which empirically supports his proposition that 'interactivity' is an antecedent of telepresence.

The unique constructs comprising the category of interactivity coincide with the three dimensions of 'interactivity' in the classical model. The unique constructs of speed of human–computer interactivity and mapping of human–computer interactivity in this study are identical to the 'speed' and 'mapping' of Steuer's (1992) study. In addition, the unique constructs of freedom of choice and freedom of operation specify the original dimension of 'range' by indicating two different user opportunities for human–computer interaction: through selecting information to observe and through manipulating the system (Murray and Häubl, 2011).

In Steuer's (1992) model of telepresence antecedents, he considered that 'vividness' and 'interactivity' are at the same level with respect to technological factors and 'telepresence' is at a higher level of user experience. In the current study, as the identified telepresence antecedents were further classified into different hierarchical levels, it was found that the above factors involving 'vividness' are at a lower level as givens, and interactivity is at a higher level, as a means in the whole structure. Further, some factors reflecting 'vividness', such as visual content display and multisensory co-stimulation, can lead to interactivity based on the research results, which was not proposed in the classical model. Regarding the newly identified relationship between 'vividness' and 'interactivity', participants had differing opinions:

> High-resolution pictures (**depth of vividness**) in the created environments always cause low loading speed (**speed of interactivity**). I guess the designers may need to make a decision on how clear are the pictures they would like to present in the environments and how fast is the loading speed they want to achieve (Interviewee No.9).

> 3D modelling systems or more advanced virtual environments with VR technology can provide more freedom for me to operate in the environments … Imaging in a 2D system, you can only use a mouse to click but in a 3D system, you can use both mouse and keyboard to control. With VR technology, you can even interact with the system by body movement … This means you can interact with the system via more sensory channels (**breadth of vividness**), not only through vision and sounds but also through touch and movement … Thus, this kind of system provides you more freedom for manipulation (**range of interactivity**) (Interviewee No. 12)

Although the current study identified a relationship among the factors involving 'vividness' and the construct of 'interactivity', further research should be undertaken to investigate the specific influences of different dimensions of 'vividness' on different dimensions of 'interactivity'.

To summarise, some identified factors leading to telepresence in the current study confirm Steuer's (1992) classical model on telepresence antecedents. Further, the findings involving related constructs deepen previous understanding of the classical model by identifying more specific components and revealing their relative importance and inter-relationships with the original constructs of 'vividness' and 'interactivity'.

5.2.2 Specifying Website Functions as Telepresence Antecedents

The study not only deepens understanding of Steuer's (1992) classical model on telepresence antecedents, but also specifically identifies some functional factors of features leading to telepresence. The identified website functions in the study are regarded as closely related to cultivating a user's feeling of telepresence; future researchers and practitioners can focus on this to achieve a better user experience. One participant described the role of these functions as follows:

> It does not target delivery of the major content to portray any exhibit or architecture in the (virtual) environment. Instead, its major purpose is to facilitate me building such a virtual environment in my mind where the feeling of telepresence can then be perceived (Interviewee No.15).

The identified functions were ultimately classified into three categories: 'atmospheric cues', 'spatial navigation' and 'avatar characteristics'.

5.2.2.1 Atmospheric Cues

The concept of atmospheric cues is borrowed from research on environmental psychology (Davis et al., 2008), and is defined as 'the conscious designing of space to create a positive buying environment to produce specific emotional effects in the buyer that enhance purchasing probability' (Kotler, 1973, p.174). In the context of shopping environments in which atmospheric cues have been commonly applied, the concept has been shown to improve the online shopping experience by influencing users' satisfaction, approach/avoidance behaviour and shopping attitudes (Eroglu et al., 2001;Eroglu et al., 2003). The identification of this construct as a telepresence antecedent in our study shows that atmospheric cues also affect the cultivation of telepresence in the more general context of VWs. The identified unique construct of 'atmospheric cues' involves picture backgrounds and sound backgrounds in the virtual environment. As mentioned by the participants, rather than delivering content-related information to users, the major focus of these factors is to build a virtual space containing all elements of the main information, such as buildings, subjects and people. According to the participants, successful construction of a virtual environment with proper atmospheric cues enables users to conveniently overlook the differences between the virtual environment and the real environment it is attempting to simulate. For example, participants highlighted the role of background visitors in the pictures for cultivating telepresence, which relates to the unique construct of atmospheric cues:

> In the scenes depicted by Quanjingke, there were other visitors in the pictures. This is the reason why I think Quanjingke produced a better telepresence experience … Although these visitors are in static images that I could not interact with, this kind of setting made the virtual tour look like a real one because in a real tour, it is impossible to be in a place alone without any other visitors (Interviewee No.23).

5.2.2.2 Spatial Navigation

Another function highlighted by the current study is spatial navigation. The identification of this function, which is focused on guiding users on spatial cognition, is consistent with the physical/spatial feature of telepresence discussed in Chapter 2 (Castelli et al., 2008). Wirth et al. (2007) explicated the spatial feature of telepresence by proposing a process model with two levels. For the first level, users adopt spatial information in a virtual environment to form a 'mental model' of the space to answer questions such as 'is this medium a space?' and 'what kind of space is this medium?'. For the second level, users further confirm their specific spatial perception to answer questions like 'Am I located in this space?' and 'Which places am I at?', which ultimately lead to the sense of telepresence. Thus, unlike the influence of atmospheric cues on telepresence, which occurs through actively establishing a virtual space, the role of spatial navigation for telepresence is more complicated and has a twofold influence. On one hand, the major purpose of spatial navigation is to facilitate users' directional discrimination to assist them with developing a 'mental model' of the virtual space in their mind and locating themselves in the space (Wirth et al., 2007;Castelli et al., 2008). Participants regarded spatial navigation as an essential function for them to 'form a holistic spatial awareness of the virtual space even if only one part of it can be seen at a time in the virtual environment' (Interviewee No.3). With the overall consciousness, it is easier for users to perceive their positions in the whole virtual space and feel that they are being there. On the other hand, spatial navigation shortens the time for solving problems when users get lost in the VW and reduces the possibility for the telepresence feeling being interrupted because of such issues. Participants emphasised their experience of being lost in the virtual environment and highlighted the function of spatial navigation for re-directing them to retain the feeling of telepresence; for example:

> When I felt lost in it (the virtual environment), I found I could hardly feel that I am being there because I really didn't know where I was. But luckily, the (virtual) tour provides a map and some directional arrows. I finally found my way and realised which position I was in with the help of them. This kind of design is quite helpful as I only took a very short time to find my way again. This experience is like when you almost lose your feeling of telepresence that you really didn't know where you were, the function helped you 'drag' yourself back into a certain position in the (virtual) space and ensured you keep feeling telepresence (Interviewee No.11).

Therefore, well-designed spatial navigation not only facilitates the development of a mental model of the virtual space for cultivating telepresence but also helps with solving problems in spatial cognition to avoid the disruption of the telepresence feeling.

5.2.2.3 Avatar Characteristics

The other identified specific feature leading to telepresence is avatar characteristics, which refer to the virtual representation of the physical body of a user in the virtual environment (Suh et al., 2011). Avatars have been commonly adopted in many communication media to represent users for constructing personal online identity and communicating with other online users (Kang and Yang, 2006;Vasalou et al., 2008). However, in the context of VWs, another important role of avatars is as the embodiment of users to place them into the virtual environment, which is closely related to cultivating users' feeling of 'being there' in the virtual environment (Schultze, 2010). It has been argued that discussion of the differences between the real world and a VW mainly derive from the limitations to users' actual bodies (Loomis, 1992). The major limitation is that users can only physically be present at a given place where their bodies are situated (Anderson, 2000). To address this limitation in the context of VWs, the function of avatars is adopted to force a swap between users' actual bodies and virtual bodies, which makes them regard the virtual representation as themselves, thereby naturally perceiving the VW from their avatar's perspective (Petkova and Ehrsson, 2008).

Further, the current study found that rather than creating an avatar that shows their ideal self for socialisation, users prefer to create an avatar representing their actual self to induce the feeling of telepresence. Some participants suggested that creating avatars in a more flexible and personalised way is better for cultivating telepresence than fixing the appearance of the avatar; for example:

> The avatar in this (virtual) environment can surely help to increase the feeling of telepresence; however, one problem is that I am a female but the avatar is a male and gender cannot be switched in the (virtual) environment. I couldn't ignore this difference between the avatar and myself and couldn't stop questioning whether this guy is me or not, which to some extent affected my constant feeling of telepresence (Interviewee No.7).

These findings on the influence of avatar similarity as one unique construct for telepresence antecedents are consistent with the conclusions from Jin 's (2009) research on avatars in Wii games: users who had avatars depicting their actual selves were more able to become psychologically immersed in the virtual environment than those with avatars representing different looks from themselves. Therefore, the avatar is one of the most significant functions of VWs to facilitate users forming the perceptual illusion that although they are physically elsewhere, they feel that they are in the virtual environment (Haans and Ijsselsteijn, 2012).

To summarise, in this subsection, three specific website functions were identified as telepresence antecedents and different functions were shown to have different ways of influencing the feeling of telepresence. Atmospheric cues are responsible for expanding the background of the VW to create an impression of space. Spatial navigation helps users form a spatial mental model and to solve spatial problems to avoid 'breaks in telepresence' (Garau et al., 2008). Avatar characteristics facilitate users to psychologically place themselves into the virtual environment and eliminate the limitations of their situated actual bodies. After expanding the understanding of the classical model of telepresence and specifying some closely associated website functions, the following subsection takes these identified factors into consideration in a synthesis based on which a new overarching model is developed to arrange the telepresence antecedents.

5.2.3 Expanding Ways for Exploring Telepresence Antecedents Using the UMC Model

In the first two subsections here related to expanding the current understanding of telepresence antecedents, the focus is to provide a deeper and better understanding of previous studies of which specific factors lead to telepresence and why, particularly from the traditional technological perspective. In addition to scrutinising and updating the interpretation of prior findings on the technological antecedents of telepresence, the current study newly identifies many categories and unique constructs as telepresence antecedents for other aspects, which is expected to broaden investigations of telepresence antecedents.

By synthesising the 21 identified categories, it was found that some categories conceptually represent one particular component and could be further classified into one feature. For instance, the constructs of user's learning profile and user's intrinsic motivation are identified as factors related to the users rather than the media or technologies. Thus, based on this finding, the current study attempts to further develop an ordered and logical model to allocate all the identified telepresence antecedents within it and to guide future related studies in an overarching framework to select and/or explore factors leading to telepresence based on their own contexts. A UMC model is developed to achieve these goals. The construction of this model is based on the interpretation of the telepresence concept, with theoretical support from Lombard and Snyder-Duch's (2001) conceptual discussion on telepresence antecedents and inspiration from Finneran and Zhang's (2003) idea of the person-artefact-task (PAT) model of flow antecedents in computer-mediated environments.

In Chapter 2, three fundamental features of telepresence concept were identified through synthesising definitions and descriptions of telepresence from the literature, as subjective, physical and mediated features. The physical feature of telepresence mainly reflects the 'transportation' essence of the concept whereas the other two features indicate major components of the telepresence experience. Specifically, the subjective feature of telepresence means that telepresence is a subjective feeling. Thus, the *user*, as the perceiver of telepresence, is a significant component of this construct. Previous studies have acknowledged that individual differences matter for cultivating telepresence and the degrees of telepresence may vary from users even in the same mediated environment (Draper et al., 1998;Bystrom et al., 1999;Nelson et al., 2006;Cho et al., 2015). Additionally, the mediated feature of telepresence indicates that telepresence is induced through the mediated experience via the media. The components of media and content were identified based on the understanding of this feature. The component of *media* is consistent with technological factors that were the focus of the majority of previous studies. The component of *content* is derived from interpretations of the mediated experience showing that the experience is achieved via the content delivered by the media. Through this content, users can immerse themselves in processing the provided information or interacting with the mediated environments. Studies have also confirmed some specific factors involving the component of content as antecedents of telepresence (Choi et al., 2016;Kim and Hyun, 2016).

Based on the interpretation of the fundamental features of telepresence, three major components were identified: user, medium and content. This idea is theoretically supported by Lombard and Snyder-Duch’s (2001) study on conceptually building a framework for understanding the telepresence concept. Their framework proposes that there are three major ways to consider possible factors leading to telepresence—media variables, content variables and user variables—that support the proposed three components of telepresence.

Moreover, the framework of flow antecedents proposed by Finneran and Zhang (2003) provides a reference point for expanding understanding of the components of telepresence antecedents. As mentioned in Chapter 2, telepresence and flow have always been regarded as closely associated constructs that both refer to an individual’s mental state (Faiola et al., 2013;Stavropoulos et al., 2013). In Finneran and Zhang’s (2003) study, they developed a PAT model to understand flow theory and to organise flow antecedents from the literature. The PAT model is intended to conceptualise the major components of flow that are influenced during the process of a person working on a computer-related activity. Thus, the model contains three distinct interaction components as well as the interactions among them, such that seven aspects in total are included in the model: person, artefact, task, the task–artefact interaction, the person–task interaction, the person–artefact interaction and the PAT three-way interaction. Similar to the processes that influence flow, the telepresence experience is influenced during the process of a user interacting with the content via a medium. Inspired by the design idea of the PAT model, it is argued here that besides the identified three major components of telepresence, the model of telepresence antecedents should also contain all interactions among them to cover each possible feature. Thus, a UMC model of telepresence antecedents is developed and the identified constructs are allocated to each aspect based on the author's interpretation of both the constructs and the features of the model (see Figure 5-1). Note that as the three components are distinct but interacting components, it is relatively subjective to distinguish boundaries between the seven factors of the model. Different researchers may have a different understanding of the boundaries and thus may allocate the factors in a different way. However, the UMC model is still valuable as it provides an overarching framework to broaden the perspective for investigating possible factors leading to telepresence and understanding these factors in a more ordered and logical way. Each feature of the UMC model is discussed below.

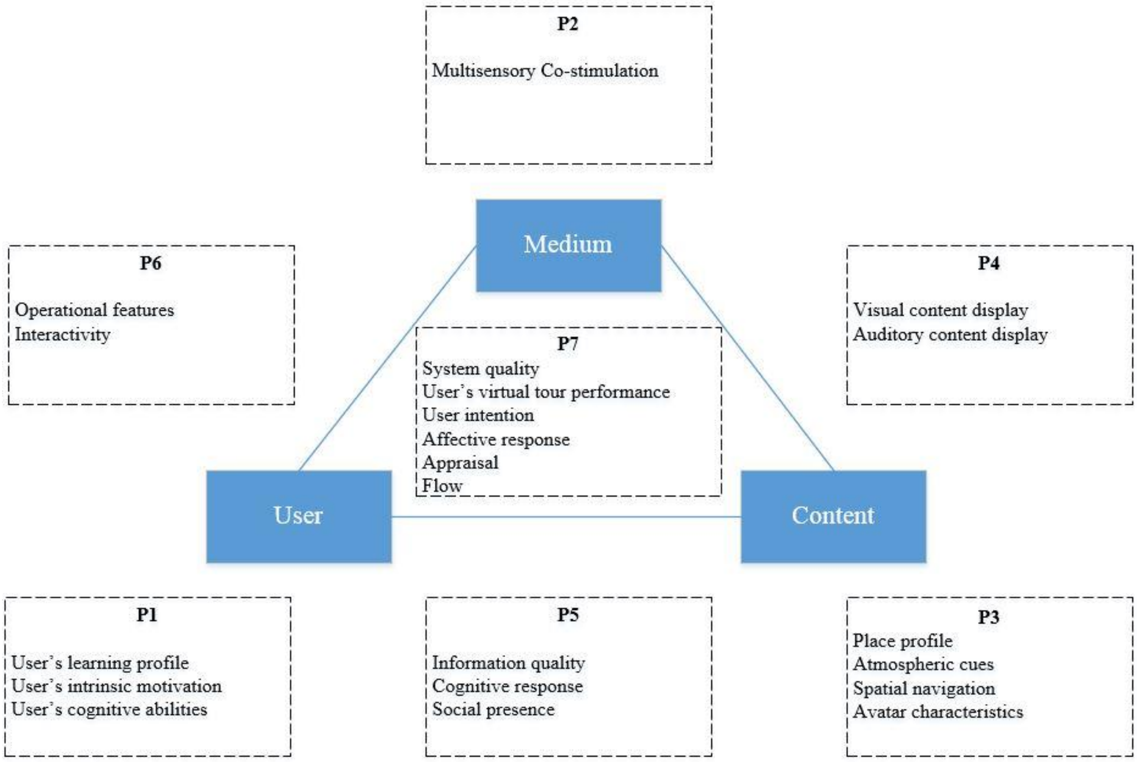


Figure 5-1: The user-medium-content model of telepresence antecedents

5.2.3.1 User

According to the literature review, one of the fundamental features of telepresence indicates it is a subjective sense. Thus, the sense perceiver–user is one of the most essential components in cultivating telepresence. It has been argued that individual differences can lead to very different degrees of telepresence even in the same virtual environment (Lombard and Ditton, 1997;Sacau et al., 2008). In the current research, three relevant antecedents were allocated to the user aspect: user's learning profile, user's intrinsic motivations and user's cognitive abilities. The selection of these constructs was based on trait and state theory, which argues that individual perception is influenced by either a user's relatively long-term, stable traits, such as knowledge and ability; or the user's relatively short-term state influenced by the temporary situation, such as intrinsic motivation (Woszczynski et al., 2002).

As discussed in Chapter 4, user's learning profile refers to user's previous experience and knowledge relevant to the virtual experience (Marquez et al., 2008). The literature indicates that increasing a user's experience and knowledge can have positive consequences, such as facilitating technology acceptance and improving task performance (Liébana-Cabanillas et al., 2014). However, the current study identified that the influence of this category on telepresence is more complex. Participants indicated that although previous experience and knowledge helped them become familiar with the operation and the virtual environment in a short time, it also increased their requirements for the realness of virtual environments. If they knew how the real place appeared, they were more likely to compare the virtual environment with the real place being simulated. Thus, for participants who have abundant related experience and knowledge of a real place, to cultivate a sense of telepresence, the virtual tour experience should be:

> unique enough to distinguish from other online experiences and real enough to be in accordance with the information obtained in the real world (Interviewee No. 12).

For user's intrinsic motivation, it was surprising to find in the current study that this factor has an extremely important role in inducing telepresence, with 22 participants emphasising this. Some respondents even argued that intrinsic motivation was more significant than the design of a virtual tour to cultivate telepresence:

> I was quite interested in this place and really wanted to learn something from this virtual experience so I felt I was so focused on it and felt strong telepresence even though the design of the system was bad (Interviewee No.5).

With respect to user's cognitive abilities, the current study identified two specific user's abilities that are more closely associated with user's perception of telepresence. One is the ability of imagination, which complements the ability of users to establish a mental model of the VW to allow themselves to become immersed in it (Ciulla, 1998). The other is attentional control, which makes users intentionally allocate their attention to the virtual environment rather than their physical surroundings (Hibbeln et al., 2016).

These factors specify what types of individual differences may influence telepresence. Thus, the findings not only empirically highlight the significance of individual factors for cultivating telepresence but take a further step to identify possible user-related factors as telepresence antecedents to promote future research on this aspect.

5.2.3.2 Medium

A focus on technological factors has been the main research trend with respect to telepresence antecedents, and they have been well studied compared to user aspects, which include three main features: what medium form a system uses, what content it presents and how it uses the medium to present the content (IJsselsteijn et al., 2000). Considering the medium factors leading to telepresence, researchers have highlighted the importance of media transparency based on the social transparency of technology theory (Lombard and Ditton, 1997;Erickson and Kellogg, 2000). According to this theory, the ability of a medium to be more transparent is more likely to influence users' perceptions (Erickson and Kellogg, 2000). Thus, telepresence occurs when the user forgets about the technology, and feels/acts as if the medium itself were not there. This argument is consistent with the fact mentioned in Chapter 2 that telepresence is one specific type of presence, which is a user's feeling of non-mediation (Cho et al., 2015). To achieve media transparency requires that the medium is close to the reality, which is seamlessly integrated into a user's action–perception loop (Haans and Ijsselsteijn, 2012).

With respect to the function of displaying content and interacting with users through content, it is quite difficult to define clear boundaries between the medium and other components. In this study, the category of multisensory co-stimulation was allocated only the pure medium feature, as this category only describes how multiple sensory channels influence telepresence (Scalisi et al., 2006), including three unique constructs: number of sensory outputs, consistency of sensory outputs and synaesthesia. Although other factors such as visual content display and auditory content display are closely related to the aspect of the medium, they also involve how the medium is used to display content. Thus, these factors were allocated to the aspect of interaction rather than the pure medium.

The discussion on the findings regarding the construct of multisensory co-stimulation is consistent with the requirement for media transparency. Attempts to add more sensory channels and to increase the consistency of all sensory channels are expected to better simulate the situation in the real environment, which further decreases the likelihood of the user noticing the existence of the medium and thus increases the possibility of inducing telepresence (Schuemie et al., 2001).

The aspect of the medium emphasises the forms of the technology, in agreement with common knowledge about telepresence antecedents, that the degree of telepresence is strongly determined by the technologies adopted to construct the virtual environments (Steuer, 1992;Suh and Chang, 2006).

5.2.3.3 Content

Telepresence is the instant feeling of users when they are perceiving or responding to the content in virtual environments (Kim and Biocca, 1997). Thus, content is the key to occupy users' attention and to compete for it amid the distractions of the physical surroundings (Coyle and Thorson, 2001). In the current study, four antecedents were allocated to this feature: place profile, atmospheric cues, spatial navigation and avatar characteristics.

Place profile represents the original source of content and determines whether sufficient information can be provided to immerse the users in the virtual environment. One participant called this the 'inborn advantages' (Interview No.13) of some virtual tours, which cannot be modified by system design; thus, selection of the place to simulate at the beginning of the design also plays a significant role in inducing telepresence.

The other three factors belonging to this feature are considered the most relevant content components for inducing telepresence. As discussed above, atmospheric cues create the proper environmental settings for cultivating telepresence (Sheng and Joginapelly, 2012). Spatial navigation helps users construct a mental model and locate their positions in the virtual environments (Lind et al., 2013). Avatar characteristics provide virtual representations of users in the virtual environment (Suh et al., 2011). The synthesised function of these three categories is to construct a virtual space in a user's mind for cultivating telepresence. Thus, according to the participants, for cultivating a better telepresence experience, the VW should have a rich and attractive environmental background, clear and stereo spatial manifestation and immersive virtual representation.

5.2.3.4 The Content–Medium Interaction

According to cognitive fit theory, a match between IT technologies and tasks is significant for user perception and evaluation of the use experience (Vessey, 1991). This theory was interpreted in the current study as meaning that a user's perception of telepresence can be influenced by whether the medium can be made great use of to convey the content. This relates to the feature of the interaction between content and medium. Based on this understanding, this interaction aspect focused on how the medium is used to display the content. Thus, two constructs were allocated to this feature: visual content display and auditory content display.

Based on previous understanding of the construct of 'vividness' proposed by Steuer (1992), media utilise different sensory channels to deliver content (Hoffman and Novak, 1996;Klein, 2003). In the current study, two major sensory channels were identified that are closely associated with cultivating telepresence: the visual channel and the auditory channel. Corresponding unique constructs for each category show that what matters is the process of displaying content via the medium, which finally leads to telepresence. Moreover, as discussed above, visual content display has a more significant influence on telepresence than does auditory content display.

5.2.3.5 The User–Content Interaction

According to IJsselsteijn et al. (2000), telepresence involves a psychological process whereby users become totally immersed in the content provided by a mediated environment while ignoring content from their physical surroundings. Thus, the interaction between user and content is mainly to do with absorbing the user's attention and immersing them, which leads to the user perceiving, processing and responding to the content. Accordingly, three constructs were allocated to this feature: information quality, cognitive response and social presence.

Information quality is regarded as users' overall evaluation of the content, which is a direct consequence of user–content interaction (Lin, 2007). It is regarded as the most direct reflection of whether the content is appropriate for users to have a feeling of telepresence (Kim and Hyun, 2016). The unique constructs composing the category of information quality, such as appropriate amount, completeness, value-added and accuracy, to some extent indicate what should receive more attention during design of the content in virtual environments.

Cognitive response refers to the influence of the content on users from a cognitive perspective, and is the combined effect of the perceived content and a user's existing knowledge (Artacho et al., 2010). According to the findings, two cognitive processes are involved to cultivate telepresence: the process of memorising and the process of position locating. For the first process, when users process information, memory is aroused to match the received information with existing knowledge (Hopp, 2014). This process leads to a thorough and immersive mental activity to which attention is allocated and consequently telepresence is induced. The second process concerning position locating in the virtual environment is more specific to the physical nature of telepresence, as telepresence is related to a feeling of locating (Suh and Chang, 2006). Respondents reported that:

> If I lost my way, how can I feel that I am being there? The feeling of telepresence is based on awareness of my location in the virtual environment (Interviewee No. 5).

Social presence refers to user perception of the warmth, sociability and feeling of human contact in the virtual environment (Hess et al., 2009). This construct represents users' reflection on the content specifically from the social perspective, and thus was allocated to the user-content feature. It has been argued that telepresence and social presence are two basic types of presence, which indicate physical and social focus, respectively (IJsselsteijn et al., 2000). The findings of the current study suggest that a relationship exists between these two types and social presence can influence telepresence. In support of this argument, one participant stated that:

> When I felt warmth from the virtual environment, I felt socially belonging to the environment, which makes me feel physically being there (Interviewee No. 15).

5.2.3.6 The User–Medium Interaction

User–medium interaction refers to how users use the medium. It has been argued that when users are using the medium, their attention may be mainly focused on the human–medium interaction, which potentially leads to telepresence (Coyle and Thorson, 2001;Keng and Lin, 2006). Thus, two categories can be classified into this aspect: operational features and interactivity. Both are descriptions of the user–medium interaction. The two factors belonging to this feature describe the interaction from different levels. Operational features refer to the more concrete characteristics of the user–medium interaction (Laudon and Laudon, 2004) whereas interactivity relates to the more abstract level involving the overall evaluation of the user–medium interaction (Mollen and Wilson, 2010).

5.2.3.7 The User, Medium and Content Three-way Interaction

The user, medium and content three-way interaction comprises the telepresence antecedents derived from the combined effects of the three-way interactions, indicating the complicated nature of the telepresence experience (Riva, 2007). As they represent the consequences of the user interacting with the medium via content, six telepresence antecedents were allocated to this feature: system quality, user's virtual tour performance, user intention, affective response, appraisal and flow.

System quality describes the user's evaluation of an information system (Ahn et al., 2007), which indicates the ability of the medium to convey the content. Thus, it belongs to a three-way interaction. A user's virtual tour experience concretely describes the user experience of using the medium to obtain and process the content (Cho et al., 2002); thus it was allocated to the three-way interaction. User intention indicates the user's subjective decision about whether they would like to undertake certain behaviour, responding to the content observed via the medium.

A virtual tour experience is a direct consequence of the three-way interaction, which concretely describes the user experience as they use the medium to process the content (Cho et al., 2002). The virtual tour experience is directly related to telepresence, which only occurs instantly within the virtual experience (Steuer, 1992). The rest of the categories of this feature can be regarded as the consequences of the virtual tour experience, which potentially influences telepresence. Affective response also refers to the user's response to the experience of using the medium to observe and interact with the content, specifically from the affective perspective. Unlike the cognitive response, which is mainly focused on the influence of content on the user, the affective response is perceived in a more complicated way. The user's emotion and affective attitude builds not only on the content they obtain but also on the experience of using the medium. Thus, this construct belongs to the three-way interaction. The construct of appraisal, which is the evaluation of the consequences of the virtual experience (Beaudry and Pinsonneault, 2010), includes two dimensions: 'expectation-disconfirmation' to evaluate whether the experience meets the original expectation (Lowry et al., 2015) and 'needs fulfilment' to evaluate whether the experience fulfils the original needs (Au et al., 2008). This is also a result of the complicated interaction between user, medium and content. Similarly, flow, which indicates the user's mental state based on their activity in the virtual environment, contains focus attention, sense of control and engagement, which also belong to the three-way interaction. Thus, they were also allocated to this feature in the UMC model.

To summarise, the development of the UMC model emphasised a change in the consideration of telepresence antecedents whereby multiple aspects should be investigated to provide a comprehensive understanding. Three major components of telepresence and the interactions among them constitute the UMC model, which broadens the previous investigation scope for telepresence antecedents. These findings are consistent with the analysis of the user experience within a medium, specifically in VWs, during which telepresence is cultivated. From the users' perspective (**U**), they use the medium and through the medium they receive, process and respond to the content. From the medium's perspective (**M**), users are the object it serves and content is the subject it delivers. From the content's perspective (**C**), the medium is utilised to reach the users. Further, verification of the influence on telepresence of the interactions among these components in the current study indicates that the process of cultivating telepresence does not occur in the simple stimulus–response way proposed in most previous studies (Mollen and Wilson, 2010;Ou et al., 2014). Instead, the process is more complicated; it involves not only the superficial components but also the multiple interactions between these components. This study identified significant factors for each interaction feature, which gradually opens the 'black box' of the original interpretation of telepresence antecedents. Therefore, it also indicates that there is some order for the occurrence of telepresence antecedents as interactions only occur based on the existence of the three major components. This finding is in agreement with the argument in the current study that inter-relationships exist among telepresence antecedents, which is illustrated in the following sections as the hierarchical structure of telepresence antecedents.

5.3 Understanding the Hierarchical Structure of Telepresence Antecedents

The data collected via the laddering interview approach contain information for identifying not only constructs cultivating telepresence but also the inter-relationships among them. Thus, in the current study, a comprehensive and structural set of telepresence antecedents were identified and the corresponding relationships were also constructed to form a hierarchical structure. The paths in the hierarchical structure illustrate how the givens affect the ends through the means, which finally leads to the feeling of telepresence. In this section, these paths are thoroughly discussed to explore the underlying mechanisms of cultivating telepresence. In the first part, the hierarchical structure is analysed based on full paths including the three levels of factors. The full paths are mainly classified into three categories based on the three mental activities proposed by the trilogy of mind (Hilgard, 1980;Mayer et al., 1997): cognition, affection and conation. In the second part, interesting findings regarding some parts of the paths are summarised to provide valuable information for further understanding of the process of cultivating telepresence.

5.3.1 Understanding Full Paths Based on the Trilogy of Mind

The identification of major full paths was based on the combined consideration of the mentioned frequency of relationship chains that contained all three hierarchical levels and the underlying meanings of the chains. Finally, three full paths were identified that were consistent with the widely accepted classification of mental activities in psychology research called 'the trilogy of mind' by Hilgard (1980). According to arguments regarding 'the trilogy of mind', the mental process can be depicted from three perspectives: cognition, affection and conation. Specifically, the cognitive aspect indicates the process of knowing the object, which represents the direct response to the external information.

The affective aspect refers to the process of the feeling about the object, which involves a connection with the person's inner state. The conative aspect is related to the process of striving towards or away from the object, which provokes voluntary activity. The major full paths found in the hierarchical structure in the current study are presented below.

5.3.1.1 Understanding the Full Path from the Cognitive Perspective

It is commonly acknowledged that better understanding of the cognition of users can lead to more successful outcomes of IS (Orlikowski and Gash, 1994;Tan and Hunter, 2002). Thus, the cognitive perspective has become increasingly important in IS research on the user experience (Nelson et al., 2000). Specifically, a full path involving the cognition of users was identified in this study, which indicates that one significant mechanism for cultivating telepresence is via the user's cognitive mental activities (see Figure 5-2).

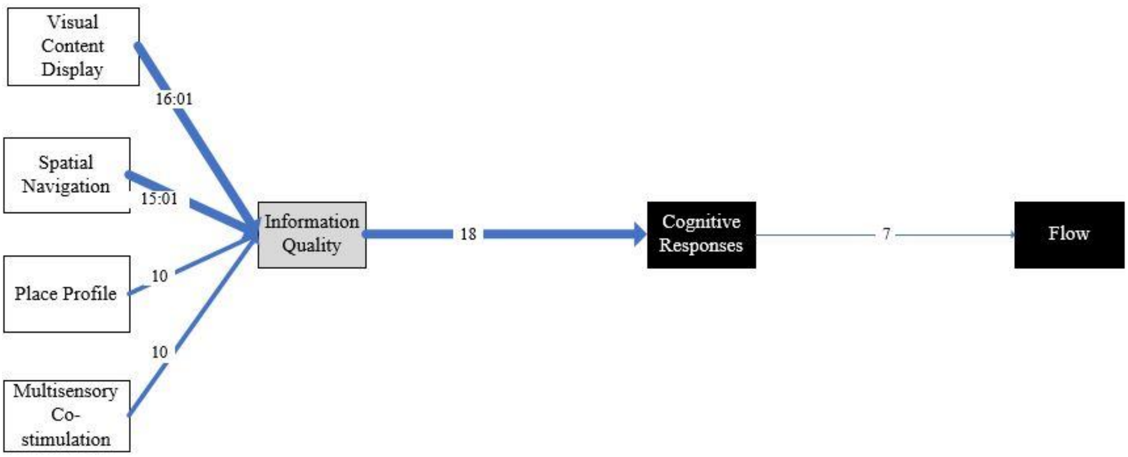


Figure 5-2: The full path from a cognitive perspective

At the beginning of the path are four main factors at the level of givens, which are the triggers for this cognitive mechanism: visual content display, spatial navigation, place profile and multisensory co-stimulation. Place profile is the original source of the information presented in the VWs and visual display and multisensory stimulation refer to the sensory channels for delivering the information to the users in VWs. Spatial navigation is the function provided by VWs to assist users to navigate and process the information. These four information-related factors directly determine the information quality perceived by users, which influences their cognitive responses. The cognition of users then affects their flow state and finally leads to a feeling of telepresence.

According to the identified full path from the perspective of cognition, it was found that the process of cultivating telepresence is accompanied by a user's action of processing the information from a VW. This finding is consistent with the major purpose of VWs, which is to deliver context-specific content to users through online channels. Thus, the information provided by the VW is extremely important for cultivating a user's feeling of telepresence. The relative significance of the identified construct of information quality, which has the highest centrality in the hierarchical structure, supports this finding. Moreover, based on the full path from the cognitive perspective, the cultivation of telepresence occurs during the process of users perceiving, processing and responding to the information. In this process, the function of information for cultivating telepresence is twofold. First, users construct a mental model based on the information provided, which directly influences their belief about whether virtual environments are close to the real world to induce the feeling of 'being there' in the virtual environment. Second, the information can be considered as the tool to absorb the users' attention so that when they are processing information, their attention is totally focused on the VW rather than on their physical surroundings. Thus, they have the feeling of 'being there' in the VW even though they are physically present somewhere else. In previous literature, some studies found the relationship between information-related factors and telepresence, which are consistent with the above finding. Kim and Hyun (2016) confirmed the influence of information quality on telepresence in a study on augmented reality. Choi et al. (2016) found the relationship between informativeness and telepresence in the study of marketing websites. Although these studies emphasized the importance of information on cultivating telepresence, they neither identified what factors can affect the information nor explained how the information lead to telepresence. Thus, the discussion on the full path in cognitive aspect in this subsection completes the previous relevant knowledge involving the importance of information on cultivating telepresence.

5.3.1.2 Understanding the Full Path from the Affective Perspective

Affection has been considered as a critical factor in human psychology and behaviour within various research contexts. In the IS discipline, an increasing number of studies are considering the affective dimensions of human–computer interactions (Jiang et al., 2010;Stein et al., 2015). In the current study, a full path leading to telepresence from the affective perspective was identified, and it is regarded as a significant mechanism of cultivating telepresence (see Figure 5-3).

Compared to the full path from the cognitive perspective, the full path involving affection is longer and involves more constructs at the levels of means and ends, which means the process of cultivating telepresence through affective mental activities is more complicated. To trigger the path, four factors at the level of givens are relevant: visual content display, multisensory co-stimulation, avatar characteristics and spatial navigation. Among these four factors, the former three directly lead to interactivity whereas spatial navigation influences interactivity by affecting operational features. The means-level factor of interactivity is thus indirectly connected to the ends-level factor appraisal via system quality. Appraisal further influences affective response, which affects user intention and finally leads to flow, directly connected to telepresence. In previous literature, some studies identified several specific affection-related factors as telepresence antecedents. For instances, Nelson et al. (2006) argued that user's game liking may affect their perceived persuasion on the brand placements in games, mediated by the construct of telepresence. Makowski et al. (2017) found that users' emotion experience in the mediated environments can influence their feeling of telepresence. Although the findings in these studies confirmed the discussion on the factors leading to telepresence from the affective perspective, they didn't further explore the specific factors influencing telepresence through the affection and the underlying mechanism of the relationship between affection and telepresence. The findings of the current study provide further information to complete and clarify the previous relevant understanding.

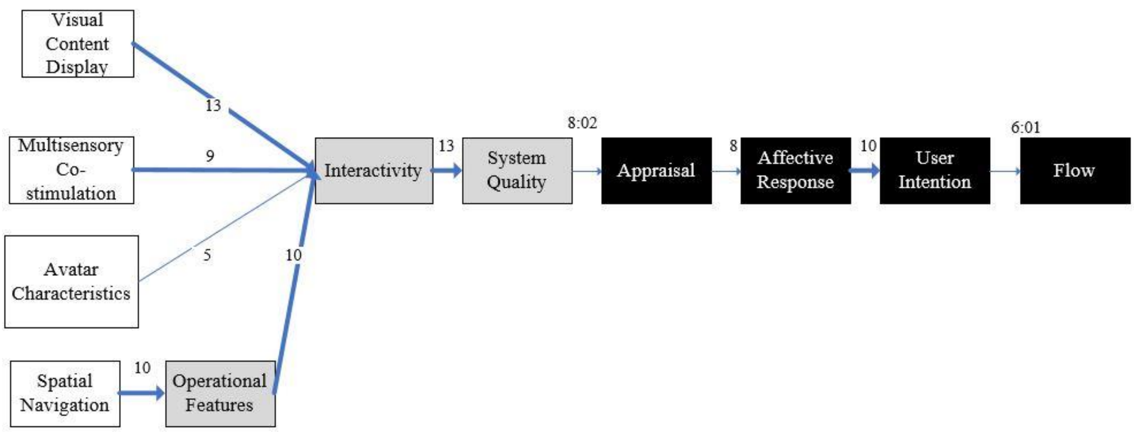


Figure 5-3: The full path from an affective perspective

Based on the identified full path leading to telepresence from the affective perspective, it was found that users can have the feeling of telepresence through their affective mental activities. Unlike the cognitive path in which the user's cognition is greatly affected by the obtained information, user's affection is mainly influenced by the interactivity between the user and the virtual environment. This finding is consistent with previous arguments that users have two major roles in VWs: one is as an information receiver and the other is as a system manipulator. Further, by comparing the cognitive path and the affective path, it was found the latter path is much longer than the former, which indicates that the process of cultivating telepresence through the affective mechanism is much more complex than that through the cognitive mechanism. Additionally, the longer path means the process is more sensitive and that any issue affecting one relationship may impede cultivation of a feeling of telepresence.

Moreover, similarities between the cognitive and affective paths is consistent with discussions regarding utilitarian and hedonic website performance in previous studies (Overby and Lee, 2006;Choi et al., 2016). According to the discussion, website performance is closely associated with users' subjective experience with a website, which can be divided into utilitarian and hedonic performance (Huang, 2003). Utilitarian performance refers to instrumental benefits based on the functional attributes of the website whereas hedonic performance refers to the fun and pleasurable experience of using the website (Huang, 2005). For the current study, within the artefact of virtual tour, utilitarian performance is related to the major function of a virtual tour, which is delivering information to form the cognition; hedonic performance refers to the interactions with the virtual environment for affection.

5.3.1.3 Understanding the Full Path from the Conative Perspective

Conation is defined as one aspect of the mental process, and includes tendency, impulse, striving or directed effort (Atman, 1987). It has been argued that of the three major mental activities, cognitive activities deal with processing information and generating thoughts, affective activities are related to producing emotions and conative activities drive people's actions (Bagozzi, 1992). In the hierarchical structure of telepresence antecedents, a full path related to conation was identified (see Figure 5-4).

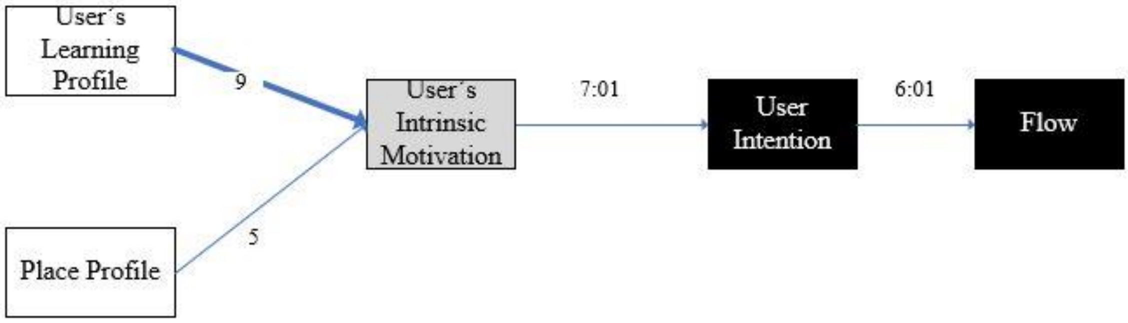


Figure 5-4: The full path from a conative perspective

The triggers of this full path are user’s learning profile and place profile at the level of givens, leading to user’s intrinsic motivation at the level of means, which further influences the ends-level factor of user intention and finally leads to flow, directly connected with a telepresence experience.

Based on the identified full path, both trigger factors are independent of the virtual tours as a user’s learning profile is determined by their previous knowledge and experience whereas place profile refers to the static features of simulated real places. The two factors influence user intention via motivation and ultimately lead to telepresence via flow. The identification of this path to some extent explains the phenomenon that individuals may differ in their degree of telepresence even in the same mediated environment. Specifically, even if the VW has a poor design, users can still have a very high degree of telepresence if they hold strong motivation and intention. This finding emphasises the significance of user features when considering telepresence antecedents.

5.3.2 Particular Partial Paths Leading to Telepresence

The discussion in the last subsection illustrated the major three kinds of complete paths leading to telepresence focusing on explaining the whole process for how telepresence is cultivated. In this subsection, some parts of the paths in the structure are selected to highlight some interesting findings.

5.3.2.1 The ‘Atmosphere Construction’ Path

In the developed hierarchical structure for telepresence antecedents, the path beginning from the stimulus of atmospheric cues is different from the two major paths discussed above. There is no mediator in the means layer for the paths by which atmospheric cues directly influence factors in the givens layer. Compared to the three full paths leading to telepresence that contain all three levels, as discussed above, the influence of atmospheric cues is more direct and immediate. The construct is directly linked to social presence and affective response; affective response further leads to user intention, which finally influences telepresence via flow.

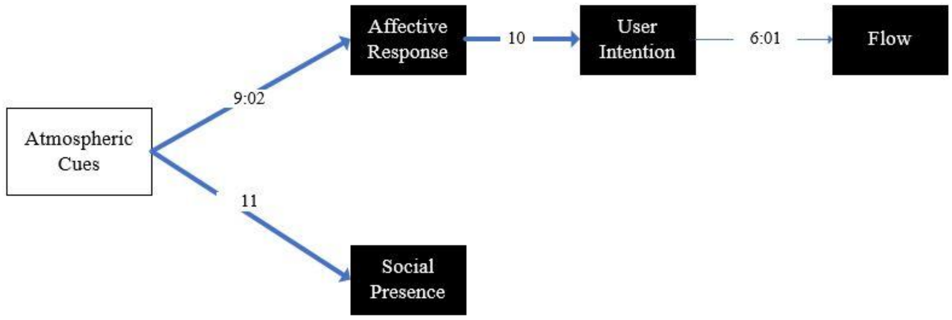


Figure 5-5: The 'atmosphere constructing' path

Based on this relatively short path at the level of means, the major role of atmospheric cues is neither delivering information to users nor facilitating human–computer interaction. There are two main functions of atmospheric cues. One is building an appropriate setting for the virtual environment that is able to cultivate social presence. The other is directly influencing users' affection and its consequent responses to cultivate telepresence. Regarding this short path, atmospheric cues should be well designed as this is a quicker way to 'drag' users into the VW and give them the feeling of being present there.

5.3.2.2 Comparison Between Auditory Content Display and Visual Content Display

According to Steuer's (1992) classical model of telepresence antecedents, the breadth (number) and depth (quality) of sensory channels influence telepresence. However, without weighting each sensory channel and exploring their respective influencing mechanisms, all sensory channels are regarded as playing an equal role in cultivating telepresence. The current study specifically identified two major sensory stimuli for telepresence (visual content display and auditory content display) and found that for cultivating telepresence, the visual channel is much more important than the auditory channel. Further, the study explored the mechanisms for how these two sensory channels influence telepresence in different ways.

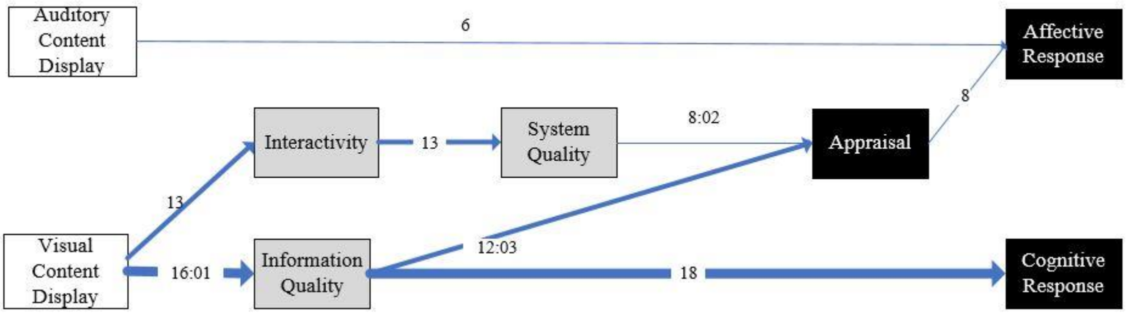


Figure 5-6: Comparison between auditory and visual channels

The visual content display construct, which has an essential role in the structure as one of the starting points for both information processing (information quality) and human–computer interacting (interactivity), influences telepresence in relatively complicated ways through both cognition and affection. However, based on the hierarchical structure, auditory display is directly linked to affective response without being mediated by any means-level factors. This finding to some extent represents a breakthrough by revealing that different sensory channels have different roles and effects in the process of cultivating telepresence. Visual stimuli have two major functions: providing abundant information to immerse users' minds; and facilitating human–computer interaction. For the auditory stimulus, although some additional information is provided through this channel, its major function in cultivating telepresence is to influence users' feelings, rather than delivering information.

5.3.2.3 Two Aspects of the Influence of Affective Response on Telepresence

Based on the hierarchical structure built in this study, affective response in the ends layer ultimately affects flow, which is directly linked to telepresence in two ways: the normal way through user intention, which was illustrated in the above discussion on full paths; and a second way that is quite interesting. For this relationship, affective response can lead to flow by influencing users' cognitive abilities including their abilities with respect to imagination and attentional control. In contrast to the previous major argument that user abilities are constant, the user cognitive abilities identified in the study are changeable and depend on users' current state, especially their emotional state. This finding is consistent with Hibbeln et al.'s (2016) argument regarding attentional control theory, that users' emotional reactions influence their cognitive abilities such as attentional control, which ultimately affects users' focused attention as one of the significant dimensions of flow. This finding again emphasises the importance of user features in cultivating telepresence.

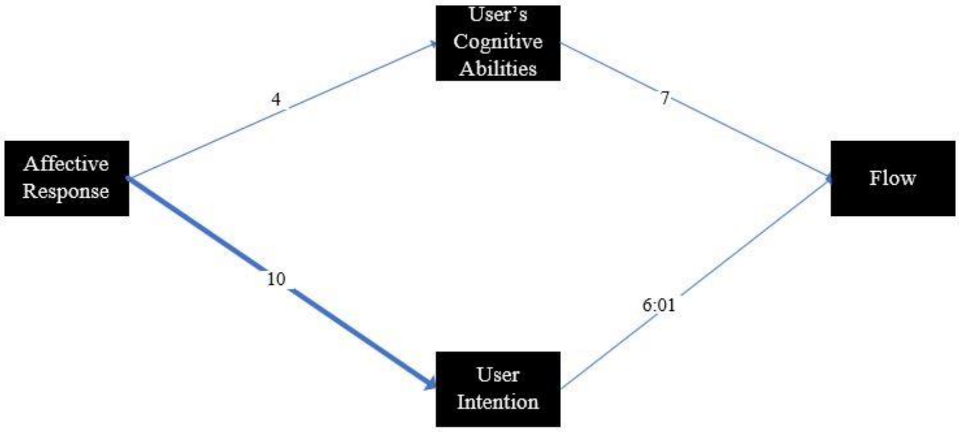


Figure 5-7: Two ways for the influence of an affective response on telepresence

To summarise, this section focused on the findings relating to the developed hierarchical structure of telepresence antecedents. The most important factors were discussed according to the different hierarchical levels. The full paths leading to telepresence were then identified to explain the major mechanisms of cultivating telepresence. Finally, some parts of the hierarchical structure were discussed to highlight some particularly interesting findings. In the following section, the findings on user segmentation in the current study are discussed by identifying groups of users in VWs.

5.4 Identifying Segments of Users

The final objective of the current study was to understand the segmentation of VW users based on the mechanisms of perceiving telepresence because researchers have argued that the perception of telepresence may vary from person to person (Lombard and Ditton, 1997;Sacau et al., 2008). According to the investigation of prior typologies of users in relevant research fields as outlined in Section 2.6.3, most classifications are based on either users' abilities/motivations or users' actual usage/use behaviour of systems. The current study provides an innovative perspective by which to segment users based on their perceptual logic during a VW experience. Specifically, the typology of users in the study relies on distinguishing the means layer of telepresence antecedents and thereby understanding the hierarchical structure of factors leading to telepresence for each cluster of VW users. The findings regarding segmentation not only verify previous propositions about the significance of the influences of individual differences on telepresence perception but also identify different types of users experiencing telepresence. This is expected to facilitate personalised design of VWs for users in the future to cultivate a better telepresence experience.

The current study identified three clusters of VW users: balanced users, cognitive users and affective users. As discussed in Chapter 2, this segmentation is based on the means layer of telepresence antecedents. As the means layer is the 'bridge' connecting the givens and ends layers, differences in means create distinctive paths of telepresence antecedents in all layers. According to the results of the cluster analysis, there are six telepresence antecedents in the means layer (operational features, interactivity, information quality, system quality, user's intrinsic motivation and user's virtual tour performance) and the three identified groups of users are significantly different in two of the six antecedents: information quality and interactivity. These two highlighted telepresence antecedents represent two different ways for users to experience a feeling of telepresence: one is by passively perceiving abundant information and the other is by actively manipulating the system.

5.4.1 Balanced Users

The first group that arose from the cluster analysis was named balanced users, which comprised the largest proportion (40%) of participants. Based on the radar diagram of the three clusters and the centrality of the telepresence antecedent calculated for each cluster, for balanced users, the constructs of interactivity and information quality were almost equally important. This finding indicates that for this type of users, both the provided information for cognition and human–computer interactivity for affections is significant for users to have the feeling of telepresence.

According the hierarchical structure for the group of balanced users, unlike for the other two clusters, its structure is much more balanced in two major ways to perceive telepresence. In other words, since telepresence has been considered as a fragile feeling, which is easy to disrupt, balanced users have the highest requirements for VW design on perceiving telepresence. Specifically, this type of user requires not only high quality of information to build their cognitions but also strong performance of human–computer interactivity for their affections. For balanced users, the design of the visual content display is the most important factor in the givens layer as it has a significant influence on both information quality and interactivity. Unlike the other clusters, balanced users also emphasise the key role of atmospheric cues in cultivating telepresence. Therefore, based on these comparisons, balanced users have stricter requirements for a balanced design for VWs to construct a virtual environment that not only provides users with sufficient and appropriate information but also facilitate users' interactivity with the system. In the ends layer, cognition, affection and conation play similarly important roles in leading to telepresence to that of cognitive responses, affective responses and user intention, which are the three most important antecedents identified in the response layer. Information quality is the main factor leading to cognitive responses and causes flow directly connecting to telepresence, whereas users' appraisal based on the evaluation of information quality and system quality influences affective responses and finally leads to telepresence via affecting user intentions.

Therefore, for the balanced users, the consideration for the VW design should be thorough and careful. As discussed before, to perceive the feeling of telepresence in a VW, they have the highest requirements that the VW should be designed to not only provide high information quality to the users but also facilitate human-computer interactivity in the virtual environment. Thus, all the features

5.4.2 Cognitive Users

The second cluster of VW users, cognitive users, highlights the significant position of information quality in the whole hierarchical structure, which included 32% of participants. This group had the highest grades for the construct of information quality, which is related to perceived information from VWs; the scores for interactivity in this group were the lowest among the three groups.

By comparing the hierarchical structure of this group with that of the other two, some significant differences were identified. First, for cognitive users, the most important paths were those from the stimuli of spatial navigation, visual content display and place profile to information quality and then to cognitive response. Second, the construct of affective response is at the end of the most important paths as a further consequence of cognitive responses rather than occupying a separate important path. Third, atmospheric cues have only a weak influence on social presence and no longer have any connection to affective response.

Based on these findings, the cognitive user type focuses only on the information they perceive during the process of a VW experience. They regard interactivity simply as a factor assisting them in building their cognition regarding the information. Further, developing cognition is their only requirement and when they achieve this goal during the virtual experience they have positive emotion and attitude, which boosts their intention to immerse themselves in the virtual environment and completely focus their attention on the environment, which finally leads to a feeling of telepresence. For this type of user, the most significant stimulus is the function of spatial navigation, which is fundamental for them to build their cognitive mental model of the virtual place. Visual content display and user’s learning profile are also essential as visual content display is the most efficient sensory channel to deliver information and user’s learning profile is also related to user’s perception and understanding of the perceived information. In the ends layer, the most significant factors are appraisal and cognitive response, which indicates that these users are more purposeful with respect to receiving information to meet their original expectations and requirements. However, they pay relatively little attention to their interaction with the system.

As for the process of perceiving telepresence, cognitive users emphasize the cognition-related paths, which are associated with the features and functions of VWs that providing information and/or facilitating users’ obtaining information in the virtual environments. For such type of users, their focus—information ultimately influences the process of perceiving telepresence mainly in two ways: first, abundant and high-quality information delivered from the VWs could occupy users’ attention and immerse users, keeping their attention from the disruption of the external information from users’ physical surrounding. This explanation is agreed with the illustration of telepresence concept that telepresence occurs when users feel they are ‘being there’ in the virtual environment that they can hardly notice their physical surrounding where they actually are. Second, based on the information observed in the VWs, this type of users create cognition on their own, which help them to build and complete the virtual space in their mind. With the help of provided information, they know the general layout of the space and understand the how different locations of the space are connected. Furthermore, they know where they are in the virtual space and how to get to the location they want to go. Thus, having a virtual space in mind facilitated by perceived information, cognitive users are more likely to have the feeling of telepresence.

5.4.3 Affective Users

Affective users, as the third cluster of VW users, accounted for 28% of participants. This type of user had the highest score for the construct of interactivity but a lower score for the construct of information quality in the means layer. Additionally, it is notable that most users in this type are females (85.71%) rather than males.

The group of affective users highlights the important role of interactivity in cultivating telepresence. For factors in the givens layer, some telepresence antecedents that are ignored by other types of users, such as avatar characteristics, are strongly emphasised by this group. The function of an avatar is considered an essential factor that facilitates human–computer interactivity. Meanwhile, the construct of operational features, which is directly connected with interactivity also holds an important position in the means layer for the whole hierarchical structure. By highlighting avatar and operation factors, this group of users showed that for them the experience of system operation is more important than it is to the other two groups of users. In the givens layer, visual content display, spatial navigation and avatar characteristics, which have significant direct or indirect relationships with interactivity, were identified as relatively important factors. Thus, for this group, these three aspects should receive more attention with respect to enhancing the user telepresence experience. In the means layer, interactivity is the most significant construct, followed by information quality. For the group of affective users, the paths with human–computer interactivity at their centre are key paths leading to telepresence and the paths from related stimuli to information quality to cognition also hold some importance. This indicates that information perception is a must-have element for cultivating telepresence for all groups of users. Moreover, at the ends level, it was found that affective response was followed by appraisal, which indicates that for this group, the original expectation and need is mainly focused on and achieved by affection.

Compared to cognitive users, affective users focus on interactivity rather than information. Their major way to perceive telepresence is through interacting with the VWs. It is shown that operation with the system is more likely to absorb affective users' attention and immerse them in the virtual environment, obstructing external disruption from users' physical surroundings. Affection-related factors are also highlighted by them, which is probably associated with the purpose of this type of users to experience VWs, as some participant who belongs to this type stated that “I want to have fun and also release my pressure via having virtual tours just as I expected in real tours. Thus, it should provide me a proper virtual environment with which I could conveniently and comfortably interact” (Interviewee No.12). It is shown that for perceiving telepresence, affective users intend to expect a well-designed mature virtual environment in which they could have interactivity while for cognitive users, they are more likely to build the virtual space in their mind based on the observed information in the VWs.

To summarise, this section interpreted three identified segments of users in VWs based on their mechanisms of perceiving telepresence. The findings explained the argument that even in the same mediated environment, the degree of telepresence varies from person to person. The analysis of different segments of users facilitated further understanding of both the mechanism for how telepresence is cultivated according to different users and the users themselves.

5.5 Summary

This chapter focused on illustrating the findings based on the analysis of research results presented in Chapter 4. Three main features were included: expanding current understanding of factors leading to telepresence; understanding the hierarchical structure of these factors; and interpreting segments of users of VWs. The findings complete current knowledge of the core construct of telepresence and facilitate understanding of this concept in the specific context of VWs. The following chapter concludes the study by presenting its theoretical and practical contributions as well as its limitations and future directions.

Chapter 6: Conclusions

6.1 Introduction

This chapter concludes the thesis by highlighting both the theoretical and practical implications of the study. It then discusses the limitations of the study and provides directions for future study. Finally, a brief summary is presented as concluding remarks.

6.2 Implications

In Chapter 5, the study discussed and generated many innovative and interesting findings related to the interpretation of the telepresence concept, antecedents and user segmentations in the context of VWs. Based on these findings, a further vital discussion was undertaken with the aim of achieving the research objectives established in Chapter 1. The conclusions deriving from this discussion are illustrated in the following sections, which examine the research implications from both the theoretical and practical perspectives. The major implications and corresponding findings are summarized in Table 6-1.

Table 6-1: Major implications corresponding to specific findings

Implications	**Corresponding findings**
<u>Theoretical Implications</u>	
Contributing to telepresence theory:	
1) Overcome the limitations of classical model of telepresence antecedents and provide a broader range for exploring factors leading to telepresence	Telepresence antecedents on different aspects were identified and accordingly a UMC model was developed to assemble the factors.
2) Provide innovative insights for understanding the complete process of how telepresence is cultivated	The connections between factors cultivating telepresence were identified, based on which the hierarchical structure was built.
3) Further explain the notable phenomenon that even in the same virtual environment, the degree of telepresence varies from person to person	According to the hierarchical structure, the perception of telepresence could be achieved through different paths; users could be segmented based on the mechanisms of perceiving telepresence.
Contributing to segmentation research:	
1) Develop a novel typology method to classify virtual world users	Users were segmented into three clusters based on the mechanisms of perceiving telepresence.
2) Provide deeper understanding of the differences among groups of users	Particular hierarchical structure of telepresence antecedents was developed for each group for further explication and comparison.
Contributing to virtual world research:	
1) Adopt an innovative way for VW design through improving user experience (telepresence)	Factors leading to telepresence were explored comprehensively; accordingly, the UMC model was developed.
2) Provide innovative insights for understanding the inner mechanisms of user experience in VWs	The hierarchical structure of telepresence antecedents was developed.

Implications	Corresponding findings
3) Provide significant knowledge for understanding VW users	Users were segmented into three clusters based on the mechanisms of perceiving telepresence and particular hierarchical structure of telepresence antecedents was developed for each group.
Contributing to information systems research:	
1) Adapt the findings on telepresence antecedents to a broad range of IS	UMC model as an overarching framework and hierarchical structure of telepresence antecedents were developed.
2) Apply an innovative approach to investigating user experience in IS	-
Practical Implications	
1) Provide some novel suggestions on updating systems for better user experience	The findings mainly showed that the quality of sensory channels is more significant than number of sensory channels.
2) Highlight some important features for designing a VW to produce great telepresence experience	Some specific functions were identified, including atmospheric cues, spatial navigation and avatar characteristics.
3) Emphasize the importance of considering VW design from users' perspective	Some user-related factors leading to telepresence were identified
4) Apply current findings to other IS rather than VW only	The hierarchical structure of telepresence was developed.
5) Undertake market research prior to design	Users were segmented into three clusters based on the mechanisms of perceiving telepresence and particular hierarchical structure of telepresence antecedents was developed for each group.

6.2.1 Theoretical Implications

With respect to the theoretical implications of the study, it makes four major contributions: to telepresence theory, segmentation research, VW research and IS research.

6.2.1.1 Contributing to Telepresence Theory

To achieve the research objectives, the study explored the construct of telepresence mainly from two perspectives: identifying possible factors leading to telepresence; and developing a hierarchical structure of telepresence antecedents to interpret the process of cultivating telepresence. Thus, the study has closed some of the significant literature gaps in telepresence research and provided a novel lens and framework for future studies related to this construct. The major contributions to telepresence theory are outlined below.

First, the study overcomes the limitations of the classical model of telepresence antecedents by exploring a wide range of factors leading to telepresence. Considering that most previous research focused on technology-only factors (Steuer, 1992;Klein, 2003;Suh and Chang, 2006;Nah et al., 2011), the current study addressed this flaw by interpreting the identified factors and accordingly assembling them into the multi-component UMC model. The construction and adoption of the UMC model responded to calls to study what influences telepresence via a comprehensive consideration from multiple perspectives. The major components of the UMC model confirm previous conceptual assumptions that factors relating to the user, medium and content components and their interactions can all influence the feeling of telepresence. Meanwhile, the stress on interactions among components indicates that there is an order of occurrence for factors, as the interactions are only based on the existence of the components. Thus, the development of the UMC model is consistent with the construction of a hierarchical structure for telepresence antecedents. The UMC model facilitates a clear and logical understanding of the identified factors. It also provides future studies with a comprehensive framework for investigating telepresence antecedents, thereby generalising the findings to a broader context.

Second, as most previous studies utilised telepresence as a mediator to explain relationships among interface features and user behaviour (Kim and Biocca, 1997;Klein, 2003;Keng and Lin, 2006), the understanding of telepresence antecedents was restricted to a single aspect and was limited in depth. However, the current study argues that current knowledge on what factors lead to telepresence is oversimplified that telepresence is not a direct response of the stimulation of the virtual environment. Adopting the laddering approach to collect information from users' perspectives of their experiences of telepresence, the study identified factors cultivating telepresence and their connections to each other. According to their positions in the whole structure, they were classified into different hierarchical levels: givens, means and ends. The hierarchical structure containing different levels and linkages among telepresence antecedents comprehensively presented how and why users feel telepresence in VWs. The study revealed the underlying mechanisms between stimulation-related factors and telepresence to provide future researchers with abundant information for interpreting how different factors at the givens level finally affect users' experience of telepresence. Further, the study is among the first to develop a comprehensive and thorough hierarchical structure for telepresence antecedents, aiming to depict the complete process of how telepresence is cultivated in VWs from a user's perspective. The relationships among telepresence antecedents, which form the whole structure, provide innovative insights for understanding user experience. Thus, in future studies, the findings relevant to these relationships are worthy of further investigation and empirical verification.

Finally, by interpreting the major full paths from the hierarchical structure of telepresence antecedents as well as understanding user segmentation based on the mechanisms of perceiving telepresence, the study explained the notable phenomenon related to telepresence experience that even for the same virtual environment, the degree of telepresence varies from person to person. Specifically, in a particular virtual environment, some users may have high telepresence whereas others may hardly experience telepresence at all. The literature depicted this phenomenon to describe the subjective aspect of telepresence without providing any satisfactory explanation (IJsselsteijn et al., 2000;Lombard and Snyder-Duch, 2001). The findings of the current study not only explain why and how individual differences in perceiving telepresence exist but also reinforce the significance of user-related topics for further investigation of the telepresence concept.

6.2.1.2 Contributing to Segmentation Research

Segmentation research can explain the diversity of users and thereby better understand them (Kuo et al., 2002). To classify users, most previous studies were based on either a user's abilities/motivations to use the IS or consequent use behaviour and final usage in IS (Barnes et al., 2007;Rosa et al., 2016). These typology methods have been criticised on the basis of flexibility and generality. However, the current study adopted a novel perspective to understand differences among users by investigating the underlying mechanisms for how they perceive their experiences. The study focused on the inner processes of the use, which involves inherent characteristics of users that are relatively difficult to identify. This type of user segmentation reveals users' final responses to the virtual experience and the essential nature of users by providing more meaningful information for understanding users. The findings confirmed and explained the unverified assumption that different users can have different degrees of telepresence experience even in the same virtual environment.

Moreover, the study developed three hierarchical structures that present the mechanisms for how the user experience of telepresence is cultivated for each of the three groups of users. With distinctive paths and highlighted linkages, the built hierarchical structures for each group provide an innovative perspective and abundant information to compare the three groups. The study is among the first to understand users in such an in-depth way rather than only considering the superficial consequences of their use. Moreover, the structures provide visual representations that not only verify the obvious differences among groups of users but also directly identify the pathways for how users differently respond to the stimulation of the virtual environment. Therefore, compared to traditional methods for classifying users, the user typology developed by this study provided more accurate, sufficient and applicable interpretations to understand individual differences among users, which can be applied in future segmentation research to provide a more innovative and deeper understanding of users in various contexts.

6.2.1.3 Contributing to Virtual World Research

This study contributes to existing research on VWs, which refers to a broad context of computer-based simulated environments incorporating a variety of representations of real-world elements (Jarvenpaa, 2007). The contributions from this perspective are as follows.

First, because users have widely accepted different kinds of VWs as substitutes and/or supplements of real life (Bououd et al., 2016), many researchers have taken increasing research interest in the context. However, most previous studies on VWs have been limited to quantitative research for testing proposed hypotheses regarding user psychology and behaviour in specific contexts (Davis et al., 2009;Yang et al., 2012). Accordingly, limited factors influencing user experience, and consequently contributing to the success of VWs, have been identified. The current study is among the first to adopt an appropriate qualitative method for exploring in a comprehensive and thorough way features in VW design that may improve the user experience. The study focus is transferred from the traditional view of the user's general evaluation of a system to the closely related and innovative view of the user's specific experience—telepresence. The identification of a wide range of factors in the current study challenges existing assumptions regarding VW design—that only technological factors matter. The UMC model developed to arrange all the identified factors provides researchers with not only a better understanding of what factors can lead to a better user experience of telepresence, but also a framework for future studies to comprehensively investigate relevant issues in this context. Meanwhile, further findings of the study challenge the assumption that upgrading the form of VWs is the most effective way to improve user experience of telepresence. The study argues that instead of blindly adopting advanced systems, ensuring high quality of current systems is more important for cultivating telepresence in VWs. Moreover, the study also identified many specific factors leading to telepresence in the context of VWs, which is expected to promote further exploration of interesting topics related to these factors in future research. In general, this exploratory study has completed and extended previous research on VWs by adding more comprehensive and in-depth knowledge.

Second, although some studies have acknowledged the critical importance of telepresence in the research of VWs (Nah et al., 2011;Faiola et al., 2013), most have adopted telepresence as the construct mediating the relationships between the selected interface features and user behaviour. Thus, only a limited number of factors depicting the characteristics of VWs have been identified as telepresence antecedents in this context. The relationships between these factors and telepresence have been considered as direct and separated connections without examining any inter-relationships among the factors. Therefore, understanding of what factors should receive more attention in design is relatively narrow, and limited to a very specific research context. However, the current study is expected to represent a starting point for exploring the inter-relationships among all existing and newly identified factors. This initial step has been taken in this study and attempts to investigate the inner mechanisms of a specific user experience—telepresence—which provides innovative insights into how some users' experience of telepresence is cultivated during the process of using VWs. The hierarchical levels identified for factors imply that the previous standpoint that a single level of factors directly leads to telepresence is too simple to interpret the user experience. Understanding the inner mechanisms for how factors are hierarchically structured not only deepens understanding of the user experience but also increases flexibility for applying the conclusions to a broader range of VWs by proper modification. Therefore, the hierarchical structure developed by our study can be regarded as a foundation for future studies further investigating the inter-relationships among the identified factors in the context of VWs.

Finally, the study also provides significant knowledge with respect to understanding users of VWs, especially from the perspective of user typology. Although relevant research has included user segmentation in the IS context (Meyen et al., 2010;White and Le Cornu, 2011), few studies provide information on user typology in the context of VWs. Thus, one contribution made by this study is to add knowledge of user segmentation to the context of VWs. Further, most user typologies have been based on users' actual usage of and/or attitude towards a specific type of IS. The current study provides a new way to classify users based on their inner mechanisms for perceiving user experience. Distinguished from the traditional user typology that is consequence-oriented this study argues that users' different responses to the same environmental stimulation derive from their different inner mechanisms of responding. Thus, the user typology in this study enables researchers to explore individual differences among users in VWs in an in-depth investigation. The approach to identifying user typology is innovative but effective for a better understanding of the users of VWs. The comparison between the traditional way and the new way of identifying user typology also emphasises the necessity of an intensive exploration of the latent characteristics of VW users.

6.2.1.4 Contributing to Information Systems Research

For IS research, the study makes theoretical contributions in two main ways. First, it innovatively adopts the construct of telepresence as the core to investigate user experience in VWs in an exploratory way, which led to the identification of many novel factors leading to telepresence. Moreover, by developing the overarching framework and hierarchical structures, the findings from this study can be adapted to a broad range of IS. Thus, the study not only provides abundant and in-depth information for future IS research but also suggests a novel perspective for studying relevant topics. Second, the study applies an innovative approach to investigating the user experience in an IS-related context. The laddering interview technique for data collection and the corresponding data analysis method enable examination of specific topics based on abundant information provided by respondents. Although this approach has not been broadly used in the IS field, it was appropriate for this study, which sought a comprehensive and thorough understanding of a specific research topic. The approach overcame limitations with respect to reference literature in the current research and achieved the research goal by exploring rich and meaningful information for construct identification and structure building. Thus, future IS research can adopt this approach to address research issues in a similar situation.

6.2.2 Practical Implications

The practical contributions made by the study relate mainly to the design and improvement of VWs, and more generally to emerging advanced technologies for building virtual environments. The findings provided not only abundant information on identified antecedents of telepresence and the relationships among the constructs, but also a new user typology to segment VW users. Consequently, the study has completed and deepened understanding of the user experience in VWs; this has many practical implications as follows.

First, regarding stimulation for users of a virtual environment, previous practitioners always believed that the more sensory stimulation channels there were, the better the user experience of 'being in' the virtual environment. Thus, when designing VWs, many designers focused on applying advanced technologies and/or advanced forms of media. However, the current study reshapes knowledge by arguing that blindly upgrading systems in the way that practitioners have done may not achieve the expected improved user experience if quality cannot be guaranteed. Moreover, the study proposes that there are different weights of sensory channels with respect to their influences on the user experience of telepresence; it thus identifies vision and audition as the two most significant senses for users to perceive a telepresence feeling. This suggests that designers should carefully consider the balance between the forms of media and their quality in the design phase. Although advanced systems with more sensory stimulation can improve user experience by increasing telepresence to some extent, this is only on the condition that quality in each sensory channel can be ensured. Similarly, 2D and 3D have been repeatedly compared by both researchers and practitioners for their influences on user experience and as a result, the 3D form has been preferred and recommended in most cases. However, this study highlights the importance of quality by arguing that a 2D VW with high quality is better for improving user experience than is a 3D VW with inferior quality. Moreover, based on the findings, for the further improvement of VWs, the study suggests that designers should first focus on improving the two major sensory stimulations (the visual and auditory channels) and when their quality has been guaranteed, other sensory channels can be added by adopting advanced technology and equipment according to the design requirements and time and money available.

Second, some specific functions were identified the study, including atmospheric cues, spatial navigation and avatar characteristics. These functions were easily ignored in previous research as their purpose is not delivering the main information to users but facilitating them to construct the virtual environment in their mind and placing themselves in the environment. Summarising the findings on these functions revealed that for cultivating a high degree of telepresence, the design of the virtual environment should pay attention to the following aspects: first, the consistency and harmony among all sensory stimulations should be preferred over adding more sensory channels; second, realness and naturalness should be enhanced in the environment as these are what VWs have lacked compared to the real world; third, when the background of the virtual environment is developed, it is also critical to guide users in their direction and position by adding and improving spatial-related functions, which help them to create a sense of the VW space in their mind; and finally, unlike the role of avatars on some social network sites, which is self-expression and socialisation, the key function of avatars in VWs is as the embodiment of a user to transfer them from their physical surroundings to the virtual environment. Thus, for a better user experience, users require higher similarity between their real appearance and their avatar to identify the avatar as themselves in the VW. Accordingly, designers should consider providing changeable images of avatars for users to personalise their avatars in VWs.

Third, the study findings emphasise the importance of user-related factors to the user experience of telepresence, which can be regarded as a starting point to empirically confirm and explore the assumption that different users experience different degrees of telepresence even when responding to the same virtual environment. The study found that the user's experience of telepresence involves a process of cognitive comparison between their previous knowledge and related experience including offline experience of the corresponding real world and online experience using similar media. Based on these findings, the study suggests that when VWs are designed with the aim to be close to reality, they should also have some distinctive media characteristics to be distinguished from similar media experiences such as browsing a website or playing an online game. The study also emphasises the significance of selecting appropriate content or features to display in the VWs as the findings show that a user's previous knowledge and experience sometimes can help them to supplement missing or blurry parts caused by the limited design and build a complete and clear VW in their mind using their imagination. Thus, it is proposed that presenting widely known features or content in VWs may more easily cultivate a user experience of telepresence. Further, the study highlights the influence of a user's interest in the content that is presented and their intention to experience the VW and thus advises the embedding of some interesting points in the content of VWs to arouse the user's interest or intention, such as adopting a story-telling mode to present, or an interactive 'Q&A' form.

Fourth, the hierarchical structure of telepresence antecedents developed in the study describes the complete and thorough process of how telepresence is cultivated. The identification of the underlying mechanisms of the user-specific experience increases the generalisation of the findings. For IS with a range of different stimulations, designers can adopt the latter part of chains of telepresence antecedents; based on this they can consider what factors should be included in the given part to trigger the entire chain and ultimately achieve the same effects. Thus, for the design of other IS, although interface and functional differences exist in diverse contexts, designers can apply a reverse-reasoning approach to explore factors from the end to the beginning and adapt their findings to the design.

Last, through the user typology in this study, three kinds of VW users were identified based on their inner mechanisms for user experience. For practitioners, these findings can be considered in market research undertaken prior to design. If designers can recognise or predict in advance their target type of users for the proposed VW, the corresponding hierarchical structure can assist in the design by satisfying the conditions to support the occurrence of the chains leading to telepresence. Understanding the design focus required for target users to have a better user experience is expected to save a large amount of time and energy in the process of design and operation and to achieve better results for the experience.

6.3 Limitations

The main limitations of the study are twofold: one results from the qualitative research approach for exploratory investigation; the other is related to the specific study artefact for conducting interviews to collect the data.

6.3.1 Limitations of Qualitative Research

By using a qualitative approach of an exploratory nature, the study achieved its goal to comprehensively and thoroughly understand the telepresence concept from three main perspectives: its antecedents; their hierarchical structure; and user segmentation based on this. As this study is only the first step in a full exploratory investigation, quantitative studies are now necessary to confirm and complement the findings. However, considering the situation in relation to relevant telepresence studies and the current research goal to address literature gaps, the adopted qualitative method was the most appropriate approach for conducting the study. Compared to other IS, VWs are still a relatively new research context and adopting the construct of telepresence to investigate user experience in this context is also an innovative research topic. Given the non-negligible literature gaps, previous research has provided insufficient information to address the research topic. Thus, instead of adopting a quantitative approach to verify previous propositions, this study utilised a qualitative method to provide abundant and in-depth information to narrow the literature gaps and resolve issues. Moreover, in contrast to other purely qualitative methods, the approach used here to analyse the collected data aimed to quantify them to some extent, which is expected to generate more structured and clear findings.

6.3.2 Limitations of Generalisation

Although the sample size in this study was appropriate for the adopted research approach, the generalisability of the findings would be further increased by enlarging the sample size. Moreover, the study used VWs for informal learning (virtual tours) as the study artefact to represent the research context. The study might have been improved by examining other types of VWs or even other forms of IS as research contexts. However, besides identifying specific factors, the study also provides an overarching framework to summarise the results and hierarchical structure to investigate the mechanisms. Thus, by adopting a specific type of VWs, the study not only offers valuable information in this specific context but also contributes to the general context of VWs and even to a broader range of IS.

6.4 Directions for Future Research

Considering the limitations discussed above, some directions for future research can be made. First, as the study is regarded as a starting point to explore the construct of telepresence in VWs, some novel conclusions proposed by the study can be further empirically verified and modified in future quantitative studies. For instance, experiments could be conducted to validate the assumptions related to the quality and quantity of sensory stimulations. Surveys with a large sample size could be adopted to test propositions regarding the relationships in the developed hierarchical structure, especially the parts involving user features, as research has seldom investigated the relevant topics of user-related factors.

Second, the study was conducted in the study artefact of virtual learning as learning is an essential and valuable part of the real world and is currently popular among Internet users. As there are VWs for all parts of the real world, some other types of VWs are also worthy of investigating, such as shopping, working and socialising in the VW. With the developed framework and hierarchical structure, this study contributes to the general context of VWs; however, future studies on other types of VWs are also expected to generate some context-specific findings and to add to the current conclusions.

Third, the study identified three groups of VW users based on their mechanisms of perceiving telepresence. Future studies could be conducted to further understand each group by exploring their characteristics, motivations, responses and performance. Comprehensive knowledge of each group of users is expected to accurately characterise the type of user. Designers can accordingly provide targeted functions and services in VWs for a better user experience.

Finally, it has been acknowledged that telepresence is a product of all media and is a key concept for investigating user experience of media. Further comparative studies of telepresence among different types of media could be conducted as telepresence is a key criterion for evaluating media. The factors that lead to telepresence and the influences of telepresence in diverse media could also be compared in studies to identify the type of media that highlights cultivating telepresence as the most significant goal for the design.

6.5 Concluding Remarks

To summarise, this study was conducted as the starting point to explore the construct of telepresence in the context of VWs by investigating the antecedents of telepresence, developing a framework and hierarchical structure of the antecedents and generating a user typology in this context. By achieving the research objectives, the study has made significant contributions both theoretically and practically. However, some limitations of the study remain as a result of restrictions with the research approach adopted. Accordingly, some directions for future studies were provided to address these limitations.

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Appendices

Appendix 1 – A Summary of Selected Telepresence Studies

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
Steuer (1992)	The technological antecedents of telepresence	Virtual Reality (VR)	Conceptual	-	-vividness (breadth, depth) -interactivity (speed, range, mapping)	-	This paper redefines virtual reality based on the concept of telepresence and identifies two technological antecedents that lead to telepresence.
Sheridan (1992)	General introduction of telepresence concept	Virtual environme nt (VE)	Conceptual	Two ways to measure: -subjective measures -objective measures	-extent of sensory information -control of relation between sensors and environment -ability to modify environment	-training efficiency -task performance	This paper proposes three measurable technological variables which determine telepresence and discusses the aspects of human performance which might be influenced by telepresence.
Muhlbach et al. (1995)	A research model focusing on telepresence in video-communicatio ns	Videoconf erencing technology	Experiment	-	-stereoscopy	-satisfaction -acceptance	The study finds that stereoscopy increases telepresence and makes video conferencing more attractive.
Kim and Biocca (1997)	Insight of telepresence in traditional media	Television	Experiment	-arrival -departure	-sensory saturation (the visual angle of the display) -sensory suppression (room illumination)	-memory -persuasion (attitude change, i.e., buying intention and confidence in	- The study finds that there may be two dimensions of telepresence, arrival (the sense of “being there” in the virtual environment) and departure (the sense of “not being here” in the physical environment);

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
						product decision)	-The study doesn't find evidence that visual angel and room illumination influence telepresence; - The study suggests that when users have telepresence, they are likely to feel persuaded.
Witmer and Singer (1998)	Comparison between two telepresence questionnaires: presence questionnaire (PQ) and immersive tendencies questionnaire (ITQ)	VE	Experiment	Two dimensions of telepresence: -involvement -immersion	(Only conceptually proposed) -control factors -sensory factors -distraction factors -realism factors	-learning -performance	-The PQ and ITQ are internally consistent measures with high reliability; -There is a weak but consistent positive relation between telepresence and task performance; -Individuals who report more simulator sickness symptoms in VE report less telepresence than those who report fewer symptoms.
Draper et al. (1998)	Telepresence literature review	Synthetic environment (SE)	Literature review	simple telepresence cybernetic telepresence experiential telepresence	through technological approach through psychological approach	-	This paper reviews the origins of experiential telepresence and the theoretical approaches commonly used to explain it. For cultivating telepresence, the technological approaches emphasize the role of control/display technology while the psychological approaches highlight psychological phenomena.
Shih (1998)	Consumer experience regarding telepresence	Cyber space	Conceptual	-	-vividness -interactivity	-immersion -time spent -positive affective feelings -probability of repeat visits	

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
Bystrom et al. (1999)	A research model containing telepresence	VE	Conceptual	-	Suspension of disbelief	Task performance	The model describes the authors' current conceptualization of the effects of display technology, task demands, and attentional resource allocation on immersion, telepresence, and performance in virtual environments.
IJsselsteijn et al. (2000)	Telepresence antecedents and telepresence measurement	VR	Conceptual	Two ways to measure: -subjective measures -objective measures:	-the extent and fidelity of sensory information -the match between sensors and the display -content factors -user characteristics	-	The most promising direction for telepresence measurement is to develop and use an integrated measurement that includes both subjective and objective components based on specific study context.
Coyle and Thorson (2001)	A research model containing telepresence to examine interactivity and vividness in commercial websites	Marketing website	Experiment	-arrival -departure	-vividness -interactivity	-	Both vividness and interactivity positively affect the telepresence in commercial websites.
Lombard and Snyder-Duch (2001)	A conceptual framework focusing on telepresence	Interactive digital media	Conceptual	Potential dimensions: -spatial presence -perceptual realism -social realism -engagement -social actor within the medium and para-social interaction -transportation -medium as social actor	-medium form variables -content variables -user variables	-enjoyment -persuasion -primary goals of advertising	The paper suggests some ways in which advertising is evolving to incorporate interactive media and emphasizes the role of research on telepresence on guiding this evolution.

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
Venkatesh and Johnson (2002)	A research model containing telepresence to examine the impact of technology design	Telecommuting systems	Survey	7 items based on Slater et al. (1994)	-technology design	-extrinsic motivation -intrinsic motivation -system usage	The study finds that technology design can influence users' motivation and usage of system through affecting telepresence.
Klein (2003)	A research model focusing on telepresence	Computer-mediated environments	Experiment	-arrival -departure	-media richness -user control	consumers' cognitive responses	Results show that user control and media richness both contribute to creating a sense of telepresence. Moreover, through telepresence, these media characteristics influence consumers' cognitive responses.
Fiore et al. (2005)	A research model containing telepresence to investigate consumer responses toward online retailer	Retailing website	Experiment	5 items	Image interactivity technology (IIT)	-experiential value -instrumental value -attitude toward the online retailer -willingness to purchase from the online retailer -willingness to patronize the online retailer	The study identifies the paths between IIT, telepresence, value variables and response variables.
Qiu and Benbasat (2005)	A research model containing telepresence to investigate	Retailing website	Experiment	7 items	-text-to-speech (TTS) voice -3D avatars	-perceived usefulness -attitudes toward a website	The study finds that 3D avatar has significant effect on telepresence.

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
	into the effects of interface design					-intention to revisit	
Suh and Lee (2005)	A research model containing telepresence to investigate the effects of VR on consumer learning	VR	Experiment	-	-	-knowledge -attitude -purchase intention	The study finds that telepresence enhances consumer learning about products.
Keng and Lin (2006)	Impact of telepresence on internet advertising effects	Advertising website	Experiment	3 levels of telepresence	-vividness -interactivity	-recall -recognition	The study proposes three levels of telepresence based on the dimensions of interactivity and vividness. It finds that high level of telepresence increases subject recall and recognition.
Suh and Chang (2006)	A research model focusing on telepresence to understand the impacts of VR on consumer responses	VR	Experiment	Spatial presence Engagement Naturalness	Multiple pictures, video clips, and VR	Product knowledge, attitudes and purchase intention	The VR interface produces the highest level of telepresence, as expected. Telepresence in turn generally augments consumers' product knowledge, attitudes and purchase intentions, and reduces consumer perceptions of product risk and discrepancies between online product information and actual products, directly or indirectly.
Nelson et al. (2006)	A research model containing telepresence to investigate brand	Computer game	Experiment	6 items on arrival and departure dimensions	Game liking	Perceived persuasion	The study finds that telepresence mediates the effect of game liking on perceived persuasion.

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
	placements in games						
Song et al. (2007)	The roles of telepresence in online shopping experience	Retailing website	Survey	5 items based on Fiore et al. (2005)	-	-fantasy -shopping enjoyment -willingness to purchase -willingness to patronize	The study finds that telepresence influences consumer fantasy and leads to experiential value and consumer intentions.
Phang and Kankanhalli (2009)	A research model containing telepresence to investigate the learning in VWs	VWs	Survey	4 items	3D realism	-social norm -concentration -enjoyment -learning outcome	The paper finds that telepresence has positive influence on social norm, concentration, enjoyment and ultimately learning outcome. Meanwhile, the 3D realism positively affects individual perception of telepresence.
Campbell et al. (2010)	A research model focusing on telepresence to investigate online advertising	Advertising website	Experiment	3 items based on Coyle and Thorson (2001)	-interactivity -involvement	-attitude toward advertisements -satisfaction	The study emphasizes that telepresence is a significant predictor of attitude toward online advertisements, satisfaction with online advertisement, and subsequent intentions to use a host website and it also indicates that interface characteristics, such as interactivity can affect telepresence.
Kwon and Wen (2010)	A research model containing telepresence to investigate the use of SNS	Social network service (SNS)	Online survey	-	-	-perceived ease of use -perceived encouragement	The study finds that telepresence can affect actual use of SNS by directly influencing perceived ease of use and perceived encouragement.
Mollen and Wilson (2010)	A conceptual research model containing	Virtual store	Conceptual	-	-operator environment -perceived interactivity	-engagement -optimal consumer	The study discusses how the constructs of engagement, telepresence and interactivity are

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
	telepresence to investigate the effect of virtual store					attitudes and behaviours	related in online consumer experience.
Zaman et al. (2010)	A research model containing telepresence to investigate creative behaviours by using IM	Instant messaging (IM) technology	Online survey	5 items based on (Novak et al., 2000)	-	-flow -positive affect -exploratory behaviour -perceived expected creativity	IM users' flow experience is increased their sense of telepresence and perceived concentration
Nah et al. (2011)	A research model focusing on telepresence to compare 2D and 3D VW	VWs	Experiment	4 items based on Klein (2003)	2D/3D virtualizations	-enjoyment -brand equity -behavioural intention	The study suggests that the 3D VW environment induces a greater sense of telepresence than the 2D VW and telepresence, in turn, influences enjoyment, brand equity and behavioural intention.
Haans and Ijsselsteijn (2012)	A theoretical framework of the relationship between embodiment and telepresence	VE	Conceptual	-	-embodiment	-	The study formulates a theoretical framework to propose that telepresence is the consequence of embodiment.
Ning Shen and Khalifa (2012)	a research model containing telepresence to investigate system design effects on online impulse buying	Retailing website	Experiment	6 items based on Kim and Biocca (1997)	-vividness -interactivity	-arousal -pleasure -buying impulse -impulse buying	The study finds that a virtual experience with telepresence has as significant effect on buying impulses over traditional marketing stimuli.

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
Bellman et al. (2014)	Comparison the effects of two types of advertisements on telepresence	Advergaming and TV commercial	Experiment	2 dimensions based on Kim and Biocca (1997)	Advergaming and TV commercial	Brand attitude	It shows no differences in the impacts of advergaming and TV commercials in telepresence, and therefore no differences in persuasive effect, measured by brand attitude.
Rodríguez-Ardura and Martínez-López (2014)	Connections of telepresence with mental imagery	Digital media	Literature review	-	Mental imagery	-	The study theoretically connects telepresence with mental imagery to study on the user experience in digital media.
Guo et al. (2015)	A research model containing telepresence in online learning	Online learning	Survey	3 items based on Kim and Biocca (1997)	-	Flow	Telepresence is one of the factors influencing students' flow experience in online learning.
Kim (2015)	A research model containing telepresence in SCS	Social commerce site (SCS)	Survey	5 items based on Fiore et al. (2005)	Vividness	-usefulness -enjoyment -participation intention	Telepresence plays mediating role between stimuli and the sequent internal states, which consequently influence participation intention.
Peng and Ke (2015)	A research model containing telepresence to examine 3D VW on real world purchase intention	3D VWs	Experiment	4 items based on (Steuer, 1992)	-immersion	-perceived authenticity -perceived trustworthiness -purchase intention	The study shows that 3D VW users obtain high sense of telepresence which positively influence user trust and intention to purchase.
Cho et al. (2015)	individual differences on telepresence	3D VWs	Experiment	4 items based on Slater et al. (1998)	-user's age -user's epistemological beliefs	-situational interest	This study finds that users' age and epistemological beliefs significantly influence their telepresence, which

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
						-perceived achievement	further affects situational interest and perceived achievement
Kim and Hyun (2016)	A research model containing telepresence to predicts the use of smartphone-based AR	Augmented reality (AR)	Survey	4 items based on Kim and Biocca (1997)	-system quality -information quality	AR reuse intention	The study finds that telepresence plays a mediated role for the relationship between AR quality and the intention to reuse AR.
Choi et al. (2016)	A research model focusing on telepresence to investigate the marketing websites	Marketing website	Online survey	4 items based on Kim and Biocca (1997)	-informativeness -entertainment	-utilitarian performance -hedonic performance	The study finds that informative and entertaining telepresence is significant for marketing websites by making the destination more familiar and interesting to potential visitors.
Coxon et al. (2016)	Investigation the relations between telepresence and user spatial abilities	VR	Experiment	6 items based on Vorderer et al. (2004)	Imagery	-	The study identifies imagery can predict telepresence to explain the individual differences in VR.
North and North (2016)	Comparison of telepresence of traditional VR environment and IVE	VR/Immersive visualization environment (IVE)	Experiment	2 items based on Slater et al. (1994)	Traditional VR environment/IVE	-	The study shows that users experience higher telepresence in IVE than traditional VR environment, which indicate IVE is more natural and offers better user experience.
Liu and Uang (2016)	The design for better telepresence experience	3D virtual store	Experiment		-depth perception cues -visual display modes -cybersickness	-	The study shows that the virtual store with autostereoscopic display and good-quality depth perception cues leads to better telepresence

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
							experience. If the depth perception cues are low-quality, 3D displays are not recommended.
Lim et al. (2017)	A research model containing telepresence to investigate the emotional factors affecting satisfaction	Television	Online survey	7 items based on Novak et al. (2000)	-loneliness -gratification shopping motivation	-satisfaction	The study finds that loneliness is an antecedent of telepresence which further influences consumer satisfaction.
Makowski et al. (2017)	The role of telepresence on memory	2D/3D movie	Online survey	14 items based on Lessiter et al. (2001)	Emotion experience	Factual memory	The study finds that telepresence plays a mediated role in the relationship between emotion and factual memory
Pelet et al. (2017)	A research model containing telepresence to examine the impact of flow in social media use	Social media	Online survey	9 items based on Kim and Biocca (1997)	-	Flow dimensions: -enjoyment -concentration -challenge -control -curiosity	The study finds that telepresence positively affects the five dimensions of flow.
Baus and Bouchard (2017)	The effect of olfactory stimuli on telepresence	VR	Experiment	44 items based on Lessiter et al. (2001)	Odours	-	The study finds that unpleasant odour has an influence on telepresence but the pleasant one does not.
Stavropoulos et al. (2017)	The effect of anxiety in real life and contextual	General	longitudinal study	32 items based on Witmer and Singer (1998)	-anxiety symptoms in real life -openness to experience (OTE)	-	The study shows that users' anxiety symptoms in real life increase telepresence in online environment because of escapism and OTE in

Authors	Focus	Context	Method	Measures	Antecedents	Consequences	Findings
	factors of physical world on telepresence						offline world decreases telepresence in online world.
Ho et al. (2017)	The effect of telepresence on children's attitude towards exergames	Exergames	Survey	4 items based on Ryan et al. (2006)	-	-game enjoyment -mood experience -attitude towards exergaming -performance for future gameplay	The study finds that telepresence is an essential experience for children to enjoy the exergames and consequently have positive attitude towards them.

Appendix B – Survey for Demographic Information (English and Chinese versions)

English version:

1. Gender

□ male □ female

2. Age

□ less than 19 □ 19-24 □ 25-30 □ 31-35 □ 36-40 □ more than 40

3. Highest education level

□ High school or below □ Some College/Diploma

□ Bachelor degree □ Master degree r above

4. Occupation

□ Student □ Research and development

□ Sales person □ Accountant

□ Human resources □ Teacher

□ Clerk □ Management

□ Administrative □ Others___________________

□ Consultant

5. Your average monthly salary (Yuan)

□ less than 1000 □ 1000-3000 □ 3001-5000

□ 5001-8000 □ 8001-10000 □ more than 10000

Chinese Version:

1. 请问您的性别

□ 男 □ 女

2. 请问您的年龄

□ 19 岁以下 □ 19-24 岁 □ 25-30 岁 □ 31-35 岁 □ 36-40 岁 □ 40 岁以上

3. 请问您的学历

□ 高中及以下 □ 大专

□ 大学本科 □ 硕士及以上

4. 请问您目前从事的职业

□ 全日制学生 □ 技术/研发人员

□ 销售人员 □ 财务人员

□ 人力资源 □ 教师

□ 文职/办事人员 □ 管理人员

□ 行政人员 □ 其他职业__________

□ 顾问/咨询

5. 请问您的每月收入

□ 1000 元以下 □ 1000-3000 元 □ 3001-5000 元

□ 5001-8000 元 □ 8001-10000 元 □ 10000 元以上

Appendix C – Ethics Approval

Human Research Ethics Advisory (HREA) Panel F: Australian School of Business
The University of New South Wales
UNSW Sydney, NSW, Australia, 2052
E: HREAPF@unsw.edu.au

16-Jun-2016

Dear Dr Zixiu Guo,

Project Title	Exploring Telepresence in Virtual Worlds
HC No	HC16319
Re	Notification of Ethics Approval
Approval Period	16-Jun-2016 - 15-Jun-2021

Thank you for submitting the above research project to the **HREAP F: Australian School of Business** for ethical review. This project was considered by the **HREAP F: Australian School of Business** at its meeting on 21-Apr-2016.

I am pleased to advise you that the **HREAP F: Australian School of Business** has granted ethical approval of this research project, subject to the following conditions being met:

Conditions of Approval Specific to Project:

N/A

Conditions of Approval – All Projects:

- The Chief Investigator will immediately report anything that might warrant review of ethical approval of the project.
- The Chief Investigator will notify the **HREAP F: Australian School of Business** of any event that requires a modification to the protocol or other project documents and submit any required amendments in accordance with the instructions provided by the **HREAP F: Australian School of Business**. These instructions can be found at https://research.unsw.edu.au/research-ethics-and-compliance-support-recs.
- The Chief Investigator will submit any necessary reports related to the safety of research participants in accordance with **HREAP F: Australian School of Business** policy and procedures. These instructions can be found at https://research.unsw.edu.au/research-ethics-and-compliance-support-recs.
- The Chief Investigator will report to the **HREAP F: Australian School of Business** annually in the specified format and notify the HREC when the project is completed at all sites.
- The Chief Investigator will notify the **HREAP F: Australian School of Business** if the project is discontinued at a participating site before the expected completion date, with reasons provided.
- The Chief Investigator will notify the **HREAP F: Australian School of Business** of any plan to extend the duration of the project past the approval period listed above and will submit any associated required documentation. Iinstructions for obtaining an extension of approval can be found at

https://research.unsw.edu.au/research-ethics-and-compliance-support-recs.

- The Chief Investigator will notify the **HREAP F: Australian School of Business** of his or her inability to continue as Coordinating Chief Investigator including the name of and contact information for a replacement.

A copy of this ethical approval letter must be submitted to all Investigators and sites prior to commencing the project.

The **HREAP F: Australian School of Business** Terms of Reference, Standard Operating Procedures, membership and standard forms are available from https://research.unsw.edu.au/research-ethics-and-compliance-support-recs.

Should you require any further information, please contact the Ethics Administrator at:

E: HREAPF@unsw.edu.au
W:https://research.unsw.edu.au/human-research-ethics-home

The HREAP F: Australian School of Business wishes you every continued success in your research.

Kind Regards

Professor Gary Monroe
Convenor HREA Panel F: Australian School of Business

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