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HUMAN VALUES IN MULTI-USER VIRTUAL ENVIRONMENTS:

AN ANALYSIS OF SOCIAL INTERACTION IN MULTI-USER VIRTUAL ENVIRONMENTS FROM A VALUE SENSITIVE DESIGN PERSPECTIVE

Master thesis

Author: Mandla Martin Shonhiwa

Supervisors: Dr. Mati Mõttus

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Supervisor: _____ ” 5.01 ” 2021

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Author: Mandla Martin Shonhiwa

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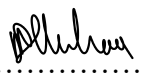

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Abstract

The future will be filled with multi-sensory, realistic, social virtual reality (social VR) and multi-user virtual environment (MUVE) experiences, as high-speed internet becomes affordable and VR technologies improve. This study aimed to identify the human values essential to social interaction in MUVEs, as well as the characteristics that support them. Through the use of the value sensitive design tripartite theoretical framework, this study revealed how MUVE characteristics, values and value tensions have differential effects on different stakeholder groups. It began with a literature review that gathered and analysed current literature to investigate MUVE characteristics as well as the features and technologies that support them. Subsequently, a conceptual investigation was conducted that identified possible human values in MUVEs. By way of empirical and technical investigation methods, data was gathered and analysed from 78 survey respondents and 18 interview participants on how MUVE characteristics, values and value tensions have differential effects on different stakeholder groups. Furthermore, the impact of MUVEs on both users and non-users was considered. Finally, this study offers design consideration as measures to support human values in MUVEs, as well as measures to address value tensions and harms.

Keywords: value sensitive design; human values; MUVE; Social VR; social interaction.

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List of Abbreviations

CTA	Cognitive Task Analysis
CSCW	Computer-Supported Cooperative Work
HMD	Head-Mounted Display
LGBTQ	Lesbian, Gay, Bisexual and Transgender, Questioning
MR	Mixed Reality
MUVE	Multi-User Virtual Environment
SAPAD	Semiotic Approach to Product Architecture Design
UTAUT	Unified Theory of Acceptance and Use of Technology
UCD	User-Centred Design
UK	United Kingdom
VE	Virtual Environment
VR	Virtual Reality
VSD	Value Sensitive Design
XR	Extended Reality

1 INTRODUCTION

This section contains information about the research problem and its significance, as well as an overview of the entire thesis. Firstly, it discusses the problem statement and its significance for MUVE and VR research. Then, it addresses the main research questions that will be answered in this study as well its aims and objectives. This section ends by describing how this thesis is organised and structured.

1.1 RESEARCH BACKGROUND

Multi-user virtual environments (MUVEs) and social virtual reality (Social VR) provide excellent potential for various applications, such as gaming, education, training and many more. Additionally, the successful deployment of these technologies has revealed extensive benefits for various industries such as oil and gas exploration, scientific visualisation, architecture, flight simulation, therapy, military training, theme-park entertainment, engineering analysis and design review. These benefits include, but are not limited to, cost-effectiveness (as costly design mistakes were noticed before manufacturing), provision of safe learning environments and assistance in visualising large datasets that would be difficult to comprehend with traditional systems (Jerald, 2016). This has prompted some researchers to argue that VR and other extended realities (XRs) are the inevitable future of computing (Pangilinan, Lukas & Mohan, 2019).

The future is full of multi-sensory, realistic, social XR experiences. Companies such as Microsoft, Alphabet, Facebook, Sony and Samsung are not only developing VR headsets, they are also investing and buying technology companies and games that focus on creating XR experiences (Kim, 2015). In early 2014, Facebook purchased VR headset company Oculus Rift,

which is indicative of the company's interest in providing fully immersive, inhabitable virtual environments (VEs) with naturalistic avatar interactions (Latham Cudworth, 2017). Similarly, Microsoft has not only been developing their mixed reality headset HoloLens, it has also partnered with Samsung, HP and Dell to ensure their VR headsets are compatible with their operating system Windows 10 ("Microsoft HoloLens", 2020). Likewise, in 2014 Alphabet created Google Cardboard, a VR headset made out of cardboard that could be sized to a user's mobile telephone, offering a low barrier to entry that offered high levels of adoption (Kesselman, 2016). These are but a few examples of how these companies have begun researching how they can offer XR experiences; however, little has been done to make these XR interactions more human.

Humans are social animals that need social interaction and peer validation daily throughout their lives; thus, chronically lonely people are more likely to suffer from heart disease, dementia and depression (Cacioppo, & Cacioppo, 2014; Hawkley, & Cacioppo, 2010). In a world devastated by depression, often attributed to a lack of social interaction, MUVEs and Social VR have been at the forefront of helping people who suffer from depression and social phobia. Moreover, studies have shown that participants who suffer from high levels of social anxiety reported significantly lower levels of social anxiety three months after exposure to VR interaction sessions (Morina et al., 2015). Therefore, as humans continue to substitute and complement in-person social interaction with virtual forms of interaction, enhancing these experiences to meet human values is increasingly imperative. Furthermore, for MUVEs and Social VR to flourish, there is a need to create exceptional VEs that allow users to interact with each other socially. However, relatively few studies have investigated making MUVEs or Social VR more human, and the currently most widely used VEs do not take into account the role of human values

(Padmanabhan, 2008). As such, this study seeks to understand how MUVEs can be better designed to account for human values.

1.2 Research Problem and Significance

Numerous usability studies have focused on specific user interfaces and measured their effectiveness from a technical perspective. However, researchers have not yet implemented a general value sensitive design (VSD) study that approaches social interaction in MUVEs from a technical and socio-structural perspective. VSD tools and methods engage both technical and socio-structural design spaces, providing a more comprehensive design space – one with the possibility for solutions that might not be considered if approached from either a technical or socio-structural perspective alone. Furthermore, the VSD approach provides suitabilities that follow from features of the technology. Any given technology is suitable for specific activities and readily supports particular values while rendering other activities and values challenging to realise (Friedman & Kahn, 2000).

Likewise, ignoring human values in MUVEs will result in the development of features that have a detrimental impact on what people value. Schroeder (2011) argues that although social interaction in MUVEs is limited to simple tasks and socialising when compared to face-to-face experiences in the physical world, we should not misinterpret this to imply that MUVE social interaction is not a 'rich' form of interaction. Although MUVEs are limited in that they do not have the multi-channel physical world experience, social interaction in these environments is vibrant insofar as users have profoundly expressive relations (Schroeder, 2011). The purpose of the current study is to establish a list of VSD design considerations for the creation of meaningful MUVE social interaction experiences.

1.3 RESEARCH QUESTION

VSD can help researchers uncover the multiplicity of potential value tensions and the associated benefits and harms of human values implicated in technological implementations (Friedman, Kahn, & Borning, 2012). The term 'value tension,' like that of 'value conflict,' conveys the idea of values potentially in opposition but allows for solutions that balance each value in relation to the others, such that the adjudication of the tension holds each value intact" (Friedman & Hendry, 2019, p. 70). Hence, this study aims to identify what people value in MUVE social interaction, to explore the benefits, harms and tensions linked to human values, to discover how to achieve a balance among the competing values, and to help designers and developers better account for human values when creating MUVEs. The research questions are therefore as follows.

1. What are the key characteristics that enable social interaction in MUVEs?
2. From a value sensitive design perspective, what human values are essential in MUVE social interaction?
3. What key MUVE characteristics support the human values that improve social interaction?
4. What are the human value benefits, harms and tensions associated with the use of MUVEs?
5. How can MUVE developers and designers incorporate characteristics that improve social interaction for users and impacted non-users using all access points?

1.4 Research Objectives

The expected outcome of this study is a list of design considerations that account for human values in the creation of MUVE experiences for social interaction. These design considerations aim to inform the creation of enhanced MUVE and Social VR experiences. Moreover, the study can be used as a stepping stone towards further research into what human values are essential in MUVE social interaction. The objectives of this study are to:

- identify the patterns, challenges and technology use in MUVE social interaction;
- identify value tensions and technical measures to address these human values;
- discuss whether or not MUVE characteristics address the identified human values and
- provide a set of design considerations that will inform future developments of MUVEs that support human values.

1.5 Research Procedure

This section gives an overview of the research methodology and describes the research approach in detail. This study's research methodology enlists the use of the VSD tripartite theoretical framework to develop a list of design recommendations that can be used to create MUVEs that better account for human values to improve social interaction. This research comprises four main parts, outlined in *Table 1*.

Table 1. Overview of the research steps and methodology

Research steps	**Research question**	**Research method**
Step 1: Literature review	What are the key characteristics that enable social interaction in MUVEs?	A literature review that gathers and analyses current literature to investigate MUVE characteristics, as well as the features and technologies that support them.
Step 2: Conceptual investigation	From a VSD perspective, what human values are essential in MUVE social interaction?	A stakeholder analysis that identifies impacted stakeholders and a literature review of VSD publications that focus on interactive technologies to identify essential human values.
Step 3: Empirical and technical investigation	What key MUVE characteristics support the human values that improve social interaction? What are the human value benefits, harms and tensions that exist in the use of MUVEs?	Implementation and analysis of a survey and value-orientated semi-structured interviews to understand implications for stakeholder groups, value tensions and potential value harms and benefits.
Step 4: Develop a list of considerations	How can MUVE developers and designers incorporate characteristics that improve social interaction for users and impacted non-users using all access points?	A proposal for MUVE design considerations, based on the analysis of the collected data.

1.6 Description of Chapters

The following Chapter Two outlines the current MUVE and VR literature discussing key MUVE characteristics, as well as the features and technologies that support them. Furthermore, it introduces VSD, its importance, key methods and tripartite methodology. Chapter Three, the research methodology, provides an overview of the research problem, as well as the detailed VSD methods and procedures used to answer the research questions.

Chapter Four then details the study's key results. These results, gathered from both quantitative and qualitative data, are organised and separated into value-focused subsections. Finally, Chapter Five discusses these results to draw conclusions and themes, attempting to answer the research questions.

2 LITERATURE REVIEW

This section defines the term MUVE, then reviews the current MUVE and VR literature discussing key MUVE characteristics, as well as the features and technologies that support them. Furthermore, it introduces VSD, its importance, key methods and tripartite methodology.

2.1 MUVE AND SOCIAL VR

Basu (2018) defines VR as "the art of substituting real-world sensory information with artificial stimuli such as visual imagery, spatialized sound, and force or tactile feedback and packaging it all together inside a Virtual Environment" (p.1). In comparison, another VR researcher defined it as a "computer-generated digital environment that can be experienced and interacted with as if that environment were real" (Jerald, 2016, p.9). This art of substituting what is real can manifest in numerous ways, which makes VR a multifaceted field. Additionally, VR is defined as a collection of technologies that include VEs and sensory inputs, and the four mediums or characteristics of VR are interactivity, three-dimensionality, immersion and real-time response to actions (Liu, Lather, & Messner, 2014).

In recent years, amidst the surge in broadband connectivity, paired with the affordability of high-speed internet, user-built VEs such as Second Life™ and massively multiplayer online games like World of Warcraft have seen in some cases hundreds of thousands of users interacting simultaneously (Schroeder, 2011). Likewise, Social VR applications such as Rec Room, BigScreen, VRChat, and AltSpace have seen an increase in traffic (Hackl, 2020). In research from Immersive Learning News (2019), social VR is defined as platforms that enable participants to enter into virtual environments using compatible VR headsets, usually represented as avatars, where they are able to interact with other participants and do various tasks and

exercises. On the other hand, the common definition of MUVE as a shared or collaborative VR system: "environments or systems as those in which users experience other participants as being present in the same environment and interacting with them or as "being there together"" (Schroeder, 2011, p.4). This study will use the all-encompassing term MUVE to refer to social VR, as social VR is a subset of MUVE.

2.2 KEY MUVE CHARACTERISTICS

In this study a review of current literature was conducted to investigate MUVE characteristics, as well as the features and technologies that support them. Accordingly, the selection of publications for this literature review was limited to materials that focus on the key characteristics, features and technologies of MUVE and VR. This study collected publications from the JSTOR, Google Scholar and ResearchGate libraries. These publications consisted of research journal articles, books and/or book chapters and electronic texts.

In total, 102 publications were gathered during the literature review. These publications were reviewed using the 'quick and dirty' method, which provides a rapid review procedure (Yi, 2014). During this procedure, a selection process transpired whereby publications that specifically discussed MUVE characteristics, features and technologies were selected. The outcome of this process was the identification of 29 publications that were examined and formed the basis for findings presented in *Table 2*. The oldest publication included in this corpus was from 2008, the newest from 2020. The results of the literature review displayed in *Table 2* include a full list of MUVE characteristics along with their definitions, identified supporting features and technologies and, finally, related publications.

Table 2. List of key MUVE characteristics, features and technologies that support them and the related publications

Characteristic	**Definition**	**Supporting Features and Technologies**	**Related Publications**
Avatars	"A character that is a virtual representation of a real user" (Jerald, 2016 p. 257).	Avatar customisation, skins, usernames / pseudonyms and avatar animations (gesture, motion capture, biological motion and emotes).	Ankomah & Vangorp, 2018; Pangilinan, Lukas, & Mohan, 2019; Pearce, 2011; Plesner & Philips, 2014; Lányi, 2012; (Stanković, 2015; Silcox, 2017; Ahram, 2020; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Makzan., 2010; Steed & Oliveira, 2010; Baruah, 2020; Bainbridge, 2010; Peterson, 2011; Šašinka et al., 2018; Rubio-Tamayo, Gertrudix Barrio & García García, 2017; Blascovich & Beall, 2010; Zielasko et al., 2017; Animesh et al., 2011; Smith & Neff 2018; Padmanabhan, 2008
Awareness	Refers to the knowledge of the presence of other users, which includes their activities and interactions. For example, users need to know if others are around and if they are attempting to interact with them (Lee et al. 2001).	Spatial awareness, contextual awareness and radar.	Pangilinan, Lukas, & Mohan, 2019; Pearce, 2011; Lányi, 2012; Stanković, 2015; Ahram, 2020; Schroeder, 2011; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Smith & Neff 2018
Collaboration	"The act of working with another person or group of people to create or produce something" ("Oxford Learner's Dictionaries", 2020).	Communication, awareness and interactability.	Pangilinan, Lukas, & Mohan, 2019; Plesner & Philips, 2014; Lányi, 2012; Stanković, 2015; Silcox, 2017; Ahram, 2020; Dieck & Jung, 2019; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Bainbridge, 2010; Šašinka et al., 2018; Zielasko et al., 2017; Menck

			et al., 2012; Basu, 2018; Slater & Sanchez-Vives, 2016; Smith & Neff 2018
Communication	Communication options are both technical and social; therefore, the options need to be implemented with certain forms of social interaction in mind because they will considerably shape social interaction between users (Schroeder, 2011).	Voice chat, text chat, voice manipulation and text to speech.	Ankomah & Vangorp, 2018; Pangilinan, Lukas, & Mohan, 2019; Pearce, 2011; Plesner & Philips, 2014; Stanković, 2015; Silcox, 2017; Ahram, 2020; Dieck & Jung, 2019; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Bainbridge, 2010; Peterson, 2011; Rubio-Tamayo, Gertrudix Barrio & García García, 2017; Blascovich & Beall, 2010; Slater & Sanchez-Vives, 2016; Smith & Neff 2018; Padmanabhan, 2008; Eid & Al Osman, 2015
Copresence	A sense of synchronized mutual and situational awareness of individuals who are simultaneously and synchronously occupying a VE (Wu, 2016).	Social presence, spatial copresence, pseudo-touch, haptics, head-mounted displays (HMDs), avatars, visual ques and auditory signals.	Pearce, 2011; Lányi, 2012; Silcox, 2017; Dieck & Jung, 2019; Schroeder, 2011; Bainbridge, 2010; Peterson, 2011; Animesh et al., 2011
Extensiveness	Relates to the range of sensory modalities presented to the user such as visuals, audio and haptics (Jerald, 2016).	Helmets, gloves, clothing, sensors, chips, motion trackers, gesture commands, hand tracking and HMDs.	Carvalho, Soares, Neves, Soares & Lins, 2014; Ankomah & Vangorp, 2018; Butt et al., 2018; Pangilinan, Lukas, & Mohan, 2019; Plesner & Philips, 2014; Stanković, 2015; Silcox, 2017; Ahram, 2020; Dieck & Jung, 2019; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Bainbridge, 2010; Šašinka et al., 2018; Rubio-Tamayo, Gertrudix Barrio & García García, 2017; Zielasko et al., 2017; Animesh et al., 2011; Basu, 2018; Slater & Sanchez-Vives, 2016; Smith & Neff 2018; Padmanabhan, 2008; Eid & Al Osman, 2015
Immersion	“A state of cognitive, emotional and motivational involvement" of the user	Extensiveness, matching, surroundness, vividness and interactability.	Carvalho, Soares, Neves, Soares & Lins, 2014; Ankomah & Vangorp, 2018; Pangilinan, Lukas, & Mohan, 2019; Pearce, 2011; Plesner & Philips, 2014; Lányi, 2012; Stanković, 2015; Silcox,

	or player with the elements of a MUVE" (Navarro et al. 2019, p.234).		2017; Silcox, 2017; Ahram, 2020; Dieck & Jung, 2019; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Baruah, 2020; Bainbridge, 2010; Peterson, 2011; Šašinka et al., 2018; Rubio-Tamayo, Gertrudix Barrio & García García, 2017; Blascovich & Beall, 2010; Zielasko et al., 2017; Menck et al., 2012; Animesh et al., 2011; Basu, 2018; Slater & Sanchez-Vives, 2016; Padmanabhan, 2008; Eid & Al Osman, 2015
Interactability	In order for users to collaborate, they need to be able to interact with objects in MUVEs. Interactability refers to the ability to modify, develop, create, or submit customized content, thus giving users almost complete control in the VE (Gottschalk, 2010).	Selection, manipulation, system control, telepresence and interactive system.	Carvalho, Soares, Neves, Soares & Lins, 2014; Pangilinan, Lukas, & Mohan, 2019; Pearce, 2011; Plesner & Philips, 2014; Stanković, 2015; Silcox, 2017; Ahram, 2020; Dieck & Jung, 2019; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Bainbridge, 2010; Šašinka et al., 2018; Zielasko et al., 2017; Animesh et al., 2011; Basu, 2018; Gottschalk, 2010
Presence	Describes "a sense of 'being there' inside a space, even when physically located in a different location" (Jerald, 2016, p.46). Furthermore, it refers to the users' implied perception of their surroundings in a MUVE (Stanković, 2015).	Navigation, interactability, sensory modalities and graphics.	Ankomah & Vangorp, 2018; Pearce, 2011; Plesner & Philips, 2014; Lányi, 2012; Stanković, 2015; Silcox, 2017; Silcox, 2017; Ahram, 2020; Dieck & Jung, 2019; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Bainbridge, 2010; Peterson, 2011; Šašinka et al., 2018; Rubio-Tamayo, Gertrudix Barrio & García García, 2017; Zielasko et al., 2017; Animesh et al., 2011; Basu, 2018; Slater & Sanchez-Vives, 2016; Slater & Sanchez-Vives, 2016; Smith & Neff 2018
Vividness	Refers to the quality of stimuli or aesthetic quality, as the 'aesthetic-usability effect' suggests users often perceive attractive products as more usable: they tend to believe that things that are aesthetically pleasing are	Poses, graphics, text, user interface, screens, animations, music, tones, resolution, lighting, frame rate, audio bitrate and sound effects.	Carvalho, Soares, Neves, Soares & Lins, 2014; Pangilinan, Lukas, & Mohan, 2019; Plesner & Philips, 2014; Lányi, 2012; Stanković, 2015; Silcox, 2017; Ahram, 2020; Dieck & Jung, 2019; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Baruah, 2020; Bainbridge,

	more effective or efficient, even if they are not (Jerald, 2016; Moran, 2017).		2010; Rubio-Tamayo, Gertrudix Barrio & García García, 2017; Menck et al., 2012; Basu, 2018
Usability	Takes into account the full range of capabilities people have, then creates products and environments that are usable by all people to the greatest extent possible (Hamraie, 2016). Horton and Quesenbery (2013) argue that this makes the technology invisible to users, helping them focus on their own activities and the experience.	Navigation, wayfinding, system control, graphical menus, efficiency, learnability, accessibility, satisfaction and usefulness.	Ankomah & Vangorp, 2018; Butt et al., 2018; Plesner & Philips, 2014; Lányi, 2012; Stanković, 2015; Silcox, 2017; Ahram, 2020; Dieck & Jung, 2019; Schroeder, 2011; Latham Cudworth, 2017; Jerald, 2016; Lakkaraju, Sukthankar & Wigand 2018; Steed & Oliveira, 2010; Bainbridge, 2010; Šašinka et al., 2018; Menck et al., 2012; Basu, 2018; Slater & Sanchez-Vives, 2016; Padmanabhan, 2008

Numerous studies have explored how to improve MUVE experiences, as well as how users interact in them. Several researchers have confirmed that social interaction in MUVE is essential because social connections are a natural step to sharing worlds and experiences. For instance, MUVEs can foster positive experiences when used to enhance learning, simulate complex activities or increase human efficiency with real-world tasks (Padmanabhan, 2008). Additionally, in MUVEs, users are not passive receivers or merely consumers of content; rather, these worlds enable them to be active participants by allowing them to interact with others and elements within them. MUVEs such as Second Life™ allow users to freely interact, which in turn enables them to foster a sense of 'community' and 'interaction'. This has prompted researchers to study the importance of communication and social conventions in MUVEs, such as gesture, tone, behaviour and emoticons (Padmanabhan, 2008).

A large number of existing studies in the broader literature examined consider 'immersion' or the 'sense of being immersed' as an essential characteristic. In other words, an essential feature for an exceptional MUVE game is its ability to involve the player with the elements and contents of that game. Navarro et al. (2019) suggest that when this happens, players experience a sense of involvement that is likened to an experience of "being in the game" and are no longer conscious of the real world around them. When players are in this state, possible experiences include losing track of time or absent-mindedness when being spoken to in real life. The authors refer to this state – "the experience of complete concentration in the game environment and a distraction-free self-absorption" – as "immersion" (Navarro et al., 2019, p.234). Likewise, Jerad (2016), identifies 'extensiveness', 'matching', 'surroundness', 'vividness' and 'interactability' as key factors that induce immersion. In light of this, it can be stated that immersion has the potential to engage

users in the experience. Basu, similarly, argues that the critical elements in experiencing MUVEs are immersion, extensiveness and interactivity (Basu, 2018).

Another aspect of MUVEs shown in the literature to be fundamental is avatars. Zhang, Yu and Smith (2019) argue that VR technologies are useful in studying human-to-human social interactions. Nonverbal communication, such as body language, gaze, gesture and facial expression, are crucial for smooth communication. This was confirmed by Smith and Neff's (2018) study that showed embodied VR and face-to-face interaction are remarkably similar in terms of verbal and nonverbal communicative behaviour, with the anticipated drop off for VR without avatars. Therefore, avatars and avatar animations in a MUVE seem to help people feel that they are indeed interacting with another person.

Another key finding of the research is that 'touch' not only plays an essential role in social interaction, it is also a fundamental human need, as it is capable of communicating distinct emotions (Eid, & Al Osman, 2015). Researchers have explored haptics with regards to trust and the value of touch in social interaction: for example, HaptiHug, which enables Second Life™ users to give each other a virtual hug (Tsetserukou, 2010). However, such technologies offer a high barrier to entry, which excludes others who might want to explore MUVEs or interact with others there.

On the other hand, Basu (2018) found that users tethered to HMDs perform tasks worse than untethered users. Consequently, for VR to become genuinely essential, it has to become invisible so that its users can solely concentrate on experiences in the MUVE. Currently, users need to wear multiple hardware interfaces or devices to have a compelling VR experience. As a result,

because users are tethered, they are limited to the tracking area, which results in a lesser range of movement. Additionally, multiple hardware interfaces introduce fatigue and cyber-sickness (Basu, 2018), as a result significantly reducing usability and leaving users less motivated to tether themselves. Eid and Al Osman (2015) argue that the ability of a human to interpret a haptic stimulus and recognise a corresponding emotion depends on far more than just the physical properties of the haptic stimulus, as convincing haptics are very contextual in nature. They believe a true breakthrough lies in the development of pervasive, unobtrusive and natural haptic interfaces that are capable of detecting haptic cues and providing high-fidelity haptic rendering, anywhere and anytime, in the same way that humans ordinarily communicate through touch.

Overall, this section has identified and defined key MUVE characteristics, avatars: awareness, collaboration, communication, copresence, extensiveness, immersion, interactability, presence, vividness and usability. Furthermore, it has listed their supporting features and technologies as well as briefly discussed the prominent characteristics.

2.3 Current MUVE Design and Evaluation Approaches

The multifariousness of VEs makes creating MUVE experiences considerably challenging. Historically, most VR and VE creators have predominantly been software engineers who possess technological expertise but lack an understanding of users and their values. This saturation of software engineers is a result of VE experiences being significantly challenging to build, thus requiring significant technical knowledge. However, the way humans perceive and interact with technological artefacts is sophisticated and cannot be solved only by providing a user manual.

Furthermore, poorly executed MUVE experiences not only frustrate users, they also have adverse health risks. Jerald (2016) argues that poorly executed VR results from a lack of understanding perception, interaction, design principles and real users. On the other hand, well-executed MUVE experiences produce entertaining and gratifying results that go far beyond what can be created in the physical world.

With the aim of producing these, several studies have explored various approaches to designing and evaluating MUVE experiences. Most researchers have explored user-centred and human-centred design as approaches to designing and evaluating MUVE experiences (Jerald, 2016; Ahram, 2020; Stanković, 2015; Dieck & Jung, 2019; Stanković, 2015). In addition to user-centred design (UCD), Stanković (2015) has used cognitive task analysis methods to identify the cognitive skills needed to perform a particular task using a particular user interface in a MUVE. In comparison, Ahram (2020) has explored the unified theory of acceptance and use of technology, as well as a semiotic approach to product architecture design. Interestingly, Southall et al. (2019) has explored a shortened version of Jake Knapp's design sprint approach and its application to designing VR solutions.

2.4 VALUE SENSITIVE DESIGN (VSD)

"VSD is a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process" (Friedman, Kahn, & Borning, 2012, p.1). In other words, VSD takes an interactional stance on technology and human values (Friedman, Hendry & Borning, 2017). To put it simply, VSD is an approach – developed by Batya Friedman, Peter Kahn and David Hendry – that accounts for human values in the design of technology. It emerged as a concept in the early 1990s, and soon after in 1999

the Value Sensitive Design Lab was founded at the University of Washington. Since then, it has been applied to multiple technologies and various industries (Friedman & Hendry, 2019). VSD sits at the intersection between technology and society, helping designers and researchers think about and consider how technology impacts societies and communities. Its tools and methods engage both technical and socio-structural design spaces, providing a more comprehensive design space – and enabling designers and researchers to offer solutions that might not have been considered if approached from either a solely technical or socio-structural perspective. However, at the time of writing, VSD prevalence is still in its infancy. Yet, in the future the focus of design on human values will become a more accepted perspective. Davis and Nathan (2015) argue that what researchers are learning in VSD today will influence how technology designers appreciate and address values in the future, hopefully rendering it the next UCD.

2.4.1 Importance of Human Values in MUVEs

Current studies have not explored the MUVE field from a VSD perspective. Nevertheless, VSD is essential because it shares and adopts many research areas and techniques from related approaches to values and system design. As outlined by Friedman, Kahn, & Borning (2012), its benefits can be understood according to eight features:

- it is proactive, or seeks to influence the design of technology early in and throughout the design process;
- it broadens the area in which values arise (unlike computer-supported cooperative work, it is not only focused on the workplace, but also on education, the home, commerce, online communities and public life);
- it has a unique methodology that is applied iteratively and integratively;
- it enlarges the scope of human values to include those with moral import;
- it distinguishes between human values and usability;

- it takes into account the two classes of stakeholders: direct (users) and indirect (impacted non-users);
- it is an interactional theory and, finally,
- it builds upon the psychological proposition that specific values are universally held.

According to van den Hoven (2007), VSD focuses on making human values part of technological design, research and development by engaging with information and communications technology (ICT). VSD "assumes that human values, norms, moral considerations can be imparted to the things we make and use, and it construes information technology (and other technologies for that matter) as a formidable force which can be used to make the world a better place, especially when we take the trouble of reflecting on its ethical aspects in advance" (van den Hoven, 2007, p.30). Additionally, VSD is more comprehensive, as it engages both technical and socio-structural design spaces with the tools and methods providing the possibility for solutions that could not be conceived of if approached from a technical or socio-structural perspective alone (Friedman, Hendry & Borning, 2017).

According to Friedman, Hendry & Borning (2017), VSD drives designers towards the ways of thinking required to identify deficiencies and to explore improvements that elevate human well-being. VSD's primary concern is placing human well-being, privacy, universal usability, trust, autonomy, dignity, justice, welfare and rights at the centre of the design and development process, articulating an interactional position for how values become implicated in technological designs (Friedman 1996). This interaction position holds that while features or properties in a technological artefact more readily promote particular values and hinder others, the technology's

actual use depends on the goals of the users interacting with it (Friedman 1996). Furthermore, VSD is iterative; it builds upon existing design practices and traditions as well as on its own process as new information, techniques, issues and advancements emerge throughout (Friedman, Hendry & Borning, 2017).

Finally, a VSD study can provide important insights into value tensions. Human values do not exist in isolation; they reside in a delicate state of balance with each other (Friedman, Hendry & Borning, 2017). Altering or focusing on one value impacts and implicates others. According to Friedman, Hendry and Borning (2017), human values can align or come into tension at numerous levels of the human experience, such as within an individual; among individuals; between an individual and a group; among groups, institutions, nations and societies or in other combinations.

2.4.1 TRIPARTITE METHODOLOGY

VSD uses a tripartite methodology that rests on the interactional stance: "That is, values shape technology development, and, in various ways, values can be enmeshed in technology" (Friedman & Hendry, 2019, p. 56). The tripartite methodology is made up of the following three investigations: conceptual, empirical and technical. These investigations seek to position the design team to robustly address the value implications of sociotechnical design (Friedman & Hendry, 2019). Furthermore, like other design methodologies, the VSD tripartite methodology is a non-linear, iterative design approach.

Conceptual investigations are informed explorations of the central issues and constructs under investigation, and can be analytic, theoretical or philosophical (Friedman, Hendry, & Borning, 2017). Additionally, the conceptual investigation is most theoretical among the tripartite

investigations, it is philosophically informed and requires consultation with philosophical or VSD literature. Empirical investigations are applied to any human activity that can be observed, measured or documented. Therefore, quantitative and qualitative methods used in social science research such as observations, interviews, surveys, experimental manipulations, collection of relevant documents and measurements of user behaviour and human physiology are applicable (Friedman, Hendry, & Borning, 2017). Technical investigations focus on the technology itself by exploring how a given technology is more suitable for specific activities and readily supports absolute values while rendering other activities and values challenging to realise (Friedman, Kahn, & Borning, 2012). Additionally, another form of technical investigation involves the proactive design of systems to support values identified in the conceptual investigation (Friedman, Kahn, & Borning, 2012).

2.4.2 VSD METHODS

VSD offers several methods that can be used during the tripartite investigations. These VSD methods guide designers or researchers in how to engage in a particular kind of research or design enquiry, enabling them to focus on critical elements in a way that positions them to obtain meaningful design insights (Friedman & Hendry, 2019). VSD researchers and practitioners have identified 17 leading methods that appear throughout VSD literature. Summarised in *Table 3* are the 17 methods along with the purpose and an overview for each.

Table 3. Summary of the 17 leading VSD methods along with their purpose and an overview

Method	**Purpose**	**Overview**
Stakeholder Analysis	Stakeholder identification and legitimation	VSD requires designers and researchers to seek out and consider a robust set of stakeholder groups, organizations, institutions and societies that are strongly affected by technology. There are two overarching stakeholder categories: direct stakeholders, who directly interact with the technology, and indirect stakeholders, who never or rarely interact with it but are affected by its use (Friedman & Hendry, 2019).
Stakeholder Tokens	Stakeholder identification and legitimation	A playful and versatile toolkit that helps designers and researchers identify stakeholders, their interactions and the relationships among stakeholders (Friedman & Hendry, 2019).
Value Source Analysis	Identify value sources	Seeks to differentiate between the explicitly supported human values, designers' or researchers' personal values, and values held by other direct and indirect stakeholders (Friedman, Hendry, & Borning, 2017).
Co-evolution of Technology and Social Structure	Expand design space	As part of the solution space, engages with the design of both technology and social structure. Engaging social structures may involve policy, law, regulations, organisational customs, social norms and others (Friedman, Hendry, & Borning, 2017).
Value Scenario	Values representation and elicitation	Narratives covering stories of use that are expanded to incorporate important humanistic and societal considerations of technology and context. These narratives emphasize implications for both direct and indirect stakeholders, related fundamental human values, extensive use, indirect impacts, longer-term use and systemic effects (Friedman & Hendry, 2019).

Value Sketch	Values representation and elicitation	Sketching activities that tap into stakeholders' non-verbal perceptions, beliefs, views, and values about a technology (Friedman, Hendry, & Borning, 2017).
Value-oriented Semi-structured Interview	Values elicitation	"Semi-structured interview questions as a way to tap into stakeholders' understandings, views and values about a technology. Questions typically emphasize stakeholders' evaluative judgments (e.g., all right or not all right) about a technology as well as rationale (e.g., why?). Additional considerations introduced by the stakeholder are pursued" (Friedman & Hendry, 2019, p. 89).
Scalable Information Dimensions	Values elicitation	"Sets of questions constructed to tease apart the impact of pervasiveness, proximity, granularity of information, and other scalable dimensions. Can be used in interview or survey formats" (Friedman, Hendry, & Borning, 2017, p. 74).
Value-oriented Coding Manual	Values analysis	"Hierarchically structured categories for coding qualitative responses to the value representation and elicitation methods. Coding categories are generated from the data and a conceptualization of the domain. Each category contains a label, definition, and typically up to three sample responses from empirical data. Can be applied to oral, written, and visual responses" (Friedman & Hendry, 2019, p. 89).
Value-oriented Mockup, Prototype or Field Deployment	Values representation and elicitation	"Development, analysis, and co-design of mockups, prototypes and field deployments to scaffold the investigation of value implications of technologies that are yet to be built or widely adopted. Mock-ups, prototypes or field deployments emphasize implications for direct and indirect stakeholders, value tensions, and technology situated in human contexts" (Friedman, Hendry, & Borning, 2017, p. 75).
Ethnographically Informed Inquiry regarding Values and Technology	Values, technology and social structure framework and analysis	"Framework and approach for data collection and analysis to uncover the complex relationships among values, technology and social structure as those relationships unfold. Typically involves in-depth engagement in situated contexts over longer periods of time" (Friedman, Hendry, & Borning, 2017, p. 75).

Model for Informed Consent Online	Design principles and values analysis	"Model with corresponding design principles for considering informed consent in online contexts. The construct of informed encompasses disclosure and comprehension; that of consent encompasses voluntariness, competence, and agreement. Furthermore, implementations of informed consent must not pose an undue burden to stakeholders" (Friedman, Hendry, & Borning, 2017, p. 75).
Value Dams and Flows	Values analysis	"Analytic method to reduce the solution space and resolve value tensions among design choices. First, design options that even a small percentage of stakeholders strongly object to are removed from the design space—the value dams. Then of the remaining design options, those that a good percentage of stakeholders find appealing are foregrounded in the design the value flows. Can be applied to the design of both technology and social structures" (Friedman & Hendry, 2019, p. 90).
Value Sensitive Action-Reflection Model	Values representation and elicitation	"Reflective process for introducing value sensitive prompts into a co-design activity. Prompts can be designer or stakeholder generated" (Friedman & Hendry, 2019, p. 91).
Multi-Lifespan Timeline	Priming longer-term and multi-generational design thinking	"Priming activity for longer-term design thinking. Multi-lifespan timelines prompt individuals to situate themselves in a longer time frame relative to the present, with attention to both societal and technological change" (Friedman & Hendry, 2019, p. 91).
Multi-Lifespan Co-design	Longer-term design thinking and envisioning	"Co-design activities and processes that emphasize longer-term anticipatory futures with implications for multiple and future generations" (Friedman & Hendry, 2019, p. 91).
Envisioning Cards	Versatile value sensitive design toolkit for industry and educational practice	"Versatile value sensitive envisioning toolkit. Comprised of a set of 32 cards, the Envisioning CardsTM build on four criteria—stakeholders, time, values, and pervasiveness. Each card contains on one side a title and an evocative image related to the card theme; on the flip side, the envisioning criterion, card theme, and a focused design activity. Envisioning CardsTM can be used for ideation, co-design, heuristic critique, evaluation, and other purposes" (Friedman & Hendry, 2019, p. 91).

2.5 SUMMARY

The MUVE and VR studies reviewed provide essential insights into the key characteristics that enable social interaction as well as the current design and evaluation approaches. Overall, these studies highlight the need for a general VSD that approaches social interaction in MUVEs from a technical and socio-structural perspective. Accordingly, the literature review covered the VSD approach, its tripartite investigations and the 17 leading methods used in VSD studies.
In summary, the literature goes a reasonable distance towards illuminating the key characteristics that enable social interaction in MUVEs, thereby answering the first research question: What are the key characteristics that enable social interaction in MUVEs?

The other research questions remain unanswered. Overall, these studies highlight the need for a VSD study to uncover the essential human values in MUVEs, stakeholders involved, the implications for stakeholder groups, value tensions and potential concerns or benefits. Consequently, these VSD investigations will enable this study to thoroughly answer all research questions.

3 RESEARCH METHODOLOGY

This section provides an overview of the research problem as well as the detailed VSD methods and procedures used to answer the research questions. The research methodology consists of three main parts:

1. An overview of the research problem and strategy;
2. a conceptual investigation that identifies the critical human values in MUVEs as well as the impacted stakeholder groups and
3. an empirical and technical investigation that includes a survey and value-orientated semi-structured interviews to gather data, interpretation of the data and finally the development of a set of design considerations for interaction designers and future researchers to consider.

3.1 RESEARCH PROBLEM AND STRATEGY

In order to research and understand the human values concerned with social interaction in MUVEs, this study used the VSD tripartite methodology. As discussed, VSD tripartite methodology is composed of conceptual, empirical and technical investigations. Furthermore, it is a mixed-methods approach that embraces both quantitative and qualitative strategies of data collection. The use of a mixed-methods research approach to study the topic helps provide a more complete understanding of the research problem because it involves the collection of diverse types of data rather than relying on either quantitative or qualitative data alone. Designing compelling MUVE experiences for social interaction requires a deep understanding of stakeholders, their values and the contexts of technology use. Studying a topic such as this requires a nuanced approach; therefore, the collection of diverse types of data is beneficial. Additionally, the VSD tripartite methodology is also an iterative methodology that supports the

continuous exploration of existing artefacts; therefore, it is effective for the study at hand. For this study to be achievable in the given time frame, it makes use of existing MUVE games because the development of a MUVE application would be time-consuming, expensive and difficult for a non-VR-expert to realise.

Firstly, this study carried out conceptual investigations in the form of research, to identify the direct and indirect stakeholders, then turned to relevant literature to help provide criteria for stakeholder values, and benefits and harms for the stakeholder groups. Afterwards, both quantitative (a survey) and qualitative data (interviews) was collected to better understand stakeholders' attitudes towards the context of the use of MUVEs. Accordingly, this study made use of an explanatory sequential mixed method approach, allowing the results obtained in the quantitative research to be analysed and explained in more detail by the qualitative research. The interviews were semi-structured, which offered a balance between questions of interest and new and unexpected insights. The interviews formed part of the technical and empirical investigations, and VSD methodological strategies and heuristics were used to support both of these.

3.2 CONCEPTUAL INVESTIGATION

For the conceptual investigation, a stakeholder analysis and an in-depth review of VSD literature were carried out. Firstly, the stakeholder analysis aimed to identify the stakeholder groups affected by the use of MUVEs. Afterwards, as no VSD study had yet identified human values in MUVEs, an in-depth review of VSD publications that focus on human values in interactive technologies was implemented. These publications were sourced from the VSD website and from the JSTOR, Google Scholar and ResearchGate libraries.

3.3 EMPIRICAL AND TECHNICAL INVESTIGATION

This study aimed to identify human values that are essential to social interaction in MUVEs, as well as the characteristics that support them. The conceptual investigation outlined in the previous section coupled with the literature review went a reasonable distance toward highlighting these critical human values and the key MUVE characteristics that support them. However, the studies reviewed lacked a focus on dealing specifically with MUVEs, implications for stakeholder groups, value tensions and potential harms or benefits. In other words, the literature and conceptual investigation did not reveal what actual MUVE users (direct stakeholders) and impacted non-users (indirect stakeholders) think, experience or value in these situations. For this, it was necessary to conduct empirical and technical investigations to engage real people. As discussed, the empirical and technical investigation method consisted of two sections: a survey and value-orientated semi-structured interviews.

3.3.1 QUANTITATIVE DATA

The survey was designed based on the conceptual investigation research that covered human values and the literature review that identified key MUVE characteristics. The questions were designed to measure how users experienced MUVEs and to give an initial, broad understanding of how direct and indirect stakeholders feel about the identified values and key characteristics.

3.3.1.1 PROCEDURE

The survey was created using Google Forms, active and collecting data over a four-week period, regarding the following:

- **Values:** immersion, collaboration, community, universal usability, trust, privacy and human welfare. Identity was not included in the survey questions, as its context was nuanced and proved to be too challenging to condense into a single

survey question. However, key characteristics that are related to and affected by identity were included in the survey questions.

- **Key MUVE characteristics:** vividness, presence, copresence, awareness, communication, extensiveness and interactabity. As with identity, questions about avatars were not included in the survey questions as their context was also nuanced and proved to be too challenging to condense into a single survey question. However, key characteristics that are related to and affected by avatars were included in the survey questions.

The first section of the survey aimed to collect demographic data and to split respondents into their respective stakeholder groups. This was achieved by asking respondents to state their gender and age, and then asking if they use MUVEs or live with a MUVE user. Once the respondents were divided into their respective cohorts, the second part of the survey focused on gathering data regarding their perceptions and attitudes towards the identified human values and key MUVE characteristics.

As argued by Joshi et al. (2015), Likert scales are rooted in the aim and purpose of research to understand the opinions and perceptions of a respondent to a phenomenon of interest. Accordingly, this second part of the survey made use of five-point Likert scale questions, asking respondents to rate their level of agreement statements (1 corresponding to ‘strongly disagree’ and 5 to ‘strongly agree’). Most of the questions in this section were adapted from previous VSD and empirical studies. Conversely, others – such as those related to trust and privacy – were adapted from the trust model developed by Gulati et al. (2018) to measure trust in human-like technologies.

3.3.1.2 Recruitment

This study made use of convenience sampling as a sampling technique. Respondents were recruited from the researcher's circle of acquaintances and their acquaintances. In addition, a link to the survey was posted on threads, hashtags and groups on social media sites: Reddit, Instagram, Facebook and Twitter. Convenience sampling allowed for non-random sampling, where respondents were accessible, readily available and affordable as none of the respondents were paid (Etikan, 2016). There was no condition to qualify; however, the third question split the respondents into two the two stakeholder groups:

- direct stakeholders consisting of MUVE users
- and indirect stakeholders consisting of people who live with a MUVE user.

3.3.1.3 Ethical Considerations

To meet research and ethical standards, survey data was kept anonymous, and to protect privacy respondents were not asked for any personal information. Furthermore, respondents were informed about the purpose of the study at the beginning of the survey (Appendix A).

3.3.1.4 Respondents

For the quantitative analysis, this study analysed a total of 78 responses to the survey. A slight majority, 48.72% (38), of the respondents identified as male, 47.44% (37) as female and 1.38% (1) as nonbinary, while 2.56% (2) omitted their gender. The most common age category of respondents, representing 47.44% (37), were aged 28 to 37, with 0% (0) of respondents between 68 and older. A majority of respondents, 66.67% (52), were direct stakeholders, while 33.33% (26) respondents were indirect stakeholders.

3.3.1.5 Data Analysis

This section will detail how the collected quantitative data was analysed and collated to make it useful in the results section. All gathered data was organised to include only valuable data, which was then analysed in a master Microsoft Excel document (Appendix B). Within the master Microsoft Excel document, various sheets were created to separate different types of data and data visualisations. These various sheets consisted of stakeholder-specific sheets as well as inter-group sheets comparing direct and indirect stakeholder groups. This provided initial insights into the respondents' perceptions and attitudes towards the identified human values and key characteristics.

Afterwards, the gathered data was analysed using IBM's SPSS Statistics software. Firstly, the four questions pertaining to trust were combined. This was followed by Kolmogorov-Smirnova and Shapiro-Wilk normality tests, which revealed departures from distribution normality for the variables (Appendix C). Accordingly, a nonparametric procedure, the Spearman's rank order correlation coefficient (Spearman's rho), was conducted on the direct stakeholder data to identify the relationships between the variables, specifically the links between human values and key MUVE characteristics. Finally, an Independent Samples t-Test was conducted to examine whether or not there was a significant difference in the variable (human values) means between the direct and indirect stakeholder groups.

3.3.2 Qualitative Data

This study used an established VSD technique, namely value-oriented semi-structured interviews, to elicit stakeholder values. The semi-structured nature of these interviews provided an opportunity to pursue topics thoroughly and also allowed the researcher to engage with new considerations or human values introduced by the stakeholders. Interview questions were honed

to elicit information about human values and value tensions concerning social interaction in MUVEs. Questions emphasised stakeholders' evaluative judgments about social interaction in MUVEs (e.g., "Are you concerned about privacy in MUVEs?" or "Is it all right or not all right that some MUVEs have a voice manipulation feature?") and their rationale (e.g., "Why?" or "Why not?"). This technique enabled the interview to tap into stakeholders' views, behaviours, experiences, perceptions and attitudes regarding social interaction in MUVEs.

3.3.2.1 PROCEDURE

Value-oriented semi-structured interviews were conducted with a portion of survey respondents to gain a more extensive understanding of their values concerning the use of MUVEs. As previously mentioned, this established VSD technique provided the researcher a set of specific questions to ask each participant but also allowed for follow-up questions and conversation to pursue issues of interest to the participant. Additionally, contextual laddering was used, as it is a proven one-on-one interviewing technique and enables researchers to understand why technological features satisfy user emotions and beliefs (Zaman, 2007).

This technique provided insight into the reasons behind participants' values as well as how the identified key characteristics support them. Two distinct interview protocols were developed: one for direct stakeholders and another for indirect stakeholders. Both interview protocols consisted of the following two sections:

1. an introductory section that aimed to warm up participants and get them comfortable and
2. a value questions section consisting of value-oriented questions, contextual laddering question follow-ups and additional leading questions (Appendix D).

The semi-structured interviews focused on asking participants about values directly or indirectly, based on criteria specified in the conceptual investigation (Friedman & Hendry, 2019). Therefore, they did not follow a structured process; instead, the questions were used non-linearly and interchangeably, providing the best technique for eliciting participant values. For example, a participant would be asked, "Are you concerned about privacy in MUVEs?" and then "Why is this important to you / why do you value this?"

3.3.2.2 Recruitment

Correspondingly, the recruitment of interview participants made use of convenience sampling techniques. A 'Recruitment Letter to Potential Research Participants' was posted on threads, hashtags and groups on social media sites: Reddit, Instagram, Facebook and Twitter. This recruitment letter briefly informed potential participants about the purpose of the study and the qualifying criteria, as well as to address some ethical concerns around privacy (Appendix E). Potential participants that showed interest were sent additional information about the project, as well as – when and if they were satisfied – a 'Consent Form' (Appendix F) and 'Confidentiality Agreement' (Appendix G). Afterwards, the date and time for the interview to take place was arranged.

3.3.2.3 Ethical Considerations

After receiving the 'Consent Form' and 'Confidentiality Agreement', participants provided informed consent about participating in the study. Additionally, all participants gave oral assent during the interviews, with one participant opting not to have the interview recorded; the researcher took notes during this interview. To meet research and ethical standards, interview data was kept anonymous, and to protect their privacy participants were not asked for any personal information. During the interviews, the researcher actively avoided discussion of non-

related topics, such as illegal activities and personal information. When transcribing the interview, all personal information was removed.

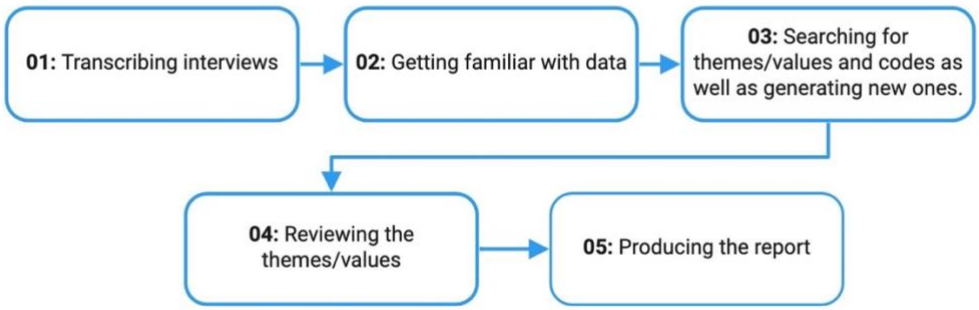
3.3.2.4 Participants

For the qualitative analysis, a total of 18 interviews from 18 participants were analysed. Depending on participants' inclinations to talk, the interviews ranged between 25 and 55 minutes. A majority 55.56% (10) of the participants interviewed identified as male, 38.89% (7) as female and 5.56% (1) as nonbinary. The most common age group for these participants, 44.44% (8), was 28 to 37, while no participants were between the ages of 48 and 57 or 68 and older. A majority 72.22% (13) of the participants interviewed were direct stakeholders, selected in order to elicit their views, behaviours, experiences, perceptions and attitudes regarding social interaction in MUVEs. On the other hand, 27.78% (5) of the participants interviewed were indirect stakeholders. These were people who live with or have a family or friends that use MUVEs; therefore, the interviews explored their perceptions of MUVE usage, as well as potential harms and benefits.

3.3.2.5 Data Analysis

All interviews were conducted and recorded in Zoom and then transcribed in Google Docs. Following this, thematic analysis began, and a master code Microsoft Excel document was created (Appendix H). A deductive thematic analysis approach was implemented, employing the perceived themes (human values) derived from the conceptual investigation. The graphic (*Figure 1*) below outlines the thematic analysis process.

Figure 1. Summary of this study's thematic analysis process



During the coding process, this study made use of value-oriented coding, where codes were generated from the conceptual investigations and the data gathered from the elicitation methods. Each category contains a label, definition and sample responses from the empirical data. Additionally, the researcher allowed the themes (human values) and codes to emerge during the data analysis. However, as this was a VSD deductive thematic analysis approach, most themes (human values) that emerged in the results were inevitably informed by the types of questions asked in the interviews.

4 RESULTS

The purpose of this section is to present this study's key results, achieved through the research procedure outlined in detail in the previous section. Results gathered from both quantitative and qualitative data are organised and separated into value-focused subsections. This study will use the explanatory sequential mixed method, analysing the quantitative results and further explaining them using the qualitative data. In this section, human values are italicised to help easily differentiate them from key MUVE characteristic.

4.1 CONCEPTUAL INVESTIGATION

4.1.1 STAKEHOLDER ANALYSIS

As presented in the literature review, VSD studies refer to users as direct stakeholders, and others impacted by those users' actions or the system are referred to as indirect stakeholders (Friedman, Hendry & Borning, 2017). According to Cranor & Garfinkel (2005), direct stakeholders are individuals who interact directly with the technological artefact or its output, whereas indirect stakeholders are all other individuals otherwise affected by the use of the technological artefact. By also focusing on these indirect stakeholders, VSD goes beyond other design methods that only consider users or direct stakeholders (Fordyce, 2019). This study uses both terms: 'direct stakeholder' and 'indirect stakeholder'; however, when referring to people who use MUVE platforms, the terms ‘users’ and ‘direct stakeholders’ will be used interchangeably.

4.1.1.1 DIRECT STAKEHOLDERS

These are MUVE users who not only directly interact with the system but also socially interact with others in MUVEs. Therefore, they are able to offer essential insights about what they value in MUVE social interaction.

4.1.1.2 INDIRECT STAKEHOLDERS

In this study, indirect stakeholders are people who live with a MUVE player. People who live with a MUVE player are a crucial group because they are indirectly impacted by MUVE usage and they might have values concerning the users and themselves that have not been considered by MUVE developers and designers.

4.1.2 RELATED HUMAN VALUES

According to Friedman et al. (2012), VSD is an 'interactional' theory because while certain design features might support or hinder specific values, use depends on user interaction. Values are at play in all phases of computer and information technology, from envisioning, designing, developing, implementing, deploying, appropriating and continual re-appropriation to re-invention (Friedman 1996). By engaging with values, VSD empowers researchers to address ethical issues in an innovative way, through the proactive integration of ethical reflection with the design stage of technology development (van den Hoven, 2007). Therefore, it is essential to carefully consider values, value tensions and value trade-offs.

Accordingly, as briefly outlined in the previous section, a total of 39 VSD publications from 1996 to 2019 that focus on interactive technologies were gathered from the VSD website, JSTOR, Google Scholar and ResearchGate libraries. Subsequently, through an in-depth conceptual investigation, the following were identified as human values that are important in interactive technologies, and may also be essential in MUVE social interaction.

Collaboration: Research undertaken by Miller et al. (2007) and Friedman et al. (2012) has identified collaboration as a human value. In MUVEs the possibility to *collaborate* is endless, as users can perform a range of tasks together, such as manipulating objects and visualising

complex models, as well as exploring spaces, building, rehearsing acting and more. As Schroeder (2011) argues, in MUVEs tracking the body – such as moving in relation to objects or interacting with them – is crucial in order to make immersive spaces useful. Additionally, immersive experiences are useful for collaboration on spatial tasks. In this study, collaboration refers to 'the act of working with another person or group of people to create or produce something' (“Oxford Learner's Dictionaries”, 2020).

In order for users to collaborate, they need to be able to interact with objects in MUVEs. As discussed, interactability, in this study, refers to the ability to modify, develop, create or submit customised content, thus giving users almost complete control in the MUVE (Gottschalk, 2010). Studies have identified interactability as a crucial factor in allowing collaboration in MUVEs. Some studies found that in collaborative tasks the most immersed user was regarded as the leader. However, according to Schroeder (2011), this is a result of what users focus on when they use different systems; desktop system users typically focus more on communication, whereas the more immersed users – people using HMDs – focus more on navigating and manipulating objects. This results in a division of labour, with desktop users taking a more supervisory role and HMD users a more active one; this was even observed in studies where users were unaware that other users were using different systems (Schroeder, 2011).

Another critical feature or factor is the ability to communicate. Sherblom et al. (2018) argue that the difference between a successful and frustrating collaboration often hinges on the quality of communication. This quality can similarly vary in MUVEs, where differing socio-technical capabilities shape communication. For example, in some cases text or voice chat can be heard and seen within a specific spatial vicinity within the MUVE. In others, everyone within the

MUVE can read or hear these regardless of whether or not they are close to the speakers, or only specific selected avatars can read or hear it (Schroeder, 2011). Furthermore, combinations of text and voice chat are possible, for example in Second Life™, but can be confusing. As these communication options are both technical and social, Schroeder (2011) argues that the options need to be implemented with certain forms of social interaction in mind because they will considerably shape social interaction between user.

Community: Woelfer and Hendry's (2011) VSD study found that the human value of *community* was associated with the following themes: maintaining relationships, connections and bonds, expressions of community, social exchanges, possession and ownership and sharing resources. Meanwhile, Deibel's (2011, p. 106) VSD study defined community as "The sense of belonging to a group of people due to sharing a set of attributes". MUVEs may help users find a sense of community online, but can also cause them to alienate people in the physical world. The definition of community used in this study is taken from McMillan and Chavis's 1986 article 'Sense of Community: A definition and theory'. There, a *sense of community* is defined as members having four elements: a feeling of belonging; a feeling that they matter to one another and to the group, a shared faith that their needs will be met through their commitment to being together and a shared emotional connection.

Human Welfare: A majority of prior VSD research identified *human welfare* as a human value. In this study, human welfare refers to people's *physical* and *psychological well-being* (Friedman & Hendry, 2019).

Physical Well-being: HMDs fostering an immersive experience in MUVEs appeared on the consumer market. However, along with the positive effects of immersion, users experienced a discomfort known as motion sickness (or cybersickness) (Rangelova, Motus & André, 2019). Motion sickness symptoms can include headaches, eyestrain, nausea, dizziness, vertigo, pallor, sweating or disorientation and often occur during or after exposure to a VE (Rangelova, Motus & André, 2019). According to Jerald (2016), there are two types of motions sickness: visually induced motion sickness, which is caused by visual motion alone, and physically induced motion sickness, from physical motion. Differences between the two include how visually induced motion sickness can be stopped by solely closing the eyes, whereas physically induced motion sickness cannot, and how vomiting is less often induced by visual motion sickness than by physical motion sickness (Jerald (2016).

In addition to motion sickness, non-moving visual stimuli might also cause discomfort and adverse health effects such as accommodation-vergence conflict, binocular-occlusion conflict or 'flicker' (Jerald, 2016). Accommodation-vergence conflict occurs due to overriding the processes of vergence and accommodation by HMDs, which can result in eye fatigue and discomfort. On the other hand, binocular-occlusion conflict occurs when occlusion cues do not match binocular cues, for example when text is visible but appears at a distance behind a closer semi-transparent object (Jerald, 2016).

Psychological Well-Being: MUVEs may not only affect users' physical well-being; they might also affect the psychological well-being of users. According to Friedman & Kahn (2000), digital interactions have the potential to affect users' psychological and emotional states. A review of relevant literature by Jones et al. (2014) found that video games had numerous positive effects on

users, such as increased self-acceptance, increased feelings of competence and achievement, reduced stress, an opportunity to relax and socialise and boosted self-esteem. However, the study also found that excessive play or addiction could be harmful to users' psychological well-being (Jones et al. 2014).

***Identity*:** Just as several VSD researchers have recognised *identity* as an essential human value, so is it an important aspect of social interaction in MUVEs. In this study, identity is understood as 'people's understanding of who they are over time, time, embracing both continuity and discontinuity over time' (Friedman & Hendry, 2019). Whether through the use of avatars or usernames (pseudonyms), users value how they represent themselves in MUVEs. Schroeder's (2011) research found that avatars allow their users to maintain a consistent identity, and MUVEs should therefore allow users to design their own avatars and support linking information within VEs to names, avatars or groups of people.

***Privacy*:** The definition of *privacy* in this study is taken from VSD, where it is understood as the 'right of an individual to determine what information about himself or herself can be communicated to others' (Friedman & Hendry, 2019, p. 50). Whereas in the physical world objects do not easily report where they have been used, what they have been used for and who has used them, in the digital world they do, which sparks privacy concerns for users (Friedman & Kahn, 2000). Additionally, several critical issues concerning the privacy of indirect stakeholders arise from the use of MUVEs and social sharing within them, such as users revealing personal information about indirect stakeholders.

***Trust*:** From a research perspective, *trust* is a multifaceted construct and is very dependent on a studied context and situation. Schroeder (2011) argues that trust is an incredibly important issue for MUVEs because researchers can explore the types of relationships that people have online and compare them to their physical world relationships. Likewise, Friedman and Kahn (2000) argue that trust matters because it allows users to reveal vulnerable parts of themselves to others, as well as to allow users to know others intimately in return. Moreover, MUVEs support interactions which have the potential to leave some users vulnerable to the actions of others (Friedman & Kahn, 2000). Additionally, Sherblom et al. (2018) highlight that relational trust is built through verbal and nonverbal communication, where one person learns to trust another. This is no different from in-person trust-building except that in a MUVE it may take longer and require more effort from users. Schroeder (2011) argues that trust in MUVEs is a matter of having a consistent identity (concerned with usernames, avatar appearance and voice) and behaviour.

Trust plays a role in decision making, risk reduction, conflict and miscommunication minimisation, which enables knowledge sharing, adoption and the continued use of a system (Chang, & Macaulay, 2008). In this study, trust is defined as the 'expectations that exist between people who can experience goodwill, extend goodwill toward others, feel vulnerable, and experience betrayal' (Friedman & Hendry, 2019, p. 51).

***Universal Usability*:** *Universal usability* is an essential value because it takes into account people's full range of capabilities, then creates products and environments that are usable by all to the greatest extent possible (Hamraie, 2016). Horton and Quesenbery (2013) argue that this makes the technology invisible to users, helping them focus on their own activities and the

experience. In this study, the term refers to the degree to which all citizens can successfully use a MUVE.

4.1.3 SUMMARY

In summary, this conceptual investigation was comprised of a stakeholder analysis that firstly identified and described direct and indirect stakeholders impacted by MUVEs. Secondly, it reviewed VSD literature to provide essential insights into the eight human values that could be essential for social interaction in MUVEs (*Table 4*). Two of the human values, collaboration and universal usability, identified in this section were also identified as key MUVE characteristics in the Literature Review; therefore, going forward this study will solely classify these as human values.

Table 4. Summary of the identified human values

Value	**Definition**
Collaboration	"The act of working with another person or group of people to create or produce something" ("Oxford Learner's Dictionaries", 2020).
Community	Members having a feeling of belonging, a feeling that they matter to one another and to the group, a shared faith that their needs will be met through their commitment to being together and a shared emotional connection (McMillan & Chavis, 1986).
Human Welfare	People's physical and psychological well-being (Friedman & Hendry, 2019, p. 50).
Identity	"People's understanding of who they are over time, embracing both continuity and discontinuity over time" (Friedman & Hendry, 2019, p. 51).
Privacy	The 'right of an individual to determine what information about himself or herself can be communicated to others' (Friedman & Hendry, 2019, p. 50).
Trust	The "expectations that exist between people who can experience goodwill, extend goodwill toward others, feel vulnerable, and experience betrayal" (Friedman & Hendry, 2019, p. 51).
Universal usability	The degree to which all citizens can successfully use a MUVE.

4.2 EMPIRICAL AND TECHNICAL INVESTIGATION

4.2.1 VALUE ELICITATION

The value-oriented semi-structured interviews conducted in the empirical and technical investigation elicited a human value, namely *informed consent*, that had been overlooked in the conceptual investigation. Informed consent in this study refers "to garnering people's agreement, encompassing criteria of disclosure and comprehension (for 'informed') and voluntariness, competence, and agreement (for 'consent')" (Friedman & Hendry, 2019, p. 51). On the topic of privacy during the interviews, 11 (84.62%) direct stakeholders and all indirect stakeholders spoke about informed consent and its importance in MUVEs. Specifically, on the questions of user data or digital footprint in MUVEs, both 11 (84.62%) of the direct and 4 (80%) of the indirect stakeholder participants suggested that they would be more comfortable if term and conditions were simpler to understand so that they would know how data collected in MUVEs would be used. Direct stakeholders stated the following:

> *"I feel like transparency is the optimum word here ... Maybe condensed it in a way that people that aren't in the tech world can understand, maybe a few words that list text that people can read. I feel like it would be better if it was shorter and it was condensed more and if it used language that I understood because I'm not a lawyer."* - Participant 1

> *"Too much legal paper and it's too much reading for me just before I'm gonna enjoy the game. I'm not gonna read 300 pages of legal documents which I don't understand half of it. If there was a way for them to make that easier to understand, yes definitely, that's something that should be done"* - Participant 7

"They should make them shorter and easier to understand because I never read those things. I probably should, but I don't think I'd understand it anyway." - Participant 12

Indirect stakeholders, meanwhile, stated the following regarding terms and conditions:

"They're so long-winded and attention spans are very short these days; we need everything instantly. We need things to be clear and simple." - Participant 10

"It shouldn't be hard to understand what is going to happen with your information and where is it going to go; it definitely should be clear ... make it plain and simple. Them over-complicating something and no one bothering to read it because it doesn't make sense" - Participant 6

4.2.2 CHARACTERISTICS THAT SUPPORT HUMAN VALUES

4.2.2.1 CORRELATIONS

A correlation was run on the direct stakeholder respondents' data to identify the relationships between the variables, specifically the links between human values as well as between human values and key MUVE characteristics. Here, correlations were considered strong when $r \geq 0.5$; correlation was considered weak when $0.2 \leq r \leq 0.5$ and no correlation was found when $r \leq 0.2$. As illustrated in *Table 5*, three strong and four weak correlations were identified between the identified human values, suggesting relationships between them. Observing the strong correlation values in order of strength, the correlation coefficient revealed a strong relationship between the two variables of *human welfare*, namely, *physical well-being* and *psychological well-being*: $r_s=0.652$, $p<0.001$, $N=52$. The second strong correlation was between *collaboration* and *community*: $r_s=0.544$, $p<0.01$, $N=52$. The third was between *collaboration* and *trust*: $r_s=0.524$, $p<0.001$, $N=52$. With regard to weak correlations, this study observed that four were

between *universal usability* and *collaboration* (rs=0.383, p<0.01, N=52), *universal usability* and *community* (rs=0.373, p<0.05, N=52), *trust* and *community* (rs=0.373, p<0.01, N=52) and *trust* and *universal usability* (rs=0.298, p<0.01, N=52.)

On the other hand, this study found three strong and ten weak correlations between the identified human values and key MUVE characteristics. Observing the strong correlation values in order of strength, it can be seen that the correlation coefficient revealed a statistically strong relationship between *collaboration* and communication: rs=0.655, p<0.001, N=52. The second strong correlation was between *collaboration* and interactability: rs=0.509, p<0.01, N=52. Finally, the third strong correlation was between *community* and presence: rs=0.501, p<0.01, N=52. The eleven weak correlations were between the following pairs:

- *trust* and communication, rs=0.455, p<0.01, N=52;
- *community* and communication, rs=0.435, p<0.01, N=52;
- *community* and interactability, rs=0.397, p<0.001, N=52;
- *collaboration* and presence, rs=0.391, p<0.01, N=52;
- *physical* well-being and extensiveness, rs=0.387, p<0.01, N=52;
- *trust* and extensiveness, rs=0.369, p<0.01, N=52;
- *universal usability* and extensiveness, rs=0.367, p<0.01, N=52;
- *trust* and presence, rs=0.339, p<0.05, N=52;
- *universal usability* and communication, rs=0.307, p<0.05, N=52;
- *trust* and vividness, rs=0.288, p<0.05, N=52
- and *trust* and interactability, rs=0.274, p<0.05, N=52.

Table 5. Findings from Spearman's rho correlation coefficient.

	Immersion	Vividness	Presence	Copresence	Awareness	Communication	Extensiveness	*Collaboration*	Interactabity	*Community*	*Universal Usability*	*Psychological*	*Physical*
Vividness	0,128												
Presence	.383**	.459**											
Copresence	0,066	0,197	0,212										
Awareness	0.235	-0,067	0,012	0,213									
Communication	0,113	.403**	0,259	0,186	0,004								
Extensiveness	.320*	0,037	0,217	-0,061	0,229	0,116							
Collaboration	0,044	0,203	.391**	0,217	-0,101	.655***	0,159						
Interactabity	0,015	0.247	.387**	.328*	0,110	.471***	0,074	.509***					
Community	0,242	0,239	.501***	0,233	0,014	.435**	0,209	.544***	.397**				
Universal Usability	-0,009	-0,019	0,110	-0,041	0,220	.307*	.367**	.383**	0,220	.256*			
Psychological	0,212	-0,005	0,129	-0,203	0,073	-0,194	0,191	-0,235	-0,166	-0,002	-0,039		
Physical	0,201	-0,264	-0,071	-0,132	0,192	-0,082	.387**	-0,011	-0,228	0,044	0,081	.652***	
Trust	0,062	.288*	.339*	0,160	0,073	.455**	.369**	.524***	.274*	.373**	.298**	-0,189	-0,082

***. Correlation is significant at the 0.001 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Correlation between human values

Correlation between human values and key MUVE characteristics

4.2.2.2 VALUE-ORIENTED SEMI-STRUCTURED INTERVIEW

In addition to the findings from the correlation coefficients, participants in the value-oriented semi-structured interview also highlighted how human values are supported by the key characteristics as well as other values.

Collaboration: This study found that 9 (69.23%) of the direct stakeholder participants implied that the ability to communicate (through voice chat) enhances *collaboration*.

> *"I speak to them [other users] to try and work together"* - Participant 13

> *"When it comes to actually playing with friends or the game that requires teamwork or for you to tell someone what to do or how to do it, then definitely voice chat is a lot easier and a lot more effective as well"* - Participant 17

This may possibly explain the strong correlation between *collaboration* and communication ($r_s=0.655$, $p<0.001$, $N=52$) found in the quantitative analysis. Additionally, the strong correlation between *collaboration* and interactability ($r_s=0.509$, $p<0.01$, $N=52$) could possibly be explained by the qualitative analysis, as 11 (84.62%) of the direct stakeholder participants implied that interactability is a characteristic that enhances *collaboration*.

> *"I like games where you don't really need to trade items and hand items to each other, but they've added it in as a bonus, because it ends up being something a lot of fun to do."* - Participant 4

***Community*:** The qualitative results possibly explain the weak correlation between *community* and communication ($r_s= 0.435$, $p<0.01$, $N=52$) found in the quantitative analysis, as 10 (76.92%) of the direct stakeholder participants implied that the ability to communicate added to forming

and maintaining a sense of community in MUVEs. Additionally, 6 (46.16%) of the direct stakeholder participants stated that they use emotes (avatar animations) when initially communicating with strangers.

> *"Emotes allow you to interact with your team to build camaraderie around your team, which is very quick and simple as pushing a button. Most systems are so big you [have] probably got a hundred types of emotes that you can use."* - Participant 8

Psychological Well-Being: Both direct stakeholders (84.62%) and indirect stakeholders (80%) identified blocking and reporting as key characteristics that help prevent or minimise the adverse effects to *psychological well-being* presented by trolls and toxic individuals.

> *"Either you can switch off the chat, so you don't see what other people say to you, report them or you block them completely"* - Participant 4

However, some argued that in most MUVEs no action is taken when a toxic user is reported.

> *"Usually, action isn't taken immediately so there's not really much you can do except for report the behaviour"* - Participant 16

> *"I think there should be a line where certain infringement should be considered beyond the pale or too much"* - Participant 17

Some participants argued that it is in the MUVE creators' best interests to act on reported individuals as it impacts the experience of other users, as well as their trust in the system.

> *"If one person is negatively impacting the game for 20 other players [then] developers have a big chance of losing those 20 other players."* - Participant 2

Identity: Eleven (84.62%) direct stakeholders stated that the ability to customise avatars and vividness supports their expressions of *identity*.

> *"That Avatar is a representation of you, your character and your personality"* - Participant 4

> *"[With] character customisation and those kinds of features you can definitely make something that you want to be or you can do the complete opposite and create something that you think you already are."* - Participant 12

Participants also suggested that usernames or pseudonyms support *identity*.

> *"My username has always been _____ because I love sci-fi and I love cowboys and old western movies. That is an expression I really like. So whenever that username isn't available in whatever game, I have to find a way to try and find my identity; it is a big part of your identity"* - Participant 16

> *"You just get used to the names when you've been playing it for a while so sometimes [you] will just play a game and you'll see a couple of names that you [recognise] and you've seen before and then you don't necessarily know them, but you know it's not complete strangers"* - Participant 17

In addition to avatar customisation and usernames, one unanticipated finding was that 9 (69.23%) of the direct stakeholders suggested that avatar animations (emotes) were a key characteristic supporting *identity*.

"Emotes, that's basically how your character would dance, or your character would do something. For example, the way you would style your character gives you a sense of the type of personality [a] person [has]" - Participant 2

Trust: A possible explanation for the weak correlation between *trust* and *community* (r_s=0.373, $p<0.01$, N=52) observed in the quantitative analysis can be explained by the qualitative data. One possible explanation for this might be linked to how most direct (11 or 84.62%) and indirect (4 or 80%) stakeholder participants said they (or people they live with) only interact with friends and family (part of their *community*) in MUVEs.

"Pretty much all the people that I interact with online in terms of gaming are people that I know, so it first started as a [physical world] friend and then we started playing online together" - Participant 15

"In terms of multiplayer games, I think what's also important is who you play with, so I have a group of friends that play games, the guys that are around me we play games [to] have fun, my boyfriend plays games too. So, I think it's a quality of the company you have that makes it a lot more immersive and fun." - Participant 16

Regarding key characteristics that support *trust*, 9 (69.23%) of the direct stakeholders that had befriended strangers in MUVEs suggested that voice chat (communication) helped them. This possibly explains the correlation between *trust* and communication (r_s=0.455, $p<0.01$, N=52) observed in the quantitative data.

"I think the voice chat has a lot to do with that as well, that you [become] open to chatting in person over either Discord or the in-game chat; you slowly get to know them a lot better than when it's just text." - Participant 17

"I feel like because that person didn't speak, I still distrusted them" - Participant 4

***Universal Usability*:** Three participants even argued that extensiveness would support the value of *universal usability* in such a way that it would make MUVEs more accessible and easier to use. This might explain the correlation observed in the quantitative data between *universal usability* and extensiveness ($r_s=0.367$, $p<0.01$, $N=52$).

> *"I think headsets are the perfect thing for old age homes. I think that having like an elderly person who can't walk or is confined to a small space – they can put on a VR headset and be transported to Venice or Greece or somewhere in the world, and they actually can explore the area [which] will do wonders for their mental health."* - Participant 16

4.2.3 VALUE BENEFITS AND HARMS

Collaboration: This study found that 10 (76.92%) direct stakeholders suggested that the ability to collaborate with others was a critical human value in MUVEs.

> *'It's more cooperation: the ability to both enjoy the game and to benefit from each other's interaction.'* - Participant 7

Community: 11 (84.62%) of the direct stakeholder said they use MUVEs to spend time or catch up with friends and family.

> *"People I play with on a weekly basis are my best friends from school and other friends who have moved to the UK. A lot of the times playing the game we often catch up, and sometimes I don't necessarily feel like playing the game, but I want to hang out and catch up"* - Participant 15

> *"It's very much the same: sometimes you go to the pub with friends, other times you play games with them and drink or socialise at home."* - Participant 5

Similarly, all indirect stakeholder participants suggested that MUVEs can be used to spend time or catch up with friends and family.

> *"If you can play with your friends that are overseas ... it would be a good way to have some common ground and touch base."* - Participant 18

> *"It's actually been quite good for our kids to get to speak to some of their cousins or their friends that they don't necessarily get to see all the time, and they do talk while playing games together and they laugh, and they interact"* - Participant 4

Regarding befriending strangers or a *sense of community* with strangers in MUVEs, most direct stakeholders (7 participants or 53.85%) said they only interact with people they know in the physical world. On the other hand, some direct stakeholders (6 participants or 46.16%) equated it with speaking to and befriending strangers in the physical world, arguing that although it is initially intimidating, meaningful bonds can be formed that lead to a *sense of community*.

> *"With that community you're building those relationships [and] you're creating those friends; you're not logging in to play a game, you're logging in to spend time with that friend or that community that you're a part of."* - Participant 2

One participant spoke about how he had met up in person with MUVE friends years after they had all stopped using it:

> *"It was actually pretty cool, and we spoke about everything other than the game, and it was just like catching up, so it's people you haven't seen in years, but you've never*

spoken face-to-face, but we knew each other because we [had] spent hours and hours online talking and playing together." - Participant 4

Human Welfare: Both direct stakeholders (84.62%) and indirect stakeholders (100%) stated that they were concerned about adverse effects on children's *psychological well-being*, as they are particularly susceptible.

"With the younger person I feel like it's very addictive; they don't know where to draw the line ... My biggest takeaway is that it's not good for young children: the lack of self-control now is not going to help them in the future" - Participant 6

Another important finding was that both direct stakeholders (84.62%) and indirect stakeholders (80%) argued that the cause of the most harm to *psychological well-being* in MUVEs is trolls and toxic individuals.

"In terms of people being toxic online, 100%. If you go and play a game by yourself with strangers, online gaming communities are usually very toxic" - Participant 14

"I find, to be honest, [that] people are a lot worse online than they are in real life – they're a lot braver; they would never say the things they say online in person, I find, so it gives people, I called them keyboard warriors, the guts to suddenly be this person that they would never be offline." - Participant 16

Identity: The qualitative data of this study showed that all direct stakeholders viewed *identity* as an essential human value, whether expressed through their avatar, username or emotes. Eleven (84.62%) of the direct stakeholders spoke about how MUVEs allow them to express themselves in ways that are nearly impossible or at least challenging in the physical world.

"I get something called gender dysphoria. A few years ago, [it would get extremely bad], so basically what I would do is that I [would] get a brand called VTech, and you can put a torso on top of your current torso, and it has a flat chest, and then wear all sorts of clothes and whatever and basically have a flat chest. So, you can still be in your body, but you can have a flat chest. I find that that helped my mental health immensely! Because I can't as a human being wake up one day [and], you know, chop off my chest. You know you have to go to surgery; you have to do this whole thing, but it's instantaneous with Second Life." - Participant 1

Privacy: When answering interview questions about *privacy*, 9 (69.23%) of the direct stakeholder participants stated that they had not thought about their digital footprint and *privacy* in the context of MUVEs. Most direct stakeholder participants attributed this to the fact that they were not using their real names within the MUVEs, so their digital footprint was linked only to their avatars.

"I don't know what happens to that data; I've never thought of it, but [I] don't really think much about it." - Participant 9

"It's something that I'm aware of but not something that I worry about too much." - Participant 12

"On online banking and on social media I use my real my name, and when I'm in the game, I have an avatar and I have a display name [pseudonym], neither of which are me. It's not a picture of me and it's not my name, that's not to say that I have a different persona online – I'm just myself – but maybe I don't necessarily associate my information or the things that I say or do in these games as being so much me as I do in all those

other platforms because it's like a different environment: it's almost like a separate place from the real world." - Participant 14

However, all direct stakeholders stated that they had thought about and continue to have concerns about their payment methods and credit card information.

"In terms of actual games, I'm not really that fazed. I guess the only thing that I'd be concerned about is my payment methods and that kind of data. It better be secure; I don't want to be hacked" - Participant 16

Similarly, 3 (60%) of the indirect stakeholders, two of who were parents and one of who was married to a MUVE user, raised concerns about payment methods and credit card information.

"Once, we loaded our iTunes account and then we noticed that all the money was finished, so we had to put some controls on that." - Participant 5

Additionally, 4 (80%) of the indirect stakeholder participants raised concerns about young children not knowing what to share and what not to share online.

"He's able to change passwords [and] he's able to add information about himself without actually coming to ask for consent, so I do think there is work that still needs to be done in terms of maybe verifying especially for the younger age and protecting them." - Participant 5

Trust: Both stakeholder groups (12 or 92.30% of direct and 5 or 100% of indirect stakeholders) believed that MUVEs can effectively be used for social interaction but cannot replace physical world social interaction – that there should be a balance. Direct stakeholders stated:

> *"I wouldn't say I would choose playing games over going to a bar. I would definitely like both, but you definitely interact with your friends in the same way [online and offline]: you are going to laugh and have a good time. So there are similarities, but also I don't think you should only do the one; I think it's good to get out as well."* - Participant 17

> *"I find that there aren't any memories that are made in that kind of context [MUVEs]: everything is just kind of interchangeable. Those experiences are interchangeable, whereas experiences that you have with people in person very often aren't."* - Participant 14

Meanwhile, indirect stakeholders stated the following:

> *"Actually, having the social interaction you need to have a balance, and I kind of sway more towards actually being in person. Humans connect together; we need to be together in order to grow and be healthy mentally and emotionally, and games cannot duplicate that fully, in my opinion."* - Participant 6

Additionally, 11 (84.62%) of the direct stakeholders and 4 (80%) of the indirect stakeholders agreed that users must be cautious when using MUVEs. On a question about comparing trusting strangers in MUVEs to trusting them in the physical world, participants from both stakeholder groups suggested that it was easier to trust people in the physical world. Therefore, these results are consistent with the conceptual investigations in finding that trusting people in MUVEs takes longer than in the physical world.

"It's difficult to trust people in the game because you don't really know them, and sometimes when they are very helpful, they're just in-game creators that are trying to sell you stuff or get you to buy their stuff." - Participant 9

"I think if you meet someone in the real world, you can kind of [trust them]. If you see them face-to-face, you can kind of judge their character; it's a lot easier to do that in person than over a game" - Participant 12

"I think I would be inclined to trust someone that I've met in real life and I know in real life more. My perspective is just that it's very easy to hide things online about yourself, about your life, about lots of different things" - Participant 14

On the other hand, 9 (69.23%) of the direct stakeholders confirmed that they had befriended strangers in MUVEs, though in most cases (5 out of the 9) it was through a friend they knew in the physical world.

"I've met a few friends online through other friends. I've met two friends ... we started gaming together and we are actually really good friends now" - Participant 12

"It will take a little bit longer online to try and get to know someone than meeting them in person" - Participant 15

"I think it's the same ... as with people in the real world, you will first be cautious with people and then when you play together then you'll trust them." - Participant 9

Additionally, both stakeholder groups suggested that it was the users' responsibility to be cautious about the information they share with strangers on MUVEs.

"I feel the same way just as you do on social media: the more personal information that you give away, the more danger you can be in; you should trust as little as you do on social media. For example, my Steam profile, which has a program to play a lot of games, literally has my name and my location: it's a nickname and my location is South Africa and nothing else ... be as anonymous as possible" - Participant 4 (direct stakeholder)

"With that being said, I don't think you can go and trust a stranger on the street either" - Participant 18 (indirect stakeholder)

"I learned from my early days of social media that if you don't know the person, don't assume that's the person that they are online: the real person ... I would never consciously divulge personal information about my name, address or anything to somebody I've never personally met ... younger gamers are very naive; they tend to give way too much information, which means that there's generally not good education for younger players around information sharing" - Participant 8 (direct stakeholder)

"I think that comes down to teaching your children; I think parents need to be a bit more aware of what's going on" - Participant 17 (direct stakeholder)

Regarding younger users, 11 (84.62%) of the direct and all indirect stakeholders stated that they were concerned about children trusting strangers in MUVEs, which suggests that MUVE creators should put more effort into ensuring that children are not vulnerable to predators.

"I don't trust other gamers. I think anything that is open to a large network can be a potential draw for predators. So, I think it could be a tool for some people trying to prey on little kids. Sometimes I think that kids who spend time in these games are sometimes

lonely or they can have mental health issues, and if someone poses as your friend on these things, it can become dangerous." - Participant 5 (indirect stakeholder)

"I would not trust an eight-year-old to be safe on [any MUVE] because they might give out too much personal information, whereas if you can safeguard that, you might be able to interact equally as much as everyone else" - Participant 4 (direct stakeholder)

Universal Usability: Most of the participants from both stakeholder groups (9 or 69.23% of direct and 5 or 100% of indirect stakeholders) believed that MUVEs are easy to use. Direct stakeholders stated the following:

"I do think it's easy enough, but maybe that's where one of the key aspects of a good game is: that it's easy enough to pick up ... the basic controls, and the basic mechanics of the game need to be quite accessible. I think that this game gets it right." - Participant 3

Indirect stakeholders stated the following:

"I just think that it's another entity that would have to be set up, and if someone guided me through it to begin with, then I'd be fine." - Participant 10

However, some direct stakeholders suggested that performing some tasks such as using avatar animations (emotes) or avatar customisation might be complex for beginners.

"It is definitely very clunky and it could be a lot more streamlined. I feel like it could be more streamlined and it shouldn't be so complicated." - Participant 1

"I think you have to start young because ... it's not very intuitive unless you are computer savvy from the [beginning]. I don't think an old person will be able to use it. I'd rather give them a console before a computer, that's for sure." - Participant 16

4.2.4 VALUE TENSIONS

***Trust vs Identity*:** From the qualitative data analysis, we can infer that there is a value tension between *trust* and *identity*. Since users can be anything or anyone in MUVEs, both direct and indirect stakeholders are concerned about predators. As discussed in the previous section, eleven (84.62%) of direct stakeholders deemed *identity* as an essential value, suggesting that expressing themselves through their avatars, usernames or emotes was essential; however, this is at odds with *trust* or the ability to trust others in MUVEs. All direct and indirect stakeholders suggested that it was more challenging to trust others in MUVEs when compared to the real world because of the aspect of anonymity.

> *"People [can] pretend to be someone they're not or they can be dishonest"* - Participant 16

In response to a question about whether MUVE users should be able to change their voice if they have a speech impediment or gender dysphoria, 10 (76.92%) of the direct and all indirect stakeholders suggested that it would be too dangerous, as predators might use it. Direct stakeholders stated the following:

> *"I think it would definitely be an issue of trust and possibly security because you wouldn't know who's talking ... on the other side, and as you say it could be a paedophile or a predator"* - Participant 7

> *"If you have children playing the game, one of those [predators] could start grooming your child [who is] playing together with them; that is not a good thing."* - Participant 4

> *"It would be very interesting if [it was] a safe space to experiment with gender norms and finding or expressing yourself in the way that you truly feel you are ... The internet, in*

> *general, can be a very scary and nefarious place, and I don't think that it would be any different in that kind of scenario. I think people would take advantage of whatever tools and means are available, and if that was available then I'm sure that it would be something that ... people will take advantage of"* - Participant 14

Indirect stakeholders stated the following:

> *"I don't know. I wouldn't trust someone like that – one of the paedophiles or someone that would come in and abduct you. You all talk or nobody talks; I would also be cautious."* - Participant 18

> *"Scammers – their job is to make you feel comfortable and lure you in to give them private information, and as I said trust can be gained so easily over the virtual world."* - Participant 11

However, most stakeholders stated voice manipulation would only work when used by familiar users (friends and family) in MUVEs.

***Identity vs Human Welfare*:** According to qualitative data analysis, we can infer that there is a value tension between *human welfare* and *identity*. Although MUVEs support *human welfare* in numerous ways discussed previously, this study identified that user anonymity makes it easy for ill-intentioned users to bully others or to display toxic behaviour.

> *"I find, to be honest, [that] people are a lot worse online than they are in real life – they're a lot braver; they would never say the things they say online in person, I find, so it gives people, I called [them] keyboard warriors, the guts to suddenly be this person that they would never be [offline]."* - Participant 16 (direct stakeholder)

> *"I think there's two sides to it. I think that people that are in the right headspace to be in there and [who] just want to be anonymous but ... want to have fun then I think it's fine [for them to be there], but I think if you're one of those kinds of dark people [then it is not].'* - Participant 10 (indirect stakeholder)

Both direct and stakeholders also suggested that because MUVEs allow users to be whoever they want, if they are depressed or suffer from anxiety, they might use it as a crutch and not get the necessary help they need in the physical world.

> *"People that use games as a form of [escapism] ... are probably in real life less emotive or less able to express themselves."* -Participant 8 (direct stakeholder)

> *"I think that it can maybe help that particular person [who] is so shy and so anxious, but it's not gonna help them if that becomes their whole life because their anxiety and they're lack of confidence – that's never going to go away ... that person is gaining a lot online but that person is going to be a social outcast and they'll never grow ... [if they don't get help in the physical world,] they [will] actually revert back to their anxious, vulnerable selves."* - Participant 10 (indirect stakeholder)

4.2.5 VALUE TENSIONS BETWEEN STAKEHOLDER GROUPS

Human Welfare: This study conducted an independent samples t-test to examine whether there was a significant difference in means between the direct and indirect stakeholder groups. As observable in *Table 6*, Levene's test of Equality of variance p-value (Sig.) shows that only two variables had a significance value smaller than 0.05: *psychological* (p=0,001) and *physical* (p=0,049) *well-being*. For these, the t-test for equal variances not assumed was necessary to use, while that for equal variances assumed could be assumed in all the other variables. The

significance values of the t-tests show that the only variables where the value was smaller than 0.05 were *psychological* (p= 0,000) and *physical* (p=0,000) *well-being*. These results suggest that there is a statistically significant difference between the mean scores of direct and indirect stakeholders.

Table 6. Findings from independent samples test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Psychological	Equal variances assumed	10,861	0,001	-4,052	76	0,000	-1,288	0,318	-1,922	-0,655
	Equal variances not assumed			-4,459	64,437	0,000	-1,288	0,289	-1,866	-0,711
Physical	Equal variances assumed	3,991	0,049	-6,019	76	0,000	-1,692	0,281	-2,252	-1,132
	Equal variances not assumed			-6,540	62,448	0,000	-1,692	0,259	-2,210	-1,175

Table 7. Findings from group statistics

Group Statistics

Human value	Stakeholder group	N	Mean	Std. Deviation	Std. Error Mean
Psychological	Direct	52	2,60	1,432	0,199
	Indirect	26	3,88	1,071	0,210
Physical	Direct	52	2,38	1,255	0,174
	Indirect	26	4,08	0,977	0,192

Regarding the question to direct and indirect stakeholders about MUVE usage having negative impacts on psychological and physical well-being, the data in *Table 7* shows that direct stakeholders had a low mean (2.60; 2.38) when compared to indirect stakeholders (3,88; 4,08), suggesting that the former had a significantly more positive perception of the use of MUVEs on their psychological and physical well-being. Once more, the qualitative data revealed possible explanations for the disparities between direct stakeholders and indirect stakeholders. All direct stakeholder participants stated that the positive effects on their psychological well-being outweighed the adverse effects. Most used MUVEs to destress and relax, stating the following:

> *"I think using MUVEs is more positive because it does contribute to a lot of my social interaction, and I really enjoy being online with friends, and I would say that positive outweighs the negative of it, or at least the negatives can be controlled"* - Participant 15

All indirect stakeholder participants agreed with the notion that there are positives, but they were more concerned about the adverse effects on their friends and family. One indirect stakeholder spoke about how his football teammate lost interest in the physical world sport, opting instead to build virtual structures with others in a popular MUVE.

> *"He stopped coming to training, and he wouldn't go to the gym with us; he was just indoors playing these games."* - Participant 11

Likewise, most direct stakeholders acknowledged that MUVEs are addictive.

> *"It's something that becomes addictive, and it's not that hard to pick up."* - Participant 3

A similar trend was observed with regards to physical well-being, whereby all indirect stakeholders expressed more concern around the adverse effects MUVEs might have on their friends' and families' physical well-being. In contrast, only 5 (38.46%) of the direct stakeholders

expressed concern about these adverse physical well-being effects, with one stating the following:

> *"I think it's not good because you're sitting on a chair looking at a screen for hours on end which I think is definitely a problem in this technological age, and I'm definitely a culprit of that."* - Participant 1

Community: This study raises the possibility that when direct stakeholders are using an MUVEs synchronous and cannot be paused it causes a value tension between stakeholder groups. Four (80%) of the indirect stakeholders suggested that because MUVEs are synchronous, they are unable to get immediate help or attention from direct stakeholders. Therefore, it can be argued that synchronous play, which plays a role in immersion and the online *community* and is deem essential by direct stakeholders, is at odds with the physical world *community* that indirect stakeholders value. Indirect stakeholder stakeholders stated the following:

> *"When I need help with something, I'm not able to get the help I need because you can't pause the games, which is a bit frustrating. That is the main reason why I'm not the biggest fan."* - Participant 6

> *"Sometimes when we ask our kids to stop playing so that we do something, they'll tell you that you can't pause."* - Participant 5

5 DISCUSSION

This chapter analyses the significant findings of this study, provides a list of design considerations for MUVE designers and developers, reviews the methods used, explains the limitations and provides input for possible further research. At a broader level, this study demonstrates how VSD can be applied to complex problems such as social interaction in MUVEs. The present study used the VSD tripartite methodology as well as several VSD techniques including stakeholder analysis, value-oriented semi-structured interviews and value-oriented coding. The previous section presented the key results by using an explanatory sequential mixed method. This method has enabled this study to understand stakeholders' views, behaviours, experiences, perceptions and attitudes regarding values when socially interacting in MUVEs. Results from all seven values identified in the conceptual investigation were analysed. Furthermore, the results revealed an unexpected new value as well as value tensions.

5.1 DESIGN CONSIDERATIONS

The results of the study provided insight into the impacts and implications of the human values identified. To develop MUVEs better suited for social interaction, based on the analysis of the collected data, this study proposes the following design considerations when implementing the following MUVE characteristics.

Communication: The ability to communicate is a vital characteristic within MUVEs, as it supports multiple values that resonate with direct stakeholders, as well as indirect stakeholders. Voice chat, in particular, supports the human values collaboration, community, identity and trust; however, it can also harm human welfare and create value tensions between trust and identity, as well as identity and human welfare. The ability to create private communication channels or

servers supports community while denying trolls and toxic users the ability to harass others or prey on minors. Furthermore, the ability to communicate with others using voice chat improves collaboration and helps unfamiliar users form bonds or trust each other. On the other hand, while the ability to manipulate or change one's voice might support human welfare in the case of a user who has gender dysphoria, it can also create distrust, as ill-intentioned users might use it for nefarious means.

In short, MUVE developers and designers should ensure users have access to voice chat in order to support the human values collaboration, community and trust. Moreover, to further support community and trust, the ability to create private voice channels should be enabled. However, MUVE developers and designers should also make it difficult for users to manipulate their voices, especially when speaking to strangers.

Avatars and usernames (pseudonyms): The ability for users to have control over how they represent themselves is critical as it gives them a sense of identity. Both direct and indirect stakeholders agree that avatar customisation is a core part of self-expression in MUVEs. Whether creating an identical digital version of one's perceived self or the complete opposite, avatar customisation supports the human values identity and human welfare. For users who suffer from gender dysphoria or anxiety in particular, the ability to customise and express themselves in a safe space can support psychological well-being.

Furthermore, how users move their avatar by use of avatar animations or emotes can support a sense of identity when used to express mood, to dance or to amuse others. Likewise, if needed depending on the MUVE, pseudonyms or usernames can allow users to maintain anonymity

while representing and expressing their sense of self. While avatars and pseudonyms enhance the sense of identity, they also create a value tension between identity and human welfare. As explored in the study, trolls, predators and toxic users can hide behind anonymity; therefore, it is essential to address allegations of predatory or toxic behaviour. In short, MUVE developers and designers should ensure users can customise their avatars and usernames. Additionally, avatar animations or emotes should be easy to access and use.

Interface, controls and extensiveness: As avatars play a central role in MUVEs, using them should be intuitive and seamless to support universal usability. Furthermore, the ability to move, animate or customise one's avatar should be straightforward because an uncluttered interface and simple controls support immersion. As reaction interactions happen in real time, users should have the ability to store and make readily available their favourite avatar animations or emotes. Extensiveness, in the form of HMDs and haptic controllers, should be available to users, as this improves universal usability. In short, MUVE developers and designers should ensure interfaces are simple and intuitive, and that VEs can be used with HMDs and haptic controllers.

Interactability: To enable successful collaboration, MUVE developers and designers should allow users to modify, create, give, receive, develop and submit custom content. Furthermore, users should know when others are nearby.

Personal data and digital footprint: Regarding users' personal data and their digital footprint within the MUVE, to ensure informed consent, legalities and terms and conditions should be fully disclosed such that they can be easily comprehended by users and impacted non-users. For users that are minors, informed consent should be obtained from their guardians. Furthermore,

users should have the ability to view all their stored data, as well as how it is being used, and also to have the ability to delete it from the system. In summary, privacy and trust in MUVEs can be supported by allowing users and impacted non-users to have informed consent about their data and the ability to be in full control of their data on the system.

Blocking and reporting: This study identified trolling, predatory and toxic behaviour as the chief harm to human welfare in MUVEs. Therefore, it is essential to develop systems and technologies that work to address allegations of predatory or toxic behaviour.

5.2 Answering the Research Questions

This study aimed to answer the following research questions:

1. What are the key characteristics that enable social interaction in MUVEs?
2. From a value sensitive design perspective, what human values are essential in MUVE social interaction?
3. What key MUVE characteristics support the human values that improve social interaction?
4. What are the human value benefits, harms and tensions associated with the use of MUVEs?
5. How can MUVE developers and designers incorporate characteristics that improve social interaction for users and impacted non-users using all access points?

To answer the first research question, this study conducted a review of current literature to investigate MUVE characteristics, as well as the features and technologies that support them.

This involved gathering and reviewing 102 MUVE and VR publications, which resulted in the identification of nine key MUVE characteristics: avatars, awareness, communication, copresence, extensiveness, immersion, interactability, presence and vividness.

Answering the second question consisted of producing findings from the conceptual investigations, coupled with the empirical and technical investigation, which identified eight human values essential to social interaction in MUVEs. The human values identified were collaboration, community, human welfare, identity, informed consent, privacy, trust and universal usability.

The empirical and technical investigation results described the value benefits, harms and tensions as well as how key MUVE characteristics support the human values. The value tensions identified in the data analysis include trust vs identity and identity vs human welfare, as well as tensions between stakeholder groups regarding the values of human welfare and community. Finally, the design considerations section offered measures to support human values in MUVEs and to address value tensions and harms.

5.3 LIMITATIONS

To the researcher's knowledge, this is the first study of human values in MUVEs; however, the data suggests that there is still much to be investigated. This is partly because the study had several limitations, consisting namely of sampling method, sample size, context and technology.

One of the drawbacks of this study was the use of convenience sampling, as it might have led to the recruitment of overrepresented subjects in the sample (Etikan, 2016). Participants for the

study were recruited mainly from the researcher's circle of acquaintances and their acquaintances. It remains unclear whether this affected the overrepresentation of people between the ages of 28 and 37, as the researcher falls within this age group. Therefore, other random sampling methods might have led to different views and insights.

Secondly, the sample size of this study was relatively small, consisting of 78 survey respondents and 18 interview participants. Hence, a larger sample size might have provided different views or insights.

Thirdly, another limitation of the present study naturally includes its inability to carry out a comprehensive technical investigation that examines the human values and key characteristics within a specific MUVE. Friedman and Hendry (2019, p59) argue that 'no one type of investigation is sufficient on its own; rather, all three investigation types are needed to inform and shape and reshape each other.' Accordingly, a comprehensive technical investigation would have enabled the researcher to examine all key characteristics in context, which might have provided more holistic results.

Finally, a more prolonged study incorporating more values-elicitation methods – such as value sketches, value scenarios, value dams, value-oriented mock-ups, prototypes, or envisioning cards – might have identified additional human values.

5.4 Future Research

While the study goes a reasonable distance toward revealing the complex values and value tensions, as well as how key characteristics support them, there are many avenues for further

research. VSD's motto is 'progress is not perfection', which is relevant to all aspects of the practice. This motto embraces the overarching perspective and strategy for navigating the challenges of addressing human values in technology. It is a reminder that achieving progress is a noble goal, even though perfection remains ever-fleeting (Friedman & Hendry, 2019).

Firstly, a follow-up survey with a larger sample size that pursues the trends identified in the empirical and technical investigation would be helpful to further investigate findings regarding a broader subset of society.

Secondly, in this study key characteristics such as copresence, extensiveness and interactability were not thoroughly examined. A comprehensive technical investigation within a specific MUVE would allow for detailed investigations into how all identified key characteristics support or harm human values in MUVEs. This thorough future investigation would also enable researchers to validate or nullify some of the study's current findings.

Finally, due to the complexity of human values in MUVEs, a more prolonged study that incorporates more VSD methods – such as value source analysis, value sketches, value dams, value-oriented mock-ups, prototypes or envisioning cards – could achieve a more accurate representation of human values, as well as a better understanding of stakeholder groups. Hence, future investigations are necessary to validate the kinds of conclusions that can be drawn from this study.

5.5 CONCLUSION

Despite the limitations, this study sheds valuable light on human values in MUVE social interaction. In summary, this study demonstrates how VSD can be applied to complex problems such as social interaction in MUVEs. Firstly, it identified nine key characteristics essential to social interaction within MUVEs: avatars, awareness, communication, copresence, extensiveness, immersion, interactability, presence and vividness. Then the study identified eight essential human values: collaboration, community, human welfare, identity, informed consent, privacy, trust and universal usability.

Through the use of the VSD tripartite theoretical framework, and methods such as stakeholder analysis, value-oriented interviews and value-oriented coding, thematic deductive data analysis and explanatory sequential mixed method this study revealed how characteristics, values and value tensions have differential effects on different stakeholder groups. The findings from these explorations suggest that there are four main value tensions, trust vs identity, identity vs human welfare, as well as tensions between stakeholder groups regarding the values of human welfare and community. Furthermore, broadly translated, the findings indicate that when creating MUVEs better suited for social interaction, it is advisable for developers and designers to ensure the following:

- that users have access to voice chat, as well as the ability to create private voice channels or servers;
- that it is difficult for users to manipulate their voices, especially when speaking to strangers;
- that users can customise their avatars and usernames;
- that emote and avatar animations are easy to access and use;

- that interfaces are simple and intuitive and that VEs can be used with HMDs and haptic controllers;
- that users know when others are near them within the MUVE;
- that users and impacted non-users have informed consent about their data as well as full control of their data within the MUVE
- and that systems and technologies are developed to promptly address allegations of predatory or toxic behaviour.

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7 APPENDIX

APPENDIX A: SURVEY

Introductory message:

We want to find out what people value in multiuser online games and virtual environments. This information will be used to suggest improvements to these systems that enhance how people socially interact with each other.

This survey is entirely anonymous, and we will not ask for any personal information. We realise how precious your time is. That is why we made sure this survey will only take less than 10 minutes. Thank you for your time and for agreeing to help us with this study, we really appreciate it.

Introductory questions:

1. Please select your gender: (multiple choice question and free text for other)

- Female
- Male
- Other _____

2. Please indicate your age group: (multiple choice question)

- 17 or less
- 18 - 27
- 28 - 37
- 38 - 47
- 48 - 57
- 58 - 67
- 68 or more

3. Please select the option below that applies to you (multiple choice question)

- I play (or have played) multiuser/multiplayer online games or environments bellow:

  Minecraft, Fortnite: Second Life Battle Royale, GTA Online, World of Warcraft, Don’t Starve Together, Apex Legends, PlayerUnknown's Battlegrounds, RuneScape, Planetside

2, Borderlands 3, Black Desert Online, Red Dead Redemption 2, Active Worlds or Rec Room.

- I live with a person who plays online multi-user/multi-player games

Thread 1: Direct Stakeholders - MUVE gamers/users

If respondents selected the first answer in question 3 they will be redirected the five-point Likert scale questions below (with one being 'strongly disagree' and five being 'strongly agree').

Human Value or Characteristic	**Question**
Immersion	I often lose track of time when I play/use the game/virtual environment.
Vividness	I prefer graphics that are life-like/realistic.
Presence	I often feel like I am part of the game/virtual environment.
Copresence	When using the game/virtual environment, I am always aware of the presence of other users near me (my avatar).
Awareness	When using the game/virtual environment, it is important to know if other users are near me (my avatar).
Communication	It is easy to communicate with other users/gamers.
Extensiveness	Wearing a head-mounted display will improve(s) social interaction with other users.
Collaboration	It is easy to create things or do activities with other users/gamers.
Interactivity	It is easy to interact with objects and elements in the game/virtual environment.
Community	I feel that I am part of a community within the game/virtual environment
Usability	I would imagine that most people would learn to use the online game/virtual environment I use very quickly.
Trust	The game/virtual environment I use is effective for social interaction.
	I believe other user/gamers have my best interests at heart.
	I feel that I must be cautious when using the game/virtual environment.
	It is not risky to use the game/virtual environment.
Privacy	The information I share on the game/virtual environment does not compromise the privacy of my close family, friends or people I live with.
Psychological Well-being	I believe that the use of the game/virtual environment could negatively affect my psychological well-being (resulting in addiction or other mental health issues).
Physical Well-being	I believe that the use of the game/virtual environment could negatively affect my physical well-being (resulting in motion sickness, muscle aches or other physical health issues).

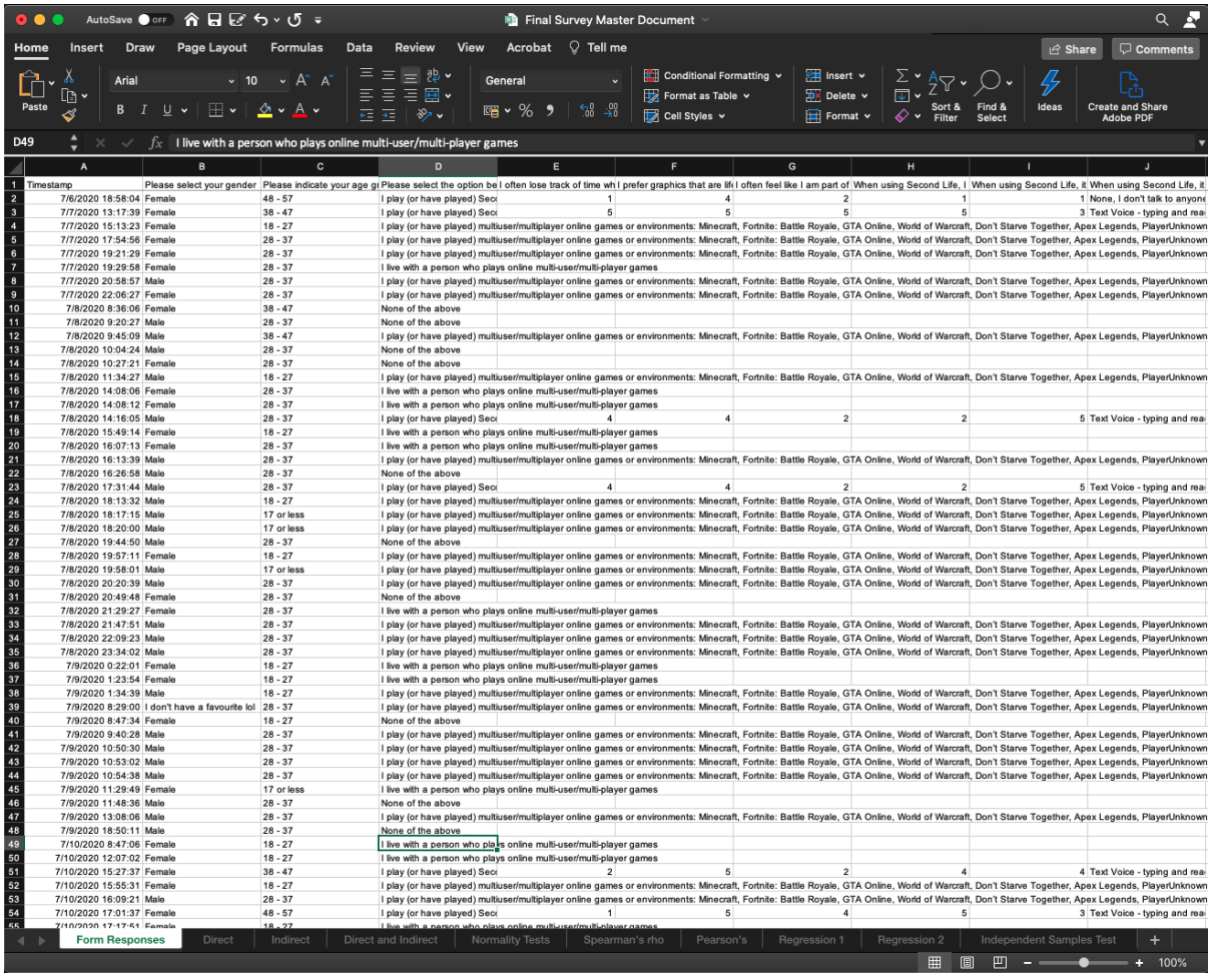
Thread 3: Indirect Stakeholders - People who live with MUVE users/gamers

If participants select the last two answers in question 3 they will be redirected the five-point Likert scale questions below (with one being 'strongly disagree' and five being 'strongly agree').

Community	People can find a sense of community in online multi-user games and virtual environments.

	Online multi-user gamers and virtual environment users focus more on building relationships online than in real life.
Usability	I would imagine that most people would learn to use the online game/virtual environment I use very quickly.
	I would imagine that most people would learn to use online multi-user games and virtual environments very quickly.
Trust	I believe that online multi-user games and virtual environments can be reliably used for social interaction.
	I believe online multi-user/virtual environment users and gamers have each other's best interests at heart.
	I feel that people who use online multi-user games and virtual environments should be cautious when using them.
	It is not risky to use online multi-user games and virtual environments.
Privacy	Information shared on online multi-user games and virtual environments is secure.
	The information shared on online multi-user games and virtual environments by my close family, friends or people I live with may compromise my privacy.
Psychological Well-being	The information shared on online multi-user games and virtual environments by my close family, friends or people I live with may compromise my privacy.
Physical Well-being	I believe that the use of online multi-user games and virtual environments could negatively affect people's physical well-being (resulting in motion sickness, muscle aches or other physical health issues).

APPENDIX B: SURVEY MASTER MICROSOFT EXCEL DOCUMENT



Final Survey Master Document

D49: I live with a person who plays online multi-user/multi-player games

	A	B	C	D	E	F	G	H	I	J
1	Timestamp	Please select your gender	Please indicate your age gi	Please select the option be	I often lose track of time wh	I prefer graphics that are life	I often feel like I am part of	When using Second Life, I	When using Second Life, it	When using Second Life, it
2	7/6/2020 18:58:04	Female	48 - 57	I play (or have played) Seco	1	4	2	1	1	None, I don't talk to anyone
3	7/7/2020 13:17:39	Female	38 - 47	I play (or have played) Seco	5	5	5	5	3	Text Voice - typing and rea
4	7/7/2020 15:13:23	Female	18 - 27	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
5	7/7/2020 17:54:56	Female	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
6	7/7/2020 19:21:29	Female	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
7	7/7/2020 19:29:58	Female	28 - 37	I live with a person who plays online multi-user/multi-player games						
8	7/7/2020 20:58:57	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
9	7/7/2020 22:06:27	Female	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
10	7/8/2020 8:36:06	Female	38 - 47	None of the above						
11	7/8/2020 9:20:27	Male	28 - 37	None of the above						
12	7/8/2020 9:45:09	Male	38 - 47	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
13	7/8/2020 10:04:24	Male	28 - 37	None of the above						
14	7/8/2020 10:27:21	Female	28 - 37	None of the above						
15	7/8/2020 11:34:27	Male	18 - 27	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
16	7/8/2020 14:08:06	Female	28 - 37	I live with a person who plays online multi-user/multi-player games						
17	7/8/2020 14:08:12	Female	28 - 37	I live with a person who plays online multi-user/multi-player games						
18	7/8/2020 14:16:05	Male	28 - 37	I play (or have played) Seco	4	4	2	2	5	Text Voice - typing and rea
19	7/8/2020 15:49:14	Female	18 - 27	I live with a person who plays online multi-user/multi-player games						
20	7/8/2020 16:07:13	Female	28 - 37	I live with a person who plays online multi-user/multi-player games						
21	7/8/2020 16:13:39	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
22	7/8/2020 16:26:58	Male	28 - 37	None of the above						
23	7/8/2020 17:31:44	Male	28 - 37	I play (or have played) Seco	4	4	2	2	5	Text Voice - typing and rea
24	7/8/2020 18:13:32	Male	18 - 27	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
25	7/8/2020 18:17:15	Male	17 or less	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
26	7/8/2020 18:20:00	Male	17 or less	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
27	7/8/2020 19:44:50	Male	28 - 37	None of the above						
28	7/8/2020 19:57:11	Female	18 - 27	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
29	7/8/2020 19:58:01	Male	17 or less	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
30	7/8/2020 20:20:39	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
31	7/8/2020 20:49:48	Female	28 - 37	None of the above						
32	7/8/2020 21:29:27	Female	28 - 37	I live with a person who plays online multi-user/multi-player games						
33	7/8/2020 21:47:51	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
34	7/8/2020 22:09:23	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
35	7/8/2020 23:34:02	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
36	7/9/2020 0:22:01	Female	18 - 27	I live with a person who plays online multi-user/multi-player games						
37	7/9/2020 1:23:54	Female	18 - 27	I live with a person who plays online multi-user/multi-player games						
38	7/9/2020 1:34:39	Male	18 - 27	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
39	7/9/2020 8:29:00	I don't have a favourite lol	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
40	7/9/2020 8:47:34	Female	18 - 27	None of the above						
41	7/9/2020 9:40:28	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
42	7/9/2020 10:50:30	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
43	7/9/2020 10:53:02	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
44	7/9/2020 10:54:38	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
45	7/9/2020 11:29:49	Female	17 or less	I live with a person who plays online multi-user/multi-player games						
46	7/9/2020 11:48:36	Male	28 - 37	None of the above						
47	7/9/2020 13:08:06	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
48	7/9/2020 18:50:11	Male	28 - 37	None of the above						
49	7/10/2020 8:47:06	Female	18 - 27	I live with a person who plays online multi-user/multi-player games						
50	7/10/2020 12:07:02	Female	18 - 27	I live with a person who plays online multi-user/multi-player games						
51	7/10/2020 15:27:37	Female	38 - 47	I play (or have played) Seco	2	5	2	4	4	Text Voice - typing and rea
52	7/10/2020 15:55:31	Female	18 - 27	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
53	7/10/2020 16:09:21	Male	28 - 37	I play (or have played) multiuser/multiplayer online games or environments: Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown						
54	7/10/2020 17:01:37	Female	48 - 57	I play (or have played) Seco	1	5	4	5	3	Text Voice - typing and rea
55	7/10/2020 17:17:51	Female	18 - 27	I live with a person who plays online multi-user/multi-player games						

Form Responses | Direct | Indirect | Direct and Indirect | Normality Tests | Spearman's rho | Pearson's | Regression 1 | Regression 2 | Independent Samples Test

100%

APPENDIX C: NORMALITY TESTS

Direct stakeholders:

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Immersion	.213	52	.000	.868	52	.000
Vividness	.234	52	.000	.829	52	.000
Presence	.202	52	.000	.896	52	.000
Copresence	.198	52	.000	.888	52	.000
Awareness	.253	52	.000	.801	52	.000
Communication	.239	52	.000	.820	52	.000
Extensiveness	.191	52	.000	.866	52	.000
Collaboration	.185	52	.000	.854	52	.000
Interactabity	.227	52	.000	.850	52	.000
Community	.190	52	.000	.869	52	.000
Universal Usability	.178	52	.000	.906	52	.001
Privacy	.326	52	.000	.767	52	.000
Psychological	.214	52	.000	.851	52	.000
Physical	.217	52	.000	.871	52	.000
Trust	.173	52	.001	.949	52	.027

a. Lilliefors Significance Correction

Indirect stakeholders:

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Community	.257	26	.000	.812	26	.000
Universal Usability	.290	26	.000	.859	26	.002
Privacy	.181	26	.028	.894	26	.011
Psychological	.274	26	.000	.845	26	.001
Physical	.251	26	.000	.824	26	.000
Trust	.161	26	.083	.939	26	.129

a. Lilliefors Significance Correction

APPENDIX D: VALUE-ORIENTED INTERVIEW QUESTIONS

During the interviews when asking the questions below, x and y were substituted with the human values and key MUVE characteristics.

Introductory questions:

What is it like to play/use a MUVEs? (Direct Stakeholders)

What is it like to live with an online multi-user gamer/virtual environment user? (Indirect Stakeholders)

How long have you been playing/using a MUVEs? (Direct Stakeholders)

How long have you lived with an online multi-user gamer/virtual environment user? (Indirect Stakeholders)

Contextual Laddering Questions:

What do you like most/best about x (the MUVE; interacting in the MUVE; being able to communicate in the MUVE; avatar animations; HMD functionality; graphics in the MUVE)

Why is this important to you / why do you value this?

What is special about this / how does this make you feel?

Value-Oriented leading questions:

Are you concerned about x in MUVEs

Why is this important to you / why do you value this?".

You mentioned x, please share a bit more about that.

When I asked you about y, mentioned x, please give an example of that.

I realised you mentioned x approximately 4 times, why is this so important to you?

And why is that so?

And why do you believe it is that way?

How did that make you feel and what changes would you like to see?

I heard you said x, can you describe what that was like for you?

APPENDIX E: RECRUITMENT LETTER TO POTENTIAL RESEARCH PARTICIPANTS

Dear Potential Participants:

My name is Mandla Shonhiwa, and I am a Master's student at the Cyprus University of Technology and Tallinn University in the Interaction Design Program. I am conducting research on social interaction values in online multi-user virtual environments.

The criteria for the study are:

Ages 16 and above

English-Speaking

Uses an online multi-user virtual environment

Such as Second Life, Minecraft, Fortnite: Battle Royale, GTA Online, World of Warcraft, Don't Starve Together, Apex Legends, PlayerUnknown's Battlegrounds, RuneScape, Planetside 2, Borderlands 3, Black Desert Online, Red Dead Redemption 2, Active Worlds or Rec Room

Lives with an online multi-user/multi-player gamer

If you meet these criteria, you are invited to express your participation. Please be aware that your participation in this research study is entirely voluntary, and you may discontinue at any time. There will be no consequences to you if you choose not to participate. My intention is to improve how people socially interact in online multi-user virtual environments, and this interview will help me better understand what people value and what challenges currently exist. In the research paper, all information from interviews will be kept anonymous. If you are interested in participating in this research study or need to get more information to make a decision to participate, please feel free to contact me at mandla@idmaster.eu

Sincerely,

Mandla Shonhiwa

Cyprus University of Technology and Tallinn University

APPENDIX F: CONSENT FORM

Hello, thank you for your time and for agreeing to help me with this interview. I really appreciate this.

First, I would like to introduce myself. My name is Mandla, and I will moderate this session.

I would like to give you a little outlook on what we're going to do in this session.

We are going to have a short interview, around 30 minutes, about social interaction in MUVEs, to help us find out what people value. This information will be used to suggest improvements to these systems that enhance how people socially interact with each other.

Do not worry, **there is no right or wrong answer**. We are trying to understand what people value, we won't be offended about any brutal feedback.

Please remember, you can abort the session at any time and without any reason.

Do you have any questions before we begin?

Before we proceed, if you agree and you would like to participate in this interview, please fill the consent form below:

Statement of Consent

I have read the above information and have received answers to any questions I asked. I consent to take part in this interview.

Your Name: _____ Date: _____

Your Signature _____

To make it easier for us to evaluate the session, we would like to record this session, if you are okay with that. The recording stays strictly internal and will only be used for the purpose of this research. If you agree, please fill the second consent form below.

Your name: _____ Date: _____

Your Signature _____

We will keep this consent form for at least three years beyond the end of the study.

APPENDIX G: CONFIDENTIALITY AGREEMENT

Name of Signer: Mandla Shonhiwa

During my activity in collecting data for this research: "Human Values in Multi-User Virtual Environments", I will have access to information, which is confidential and should not be disclosed. I acknowledge that the information must remain confidential, and that improper disclosure of confidential information can be damaging to the participant.

By signing this Confidentiality Agreement, I acknowledge and agree that:

I will not disclose or discuss any confidential information with others, including friends or family.

I will not in any way divulge, copy, release, sell, loan, alter any confidential information except as properly authorised.

I will not discuss confidential information where others can overhear the conversation. I understand that it is not acceptable to discuss confidential information, even if the participant's name is not used.

I will not make any unauthorised transmissions, inquiries, modification or purging of confidential information.

I understand that violation of this agreement will have legal implications.

Signing this document, I acknowledge that I have read the agreement, and I agree to comply with all the terms and conditions stated above.

Signature: _____ Date: _____

Thank you very much for your participation! Your feedback has been valuable to my research. I will eventually write a research paper about the conversations we have had with you and other research participants. In the paper, we would like to include anonymous quotations from some of the participants with attribution in the form of "Participant 01." Do you give me permission to use excerpts from this interview in this research paper? Is there anything that we discussed today which you would like me not to quote?

Thanks again!

APPENDIX H: THEMATIC ANALYSIS MASTER CODE MICROSOFT EXCEL DOCUMENT