PARTICIPATORY CO-PRODUCTION AND AUGMENTED REALITY FOR OCEAN HERITAGE: PRESERVING OCEAN KNOWLEDGE, CULTURE AND RELATIONSHIPS IN NAMIBIA

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PREFACE

I have always had a keen interest in culture and heritage. One key motivation for undertaking this research was my interest in learning more about my personal roots and cultural heritage, particularly the ocean's connection to it, evident in traditional jewellery such as *onyoka* created with seashells and oysters. I wanted to understand the ocean's role in traditional and customary practices and beliefs. Growing up, my friends and I often discussed how little we knew about our cultural heritage and the lack of avenues to learn about it. My master's degree in informatics focusing on information access and dissemination made me reflect on how I could learn more, share, and preserve my heritage using digital technologies to facilitate its continuity of use. This is how technology became one primary pillar of this research.

Coastal communities have long-standing Indigenous and experiential knowledge, as well as intricate relationships and connections with the ocean, which they depend on for their way of life. My research aims to surface ocean heritage and relationships and examine how they are formed, their significance, and contribution to way of life. I acknowledge my knowledge limitations regarding ocean heritage and relationships, and as a result, engaged with coastal community members who are referred to as co-researchers from two Namibian coastal towns, Swakopmund and Walvis Bay to understand their diverse ocean heritage and relationships. Throughout this research, I have been humbled by their warm welcome and eagerness to share. I was even more amazed by the strong relationships that formed between co-researchers as they connected over personal and collective ocean heritage and relationships and their expressed desire to share their knowledge with others with the hope they connect with the ocean or learn how to utilise ocean resources.

These interactions and bonds reflect the potential of Participatory Design (PD) and especially Ubuntu, which emphasises social relations, community interactions, and respecting the contributions of everyone engaged in research. Therefore, by virtue of Ubuntu and PD, I respected and acknowledged co-researchers' indigenous and experiential knowledge, and the intricate web of relationships through which ocean heritage is expressed.

In terms of my positionality, I am a young Namibian female researcher who has previously engaged with Namibian communities in similar contexts. This experience provided me with a broad understanding and familiarity with the research context, culture, customs, and effective ways to engage with Namibian communities. I also speak and understand four Namibian languages—English, Oshiwambo, Afrikaans, and intermediate Otjiherero—allowing for

efficient communication and engagement within the social and cultural context of this research and with the co-researchers. Additionally, my experience working with digital technology innovations facilitated the development of *Efuta Letu Sida Hurib*, the augmented reality (AR) application.

Adapting an approach similar to Winschiers-Theophilus et al. (2010; 2012), who conducted research with communities in a similar context, I employed PD as the overarching methodology because of its collaborative capabilities. Through PD methods, co-researchers were actively involved throughout the research and co-production of *Efuta Letu Sida Hirib*. This approach built trust and promoted empowerment and respect among co-researchers. PD also facilitated creative and visual practice, including photography, videography, role-playing, poems and letters to the ocean, shared objects and materials signifying ocean heritage and relationships, and the creation of 3D models and co-production of *Efuta Letu Sida Hirib*. Beyond the research workshops, co-researchers also conducted research, held conversations with elders to clarify information, and shared their ocean heritage, experiences, and expertise. These contributions shaped the direction of the research process. For that reason, co-researchers are integral to this research and hold ownership and decision-making power over *Efuta Letu Sida Hurib*.

This research addresses the gap concerning the diversity of Namibian ocean heritage and relationships, as well as concerns that culture, traditional practices, and knowledge in the context of Namibia are declining. Through the PD and co-production process of *Efuta Letu Sida Hurib*, this research facilitated the exploration of diverse and threatened ocean heritages, which are significant to coastal communities and promote wellbeing and way of life. This research further provides recommendations and design reflections for creating and using AR applications such as *Efuta Letu Sida Hurib* to support and preserve ocean heritage. It provides evidence to support future researchers in effectively conducting research that is cognisant of different and context-specific technological challenges. Insights into the perceptions and concepts of 3D model authenticity and value are provided, demonstrating that digital objects can also trigger and imbue the value/significance of original objects. In the broader Namibian context, this research findings serve as a bridge between stakeholders, communities and cultural heritage, and ocean institutions to promote multidisciplinary initiatives that facilitate heritage safeguarding and environmental sustainability.

I am grateful for how this research work progressed, and I look forward to continue collaborating with co-researchers to sustain, diversify, and enhance *Efuta Letu Sida Hirib's*

legacy by sharing it with more people and inviting them to contribute personal and collective ocean heritage and relationships. My aspiration is for diverse ocean heritage and relationships to be supported and safeguarded for intergenerational sharing and continuity of use.

It is my firm conviction that cultural heritage will always be a part of people and shape who they are. This research, therefore, intends to highlight the importance of heritage and the significance of safeguarding it. My hope for you, the reader, is that as you engage with this work, you too will reflect on the importance of ocean heritage or the relationships you have with the broader environment.

ABSTRACT

Human wellbeing depends significantly on our entanglement with the natural environment, including the ocean and its resources. The ocean is a space and place with which people often form intricate and diverse relationships encompassing values that extend beyond economic considerations and contribute to various non-material aspects of wellbeing, health and happiness. The ocean and the diversity of these values hold great importance for individuals and have been sustaining communities culturally, historically, spiritually, medically, and economically for centuries, highlighting the nuanced ways communities and cultures establish connections with the ocean.

With a particular focus on digital technologies, this research examined the significance of ocean heritage and the numerous ways coastal communities benefit from and relate to it. This research explored how the development of new digital approaches can surface and preserve diverse ocean knowledge, community and personal perspectives and values that underpin coastal life and are expressed through physical and intangible cultural heritage, histories, customs, identities, spirituality, art and traditional medicine. By investigating the role and use of immersive technologies with a focus on augmented reality and photogrammetry to support ocean heritage, the research found novel means to record and share ocean heritage in Namibia. The opportunities and challenges of augmented reality encountered during the co-production processes are discussed in the broader context of how this might ultimately help preserve knowledge and heritage of these ocean cultures in the long term through knowledge documentation and sharing.

The thesis reflects on existing collaborative theories and co-designed augmented reality technologies that support community development and cultural heritage. Adopting participatory design as the overarching methodology coupled with rapid ethnography, this research conducted focus group workshops and collaborated with coastal community members (referred to as co-researchers). Through the workshops, an augmented reality application titled *Efuta Letu Sida Hurib* translated as 'Our ocean, Our ocean' in Oshiwambo and Khoekhoegowab, was created with the aim to surface and preserve some aspects of the deep community knowledge of and relationships with the ocean.

This research highlights the importance of ocean heritage as shared by co-researchers. It emphasises the efficacy of collaborative research work and how it was employed to facilitate the co-production of *Efuta Letu Sida Hurib*.

DECLARATIONS

I, Marly Muudeni Samuel declare that the enclosed submission for the degree of *Doctor of Philosophy* consisting of a written thesis meets the regulations stated in the handbook for the mode of submission selected and approved by the Research Degrees Sub-Committee.

I declare that this submission is my own work and has not been submitted for any other academic award.

Signed:

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Date:

17/04/2025

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ABBREVIATIONS

2D	Two Dimensional
3D	Three Dimensional
App	Application
APK	Android Application Kit
AR	Augmented Reality
AT	Authors Translation
C#	C-sharp
CBCD	Community-Based Co-Design
CoP	Community/ies of Practice
CPU	Central Processing Unit
DRC	Democratic Resettlement Community
F	Female
GSA	Glasgow School of Art
GPU	Graphic Processing Unit
HMD	Head-Mounted Displays
HUD	Heads-Up Display
IDE	Integrated Development Environment
IK	Indigenous Knowledge
M	Male
MR	Mixed Reality
NHCN	National Heritage Council of Namibia
NYC	National Youth Council
OOH	One Ocean Hub

PD	Participatory Design
PDF	Portable Document Format
PIS	Participant Information Sheet
QCA	Qualitative Content Analysis
QR code	Quick Response Code
RFID	Radio Frequency Identification
RtD	Research through Design
SDK	Software Development Kit
SSM	Small-Scale Fishers
UKRI	United Kingdom Research and Innovation
UNAM	University of Namibia
UN	United Nations
UNDP	United Nations Development Project
UNESCO	United Nations Education, Culture and Science Organisation
VR	Virtual Reality
XR	Extended Reality
YoA	Years of Age

GLOSSARY: TERMS DEFINITIONS

.OBJ: Geometry Definition File Format, a prominent 3D model file format used in computer graphics and design.

!Nara plant: The research investigates and discusses the importance of the !Nara plant and its various uses. The !Nara plant, also known Acanthosicyos horridus is a melon that is Indigenous to the Namib desert (Cock, 2014; Kerby et al., 2022). It is usually referred to as Nara, butternuts, or butterpips in English, and !Naras or !Nara in Khoekoegowab, one of the Khoisan languages. The exclamation mark (!) is pronounced with a click consonant that is accentuated by smacking the tongue on the upper surface of the mouth. The significance of the !Nara plant is shared by the Topnaar ǂAonin co-researchers, who explain how !Nara plant links back to the ocean and it is important to their people and history.

Aawambo: Aawambo people, also called Ovawambo, are a Bantu ethnic tribe Indigenous to Southern Africa, situated primarily in Namibia.

Afrikaans: Southern African language evolved from Dutch brought to the Cape by Protestant settlers in the 17th century, and it is an official language of South Africa, which is also spoken in Namibia.

Augmented reality (AR): This research co-produced an AR application (*Efuta Letu Sida Hurib*) that supports, records and preserves ocean heritage and relationships. In this context, AR refers to an interactive experience that combines the real world with computer-generated content. Section 6.4.3 provides an explanation of *Efuta Letu Sida Hurib*.

Co-production: Refers to the development and deployment approach employed in this research, which involves co-researchers and the author collaborating to design, produce, test, evaluate and refine *Efuta Letu Sida Hurib*.

Co-researcher/s: Refers to participants who took part in this research. The term ‘co-researcher/s describes individuals who participated in this research and shared their experience to contribute to research and knowledge on a particular topic.

Digital Authenticity: Refers to the perceived value and significance of a digital object based on or compared to the original object it represents. Further discussed in Section 2.4.2 and 8.5.

Efuta Letu Sida Hurib: The name of the AR application chosen by co-researchers and translated as 'Our ocean, Our ocean' in Oshiwambo and Khoekhoegowab, two Namibian Indigenous languages. Please note that hereafter, the AR application co-produced with co-researchers is referred to by its name: *Efuta Letu Sida Hurib* (except in a few instances where the term AR has to be used for technology emphasis). The origin of the name is explained in Section 5.1.2.

Ehumokomesho: Literally translated as development.

Formal and informal communities: This research makes reference to formal and informal communities. Formal communities refer to urban developed locations in coastal towns, and informal communities refer to rural, underdeveloped, or low-income locations in coastal towns.

Global North: Refers to developed nations in the northern hemisphere (including Australia, Europe, Israel, New Zealand, Northern America, Japan and South Korea) that have relatively high income rates and GDP, with advanced technology, infrastructure, and political stability (Kowalski, 2021).

Global South: Refers to developing nations located predominantly in the southern hemisphere (including Africa, some countries in Asia, the Caribbean and Latin America), with a relatively low GDP and experiencing a variety of infrastructural challenges (Kowalski, 2021).

Khoekoegowab: A Namibian Indigenous language also known by the ethnic terms Nama, Damara, or Nama/Damara and formerly known as Hottentot.

Knowledge and cultural heritage digitalisation: Refers to using digital and technological mediums, for example AR, to capture, record and document knowledge and cultural heritage for the purpose of preserving them available for posterity and making them accessible to a wider audience.

KoOwambo: Regions in north-central Namibia (Oshana, Ohangwena, Omusati, and Oshikoto regions) and south-central Angola (Cunene Province) are mostly occupied by the Aawambo people.

Ocean heritage: The research investigates and discusses the importance of ocean knowledge, culture, and relationships for coastal communities. The umbrella term ocean heritage refers to complex relationships and expression of intangible, tangible, Indigenous and experiential ocean knowledge and culture, which are diverse and include values and connections that look

beyond economic considerations and contribute to various non-material aspects of wellbeing, including those that are economic, institutional, socio-legal, social (Allison et al., 2020), medicinal, spiritual, artistic, historical, psychological and physical.

Ocean Indigenous knowledge: Refers to Indigenous, traditional, and experiential ocean knowledge and beliefs that coastal communities have and use and that are valuable to their way of life, and have been passed down through generations by way of traditions, practices, word of mouth or experience (see also Bruchac (2014), to read about Indigenous and traditional knowledge).

Olukula: A mixture of lard and finely crushed pieces of the red root of the Transvaal Teak or red ochre. The root and ochre give the mixture a red/pink colour. Aawambo women apply this mixture on their skin and rub it onto traditional onyoka jewellery made with oysters and seashells (Gondwana Collection Namibia, 2011).

Omuthigululwakalo: Directly translated as cultural heritage.

Onyoka: Waist beads or necklaces made from oyster/seashells (now also created with glass beads), also known as onduwi or oshinyenye.

Oshiwambo: One of the Indigenous Bantu languages which is a dialect cluster spoken by the Ovawambo people in Angola and Northern Namibia, spoken by over half of the people in Namibia, particularly the Ovawambo people. There are twelve Oshiwambo dilects namely Oshindonga, Oshikwanyama, Oshingandjera, Oshikwambi, Oshikwaluudhi, Oshikolonkadhi, Oshimbandja, Oshimbalantu, Oshivale, Oshikwankwa, Oshikafima and Oshindombodhola of which the written standards are Oshikwanyama and Oshindonga dialects (Ndume, 2010; Mbenzi, 2019).

Participatory Design (PD): Refers to the overarching collaborative design methodology that informs the 'how' and guides the methods, approaches and procedures used in this research. It brings together users (coastal community members), designers (author), and stakeholders to share and gain knowledge, which is then used in the design and development process of products (AR app) to ensure that the final product aligns with the needs of users. PD also encompasses other collaborative principles and approaches, such as co-design and co-production.

Preservation: Refers to the preservation of ocean heritage through continuity of use and intergenerational sharing.

Respondent/s: Refers to local coastal community members, different from the co-researchers, who participated in the testing and evaluation demonstrative feedback sessions aimed at assessing respondent's user experience and satisfaction with the co-produced AR application.

Ubuntu: This research addresses the principle philosophy of Ubuntu. Ubuntu is a traditional African philosophy, derived from Zulu, a South African language. It highlights the interrelations and connectedness of all people and their mutual support and responsibility towards each other's wellbeing and it places emphasis on '*being self through others'* (Mugumbate and Andrew, 2013, p. 83). It is a form of humanism which is expressed as "*I am because we are*" or "*humanity towards others*" (Nicolaides, 2022, p. 1). Ubuntu is discussed in Chapter 2, Section 2.6.1.

Topnaar #Aonin: The Topnaar ǂAonin (meaning "*people living on the edge*") people are a clan of the Khoisan Nama people in Namibia.

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Cocooned in Harmony

The ocean, with its winds and tides,
waves and sands, breadth and depth,
power and grandeur, flow and ebbs,
histories and narratives, tranquillity and hostility,
shades of colours and vistas, vagaries,
and a host of other attributes,
provides the perfect example of the lived realities of the people,
the different phases of their lives.

The ocean reflects and mirrors what they go through daily.
Talking to the ocean then, is like pouring out your heart to a non-judgmental friend
who truly understands your situation.
They may not have the solution to your problem directly,
but you always feel better and lighter afterwards.

Eric Debrah Otchere, 2022

CHAPTER 1

INTRODUCTION AND RESEARCH BACKGROUND

Immersive technologies including augmented, mixed and virtual reality have been used to record, document and disseminate heritage narratives across the globe. They have been employed in various fields, including gaming, tourism, medicine, and education (Jacobs et al., 2022; Al-Ansi et al., 2023; Khan and Khan, 2024), and to provide a medium for creating augmented immersive learning experiences (Al-Ansi et al., 2023) across different disciplines and contexts. This research investigates the role and potential of immersive technologies, with a focus on augmented reality (AR) and photogrammetry, in surfacing, supporting and preserving intricate ocean heritage of Namibian coastal communities for posterity. The term preservation, used throughout this thesis, does not refer to archival preservation but to the role of engagement with co-researchers in surfacing ocean heritage (see Glossary for definition) and relationships and it encourages intergeneration sharing between the groups as a form of preservation through continuity of use. Furthermore, the author is aware that the research's digital output (*Efuta Letu Sida Hurib*) is also subject to archiving and preservation (see Section 3.4.2 for a description of how *Efuta Letu Sida Hurib* is digitally archived).

By utilising participatory engagement approaches, this research captures complex heritages, expressions, relationships and values of intangible and tangible ocean knowledge and culture. Allison et al. (2020) explain that these diverse values extend beyond economic considerations and contribute to various non-material aspects of wellbeing including those that are economic, institutional, socio-legal, social, medicinal, spiritual, artistic, historical, psychological and physical. These relationships and values are referred to as ocean heritage in this research. To better comprehend ocean heritage, this research examines diverse ocean relationships existing between co-researchers i.e., individuals who participated in this research (for a more precise definition, see the Glossary) and the ocean and seeks to understand how they are formed, their significance, and contribution to way of life. Collaborative efforts were established with coastal co-researchers to share individual perspectives on the importance of the ocean. During the research, co-researchers interacted with different immersive and digital technologies to explore how these tools facilitate heritage preservation in various contexts, with an emphasis on the benefits of co-producing AR digital applications that support knowledge and cultural heritage. As a part of the co-production methodology, co-researchers brought and shared ocean objects

and materials symbolising ocean heritage, which were modelled in 3D and embedded into a co-produced AR application titled *Efuta Letu Sida Hirub*.

Employing AR and 3D models to both capture and explain ocean heritage, harnessed AR's potential for preservation while also creating a platform for ocean heritage narratives to be shared and learned across different Namibian contexts (shared between co-researchers from Namibian coastal and inland communities). Moreover, *Efuta Letu Sida Hurib* created a platform for new ocean heritage and relationships to emerge. While this research and use of AR created possibilities for preservation and digital education, it similarly presented challenges such as technological inclusivity, access to infrastructure and digital literacy (see Section 2.3.1 for further reading about technology design and accessibility). Because this research investigated the potential of AR, the author notes that when working and developing AR applications, specific device requirements such as a computer with 16 gig RAM and an operating system of Core i5 or higher is needed. The application also has to be installed on mobile devices that meet specific ARCore requirements (see Section 6.3.3 for an explanation of device requirements). Depending on context, these requirements sometimes present challenges in terms of technological access and use. Consequently, this research explored different technological infrastructures and types of AR (see Section 6.2.1) suitable for use within this context and examined digital exclusion implications experienced as a result of employing AR.

This research further reflects on the methods used and how relationships with communities are best shaped. Collaborative relationships with communities are built over a period of time and through multiple engagements (Winschiers-Theophilus et al., 2010). Therefore, to fully understand the different relationships co-researchers have with the ocean, participatory design (PD) was employed as the overarching methodology, coupled with principles of rapid ethnography methods. To engage co-researchers, collect data and co-produce *Efuta Letu Sida Hurib*, focused group discussions and a questionnaire were utilised (see Sections 3.3 and 7.3).

1.1. Research Context

This research focuses on Namibia (see Figure 1.1.), a diverse coastal country in southwest Africa with a rich cultural heritage and one of the most productive coastlines next to the Namib desert that extends 1,570 kilometres (km) and 200 nautical miles westwards into the ocean (Robertson et al., 2012). The country is surrounded by the Kuiseb River in the west, the Kunene River in the north and the Orange River in the south. The country's ocean forms part of the

Benguela Current Large Marine Ecosystem (Benguela Current Large Marine Ecosystem, 1999) and has a nutrient-rich cold Benguela current that supports marine resources, and the fishing industry and economy (Robertson et al., 2012) that provides numerous resources and opportunities which have employed people in formal and informal sectors.

Figure 1.1: Namibia's location on the African Continent. Photograph: Shosholoza. Picture retrieved from https://creativecommons.org/licenses/by-sa/3.0/ (CC BY-SA 3.0).

There are four coastal towns found on the coast of Namibia, which are Henties Bay, Lüderitz, Swakopmund, and Walvis Bay. This research scope focuses on and collaborates with co-researchers from Swakopmund and Walvis Bay (see Figure 1.2) and collaborates with two Topnaar ǂAonin co-researchers who are originally from Utuseb (a Topnaar ǂAonin settlement close to the Kuiseb River and located about 40 kilometres from Walvis Bay) but reside in Walvis Bay. Archaeological data suggest that Walvis Bay was first inhabited by the Topnaar ǂAonin people in the early 1700s (Kinahan, 2017), who were later relocated into the desert. See Section 4.1. for a discussion about the history of the Topnaar ǂAonin people.

Figure 1.2: Map of Namibian. Photograph: Public domain (CC-O).

Namibian coastal communities have long-standing cultural connections to the ocean. They hold a variety of ocean Indigenous, traditional, and experiential knowledge that have been passed down and used for generations. These knowledge and experiences suggest that coastal communities have diverse relationships with the ocean that are intricately linked to various ocean related activities and beliefs that coastal communities heterogeneously practice and engage in. A detailed analysis of human relationships with the ocean was undertaken in this research to examine whether similar inputs and narratives would emerge in data shared by co-researchers. Allison et al. (2020, p. 2) describe ocean relationships as follows:

> *"The human relationship with the ocean is diverse and complex. It is built on values that are often non-monetary, and which contribute to non-material dimensions of wellbeing. These values are essential to broader human flourishing. They include contributions to cultural and social and legal identity; a sense of place; occupational pride and self-respect; spirituality; mental and bodily health; and human security. The plurality of these values and interests matters to individuals and societies..."*

Namibian coastal communities have relied on and connect with the ocean in different ways, which is consistent with Allison et al. (2020) findings. They are depended on it for food, to create traditional and customary jewellery and crafts, practice cultural and spiritual beliefs, to fish, connect with ancestors, remember history, for medicinal practices, identities, and for psychological and physical wellbeing. However, there is a research gap on the diversity of ocean heritage and relationships, how they are formed, and why they are important to Namibian coastal communities, and this research seeks to address this knowledge gap. This research provides evidence of how ocean heritage and relationships are formed and why they are important for Namibian coastal communities. Furthermore, coastal communities face challenges relating to ways in which ocean heritage is preserved for posterity, with some co-researchers emphasising that culture, in the context of Namibia, is declining because of limited cultural knowledge transmission and documentation (see Section 2.1.1. on knowledge and culture decline).

Moreover, communities are faced with the negative effects of ocean mismanagement and misuse, which add to challenges related to climate change, unsustainable fishing practices, pollution, and loss of marine habitat (Agarwala, 2022). These challenges affect the ocean's ecosystem, resulting in a decrease in fish numbers (Satumanatpan and Pollnac, 2020), which in turn affects communities relying on and living in close proximity to the ocean, particularly small-scale fishermen (see Sections 4.4 and 7.3.8 for discussion challenges faced by small-scale fishermen). The Organisation for Economic Co-operation and Development (OECD) (2016) emphasised that ocean governance is now challenged to develop reliable strategies that protect not only the climate and environment but also support economic advancement, improve the quality of life, and uphold principles of inclusivity, fairness, and justice (see also Parry, 2015; Cohen et al., 2019).

To unpack and understand the context and complex relationships that coastal communities have with the ocean, this research collaborated with 13 co-researchers who reside in formal (urban

part of town in close proximity to the ocean) and informal (rural/underdeveloped/low-income part of town far from the ocean) coastal neighbourhoods and have knowledge about the ocean, its benefits, and resources. This research notes that, despite the fact that all co-researchers reside in coastal towns, some have limited access to the coast and are unable to participate in ocean activities because of financial constraints and the geographical part of town they reside in. This challenge presents a barrier that results in the exclusion and disconnection of certain individuals from the ocean. Consequently, individuals from informal communities have limited opportunities to experience, engage, benefit from, and learn about ocean opportunities, resources, and activities. While the primary objective of this research was to surface, record and preserve ocean heritage using technology, co-researchers also wanted to establish a platform that shares and enables people to learn about the Namibian ocean and the different cultures and heritage related to it.

In early research work, Geertz provided insights into the concept of culture, and explained that culture is "*a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge about and attitudes toward life*" (1973, p. 89). This explanation highlights the importance of culture and heritage and how it enables people to attribute meaning and value to their lives, and this aligns with this research's focus on investigating and digitally documenting ocean Indigenous, cultural, traditional, and experiential connections that relate to co-researchers' way of life.

Since the 1990s digital technologies have been valuable in representing knowledge and cultural heritage within communities (see Section 2.2.2 for further discussion). In addition, it has created new platforms through which communities can learn from and about traditional practices. In a research study focused on knowledge documentation, Gallert et al. (2016) employed Wikipedia as a digital platform to preserve Indigenous knowledge of the Ovahimba people from Namibia. The aim of the study was to gather information from the Ovahimba people which at that point was not available in written format and thus remained undocumented. Gallert et al. (2016) argue that oral narratives are not different from written narratives and that both knowledge forms are reliable and verifiable and can easily be similar, ascertainable and viably documented on digital knowledge platforms such as Wikipedia. Consequently, this research acknowledges and respects the Indigenous and experiential ocean knowledge contributed by co-researchers, while employing AR as a digital tool to support and preserve said ocean heritages.

There is an importance to capturing and preserving cultural heritage and knowledge, but this research also notes that everyone or every culture is not open to sharing their knowledge, because some cultures believe that knowledge is sacred or might end up in the wrong hands (Kotut, 2021) (see Section 2.2.2). Another perspective to consider is that many civilisations have always documented and recorded their cultural heritage and knowledge in various ways, including through their names, music, dances, poems, and art. Consequently, this research acknowledges the importance of respecting, understanding, and learning about different ways in which knowledge was and is being documented and recorded, while also being mindful of what knowledge should and should not be shared or made accessible to external parties.

The Namibian National Heritage Council (NHC), which is the national administrative organisation responsible for safeguarding Namibia's natural and cultural assets, focuses on four main heritage categories: heritage artefacts, heritage sites, intangible cultural heritage, and world heritage (National Heritage Council of Namibia, 2004). In conjunction with the NHC's heritage categories, this research explores ocean heritage and the importance of preserving them. The NHC's suggests at least 180 Namibian historic heritage places and sites of significance. In terms of maritime tangible and intangible cultural heritage, this list only includes the Namib Sand Sea and the point where the ocean meets the desert in Skeleton Coast which is along the coastline of Namibia. However, there are some ocean related cultural heritages that hold significant value for coastal communities that are not on the list. For example, the poems and songs about the ocean sung by the Topnaar ǂAonin people or *onyoka* the Aawambo traditional jewellery made with seashells and oysters (see Section 4.2 for a discussion on Ocean Cultural and Historic relationships). Therefore, co-researcher's ocean heritage is investigated to understand and uncover nuanced and complex cultural or otherwise relationships with the ocean and how these relationships can be supported by digital technologies such as AR.

1.2. Research Questions

The research investigates the following overarching research question:

(1). How can AR support Namibian coastal communities in surfacing and preserving ocean heritage and relationships? In parallel with this overarching question, the following sub-questions are explored:

(2). What are the connections, relationships, and experiences that coastal communities have with the ocean? How are they formed, why are they important, and how can they re-engage communities with the ocean?
(3). What role does the ocean play in contributing to the wellbeing of coastal communities?
(4). In what ways does PD facilitate a digital co-production and learning process for coastal communities?

1.3. Research Objectives

The research questions informed the following research objectives, which in turn guided the research process:

⇒ Explore how PD practices can facilitate a co-production process and create a platform (physical and digital) for coastal communities to express and share unique ocean heritage and relationships.
⇒ Introduce and explain how digital technologies were used in different cultural contexts for heritage preservation, and create a platform for immersive and digital technologies education and engagement.
⇒ Use AR and 3D modelling technologies to surface, share and preserve Namibian coastal communities' diverse ocean heritage expressions and experiences that represent and communicate the importance of the ocean.

Guiding theories addressed to ground this research include African Ubuntu principles of interaction, which emphasise the significance of Indigenous heritage and promotes values of coexistence and harmony among African people (Ngubane and Makua, 2021). Production of significance, which highlights that community engagement and learning process throughout the research's co-production process is as important as the final product (*Efuta Letu Sida Hurib*) (Jeffrey et al., 2020). Communities of practice (CoP) which explores how communities pursuing a common objective collaborate with each other and create platforms that provide access to shared resources (Amery and Griffin, 2020). Place attachment refers to psychological, emotional and physical connections that develop between a human being and a physical environment (Lomas, Ayodeji and Brown, 2023). These theories are further discussed in Section 2.5.

The research additionally includes a number of photographs that visually represent the information being discussed. Unless otherwise specified, all photographs were taken by the author. This research also includes contributions that were originally shared in Oshiwambo,

one of the Namibian Indigenous languages and translated into English. With consent from co-researchers, the Oshiwambo contributions were shared with an Oshiwambo/English teacher who translated the data into English. The author, who is a native Oshiwambo speaker, further reviewed the translations to ensure that the information and messages shared were accurately translated and represented. The Topnaar ǂAonin co-researcher also shared and translated his Kheokhoegowab (a Namibian Indigenous language) contributions into English.

1.4. Research Benefits

The co-production process fostered a sense of ownership and commitment among co-researchers as they assumed agency during the research process and over *Efuta Letu Sida Hurib* itself. Knowledge exchange between the author and co-researchers was facilitated, with the author learning more about her own cultural traditions, customs, roots and identity through the process. Moreover, co-researchers were provided with a platform to share their opinions about digital technologies, different ways of utilising ocean resources, the importance of the ocean, and the research methods utilised. Workshop discussions facilitated conversations about the gap and impact of digital technologies on informal communities and developing countries, and its future in these contexts. The ocean contributions shared by co-researchers enabled the author to develop *Efuta Letu Sida Hurib's* interface, including its content and features and the role of co-production engagement encouraged ocean knowledge and heritage intergeneration sharing and continuity of use for co-researchers.

1.5. Ethical Considerations and Approach

When working with communities, especially those from low-income groups, ethical research methods must be carefully considered (Bracken-Roche et al., 2017). The purpose and objectives of this research were carefully explained to co-researchers to ensure that the research process was adequately communicated and that expectations were managed.

This research sought to establish and maintain a sustainable and trusting relationship between the author and co-researchers by adhering to ethical approaches that provided a foundation for equitable engagement, respect for contributions, cultural diversity and reporting back to co-researchers (Mirza, Bellalem and Mirza, 2023). These approaches guided and grounded the research process. To comply with the Namibian Government's research regulations and the Glasgow School of Art's (GSA) ethical considerations, the author secured a research permit (see Appendix 1: A-B) for every year that fieldwork was conducted. Moreover, as a Namibian citizen from the Aawambo tribe, who has previously worked with communities in similar

contexts, the author had an understanding and familiarity with the cultures, customs, and interactions with Namibian communities. The author also speaks and understands four Namibian languages - English, Oshiwambo, Afrikaans and intermediate Otjiherero - allowing for an efficient transition within the social and cultural context of the research and with the co-researchers.

Informed consent was exercised and co-researchers had the freedom to withdraw from the research at any stage. Participant information sheets (PIS) (see Appendix 1: C-D) that explained the research project, its objectives, duration, and potential benefits and risks were also provided. Confidentiality and the anonymity of co-researchers were considered. Co-researchers requested that their names and contributions be anonymised in this thesis and any other publications or presentations. Therefore, to comply with co-researchers' anonymity request, their names are also anonymized on the application screenshots shared in this thesis. However, with regard to *Efuta Letu Sida Hurib*, co-researchers requested that their contributions be credited and acknowledged. This request corresponds with Akuffo's (2023, p. 1) argument that sometimes "*participants with a personal stake refuse confidentiality when they want to be acknowledged for their data*" and work.

Throughout the research duration, co-researchers were continuously informed and updated about the research progress. A WhatsApp group was created for this purpose, which also fostered information sharing and communication about ocean heritage and activities between co-researchers and the author. Co-researchers were also informed of their ownership, use and distribution rights of *Efuta Letu Sida Hurib* and provided consent for *Efuta Letu Sida Hurib* to be shared for research purposes. Collected data was not used for any other reasons than those specified and agreed upon in advance with co-researchers. Furthermore, co-researchers were informed of the data protection protocols in place ensuring that the data collected during the workshops, as well as other contributions, are held on a secure GSA network, protected by passwords and other security mechanisms.

This research highlights that the presented findings (especially those talking about ways to use ocean resources for medicinal purposes) are personal views, opinions, beliefs, and contributions provided by co-researchers and should not be considered as recommendations from the author. The primary focus of this research is not to authenticate any claims shared by co-researchers. Instead, this research is interested in understanding the diverse ocean heritage and relationships coastal communities have and the role AR can play in preserving ocean

heritage in Namibian contexts. This research further notes that the examples used in this research come from the specific groups that engaged in the research and are not intended to be encyclopaedic.

1.6. Thesis Chapter Outline

Chapter 1: Introduction and Research Background

Chapter 1 provides an overview of the research context, background, and scope. It highlights the specific problem being addressed and outlines the research questions guiding this investigation. The chapter provides an overview of the research benefits and implications, and concludes with the ethical principles followed.

Chapter 2: Related Work

Chapter 2 explores previous literature to contextualise the approach and findings presented in this research. It incorporates relevant knowledge to address the primary and sub-research questions. The chapter further explores different theories that guide the research co-production process including Ubuntu values and principles, production of significance, communities of practice, and place attachment and biophilia.

Chapter 3: Research Methodology and Approach to Co-production Process

Chapter 3 explores the methodologies, research principles and design process employed in this research. It discusses PD as the overarching methodology, complimented by the principles of rapid ethnography. The chapter explains the research setting, engagement of co-researchers, data acquisition and analysis processes.

Chapter 4: Workshop Results: Exploring Ocean Heritage and Relationships

Chapter 4 draws upon empirical results obtained during fieldwork to analyse co-researcher's relationships with the ocean by way of the following thematic categories including cultural and historic; wellbeing; artistic; economic and livelihood; conservation relationships.

Chapter 5: Technology Exploration and Co-Production Results of *Efuta Letu Sida Hurib*

Chapter 5 investigates different digital technologies explored and outlines the development and design process including the functionality and content provided on *Efuta Letu Sida Hurib*. It includes and explores insights, ideas and suggestion provided by co-researchers regarding the importance of the ocean and explores objects/materials symbolising ocean heritage shared during the workshops.

Chapter 6: Technical Co-production Process and Development of *Efuta Letu Sida Hurib*

Chapter 6 explores the role of AR in supporting Namibian coastal communities to record and preserve ocean heritage and relationships for posterity. It explains the co-production phases, technological equipment and user requirements, 3D modelling and the development process of *Efuta Letu Sida Hurib*.

Chapter 7: Respondent Engagement and User Testing Sessions: *Efuta Letu Sida Hurib* Demonstration and Feedback Results

Chapter 7 analyses user experience and feedback with regard to *Efuta Letu Sida Hurib*. Information obtained from co-researchers and respondents at demonstrative sessions is examined.

Chapter 8: Conclusion

Chapter 8 reflects on the significance of diverse ocean knowledge, cultural practices and relationships. It discusses the potential of AR in supporting and preserving Namibian ocean heritage for posterity. It explores the importance, meaning, and relevance of the research, drawing on the contributions shared by co-researchers. The Chapter provides recommendations on the use of AR when collaborating with communities and proposes future research to advance inclusive immersive technologies.

CHAPTER 2

RELATED WORK

Chapter 2 explores previous literature to contextualise the findings presented in this research. It incorporates relevant knowledge pertaining to this research's primary and sub-research questions. This chapter examines literature relating to promoting knowledge practices, decolonising technology design and research practices, ocean relationships and connections, and participatory design (PD) with communities. The literature is investigated to support this research's grounding on collaborating with coastal community members to utilise technology and co-produce an AR application aimed to support, record, and preserve ocean heritage. The theoretical frameworks underpinning this research include Ubuntu values and practices, production of significance, community of practice, and place attachment and biophilia: human connections with nature. This research reflects on PD interventions and research studies undertaken with Namibian communities to contextualise empirical evidence and the co-production of *Efuta Letua Sida Hurib*.

2.1. Promoting Knowledge Practices

Knowledge is vital to human evolution, progress, and development. It educates and expands people's perspectives of the world, which promotes innovative and creative ideas, and empowers people, communities, and societies.

The concept of knowledge is part of an extensive history dating back to the origin of humanity. For millennia, knowledge studies using epistemological methods have served as a foundation and guide for prior and current understanding of ways of life and human activities such as history, innovation, customs, heritage, and science. Knowledge production and preservation have been, and are still, crucial to the evolution of civilisations. Everything human beings have come to learn is the result of direct knowledge acquired through first-hand experience or indirect knowledge acquired through input from others (Lockhart et al., 2015).

Knowledge in any contemporary form comprises a wide range of viewpoints that do not follow a narrow definition of scientific credibility or the demand of quantitative precision that applies very well in fields of physics, mathematics, or engineering (Naude, 2019). For example, in some culture's knowledge is passed down verbally, as well as through various intangible means such as songs, dance, paintings, stories, and names. The Namibian Twyfelfontein World Heritage Site, which is located in the northwest Kunene region, 90 kilometres west of Khorixas,

is an example of nonquantitative Indigenous knowledge. The site is home to some of the oldest rock paintings that were drawn by Khoisan hunter-gatherers as a way of teaching, preserving, and disseminating their practices and knowledge to their descendants. The site and its rock paintings illustrate knowledge of the Khoisan people's hunting methods, heritage, customs, way of life, and their history. Praise traditions practiced by the Ovaherero people of Namibia is another example of knowledge documentation. Kavari (2000, p. 20) describes praises as "*allusive, compact, socio-historical, genealogical, imaginative and eulogistic utterances which are believed to capture and evoke the essential qualities of the referent, and to identify it*". They are a form of communication serving as a source of pride, admiration and recognition, reflecting personal, social, cultural, and spiritual identity and values, expression of historical and ancestral facts, and enhances education by enriching contemporary knowledge and experiences and demonstrates artistic values (Kavari, 2000). Praises encourage relationships between the Ovaherero people and reinforce relationships with places and the past itself (Morgan, 2013). It is accounts such as these and many more that have preserved and made information and knowledge dissemination possible within the Namibian and broader African context, ensuring its availability to future generations.

By recognising the importance and variety of knowledge across different cultures, researchers and practitioners are able to appreciate different forms of knowledge and the ways in which it is produced and preserved. This viewpoint is reflected in the ocean knowledge shared by co-researchers and this research further recognises that knowledge generation and preservation are essential for humanity's evolution and wellbeing, and the continued development of civilisation.

2.1.1. Significance of Knowledge Documentation

With amplified awareness of sustainability and development, Indigenous knowledge documentation has gained prominence (Kotut and McCrickard, 2021) with various studies emphasising the importance of preservation, especially that of cultural heritage (see also Ul Abiden Malik et al., 2023).

While technology is frequently perceived as a potential threat to numerous cultural practices, it is important to recognise that various technological innovations have played a pivotal role in the identification, documentation, dissemination, education, and protection of intangible cultural heritage (Lu et al., 2019). Kotut and McCrickard (2021) note that researchers have been collaborating with communities to leverage technology to document Indigenous

knowledge for the purpose of preservation and their study recognised approaches that Indigenous communities took in safeguarding Indigenous Knowledge. Another study into heritage preservation conducted by Albourae et al. (2017) focused on multidisciplinary inventive cultural heritage informatics. The research used technology to digitally reconstruct, document, and protect cultural heritage knowledge related to the Al-Balad heritage site in Jeddah, Saudi Arabia. The project established an architectural database of Al-Balad, a historical heritage site of Jedda constructed in the early 15th century and recognised as a UNESCO World Heritage Centre in 2014. The project digitally recreated, preserved, and created a platform for people to interact with Al-Balad through an immersive setting employing Building Information Modelling (BIM). Unfortunately, due to rapid development and inadequate structural maintenance, the unique architectural tradition that emerged in Al-Balad was lost, resulting in the irreversible erosion of this heritage. As a result, the project digitally preserved the heritage site with the aim of providing tourists with accurate guidance and context information, as well as a more engaging historical experience of Al-Balad (Albourae et al., 2017).

Another study conducted by Stanley (2020) explored an appropriate development method of a crowdsourcing task management application as a tool for safeguarding Indigenous knowledge. The research collaborated with knowledge holders from the Ovahimba and Ovaherero Indigenous communities from Namibia and sought an opportunity for communities to make requests for their traditional objects to be converted into 3D models. The 3D models representing traditional objects were then imported into the HomeSteadCreator (see Rodil et al., 2012), an existing digital Indigenous knowledge visualisation tool, which the communities' knowledge holders utilised to educate younger generations about their cultural heritage, promoting intergenerational sharing and learning of significant Indigenous knowledge.

StoryBeads, a research project conducted by Smith et al. (2011), combined material artefacts with technology to record oral histories to safeguard Indigenous knowledge related to the beadwork of the BaNtwane people. The BaNtwane people are a small tribe residing in the north-eastern region of South Africa (Magubane and Klopper, 2001). The project documented the significance of beadwork in the community's native language (Dema) to ensure that the cultural importance of the practice was preserved for posterity. Similar to the preservation objectives of the current research, *Storybeads* developed eBeads and an input system referred to as StoryTeller. eBeads consists of a handmade bead embedded with a radio frequency identification (RFID), and the input system consisted of a laptop computer, speaker, microphone and an RFID reader. These devices were used by the BaNtwane to record, preserve

and share their stories. Smith et al. (2011) explained that preservation in customary African settings is achieved through people's recollections of tales and stories, and for that reason, this application was envisioned to address the challenges posed by community members living farther apart and participating less in traditional storytelling events.

Zaman, Kulathuramaiyer and Yeo (2011) inform us that Indigenous knowledge is primarily tacit, characterised by oral transmission and practical applicability. Indigenous communities have distinct methods for governing and conserving knowledge, passing it down through generations based on community ownership and power. Zaman, Kulathuramaiyer and Yeo (2011, p. 3) highlight that "*knowledge thus lives in the memory of the community as oral literature and the collective intelligence of the community is kept locked up implicitly within the community memory*". Kapepiso and Higgs (2020) similarly assert that in Africa, Indigenous knowledge is primarily transferred through oral methods from generation to generation. However, oral knowledge transfer within communities encounters challenges, particularly due to the migration of youth from rural to urban areas, which hinders knowledge transfer approaches and contributes to the decline of customary practices (Maasz et al., 2018). In certain cases, this decline may not be considered a matter of concern. In other instances, it can be perceived as the erosion of knowledge, culture and traditions.

There is an imperative to documenting and preserving Indigenous knowledge and cultural heritage. Hance (2015, p. 1) states that "*In one of the great tragedies of our age, indigenous traditions, stories, cultures and knowledge are winking out across the world. Whole languages and mythologies are vanishing, and in some cases, even entire indigenous groups are falling into extinction*". This decline can also be attributed to colonialism, globalisation and government policies that threaten relationships between Indigenous persons, communities and the environments they live in (Fernández-Llamazares et al., 2021). Communities and local people should therefore continue to appreciate, practice and value Indigenous knowledge as the foundation of their communities (Kaya and Seleti, 2013), while also understanding that documenting and preserving Indigenous traditions and knowledge for posterity, guarantees that the knowledge does not decline as elders depart from this world (Oyelude, 2023).

To ensure the continuity of Indigenous knowledge and cultural heritage, preservation measures should be considered through various safeguarding means, such as written methods, photography, audio, song, video, art and digital means. According to Owusu-Ansah and Mji, (2013, p. 5) "*indigenous African knowledge is vulnerable because many of the carriers of this*

knowledge are dying without the documentation of these knowledges. To preserve such knowledges, a new path must be charted and a paradigm shift is imperative". Creating digital knowledge recording systems and applications can be especially beneficial for documenting and providing access to cultural knowledge (that is appropriate, with permission, for general dissemination) (Smith et al., 2011). However, an important question arises: is the use of digital technologies an effective way to record and preserve knowledge and culture? This leads to questions of digital equity: do communities have access to information and technology infrastructure needed to digitally document heritage? This question is investigated in this research.

While knowledge recording and preservation are important for averting the decline of Indigenous knowledge, traditions, and cultural customs, this research emphasises that certain knowledge is not appropriate or accepted for sharing (see also Stanley, 2020). Some knowledge is learned or passed on to people because they have a right to it, but in other circumstances, knowledge is transmitted only to specific persons in a family or community. What can be known or shared, who can know it or receive it, why it is shared, and how it is shared are all highly mediated. For instance, knowledge from specific members of the community, such as a medicine man, is not allowed to be shared with just anybody.

Campbell, Thorlakson and Braund-Allen (2017) also explain that some Indigenous people consider their knowledge to be sacred or belonging to an elder, and they will not share it irrationally. In other cases, cultural vulnerabilities or barriers may prevent individuals from sharing Indigenous knowledge. As a demonstration of knowledge that is proprietary and openly divulged, Campbell, Thorlakson and Braund-Allen (2017, p. 102) note, "*the location of sacred sites, images of the dead, or the preparation method for a traditional medicine may be things people do not wish to reveal*". Knowledge holders or community members may also abstain from sharing knowledge if they believe the knowledge may be abused, misused, or treated disrespectfully (Campbell, Thorlakson and Braund-Allen, 2017).

As researchers, it is important to understand and respect knowledge holders' decisions not to share knowledge, and also be able to distinguish between knowledge that is and that which is not appropriate for transmission. To discern, understand and respect the nature of knowledge that is appropriate for sharing (knowledge and findings included in this research), this research collaborated and consulted with coastal co-researchers. Through this process, the author

learned from co-researchers, obtaining knowledge about diverse relationships that people have with the ocean.

While this research emphasises the importance of recording knowledge, it also recognises that communities usually have structures and organisations that guide the use and transmission of traditional and Indigenous knowledge. It is unknown whether these structures exist within participating coastal communities because this research did not encounter any such restrictions. When asked if there were any cultural restrictions that govern the right to sharing the knowledge they contributed, co-researchers stated that there were none and that there is an imperative to share ocean knowledge for posterity.

Knowledge is enhanced when knowledge is shared and individuals learn from one another through various experiences, perspectives, and expertise or when they collaboratively work on solutions. Hendriks (1999) agrees that knowledge can be enhanced by sharing it; however, knowledge sharing can also be damaging to knowledge, as retainers of the knowledge may use it inappropriately, disrespect or misrepresent it, and when acquired knowledge benefits certain individuals at the expense of the original knowledge holders. An example of this is the utilisation of Indigenous medicinal knowledge from the San tribes situated in Southern Africa. The San people, who are classified as Indigenous communities, possess a wealth of Indigenous knowledge, and they are acknowledged for their expertise in the domain of traditional and Indigenous medicinal knowledge, particularly concerning the Hoodia plant. Throughout the years, this knowledge has been orally conveyed to researchers and subsequently disseminated to various institutions, leading to its utilisation, and in some cases without informing or compensating these communities from which the knowledge was originally sourced (Kapepiso and Higgs, 2020). This research thus asks, what are some of the factors that contributed to the exploitation of knowledge? In response, Kapepiso and Riggs (2020, p. 1) explain that:

> *"oral transmission format is not accommodated by Intellectual Property regimes such as copyright and patent law, making it vulnerable to exploitation by research institutions and pharmaceutical and biotechnology companies who have sought to capitalise on this freely-available knowledge in what is known as biopiracy and bio-prospecting.*"

Because, in previous years, Indigenous knowledge was not protected through scientific or legal means, this led to unethical use, transmission and exploitation of this knowledge. It not only perpetuated injustices but also compromised the economic wellbeing of Indigenous

communities, as most of them did not benefit from the proceeds of their knowledge being used or commercialised. Numerous Indigenous communities were also not in agreement with how their knowledge was used as Varadarajan (1989, p. 372) explains:

> "*many indigenous and local communities object to the way their communally developed agricultural strains, folklore, and traditional medicines-their "traditional knowledge"-serve as free building blocks for the patents and copyrights of outsiders, often without any recognition, compensation, or control over the way this information is used*"

In recent years, various African countries have taken initiative to implement systems and policies aiming to acknowledge, safeguard, support, develop, and protect Indigenous knowledge. The Gadaa system in Ethiopia (Jima, 2022), the Protection of Traditional Knowledge and Cultural Expressions Act 2016 in Kenya (National Council for Law Reporting, 2016) and the Indigenous knowledge system in South Africa (Department of Science & Technology, 2004). In this aspect, Namibia does not have a formal Indigenous knowledge system or legislation. However, Namibia adopted the Nagoya Protocol on Access and Benefit-Sharing in 2014, with the goal of increasing the economic and social advantages of genetic resources for Namibian producers and traditional knowledge holders (Nakanyete, Matengu and Revilla Diez, 2023). Additionally, in 2023, the Namibian Government began measures to develop an Indigenous Knowledge Systems Policy to protect and acknowledge the value and significance of Indigenous knowledge (Weidlich, 2023).

2.1.2. Knowledge Production Practices

Participatory collaboration initiatives have advanced knowledge production practices by enabling stakeholders and knowledge holders to manage, update or create novel solutions to address challenges (Strand, Rivers and Snow, 2022). This process is referred to as knowledge co-production. According to Norström et al. (2020, p. 183) knowledge co-production is an "*iterative and collaborative processes involving diverse types of expertise, knowledge and actors to produce context-specific knowledge and pathways towards a sustainable future.*". Co-production processes promote cooperation in the creation of knowledge for development within arenas such as government, business, and civil society (Schneider et al., 2021). Furthermore, this approach promotes inclusive knowledge exchange and learning that addresses fundamental power imbalances in academic research (Schneider et al., 2021; Strand, Rivers and Snow, 2022) .

Co-production processes facilitate appropriate responses to societal challenges by adopting inclusive and self-reflective approaches and recognises opportunities it provides, such as shared learning and collaborative problem-solving (Howarth et al., 2022). In knowledge co-production, learning extends beyond the creation of new ideas and encompasses a broader spectrum benefits, including cultural transformation, shifts in values, methods of respect, appreciation, and a deepened recognition of each partner's contributions (Visman et al., 2018). It also brings different people and institutions together, as well as their different customs and perspectives on how things are understood and done (Osuteye et al., 2019). This approach recognises that communities possess significant knowledge and expertise, and their meaningful participation not only strengthens the quality and practicality of research outputs, but also provides the potential to define and develop practices and solutions that directly affect communities' lives. Thus, for inclusivity and to maintain ethical standards and guidelines for information management and scientific honesty (see Dilger, Pels and Sleeboom-Faulkner, 2019), this research employed participatory design methods while engaging with coastal co-researchers.

2.2. Ocean Relationships and Connections

The ocean has consistently been a captivating place for human beings, triggering different emotions, experiences, histories, beliefs, connections, inspiration, and values. The complex connections between people and the ocean are rooted in both practical and emotional aspects that transcend beyond the physical bounds of coastal communities, encompassing identity, culture, knowledge, spirituality, and wellbeing. There is a need to understand the significance of these relationships, given that they highlight the ocean's value for society and emphasise the urgency of sustainable conservation. This research surfaced intricate personal and community relationships that exist between the ocean and co-researchers, using collaborative approaches.

Allison et al. (2020) explain that there is not a single universal human connection with the ocean that applies to everyone. Different people from around the globe find themselves with diverse socio-economic, systemic, social, historical, and cultural connections with the sea. Each individual possesses distinct interests, viewpoints, encounters, economic considerations, emotional attachments, and cultural and social associations with different aspects of the ocean. These diverse connections were revealed during knowledge exchange workshops, as co-researchers discussed and shared why and how the ocean is important to them (see Chapter 4 for the different ocean relationships shared by co-researchers). Therefore, in order to preserve the ocean's role in promoting the wellbeing of humanity through both tangible and intangible

benefits, it is imperative to build a sustainable ocean economy that considers and is inclusive of the range of diverse relationships and values.

Throughout history, people have used the ocean and its surrounding bodies of water for a variety of reasons such as "*navigation, migration, fishing, trading, pleasure and seeking solace, spiritual enlightenment, adventure, material enrichment, social identity, cultural expression, artistic inspiration or good health*" (Allison et al., 2020, p. 3). These reasons indicate that human interactions, connections, and conservation efforts with the ocean are connected to people's cultural, spiritual, emotional, psychological, and physical attributes. Gee et al. (2017) assert that cultural values provide people with a sense of place and a feeling of identity, which are frequently linked to wellbeing and quality of life. In addition to being a place and symbol of history, peace, ancestry, harmony, fascination, creativity, and transcendence, the ocean also plays a key role in defining and maintaining different cultures and customs (Gee et al., 2017; Strand, Rivers and Snow, 2022). The role of the ocean concerning cultural, spiritual, and traditional customs was also revealed in this research (see Chapters 4 and 7 for further discussion on ocean heritage and relationships).

2.2.1. Understanding the Limitations of Namibian Ocean Heritage and Relationships

In their study focusing on the different relationships people have with the ocean, Allison et al. (2020) emphasise that coastal communities have intricate ocean relationships and connections that contribute significantly to wellbeing and way of life. These relationships differ depending on context. Lim, Ito, and Matsuda (2023, p. 1) conducted research centred on understanding the ocean relationships of the Ama or Amasan women/men divers "*who use rapid diving techniques without using scuba gear or compressed air*", solely relying on traditional diving approaches and local knowledge. Additionally, Strand et al. (2022) investigated ways in which ocean knowledge, connections, and values of Indigenous and local communities from Algoa Bay, South Africa, can be integrated into ocean management approaches. These studies provide important inputs into existing ocean relationships, why they are important to coastal communities, and how they contribute to livelihoods. However, though these existing literatures explore various ocean relationships in different countries, there remains a gap in surfacing and understanding the diverse ocean relationships of Namibian coastal communities. As such, this research investigates the diverse relationships that Namibian coastal communities have with the ocean.

This research takes a step further to address concerns that culture, traditional practices, and knowledge in the context of Namibia are declining and investigates how digital technologies with a focus on augmented reality can support and preserve Namibian ocean heritage and relationships. Koiki- Owoyele, Alabi, and Egbunu (2020) explored safeguarding measures of Africa's cultural heritage through digital preservation. Similarly, extensive research on safeguarding Indigenous knowledge and cultural heritage has been conducted in the context of Namibia by researchers including Winschiers-Theophilus et al. (2010, 2020), Bidwell (2014), Kapuire et al. (2016), Stanley (2020), and Muashekele et al. (2023, 2024). These studies provide meaningful insights into the importance of safeguarding heritage using technology through collaborative means. The author learns from these studies and their approaches and seeks to investigate and surface diverse Namibian ocean heritage and intricate relationships, including but not limited to historical, cultural, customary, spiritual, medicinal, food sustenance, economic gain, and psychological and physical wellbeing. The author collaborated with coastal co-researchers from Swakopmund and Walvis Bay to better understand personal and collective ocean heritage and relationships, why they are important, and how they contribute to their livelihoods. The findings of this research are based on co-researchers' shared ocean-lived experiences, which contribute to context specific knowledge to the study of ocean relationships.

2.2.2. Ocean Experiences, Knowledge, Culture, and Relationships

Cultural identities and expressions of the oceans are numerous and diverse, comprising tangible and intangible connections. Many cultures regard the ocean as a source of life, healing, spirituality, and ancestor's homes, with their beliefs and practices reflecting this (Strand, Rivers and Snow, 2022). Tangible and intangible connections to the ocean are also reflected in cultural expressions such as music, art, storytelling, and other forms of heritage that have been preserved over time (Henderson, 2019). In the South African context, for example, the ocean is important to many Nguni communities and customs since it is the dwelling place of their ancestors. Many individuals from Eastern Cape Nguni communities believe that being near bodies of water, including rivers, lakes or the ocean, brings you nearer to God and the ancestors (Bernard, 2010), and individuals frequently pray and meditate close to these locations.

The ocean is also important to the millions of coastal inhabitants of the Philippines archipelago, who are dependent on the oceans as a source of livelihood, food security, and sociocultural wellbeing (Satizábal et al., 2020). Another example in evidence is a death ritual practiced by surfers from Australia and Hawaii who have a long history of taking part in the paddle-out

ceremony, which is considered to be a surfing funeral. During a paddle-out, surfing groups from many locations come together to remember and share memories about a member of the surf line-up who has passed away. It is regarded as an ocean based funeral ceremony, where the departed are metaphorically and materially placed in the ocean through cremains, and bid farewell through physical ritual gestures. Many Ghanaian communities along the coastline also engage in collaborative fishing practices. While chanting and singing traditional ocean songs, they harvest fish from the ocean using a variety of traditional knowledge, methods, and resources, including wooden canoes and nets (Otchere, 2019; Amadu, Armah and Aheto, 2021). Their collaborative fishing practices demonstrate the fundamentals of Ubuntu principles, which are discussed later in Section 2.5.1.

In the context of Namibia, this research collaborated with coastal women who engage in the practice of collecting seashells. Armed with buckets, they scour the coastal beaches at low tide, meticulously selecting seashells and mussels that have washed ashore to create Aawambo traditional jewellery known as *onyoka* (the significance of *onyoka* is further discussed in Section 4.1.1), as well as other ornaments such as waist belts adorned with seashells (Figures 2.1 and 2.2). These jewellery and ornaments are created using traditional and Indigenous knowledge that has been passed down through generations. Shigwedha (2004) asserts that they are typically worn during important traditional rituals, cultural gatherings, and ceremonies, emphasising the significance of the ocean to these traditions and practices.

Figure 2.1 (a-b): Oshiwambo traditional waist adornment and belt made with seashells. Photograph a: Maria Kauhondamwa, 2020. Photograph b: Marly Muudeni Samuel, 2021.

Figure 2.2 (a-b): Onyoka - Oshiwambo traditional jewellery, created with seashells and adorned with African wood beads. Photograph: Marly Muudeni Samuel, 2022.

The ocean is also important in traditional medicine and healing practices (Proulx et al., 2021). For example, ocean resources such as seaweed and seal oil are used in traditional medicinal procedures due to their therapeutic benefits. In his research work, Fortuine (2011) revealed that treating wounds with seal oil was standard practice among some traditional Alaskan Indigenous cultures. Traditional healers in Moroccan communities have also employed seaweed for its "*nutraceutical benefits for a healthy lifestyle*" (Seghiri and Essamri, 2019, p. 3). Likewise, some co-researchers shared that they use seaweed and seal oil for healing purposes and apply it to treat ear infections, head sores, and burns (see Section 4.2 for further discussion). The ocean is also thought to have powerful healing abilities (Charlier and Chaineux, 2009; Zeien, 2012) for the soul, both psychologically and physically, and it is recognised as a space for people to restore wellbeing and health regardless of religion, custom, or cultural history (Strand, Rivers and Snow, 2022).

The ocean has consistently played an invaluable role in shaping human cultures across the world. One of the co-researchers reiterates that the ocean is a provider, protector and sustainer and this opinion is further asserted by Earle:

> "*The sea shapes the character of this planet, governs weather and climate, stabilises moisture that falls back on the land, replenishing Earth's fresh water to rivers, lakes, streams—and us. Every breath we take is possible because of the life-filled life-giving sea; oxygen is generated there, carbon dioxide absorbed. Both in terms of the sheer mass of living things and genetic diversity, that's where the action is. Rain forests and other terrestrial systems are important too, of course, but without the living ocean there would be no life on land. Most of Earth's living space, the biosphere, is ocean—about 97 per cent*" (Earle, 1996, p. 52).

Given that the ocean is connect to multiple aspects of humanity, it indicates just how important it is to humanity. The sea has inspired ocean stories, folklore, history, and artistic expressions that have become important for human identities and relationships. However, cultural values and relationships associated with the coastal places and the ocean are frequently disregarded and neglected in settlement-based ocean management methods (Gee et al., 2017; Saunders et al., 2020; Strand, Rivers and Snow, 2022). This is frequently attributed to the difficulties of conceptualising and capturing the intangible character of these relationships (Gee et al., 2017), further emphasising the importance of participatory methodologies and alternative approaches to surfacing, communicating and preserving traditional ocean knowledge and customs beyond the spoken and written word.

2.2.3. Safeguarding Knowledge and Culture Heritage

The concept of heritage is contextually broad, embodying numerous distinctions and defined differently based on the conceptions of individuals, communities, cultures, and countries. It encompasses authentic and inauthentic (Hall, 2007), tangible or intangible, and cultural or natural (Lowenthal, 2005) forms of heritage.

Namibia is home to a diversity of ethnicities rich with cultural heritage, as well as natural heritage sites. There are two examples in relation to heritage sites. The first is the Namib sand sea, where the Atlantic Ocean meets the desert (UNESCSO, 2013). The second is the /Ui-//aes Twyfelfontein heritage site that holds the largest collections of rock paintings done by the early hunters and gatherers (also known as the San people) on the African continent (UNESCSO, 2007). These long-standing sites are part of, and are integral to, the Namibian people and their cultural heritage, traditions, and practices.

Additionally, some Namibian communities have strong ocean cultures, histories, and beliefs. Some believe that when visiting an ocean town, they must wash their faces or feet in the ocean as a way of showing homage and respect to the ocean for it to welcome you into the town (see Figure 2.3). Others believe that the ocean possesses immense healing powers and when they are sick, they go to wash themselves in the ocean (Charlier and Chaineux, 2009). Individuals also believe that the ocean has spiritual powers and they collect ocean water to keep or sprinkle around their houses, believing that it will shun bad spirits and bad luck. The ocean is also thought to have a way into people's soul, and can calm and relax them. As a result, people go to the beach when they are having a bad day or are unhappy, and the ocean helps them feel better.

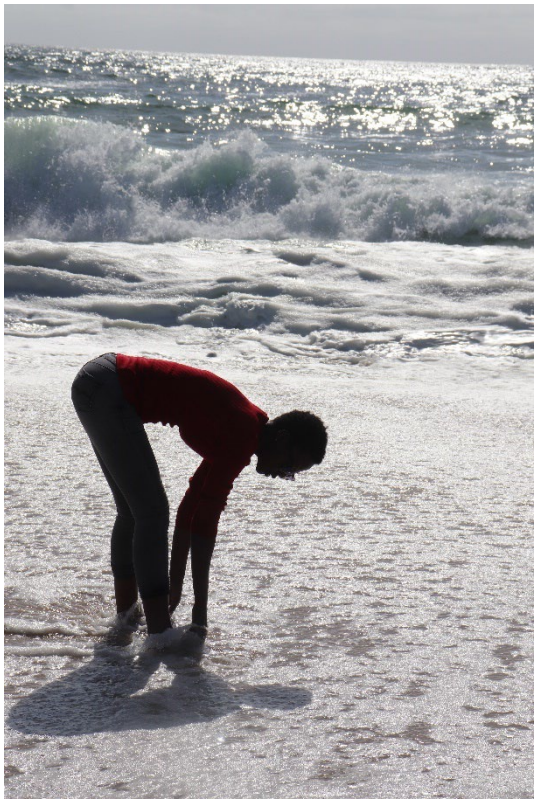


Figure 2.3: Practice of washing feet in the ocean water to pay homage to the ocean. Photograph: Marly Muudeni Samuel, 2021

The Topnaar ǂAonin people of Namibia who were the first recorded dwellers to have settled in Walvis Bay along the Kuisib river in the early 1700s (Kinahan, 2017), also hold intricate ocean connections. Today, their descendants describe cultural practices that were followed in the past by their ancestors to protect and live sustainably through the ocean. To date, when sitting around a fire with family members, the Topnaar ǂAonin elders share stories of these practices and their old ways of living (for a film about the Topnaar ocean people, see Stevenson and Lindstrom, 2023).

2.3. Decolonising Research Practices

The concept of decolonisation aims to confront and eliminate persistent power disparities and structures based on colonial ideologies that perpetuate injustice and exclusion. Hayward et al. (2021, p. 5) described decolonising research as "*a process whereby Eurocentric views and methods are decentred and dismantled, thus, Indigenizing research can be viewed as a centring and strengthening of Indigenous views and methods.*" Scholars further argue that decolonising research methods prioritises Indigenous perspectives and epistemologies, while purposefully challenging colonial conventions (Smith, 1999; Simonds and Christopher, 2013; Hayward et al., 2021). Thus, decolonising research practices allow us to recognise the agency, knowledge,

and lived experiences of communities, especially those in the Global South, empowering them to reclaim and rewrite their narratives. These historically oppressed, and frequently marginalised communities, have endured the adverse effects of colonialism, resulting in knowledge misappropriation, loss of land and culture, resources and economic exploitation and socio-racial discrimination (Garcia-Olp, 2018; Domínguez and Luoma, 2020; Oyelude, 2023; Smye et al., 2023).

In an effort to recognise and include Indigenous knowledge, research studies have been focusing more and more on decolonising academic and research practices (Smith, 1999; Keikelame and Swartz, 2019; Hayward et al., 2021; Lipscombe et al., 2021; Kennedy et al., 2022). The vast majority of Indigenous knowledge has continuously been established and passed down verbally from one generation to the next and through socialisation norms (Mapedza et al., 2022). Despite some of these knowledge not having been documented or validated as scientific knowledge, according to Global North scientific accreditation standards, Indigenous knowledge sharing and socialisation norms enabled the transmission and applicability of knowledge and continuation of cultural traditions and practices.

This research adopts the definition of Indigenous knowledge given by Ncube (2022, p. 239) that "*Indigenous knowledge is an extensive and valuable knowledge system that is adaptable, a dynamic system based on skills, abilities, and problem-solving techniques that change over time depending on environmental conditions*". It is expertise, skill, and know how rather than institutionalised formal knowledge. It includes traditional and moral knowledge and practices, which are embraced by individuals throughout their daily lives and manifested through a variety of ways including storytelling, anecdotes, attitudes, traditions, beliefs, customs, music, dance, feasts, ceremonies, crafts, and culture (Dampney, Busch and Richards, 2007; Oyelude, 2023).

The ocean similarly plays a role in Indigenous knowledge systems around the world, particularly in terms of the utilisation of marine resources. Pérez-Lloréns et al. (2023) note that the Khoikhoi and San people of South Africa use seaweed as herbal medicine to treat various ailments (see Section 4.2) This is an example of a practice that has been followed by people as a result of acquired Indigenous knowledge rather than learned scientific knowledge. Similarly, co-researchers explained that some people from coastal communities possess knowledge and engage in the practice of healing using marine resources such as seal oil and

seaweed, as discussed in Sections 2.2.1 and 4.4. These knowledge and practices have been passed down through generations and are still being enacted to date.

However, a distinct epistemological reality with strict validation standards created by theories of Western imperialism and knowledge hierarchies comes into play when the legitimacy of Indigenous knowledge is questioned. These Western paradigms that have long determined the basis of that which constitutes scientific and academic knowledge, are exclusive, restrictive, and dismiss the credibility of different sources and knowledge. In agreement with Naude (2019), this research argues that the practices by which knowledge is 'validated' must embrace decolonisation because the approach of assessing knowledge using predominantly Western criteria has the potential to exclude knowledge that is regarded as the 'other' (see Saïd, 1978; Porter, 1994; Turner, 2004 for a discussion about orientalism and the 'other'). Therefore, ocean heritage and knowledge expressions of co-researchers are recognised as important and insightful in this research. Though not formally documented to constitute scientific or academic knowledge, these expressions, particularly those passed down through generations, highlight the significance of Indigenous knowledge practices and the role they play for coastal and broader Namibian communities' way of life.

Mbembe (2015) argues that for knowledge to be universal, it must also be plural. Academic institutions must therefore pursue decolonisation by acknowledging and including Indigenous forms of knowledge and ways of knowing. In order to make research interventions contextually appropriate and durable, practitioners should explore, value, respect and utilise Indigenous knowledge, perspectives, and methods equally to Western paradigms (Datta, 2018). This strategy abandons a top-down, Western-centric model in favour of a more inclusive and equitable approach when collaborating with Indigenous communities. Researchers can prioritise the lived experiences of community members in order to support and promote mutual learning and cultural integrity. Acknowledging, and challenging power dynamics can encourage just and equitable participation, resulting in more substantial results for both researchers and engaged communities. Decolonising research and knowledge production practices allow for the recognition of alternative types of knowledge that are not scientifically proven in the 'Western' sense.

2.3.1. Decolonising Technology Design and Accessibility Practices

Similar to decolonising research practices, it is also necessary to explore digital technologies from a decolonial perspective. Around 2.7 billion people worldwide, primarily with low

incomes and from rural residentials, find themselves excluded and "*on the wrong side of the digital divide*" (Sanders and Scanlon, 2021, p. 136). Bon et al. (2022) argue that being digitally connected, particularly by means of the internet and using technology driven solutions, is widely regarded as the key to living a better life. The vast majority of people in the Global North, (with the exception of those who choose to adhere to Indigenous traditional ways of living or those who do not want to be digitally connected) rely substantially on digital technologies such as online shopping, self-check-out counters, mobile pay, online/mobile banking, transportation services, online payment services, communication platforms, gaming, television services, job applications and school lessons, to mention a few. These technological innovations are believed to have increased the quality of life and convenience of communicating and conducting work or going about our daily routines, resulting in less time spent on daily activities (Watts, 2023). And, because digital technologies, online platforms, tools, and innovations that are normally accessible through technology infrastructure such as the internet and digital mobile devices or computers are a part of our daily life, technology demand and dependency continue to grow.

For example, the Covid-19 pandemic highlighted the significance of technology and possessing digital skills to remain socially connected or sustain businesses in a world that was forced into isolation. Simultaneously, it also showed that vulnerable populations who are unable to access, connect to, or lack basic proficiency in how to use digital technologies face the potential of being excluded from benefiting from an information reliant society (Ragnedda and Mutsvairo, 2018). The digital world also promotes colonial patterns of inequality (Stam, 2021; Bon et al., 2022) that are perpetuated by low income levels or unemployment, low literacy (Centers for Disease Control and Prevention, 2023), and lack of access to technology infrastructures or inadequate technology usage knowledge (Sanders, Brandt and Binder, 2010). All of these factors contribute to the advancement of digital coloniality.

People from disadvantaged backgrounds, particularly those in the Global South, are frequently excluded from discussions about the digital and technological. This is unfavourable, given that the effects of digital technologies have far-reaching implications for their lives and future (Bon et al., 2022). On this subject, co-researchers explained that coastal information, including coastal news, activities, events, festivals and how to use ocean resources, are mostly disseminated through digital platforms such as WhatsApp and Facebook, as well as radio, newspapers, and television. However, some coastal residents, particularly from informal communities, do not have access to these platforms and remain uninformed about the ocean

and other activities, excluding them from opportunities to learn and contribute to important community and ocean related debates.

Bon et al. (2022) ask a very important question regarding technology inclusion: will ever-present digital connectivity bring social justice, equality, and a more sustainable and flourishing world closer to everyone? Current research acknowledges that, at the moment, digital technologies, access, and connectivity is able to promote social justice, information access, freedom of speech, equality, and a sustainable and flourishing world, but not for everyone, only for some. Those who have no, or limited digital connectivity miss out on the opportunity to benefit from its positive prospects. Learning about the digital and technological world from a decolonial viewpoint can help researchers better understand how the evolution of technology impacts individuals and communities. It also assists in understanding the often-unnoticed patterns of power in social and technological structures (Stam, 2021; Bon et al., 2022). For instance, investigating steps that can be taken to encourage technology companies from discontinuing digital innovations, platforms or application functions that are considered outdated in some contexts but are not in other contexts.

When considering technology in its whole, it is important to note that the majority of technologies are created to work effectively in the Western perspective, which is an entirely different worldview from the one being investigated in this research. Therefore, decolonising research and design practices, and dissemination approaches is about subverting decolonial institutions and Western ideologies (Bhambra, Gebrial and Nişancıoğlu, 2018), and in this context, decolonising technologies such that they are used in ways that the original designers did not anticipate.

This research highlights that, although the advancement of technology improved our daily lives (Woessner et al., 2021) and has presented benefits in various sectors such as healthcare, entertainment, communication, tourism, e-commerce and education (Arena et al., 2022), technology equally presents various unintended challenges that have been detrimental to human health and wellbeing (Woessner et al., 2021). Due to technological advancements, people no longer exert themselves, which has resulted in reduced physical activity for many (Alotaibi et al., 2020). Technology has also presented challenges related to online privacy issues, theft and stolen data, stalking and blackmailing, cyberbullying, attacks and phishing, and social isolation (Vega and Brennan, 2000; Englander, 2019; Livingstone, Stoilova and Nandagiri, 2019; Quach et al., 2022). Therefore, in addition to decolonising technology and

creating inclusive digital recording platforms, there is also a need to resolve technological challenges being faced by everyday technology users, to ensure that they are able to maximise the benefits of technology.

2.4. Participatory Design with Communities

Community inclusion has become an increasingly significant point of reference, particularly when conducting research in the fields of PD and co-design (McHattie and Dixon, 2021). This research employs PD as its overarching methodology. PD originated in Scandinavia in the 1980s, with a primary focus on work environments. It was inspired by ethnographic research that examined the introduction of technology into workplaces, offering staff an opportunity to voice the consequences and challenges they experienced at work because of change (Kensing and Greenbaum, 2012) (see Section 3.1.1 for further discussion on PD). Recently, PD approaches have diversified and have been applied in different collaborative contexts, domains, disciplines and communities (Luck, 2018) with the goal of developing new technologies, applications and products. Kauhondamwa et al. (2018) state that participatory approaches that adequately consider user needs and requirements to produce innovative methods and products effectively address exclusion when communities and social groups are included throughout the production process. Through participatory methods, communities can contribute to innovative designs for technology applications that they will be utilising. Participatory and creative processes can also generate a sense of pride in participants and encourage them to reconnect with their heritage (Winschiers-Theophilus et al., 2020), as revealed in this research.

PD methods engender analytical perceptions of the present, and when certifiable PD approaches are followed, obstacles of biases and misconceptions are reduced (Kauhondamwa et al., 2018). When employing PD methods, differences between groups and cultures, particularly in a culturally diverse setting, are accounted for (Kapuire et al., 2014). On this point, Smith (1999, p. 193) elaborates that "*when Indigenous peoples become the researchers and not merely the researched, the activity of research is transformed. Questions are framed differently, priorities are ranked differently, problems are defined differently, and people participate on different terms.*" This inclusive approach is cognisant of all parties involved and the product being developed.

When collaborating with communities, it is important to respect existing community protocols and structures while also working on establishing and maintaining relationships and trust between researchers and community members (Kapuire et al., 2014). These relationships and

trust can be developed through a variety of active engagements, including workshops. To encourage these kinds of relationships, this research held 14 workshops over two years, allowing co-researchers to actively participate in this research. Christopher et al. (2008) also recommend that to manage participatory research effectively, both researchers and community members need to acknowledge institutional and personal histories, understand the research context, be interactive, recognise the expertise of collaborators, and be open regarding interests, intentions and expectations. Thus, creating lasting relationships with communities is beneficial for collaboration, networks (Winschiers-Goagoses et al., 2012) and inclusive participation.

This research also highlights that power dynamics and hierarchies must be recognised and effectively addressed when conducting PD research with communities. This research acknowledges that hierarchies were present in the research process and were perpetuated by pre-existing relational structures, including culture, traditions, customs and perceived social status. Yoko et al. (2024) present an important argument in this regard, stating that:

> "*hierarchies are inseparable from our bodies. They are part of our gaze, attire, habits, pitch, touch, speech, posture, movements and presence. They extend into acts like… how we use honorifics in addressing one another…. Respect for hierarchies is enmeshed with how we listen, respond and how we relate.*"

This research agrees with Yoko et al. (2024) and adds that in specific contexts, hierarchies can be positive when perceived through a lens of respect. Yoko et al. (2024, p.53) further state that "*multiple relationships to hierarchies are complex yet necessary to enable various ways in which participants learn, have agency and feel valued*", which resonates with this research's hierachical grounding. For example, the author collaborated with co-researchers who were older in age thus relational hierarchies of respect based on customs and traditions were already in place. Honorifics (referring to co-researchers as Mr, Mrs/Ms or Mee (Oshiwambo term used when greeting or addressing older women) were used. Therefore, hierarchies in this research were perceived from a positive point of view and not with a negative dominant connotation. Moreover, the utilisation of PD and Ubuntu principles encouraged inclusive, respectful, and mutual sharing and engagement for co-researchers and the author.

McHattie and Dixon (2021, p.1) also argue that PD approaches "*support the process of communities 'coming together', of establishing collaborations around issues or concerns*" being faced. Consequently, collaboration with communities yields improved perceptions of the cultural differences that influence how technology is used and adopted (Ssozi-Mugarura, Blake

and Rivett, 2015). Because communities are part of the PD process, they develop a connection with the product, giving them a sense of ownership. Then again, communities need satisfactory experience with technology to contribute to design choices. When designing with communities that have had limited exposure to modern technologies, it is essential that participants be introduced to various existing technologies so they can become acquainted with the fundamentals of technology, which also creates avenues for growth. Moreover, when community participants are included in the design or participatory process, it creates a platform for them to learn and experience new technologies not known to them (Maasz et al., 2018). This current research agrees with Maasz et al. (2018), and as such, co-researcher explored and engaged with different digital technologies that promote knowledge and cultural heritage (the technology exploration phase is discussed in Section 3.3.1.1)

Winschiers-Theophilus et al. (2012) explain that researchers should encourage participants to reflect on activities and technology interventions during the design process to assist in re-adjusting techniques and choices to mould the design process itself to such an extent that together, researchers and participants can change the environment and reposition of participation. Researchers should acquire adequate knowledge to promote research practices that recognise community communication etiquette. It is important to mention that an essential role of researchers and designers lies in recognising that being part of the participating community also makes them participants and "must embrace the experience of "being participated" (Winschiers-Theophilus et al., 2012, p. 99). A participatory experience presents researchers, designers and community members with an opportunity for mutual learning while developing novel perceptions about participation.

This research also acknowledges that PD approaches can sometimes facilitate unprincipled research practices such as tokenism. Romsland (2019, p. 2) elucidates that tokenism is "*a term used to presenting the appearance of user involvement in decision making when users do not actually have much influence*". This approach presents tokenistic challenges of exclusion and false representation, which must be addressed to ensure inclusive PD research. This research did not engage in tokenistic PD research, but rather embraced Ubuntu principles to encourage co-researchers to freely express themselves and share ocean heritage contributions, which were acknowledged, respected and included on *Efuta Letu Sida Hurib* (see Section 3.3.1).

Consequently, collaborating with communities is full of learning prospects and assumes a dedication to shared knowledge that empowers facilitators to modify previous methods and

techniques (Winschiers-Theophilus et al., 2012). The process also builds relations that avert exploitation and other unprincipled research practices (Maasz et al., 2018). PD methods employed in this research guided the co-production process. The author actively reflected on PD methods to promote inclusive participation. This participatory approach provided an opportunity for mutual learning between the author and co-researchers and the development of novel ocean heritages and perceptions about participation.

2.4.1. Employing Technology and Community Collaboration

This research explores ocean heritage and relationships through augmented reality (AR) technologies. AR is defined "*as a real-time direct or indirect view of a physical, real-world environment that has been enhanced by adding virtual computer-generated information to it. AR is both interactive and registered in 3D as well as combines real and virtual objects*" (Carmigniani and Furht, 2011, p. 25). In the context of this research, AR is utilised to enable co-researchers to (1) experience new digital technology developments, (2) learn about digital recording and preservation, (3) share and engage in ocean discussions and (4) co-produce an AR application aimed at recording and preserving ocean heritage.

As immersive technologies gain popularity, designers in different disciplines are collaborating with communities to develop persuasive and meaningful digital applications. A project in Namibia, conducted by Winschiers-Theophilus et al. (2020), worked on co-creating AR fridge magnets with a San community (see Figure 2.4). The AR fridge magnets aimed to record and share San culture and heritage stories. Throughout the process, the researchers photographed the community as they engaged in cultural activities and San community members drew and designed different images relating to their heritage. The researchers and community members also created videos that explained the San people's different cultural practices and Indigenous knowledge. The photographs and drawings, which also served as image marker triggers, were printed on the AR fridge magnets. The accompanying video materials were linked to the trigger marker images and incorporated onto a mobile AR application. When the mobile application scans one of the images, a video describing the significance of the specific image is played. The research project worked with community members and used collaborative methods to record Indigenous knowledge and cultural practices of the San people. It also aimed to provide community members with knowledge and skills that would enable them to participate in development and cultural projects that benefit the community as a whole.

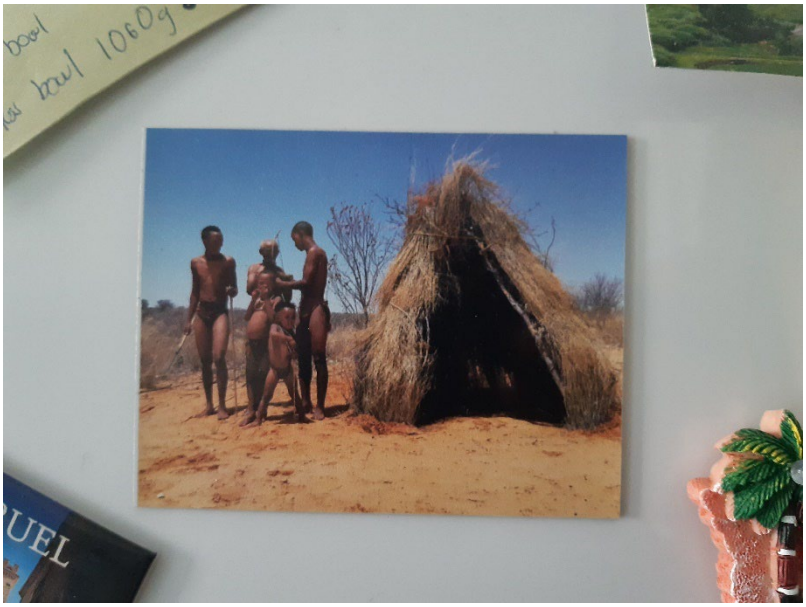


Figure 2.4: San culture inspired AR frigde magnet. Photograph: Marly Muudeni Samuel, 2022

Kauhondamwa et al. (2018) co-created AR personal accessories that enhance social wellbeing in the everyday urban life of San youth. The project developed an AR accessory wristwatch (inspired by the "Ben 10" watch) that contained a picture emoticon (hand-drawn by the participants) that expressed an emotional state and communicated a certain feeling (happiness or sadness) shared by the San youth. The concept of the AR accessory was to use the picture emoticons as marker triggers to display a motivational action that included a picture, video, or audio, different from the picture emoticons on the watch, that motivated the youths whenever they felt unhappy or unmotivated. When the AR application scans the picture emoticon on the watch, it displays or plays the desirable motivational response that helps the San youth in letting go of unpleasant feelings of sadness or being unmotivated (Kauhondamwa et al., 2018).

Kambunga, Winschiers-Theophilus and Smith (2020) engaged Namibian born free youths (youth born after the year 1990, following Namibia's independence in 1990) in developing cultural awareness through the interpretation of the past. The research adopted the fridge magnet concept and printed archival photographs of Namibian cultural and historical heritage on AR fridge magnets. When the AR application scans the picture on the fridge magnets, videos explaining the specific dance or historical event illustrated by the photograph are played (Kambunga, Winschiers-Theophilus, and Smith, 2020). These are some examples of Namibian context specific AR applications co-created with participants and communities to support and document cultural heritage. These applications were shown to the co-researchers at the start of

the research for them to experience and explore different Namibian technologies developed for cultural heritage documentation (further discussed in Chapter 5).

The cultural heritage sector has the potential to benefit greatly from AR technologies (Johnston et al., 2020). Engaging AR technologies can provide museums, historical centres, and cultural heritage sites with the ability to improve user experiences by viably captivating and engaging users and disseminating digital visual data in immersive ways (Kim et al., 2017). Furthermore, designers and developers have utilised immersive technologies to design particularly for cultural, historical, and entertainment industries, and have incorporated functions that allow for product personalisation and different realities to be digitally visualised (Kauhondamwa et al., 2018). The variety of the AR applications solely in the cultural sector shows the potential that immersive technologies create, especially when engaging participants to experience various simulated realities produced through AR. The relevance and value of AR applications could improve quickly if researchers and designers continue to focus more on co-producing, creating, and involving participants, in product testing, and repetitive development with user feedback to help with application refinement (Johnston et al., 2020).

However, it is important to note that AR presents several challenges that need to be addressed. The first challenge is precise object/marker spatial registration that allows the AR software to register the markers that trigger an AR output, especially when working outdoors. According to Rao et al. (2017, p. 3), this occurs "*due to the huge range of uncontrolled outdoor environments*", which necessitate a combination of several sensors in an outdoor AR platform to achieve an accurate registration process. This is because AR feature-based detection requires an appropriate level of detail and contrast differentiation for the system to register and authorise a link between the digital representations and the reference marker on the application's database. Thus, Marques, Roca and Tenedório (2017) argued that to improve user experience, AR should have high precision while avoiding latency (AR technology challenges further discussed in Section 6.2.1.3). Other challenges to be considered when using AR image recognition have to do with environmental factors such as extreme or no sunlight, as it can negatively impact AR marker discovery and processing (Rao et al., 2017). For example, bright sunlight can affect the registration of an AR software when scanning a marker outside in the sun.

Nevertheless, as technology evolves, solutions to challenges are developed every day to improve the practicality of digital innovations. As explained by Johnston et al. (2020), AR

presents opportunities for enhancing and digitising cultural heritage and exhibition spaces, presenting prospects for personal experiences and inherent engagement with objects and their digitally associated content and representations. The current research proposes that by utilising AR, ocean heritage can be supported and preserved for posterity. Co-researchers further state that using digital technologies such as AR to promote ocean heritage can encourage wellbeing and provide new avenues for ocean education, conservation, and sustainability.

2.4.2. Digital Heritage Visualisation

Heritage digitalisation and visualisation have recently gained popularity, with a range of historical and cultural knowledge, objects, artefacts, media (songs, videos, audio), art, and books being digitally recorded. Similarly, the importance of employing technology in visualisation efforts has grown meaningfully during the past three decades (Economou, 2015). Researchers in heritage studies have been utilising digital and immersive technologies such as augmented reality (AR), mixed reality (MR), virtual reality (VR), and extended reality (XR) (Chapman, 2022; Tang et al., 2022) to create digital visualisations of cultural and historical artefacts and sites for documentation and educational purposes. These technologies are utilised through digital devices such as head-mounted displays (HMD), joysticks, glasses, multi-display 3D stereo glasses, mobile devices, cameras, and omnidirectional setups (Sacks et al., 2015; Davila Delgado et al., 2020; Babalola et al., 2023).

However, some studies have opposed the use of digital technologies in representing cultural heritage, arguing that the intersection of technologies and heritage representations diminishes the authenticity of heritage objects because they do not possess the same authenticity or 'aura' as the original objects they represent (Huggett, 2004). Latour and Lowe, (2010, p. 5) explain it, stating that "*Only the original possesses an aura, this mysterious and mystical quality that no second hand version will ever get*". Benjamin further argued that "*the presence of the original is the prerequisite to the concept of authenticity*" (Benjamin, 1968, p. 3). This current research disagrees with this argument and raises the question: can digital heritage objects have the same authenticity as the original objects they represent. Yes, the authenticity of digital objects can be similar to the original objects they represent because "*aura can migrate from an original to its reproductions*" (Jeffrey, 2015, p. 148). This research's findings indicated that an original object's significance also determines how a digital representation is perceived by spectators and that the authenticity and value of the original object can be experienced through and represented by the digital object (see Sections 7.3.2 for contributions and a discussion about the value of ocean heritage 3D models and 8.5 for discussion about realism and

authenticity). Therefore, authenticity and value can be transferred from an actual object to its digital reproductions. In the case of this research, the 3D digital reproductions of ocean representation were as meaningful and valuable as the actual objects/materials they presented because of the history they possessed, what they represented and how they were perceived.

Technology has given conception to a new dynamic digital era that is not fully understood, particularly by those who are unfamiliar with it. Employing mechanical or digital technology reproductions can be liberating (Benjamin, 1968) and has the potential to safeguard Indigenous knowledge. However, it also presents many challenges (Jensen et al., 2012) including misrepresentation and technological infrastructure literacy and access. Consequently, nations and communities are working to address these digital technology challenges, which are being improved every day to ensure they can be effective tools to record and preserve cultural heritage. Cultural heritage documentation through digital methods can be important to preservation efforts. For example, in some customs, cultural knowledge is transferred through stories or word of mouth, which sometimes leads to loss of information when the chain of narration stops for some or other reasons (Smith et al., 2011). It is also necessary to highlight that some cultures and communities may find the practice of sharing or documenting knowledge inappropriate and may refuse to share and digitally preserve their cultural heritage, as explained in Section 2.1.1. Albourae, Armenakis and Kyan (2017) argue that there is a growing need to preserve and document cultural heritage and digital technology can play a significant role in this regard. Cultural heritage documentation is recognised as essential to preservation and provides lasting records of heritage and knowledge (LeBlanc and Eppich, 2005) that will be used by people for learning purposes in the present and future. Thus, if cultural heritage is preserved and digitally recorded, it stands a greater chance of being available for many generations to come.

2.5. Theoretical Framework and Analysis

This research draws from a variety of concepts and principles and employs theories such as Ubuntu principles and practices (Nicolaides, 2022), production of significance (Jeffrey et al., 2020), communities of practice (Wenger, 1998b, 2011), and place attachment (Altman and Low, 1992) and biophilia (Barbiero and Berto, 2021). These theories inform this research's co-production process, research methods and procedures, and data analysis.

2.5.1. Ubuntu Principles and Knowledge Exchange

Ubuntu is "*an indigenous knowledge system and way of life for African people*" " (Ngubane and Makua, 2021, p. 2) with the capacity to restore Indigenous values, heritage, customs and civilisations, as well as to promote principles of coexistence, cooperation, and social harmony among people from many origins. It is an approach to life that has been utilised for generations to build, direct, and preserve positive human engagements, connections, and wellbeing (Ramose, 2002).

Derived from the Nguni Bantu people, the concept of Ubuntu encapsulates the idea of humanity. Ubuntu is often interpreted as "*I am because we are*" or "*humanity towards others*" (Nicolaides, 2022, p. 1). In most African traditional customary lives, a person does not exist alone, but collectively (Mbiti, 1990). While the philosophy of Ubuntu originated in Southern Africa, it has since become shared and accepted across the continent (Bolden, 2014). The concepts fluidity enabled it to acquire new meanings and definitions throughout history, most likely as a result of shifting political and social contexts (Gade, 2012). Khomba (2011, p. 127) defines it as "*the capacity in an African culture to express compassion, reciprocity, dignity, humanity and mutuality in the interests of building and maintaining communities with justice and mutual caring*". Lefa (2015, p. 4) further explains that "*Ubuntu lies at the heart of the African way of life and impacts on every aspect of people's wellbeing*." The perspectives of Ubuntu examine the principles, values and logic that define African communities, and their relationship to concepts of personhood and identity. The concept is viewed through a lens of social relations that values the opinions of all collaborators, looking to achieve a collective consensus and advance together (Bidwell, 2014). The concept has also been employed in community based participatory initiatives targeted at developing digital technology solutions (Kapuire et al., 2016) (see also Adeola, Evans and Ngare, 2024).

Consequently, this research is approached from perspectives exemplified by the concept of Ubuntu, which further examines relationships between co-researchers and community members and encourages collaborative participation in the research and co-production process, as well as collective sharing of ocean knowledge, benefits, culture, and relationships. Ubuntu principles are also incorporated into this research because highlight the importance of collaborative learning, support, and harmony among people, as evidenced through the contributions shared by co-researchers and additional findings documented in this research.

Ubuntu principles embraced in this research promote Indigenous values, knowledge, and culture. They further encapsulate concepts and perspectives of PD scholarships, as well as decolonising technology, research, design methods, and dissemination approaches, all of which aim to promote inclusivity and the sense that people can collaborate, exchange knowledge, and resolve common challenges together. Ubuntu principles synergises with the other theories investigated in the current research including production of significance (Jeffrey et al., 2020) and communities of practice (Wenger, 1998b, 2011) (see Section 2.6.3 for further discussion).

These theories, Ubuntu and communities of practice, are guided by principles where people and communities work together for mutual benefit while finding meaning in the collective activities they engage in. In the West, one form of collaborative community work and connections is considered CoP or interest (Ceatha, 2019; Bicchi, 2022). Within this research context, co-researchers were bound together and to the ocean by a mutual understanding of ocean heritage and practices that they have in common founded in similar values and principles. Therefore, the concept of 'CoP' already existed in African cultures and contexts, practised through philosophies such as Ubuntu. Emphasis is placed on the importance of learning from each other, resonating with Ubuntu principles that state that "*A person is a person through other people*" (Graness, 2018, p. 397). In support of Ubuntu, co-researchers described how various fishermen from coastal communities come together to learn how to fish from one another, and how women collectively learn how to use ocean resources. Women gather in groups to teach each other how to cook specific fish, use seaweed in gardening, decorate homes with shells, sea sand, and stones, create art with ocean resources, and how to make contemporary and traditional jewellery out of oysters and seashells. Similarly, co-researchers collaborated to co-produce *Efuta Letu Sida Hurib* with the objective of preserving and sharing knowledge related ocean heritage. These actions and approaches are rooted in Ubuntu principles that that are comparable to CoP.

To encourage PD approaches, this research employed fundamental concepts of Ubuntu, which are regarded by many African communities as a communal practice (Winschiers-theophilus et al., 2012) and an important way of life. By following the principles of Ubuntu, the approach of engaging communities was founded on common good, reciprocity, mutual interest, and knowledge sharing and learning together (Khomba, 2011; Ujomudike, 2016; Mayaka and Truell, 2021). Co-researchers also highlighted the need for sharing knowledge for other people to learn from it, as a result, the co-production process facilitated the practice of Ubuntu. The co-production process was as important as the final AR application (*Efuta Letu Sida Hurib*)

because the entire process was a learning experience for co-researchers and the author as they gained novel knowledge, engaged with different technologies, and co-produced *Efuta Letu Sida Hurib*.

2.5.2. Production of Significance

Building on the scholarship of Ireland, Brown and Schofield, (2020), this research examined and embraced the concept of the production of significance by emphasising the importance of community engagement throughout this research's co-production process instead of only focusing on the importance of the end product *Efuta Letu Sida Hurib*. Similar to the work of Maxwell (2017), this research engaged with co-researchers in a co-production process. During the process, co-researchers shared respective ocean heritage, participated in data gathering and co-produced the AR application. They also brought and shared ocean objects/materials representing ocean heritage that were converted into digital 3D models and added to *Efuta Letu Sida Hurib*.

In their work, Jeffrey et al. (2020) reveal that, in the context of co-production with communities, there are complicated relationships between the production of significance and digital recording. However, communities are still able to intervene in these relationships, frequently challenging existing mechanisms of significance and establishing alternative forms of significance that refute traditional expert, legal, and pseudo-legal frameworks (Jeffrey et al., 2020) . Given that significance is produced and reinforced in part by the mobilisation of resources, it is important to recognise that there is an intrinsic relationship between significance and the form and frequency of activities associated with a heritage object or site. However, Jeffery et al. (2020, p. 3) state that "…*it is not always easy to unpick the relationship between the act of recording and the significance of a site*".

The opposition is whether digital records are being produced because the heritage objects associated with them are thought to be significant or is the production of digital records producing significance. In other words, are we recording them because they are significant, or are we making them significant by recording them? In the case of this research, did co-researchers and respondents find meaning in the 3D models representing ocean relationships (See section 5.1.1. for objects/materials representing ocean relationships) or the technology that was used to digitally record the significance of the ocean representations? This question is answered in Chapter 7.

Co-production enables involved stakeholders to reflect during the process, which leads to transformation (Cahn and Gray, 2012). Maxwell (2017) explains that the actual experience and process of creating digital 3D visualisations, recording outdoors, and learning from one another was both a learning opportunity and rewarding experience for everyone who was involved in their research project. Cahn and Gary (2012) further emphasise that through co-production, the system itself and the co-production process evolve, and the product and producer, as well as process and outcome, are all transformed while challenging previously existing beliefs and ways of working.

The practice of recording itself contributes to the sense of an object's significance. While digital recording evidently serves to reinforce specific forms and hierarchies of significance, Jeffery et al. (2020) assert that it can also serve to challenge pre-existing notions of significance and make known new forms of significance, that link to local, personal, and emotional connections. However, as digital heritage preservation researchers, it is also important to investigate the question of the authenticity of digital reproductions of heritage spaces and objects (Jones et al., 2018). This research examined how co-researchers and respondents who engaged with *Efuta Letu Sida Hurib* perceived the authenticity of the digital 3D models created from objects/materials representing the co-researchers' ocean heritage. The findings indicate that the authenticity, value and relevance of the actual objects/materials also determined and added to the authenticity, value and relevance of the digital 3D representations.

Though certain 3D models did not realistically resemble the actual objects they represented, co-researchers and respondents still found meaning in them because of what they signified. Therefore, it is important to not primarily focus on accurate and photorealistic-looking digital records. There is a balance between the production of accurate and photorealistic-looking digital heritage representations because the quality of the product matters, but, as demonstrated in this research, it is not the only factor that matters (see Sections 7.3.2 and 8.5 for feedback and discussion about photorealism).

This research reinforces that the co-production process was significant for the author and co-researchers who, through the workshop dialogues, learned about, explored, networked, shared, and preserved ocean heritage. The co-production process provided co-researchers with an environment to openly communicate, and that enabled co-researchers to come up with creative ideas, concepts and content featured on *Efuta Letu Sida Hurib*. The process provided co-researchers with a sense of purpose and fulfilment, as they not only shared and documented

ocean heritages but also established a collective community between themselves to learn, support and motivate each other during the workshop discussions and beyond the workshop setting.

2.5.3. Communities of Practice: A Social Theory of Learning

A community of practice is categorised by three fundamental characteristics: mutual engagement and collaboration, working towards a common goal, and access to a variety of shared resources (Amery and Griffin, 2020). Wenger and Trayner (2015, p. 2) further explain that "*Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly*", similar to how the co-researchers came together with a common ocean interest and co-produced *Efuta Letu Sida Hurib*. Within communities of practice, members can communicate through both physical and digital means (Wenger and Snyder, 2000). Both of these communities of practice interaction concepts influenced this research, as it created a physical platform for co-researchers to interact and share knowledge about the ocean, while also producing the AR application.

It is important to keep in mind that the provided definition of communities of practice enables intentionality of learning but does not necessitate it. For example, a community may come together for the purpose of learning, or learning can occur by chance as a result of members interacting (Wenger and Trayner, 2015). For the current research process, the latter is true. Through workshops, co-researchers discussed the benefits and significance of the ocean and, in the process, gained new knowledge from each other.

The concept of a community of practice offers valuable perspectives on learning, knowing and knowledge sharing (Haas et al., 2021). These learning perspectives analyse social participation as an approach focusing on social theory components such as learning as belonging (community), learning as becoming (identify), learning as experience (meaning), and learning as doing (practice) (see Figure 2.5). According to Wenger (1998a) the fundamental focus is on learning as a form of social or communal participation. Participation in this regard relates to a broader process in which participants actively engage in the operations of community groups, while also developing identities that are connected to these communities, rather than just engaging in specific events and activities with certain individuals. This type of participation impacts who we are, the actions we take during these activities, and how we perceive those actions.

Figure 2.5: Social theory of learning components, adapted from Wenger (1998a).

This form of participation, learning, and engagement was evident throughout this research process, as co-researchers actively participated in workshop activities, forming relationships, and sharing their ocean experiences and knowledge with each other. The concept of knowledge sharing was important to majority of the co-researchers, as they believed that knowledge and culture were decreasing and that something needed to be done to preserve knowledge. Consequently, co-researchers co-produced a digital AR application aimed at recording and preserving ocean heritage for posterity.

This research, therefore, further demonstrates that communities of practice emerge through a process of legitimate peripheral participation (Busch-Jensen, 2012) and around matters that are important to individuals, such as shared concerns and passions about work tasks, problems, struggles, or opportunities in their daily lives. The contributions and actions within community groups represent members (co-researchers) personal views of what they believe to be important (Wenger, 1998b). This is evident in the contributions provided by co-researchers as they reflect on their personal perspectives about the benefits and significance of the ocean for them and their communities.

Moreover, communities of practice are able to exist as long as people value and are interested in taking part in community activities (Wenger, 1998a). Since communities of practice are

voluntary, their ability to create enough excitement, importance, and significance to attract and engage members is essential to their long-term success (Cuddy, 2002). Co-researchers, for example, were interested in learning more about the ocean and preserving ocean heritage. Accordingly, their enthusiasm and willingness to continue participating lasted a long time because of their interests. Factors that motivate community members decisions on whether they should participate and share their knowledge in physical or digital communities of practice settings include reciprocity and satisfaction (Cheung, Lee and Lee, 2013; Haas et al., 2021). In other instances, the value and interest of communities of practice are also perceived in relation to benefits and costs to community members and support from leaders (Cuddy, 2002; Sedighi et al., 2017). Although many variables can motivate a community, nothing can replace the sense of "*aliveness*" that comes from communities working together for a common goal (Cuddy, 2002, p. 1).

It is also important to understand that not every group that is observed as a community falls under the purview of a community of practice. For example, a neighbourhood or a group of friends and families who are often referred to as a community, are not usually considered as communities of practice (Wenger and Trayner, 2015). Communities of practice generally include three specific components (see Figure 2.6):

- **A domain**: revolving around a common area of interest and where membership involves a commitment and dedication to the domain (Wenger and Trayner, 2015). In this research context, the domain is the ocean.
- **The community**: within a community, members participate in collective events and conversations, assisting one another, and exchanging information. They establish connections that allow them to gain knowledge from one another (Wenger and Trayner, 2015). In this research context, the community was established through iterative workshops.
- **The practice**: A community of practice is more than just a group of people who like the same books, music, or films. Practitioners in communities of practice establish a shared practice and repository of resources which include stories, history, experiences, instruments, techniques, and strategies for dealing with reoccurring challenges. Communities of practice are not easy to establish, as they require time and constant communication (Wenger and Trayner, 2015). In this research context, the practice was the ocean heritage and the co-produced AR application.

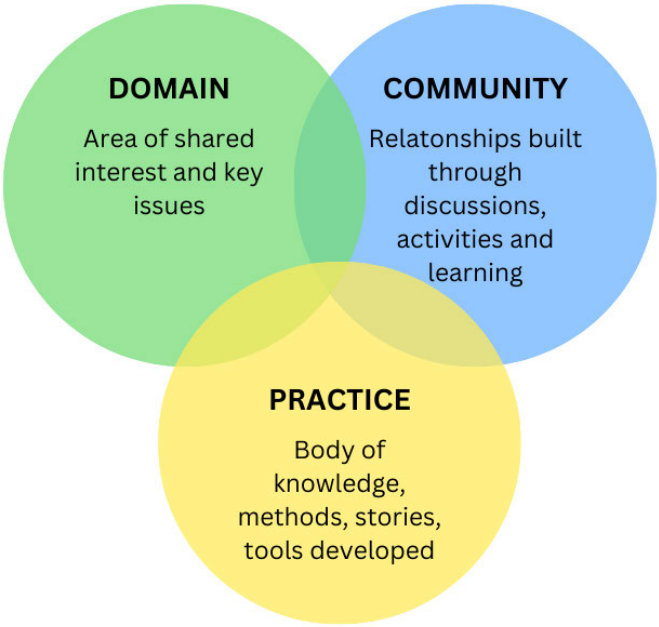


Figure 2.6: Characteristics of community of practice adapted from Wenger and Trayner (2015).

Co-researchers have intricate relationships with the ocean, which were expressed during workshop activities with the aim of sharing, gaining and preserving knowledge. Through these iterative engagements, co-researchers interacted with one another and external collaborators, while using various resources, and in the process, they continued to learn. This collaborative learning process resulted in common practices of knowledge centred around a range of topics including different ways of creating traditional and contemporary jewellery, and learning to use seaweed extract to fertilise gardens and ocean resources to decorate homes. These common practices reflect collaborative initiatives and social relationships.

Through the concept of communities of practice, the author and co-researchers shared and gained knowledge about the ocean, and interacted and collaborated to create a digital AR application that records and preserves these knowledge and interests for posterity.

2.5.4. Place Attachment and Biophilia: Human Connections with Nature

Ocean relationships in this research are grounded in the theories of place attachment (Altman and Low, 1992) and biophilia (Barbiero and Berto, 2021) throughout this research. These theories argue that human beings have unique connections with nature and they reside, use and attach meaning to places which they feel connected too, including their homes, neighbourhoods, cities, parks, recreational and environmental spaces, communities and rural areas (Altman and Low, 1992). These connections emerge as a result of feelings, social belonging and shared memories (Hay, 1998) that people have with their surroundings.

The first mention of place relationships was in 1963, when Marc Fried conducted a study on psychological implications that resulted from the forced displacement of people from Boston suburbs (Fried, 2000). According to the study's findings, residents of the Boston suburbs compared the feeling of being displaced from their neighbourhoods to the sorrowful feeling of losing a loved one, indicating their strong connection to the suburb. The term place attachment was later grounded by Low and Altman, defining place attachments as the bonding that happens between people and their environments (Altman and Low, 1992). Hernández et al. (2007) also stated that these environments are places where people "*prefer to remain and feel comfortable and safe*" (Hernández et al., 2007, p. 1), as evidenced by the ocean relationships shared by co-researchers in this research.

Lomas, Ayodeji and Brown (2023) explain that a person's attachment to a place extends beyond its physical and geographic attributes and relates to the emotional connection that develops between that individual and a physical environment. Scannell and Gifford (2010) suggested a place attachment framework (see Figure 2.7) that focusses on three separate place attachment dimensions: person, place, and psychological process, as well as the relationships or actions that emerge as a result of these dimensions. As illustrated by the tripartite place attachment model (see Figure 2.7), co-researchers emphasised that they find meaning by living in Swakopmund and Walvis Bay because of the ocean, which provides numerous benefits ranging from cultural, spiritual, psychological to economical, artistic, physical and historical benefits (see Chapter 4 for discussion on ocean relationships). These relationships and their experiences come together to form a place attachment and biophilic connections that are unique to co-researchers and are linked to their individual beliefs, values, perceptions, and aspirations, concerning the ocean.

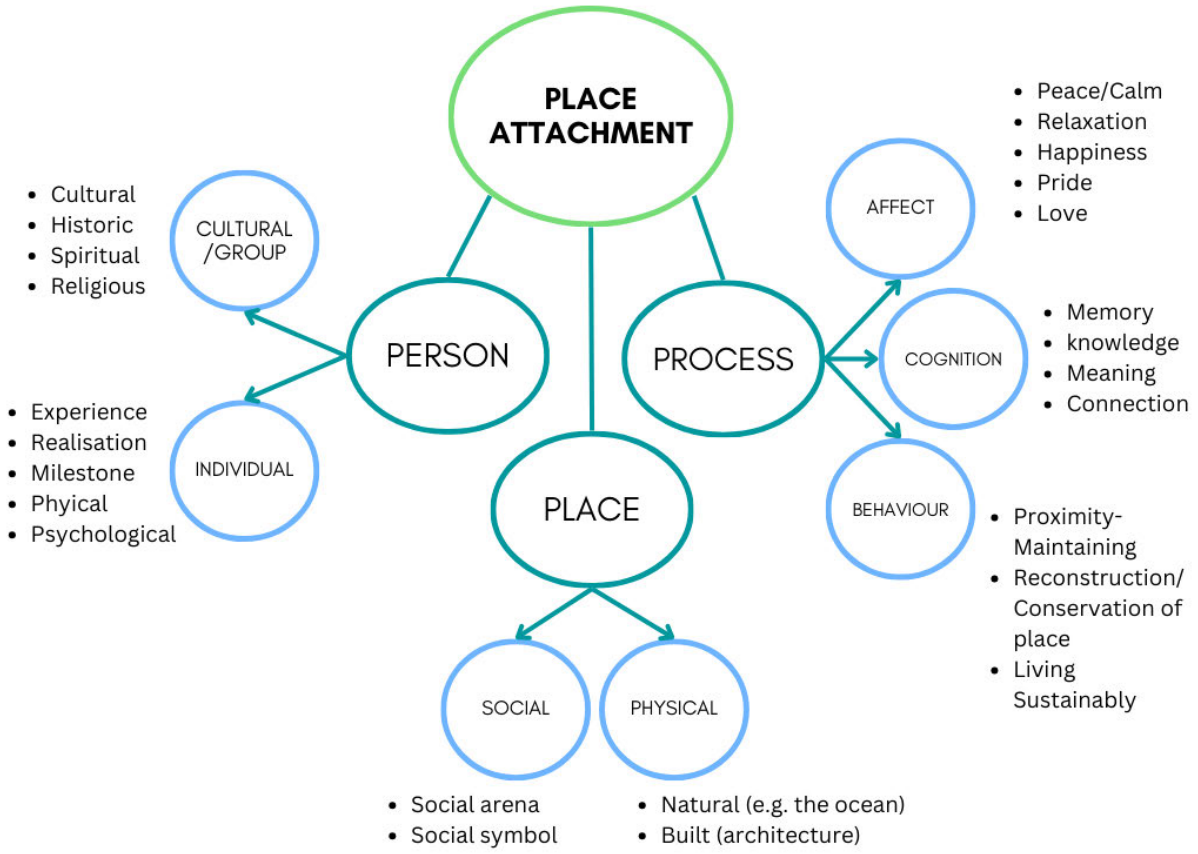


Figure 2.7: Tripartite Place attachment model adopted from Scannell and Gifford (2010)

Furthermore, the theory of biophilia which teaches human-environmental connection principles, similar to place attachment was investigated. While biophilia emphasises the bond between people and the environment, its grounding states that people grow to care for their environment as a result of their relationships with it, which is important in this research because co-researchers discuss the importance of conserving the ocean.

The concept of biophilia was originally coined by Erich Fromm, who described it as an intense love for everything that is alive and life itself (Fromm, 1973). He further adds that biophilia is "*the experience of union with another person, with all men, and with nature*" (Fromm, 1956, p. 17).

According to Fromm (1956), biophilia can restore a sense of power in human beings, allowing them to overcome feelings of separateness and isolation. This notion of having the power to overcome isolation and separateness was also revealed in this research, with co-researchers sharing that the ocean is a safe place for them to go when they feel unhappy, sad, or alone. Fromm also claims that not everyone is able to have a biophilic connection with nature and that

some people have an adverse relationship with nature because of circumstances such as unemployment, lack of justice, security, and freedom. This viewpoint is further backed by findings shared by respondents, who indicated they do not have relationships with the ocean for various reasons, including fear and grief (contribution about grief can be found in Section 7.3.7).

The concept of biophilia is secondly coined by Wilson (1984), who describes biophilia as the evolutionary trait of adaptation that enables people to establish psychological connections with nature and the world (Wilson, 1984). He further elaborates that biophilia is "*our innate tendency to focus upon life and life-like forms and, in some instances, to affiliate with them emotionally*" (Wilson, 2002, p. 134). These connections can also be known as place meaning or sense of place and they "*develop from an array of emotions and experiences, both positive and negative*" (Manzo, 2005, p. 67) that a person experiences when in a certain environment.

There is not a lot of recent literature on the concept of biophilia, yet its definition and grounding correlate with ocean relationships and connections revealed in this research. How co-researchers, respondents, and people in general connect with nature beyond its material benefits and rely on it for economical, psychological, physical, and spiritual wellbeing. This perspective is further supported by Kellert and Wilson (1993) who claim that human dependency on nature extends far beyond fundamental issues of material and physical needs and takes into account human desires for fulfilment, meaning and satisfaction on an aesthetic, intellectual, cognitive, and even spiritual basis. Furthermore, because human beings emotionally affiliate themselves with nature, they become fascinated by it and react by giving involuntary attention to natural environments, and in turn, this directed fascination and attention can rejuvenate adults and children from psychological exhaustion (Berto, 2005; Barbiero et al., 2007).

Gunderson (2014) expanded Fromm's scholarship of biophilic connections to nature, suggesting that "*Fromm's love of nature means "(1) an active concern for nature's growth and prosperity, (2) responding to and meeting its needs, (3) respecting nature's independence from human interests, and (4) knowing nature without dominating it*" (Gunderson, 2014, p. 192). Barbiero and Berto (2021) also add that biophilia is an inherent human character that is important in building healthy and harmonic relationships between human beings and the environment. These opinions are reflected in the findings of this research, with co-researchers sharing different connections they have with the ocean, why the ocean is important to them and what they do to continue protecting and sustaining it.

When considering the ocean as a place of peace and tranquillity, Barbiero and Berto (2021) further state that biophilia considers various categories of nature and human cultural practices and the duration of time spent in nature, which encourages human beings to reflect on psychological and physical wellbeing when in close proximity with natural settings. Barbiero and Berto (2021) also add that, not having enough or regular interactions with nature can have a negative impact on both psychological and physical wellbeing. These viewpoints resonate with a variety of ocean beliefs and customs performed by some Namibian people, such as paying homage to or washing one's feet and hands in the ocean when visiting a coastal town, with the belief that the action wards of bad luck and spirits. Another practice is going to the beach when feeling sad with the belief that the presence of the ocean will make you feel better. These practices and relationships are believed to promote psychological and physical wellbeing, and as indicated through this research findings, the ocean contributes to the wellbeing of co-researchers in various ways (these contributions are addressed in Chapter 4, 5, and 7).

Additionally, in her study on biophilic environment, Montgomery (2015) explained that because human beings observe and gain knowledge from their environments, they are conscious of the impact they have on the environment, which connects back to the relationships they have with the environment. In their contributions, co-researchers revealed that they have intricate relationships with the ocean and because of these relationships, the ocean is important to them. Co-researchers are therefore consciously aware of and advocate for the conservation of the ocean. *Efuta Letu Sida Hurib* also provided a platform for co-researchers and respondents to interact, experience and learn about ocean culture and knowledge, enabling them to establish new and improved biophilic relationships with the ocean.

2.6. Conclusion

This Chapter justifies, supports, and contextualises the findings presented in this research. It established the research approach by drawing on concepts, principles, and theories from past research, including knowledge practices, decolonising technology design and research practices, ocean heritage, participatory design (PD), Ubuntu, the production of significance, communities of practice, biophilia and place attachment theories. The literature and theories assisted with framing and addressing the research questions and encouraged suitable approaches to collaborating with communities.

The findings of this research indicate that co-researchers have varied relationships with ocean, which are often influenced by cultural and traditional practices, Indigenous and experiential knowledge, histories, wellbeing and a desire for economic growth (see also Allison et al. 2020). However, concern was expressed that if ocean heritage is not protected and preserved it is at risk of neglect and decline. At threat is the continuity of use and intergenerational sharing of ocean knowledge including history (particularly of the Topnaar ǂAonin people), teachings about the benefits of ocean resources (seaweed), and the ongoing undertaking of cultural and traditional practices (Aawambo customs).

Related literature further indicates that digital technologies have been effectively employed to safeguard Indigenous knowledge in different contexts (Smith et al., 2011; Albourae et al., 2017; Stanley, 2020; Ul Abiden Malik et al., 2023;), as discussed in Section 2.1.1. However, the author also acknowledges the challenges presented by technology (Stam, 2021; Bon et al., 2022), which in some contexts exacerbate the digital divide (see Chapters 6 and 8). Findings of this research also highlight the significance of supporting and preserving ocean heritages with digital technologies such as AR to promote intergenerational sharing and continuity of use, while also respecting knowledge that can and cannot be shared in particular contexts. Drawing on the concepts, values, principles and theories presented in this Chapter, the following Chapters analyse data collected during co-production workshops with co-researchers in Namibia. The co-production process and workshops facilitated the development of *Efuta Letu Sida Hurib*.

CHAPTER 3

RESEARCH METHODOLOGY AND APPROACH TO CO-PRODUCTION PROCESS

Chapter 3 discusses the methodologies, research principles and design process employed in this research. It analyses the research mechanism and logic of inquiry, which includes participatory design as the overarching methodology, complemented by principles of rapid ethnography. It includes an explanation of the research setting, the process followed in selecting and engaging with co-researchers, and the workshops conducted to address the primary and sub-research questions. Finally, it examines the methods and procedures employed to collect data, including Qualitative Content Analysis (QCA) and thematic analysis. It explains the rationale for their use and the data analysis process. This Chapter concludes by providing an analysis of the themes that emerged from the collected data.

As discussed, and detailed in Section 2.5, this research is informed by a variety of concepts, principles and theories. It draws firstly upon Ubuntu (Nicolaides, 2022; Bidwell, 2014), which promotes collaborative participation, mutual sharing and learning, and values the social relations and opinions of all. Secondly, the concept of production of significance (Ireland, Brown and Schofield, 2020) highlights the importance of community engagement and development through and during the co-production process. Third, Wenger's (1998b, 2011) scholarship regarding communities of practice describes how community groups who share the same interests and concerns work together to create outputs or solutions through mutual and regular engagement and interactions. Lastly, this research leverages place attachment (Altman and Low, 1992) and biophilia (Barbiero and Berto, 2021) to understand the diverse heritages and relationships that co-researchers have with the ocean.

3.1. Research Mechanisms and Logic of Inquiry

There is a growing body of research dedicated to exploring multidisciplinary, interdisciplinary and transdisciplinary methods that facilitate the integration and application of diverse academic disciplines for collaborative community engagement (Stock and Burton, 2011; Guimarães et al., 2019; Butt and Dimitrijević, 2022). Substantial progress has been made towards integrating different disciplines (Venville et al., 1998), which in turn, has encouraged researchers to adopt and develop inclusive methodologies that value diversity and cooperation. Researchers are now employing methods that are best suited to the needs of their research contexts and the

participants they collaborate with (Smith et al., 2020). Similarly, collaborative inclusive approaches are employed in this research, which explored how these methodologies support and are appropriate for this research context.

3.1.1. Participatory Design

Participatory design (PD) is employed as the overarching methodology to guide this research's formulation, workshops, and co-production process conducted with Namibian coastal co-researchers. PD surfaced approximately five decades ago and is grounded on a Scandinavian philosophy of systems design, often referred to as cooperative design. While previous PD approaches primarily focused on work environments, in the late 1990s scholars such as Braa, p. (1996, p. 16) argued that "*the participatory design tradition typically has addressed the workplace while a third world environment typically consists of economically disadvantaged communities where the majority is without formal employment. Thus it is important to recognise that third world participatory design approaches need to emphasise the community, rather than the workplace*". He further asserts that if researchers are to continue the tradition of promoting democracy, computing and technological influence through PD in the global South that "*we need to shift the focus from the workplace to the community*" (Braa, 1996, p. 16). Although Braa's argument is now 25 years old, it remains relevant and must be acknowledged especially when working in developing countries such as Namibia. Velden and Mörtberg (2014), further emphasise that PD is a set of design practices that involve future users as collaborators during the design process. PD is founded on the collaborators' honest decision-making power and the incorporation of their values into the design process and the outputs, which are frequently working prototypes of a product or service (Velden and Mörtberg, 2014). This research employed a PD approach and co-produced *Efuta Letu* Sida *Hurib*, an AR application that supports and preserves ocean heritage for posterity (the co-production process and AR application results are explained in Chapters 5 and 6).

Greenbaum and Halskov (1993) proposed three justifiable perspectives in which researchers can employ PD approaches:

- a pragmatic perspective, a practical method for increasing productivity;
- a theoretical perspective, a strategy for overcoming the challenge of a lack of mutual understanding between developers and users;
- a political perspective, a democratic approach to give people an opportunity for them to influence their workplace

This research's PD methodological objectives are rooted in the first and second of the above perspectives. It follows a structured process which includes planning, systematic execution, and reflective analysis, all of which are imperative components of PD. Bødker and Kyng (2018) state that most current PD practices are focused on promoting direct collaboration between individuals and designers to address everyday societal and technological usability challenges, either by employing technological or other innovative solutions. For this research, PD approaches moved beyond questions of usability to address ocean related benefits and challenges that coastal communities face. These approaches investigated the significance of the co-production process for co-researchers, how participants interacted with digital technologies and explored the potential of AR to support and preserve ocean heritage for posterity. Moreover, *Efuta Letu Sida Hurib* provided a platform for co-researchers to exchange and learn about ocean knowledge and the various approaches to using ocean resources for cultural, spiritual, artistic, medicinal and wellbeing benefits, which further promoted sustainable communities.

Accordingly, this research adopts a PD approach similar to that of Winschiers-Theophilus et al. (2010; 2012) and Bidwell et al. (2011; 2014), which are established within a Namibian context to promote collaboration between individuals, designers, and researchers with the aim of producing empowering knowledge or products. Their research approach does not only incorporate community participation practices, but also considers and encourages Ubuntu principles and acknowledges community knowledge and values. Similarly, this research draws and learns from Ubuntu principles in its overarching framework.

McAra (2017, p. 197) further highlights that "*PD is built upon an ethos that seeks to empower and give voice.*". This research recognises that PD provides a platform that promotes numerous benefits that are essential to community-based research practices, including the empowerment of co-researchers, mutual learning, and knowledge sharing. Researchers also gain an understanding of design requirements and collaboratively create a value end product. PD promotes moral values that are suitable for particular contexts (Velden and Mörtberg, 2014; Harrington, Koon and Rogers, 2020), and involving users in PD activities has been widely recognised as a means of creating more usable and accessible systems (Winschiers-theophilus et al., 2012).

Following PD principles, this research formulated a workshop plan that consisted three phases. The research design, process flow and steps (see Figure 3) follows an iterative collaborative

spiral of steps and promotes partnership between the researcher and a group or community who partake in the research process (Rose, Spinks and Canhoto, 2014). Figure 3 illustrates this research's design process flow, including an iterative cyclical process comprising five stages: diagnosis, planning, activity, observation and reflection.

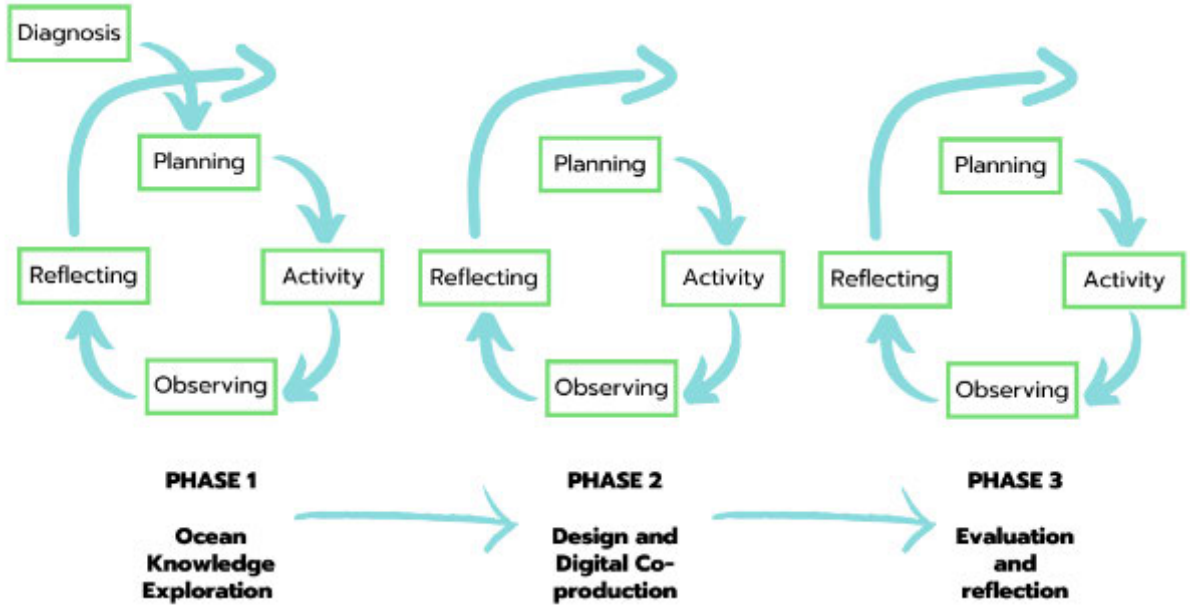


Figure 3.1: Illustration of the three distinct PD phases employed during the course of the research study. Adapted from Agile iterative cycle methodology (Fagarasan et al., 2021).

The process flow and steps are adopted from agile methodology (Fagarasan, 2021), as well as the PD framework outlined by Jensen et al. (2018). The framework, originally adapted from action research, is described by McNiff and Whitehead (2011, p. 8) as "*a disciplined, systematic process*" that allows researchers and practitioners from different disciplines to examine and assess the work they undertake. The activities conducted during the above research phases are explained in Section 3.3.

This research additionally employs interventions borrowed from community-based co-design (CBCD), which ensures that research participants are involved in the research design process at all stages (Blake et al., 2011; Kapuire, Winschiers-Theophilus and Blake, 2015, Stanley, 2020). CBCD practices empower participants with skills (Van Zyl and Vannini, 2013), and often engender wellbeing by generating platforms for self-expression (Sabiescu, 2015), which are consistent with the objectives of this research. CBCD is a construct of the PD philosophy and its values reflect and are acknowledged by the principles of PD employed in this research.

This research further engages co-researchers in a co-production process (see Section 3.3) drawing from Cahn and Gray's (2012) views that state that co-production approaches should

challenge already existing conceptions and ways of working while being transformative, and altering the production process, the outcome as well as the product being produced and the people producing it. Therefore, the co-production process applied in this research, facilitated the establishment of a partnership between the author and the coastal co-researchers, enabling inclusive participation, which in turn developed a foundation for mutual respect and trust, collaboration, sharing and learning, and commitment.

Additionally, employing principles of PD created a platform for the author and co-researchers to realise and apply concepts of self-representation, knowledge exchange and power-sharing (Young and Brownotter, 2018). *Efuta Letu Sida Hurib's* research and co-production process demonstrated how using PD principles ensured that both author and co-researchers views were considered, which enabled decisions to be agreed on collectively.

3.1.1.1. Ethnography

The origin of Ethnography can be found in anthropological studies conducted in the early 1900s with small, rural, and frequently remote communities by researchers such as Matthews (1877), Spier (1928), and Malinowski (1929). Ethnography as a research practice is undertaken for long periods of time. The study of ethnography investigates social connections, practices, and perceptions that happen within groups, gatherings, associations, and communities. The aim is to gain rich, comprehensive knowledge of individual perspectives and activities and the nature and environment (including sight and sound) of the communities they live in through an assortment of various data gathering methods, including focus groups, interviews, and participant observation (Reeves et al., 2017).

This research employs rapid ethnography interventions as defined by Millen (2000) and Pink and Morgan (2013). In contrast to traditional ethnography, rapid ethnography is executed in a short period of time. Millen (2000, p. 1) describes it as a '*collection of field methods intended to provide a reasonable understanding of users and their activities given significant time pressures and limited time in the field*.' The author recognises that undertaking research with communities, particularly when learning about cultures and ways of life, can take a significant amount of time. However, as Millen (2000) notes, time to conduct long-term comprehensive community research may sometimes be limited. Rapid ethnography is important in this regard, as it enables researchers to learn about and interact with communities in a short period of time. Pink and Morgan concur and explain that:

> *'short-term' ethnography can be viewed in relation to a specific collection of research practices and significance levels and that it is not necessarily defined by long-term engagement in the lives of other people. Rather, it entails thorough excursions into people's lives, employing observational methods to establish contexts in which to immerse them into questions that are to disclose what matters to those people in the context in which the researcher is attempting to investigate and discover.* (2013, p.351)

Pink and Morgan's description of "*short-term*" ethnography aligns with the time constraints that this research had to work within. It allowed for interactions with coastal communities to explore, understand, and learn about their diverse connections, relationships and cultures with the ocean and coastal areas through observational and other complementary methods. By utilising interactive observation techniques including participant observation and collaborative qualitative data analysis (Millen, 2000), insightful information about Namibian ocean heritage was captured.

3.2. Research Setting, Participants and Data Gathering Approach

Employing the practice of rapid ethnography, 18 workshops were conducted with co-researchers from Swakopmund, Walvis Bay and the Topnaar ǂAonin community. The workshops duration was between 2-3 hours, over a period of seven months between 2021 and 2023. The co-researchers ages ranged from 18 to 65 and included individuals who were born and raised in coastal towns and young adults from the Topnaar ǂAonin community. Depending on availability, some co-researchers attended all the workshops, while others only some. As a result, the number of co-researchers who attended individual workshops ranged from 2 to 9.

The diverseness within the group was evident in terms of educational levels, age group, gender, languages spoken, digital literacy, and cultural expectations towards ways of interaction, self-expression, and knowledge sharing. This research notes that it did not encounter any challenges brought on by the heterogeneity of the group, rather, it encouraged collective participation.

3.2.1. Participant Selection Process

Participants were selected based on the criteria that they reside in Swakopmund and Walvis Bay. Consequently, the author employed convenience sampling and reached out to Ministries, local councils, and chairpersons of fishing associations, women groups, fishermen groups and acquaintances for recommendations. Following referrals from the Ministries and local councils, as well as chairpersons of various groups, the author contacted recommended groups

and extended invitations for their involvement in workshops, contingent upon their availability and willingness. The author contacted 25 individuals, of which 14 confirmed their interest in participating in the workshops: nine co-researchers were from Swakopmund and five from Walvis Bay. Two of the Walvis Bay co-researchers are part of the Topnaar ǂAonin community (see Section 4.1.2 for a discussion of the history of the Topnaar ǂAonin people).

Unfortunately, one co-researcher from Swakopmund was unable to continue attending the workshops and withdrew from the research after two workshops. She did, however, give consent for her contributions to be included in this work.

3.2.2. Establishment of Alias Names

The author is of the opinion that referring to the individuals participating in this research as participants distanced them from the collaborative work of this project. Addressing the co-researchers as participants, implied their role in the research was limited to only being participants; however, that is not the case. Co-researchers collaborated and contributed substantially to the research. They gathered information, shared their ocean heritage, co-produced *Efuta Letu Sida Hurib* and assisted with the preparation of the demonstrative feedback sessions. They were indeed central to the research process.

Since this research focuses on contributions from co-researchers regarding ocean heritage, the subject of including real names emerged during one focus group conversation. Co-researchers debated whether to use their real names to accompany their contribution on *Efuta Letu Sida Hurib*.

In these discussions, co-researchers were very adamant about including their real names on the AR application. The reason being the information included on *Efuta Letu Sida Hurib* held significant value and represented cultures, histories, beliefs, identities and described ways of life. Co-researchers shared that including their names on *Efuta Letu Sida Hurib* would credit their participation in developing the application and would create a footprint of their work while engendering a sense of belonging and ownership. The notion that names being included on *Efuta Letu Sida Hurib* would make co-researchers proud (for having been part of and created something) and bring about recognition (from other people), indicates that names have a substantial influence on how people see themselves, and how they connect and identify with their surroundings, people, cultures, histories, and beliefs. Names represent the most valuable possessions in our lives, they link us to our origins, to our past (Berdzenishvili, 2021), and they give significance to everything (Giovagnoni, 2019). A name is the most direct link people have

to their unique identity. It is a sign of respect, a courtesy gesture and a means of acknowledgement (Russell, 2014). Although co-researchers wanted their names included on the app, they requested that their real names not be included in this thesis to maintain anonymity. To ensure confidentiality, the submitted archived version includes alias names instead. Instead of using conventional alias indicators, such as Participant 1, P2, or Participant A, co-researchers were asked to come up with aliases to anonymize and reference direct quotes (see Table 1).

#	Alias Name	Gender	Town
1	Morangie	M	Walvis Bay
2	Haba	F	Swakopmund
3	Jota	F	Swakopmund
4	Rejoice	F	Walvis Bay
5	Letisia	F	Swakopmund
6	Sara-Leigh	F	Walvis Bay
7	Ousitjie	F	Swakopmund
8	Anna	F	Swakopmund
9	Edwin	M	Walvis Bay
10	Lato	F	Swakopmund
11	Sofia	F	Swakopmund
12	Lucio	M	Walvis Bay
13	TheOne	M	Swakopmund
14	Kapandu*	F	Swakopmund

Table 3.1: Alias names, gender, and towns of co-researchers. The author collaborated with 14 co-researchers from Walvis Bay and Swakopmund. The co-researcher with an asterisk (*) only attended the first two workshops.

3.2.3. Approaches for Gathering Data

The rationale behind the researcher's choice to collaborate with coastal communities was motivated by the need to understand the intricate connections and relationships that people have with the ocean and this collaboration was essential in addressing the research questions.

A qualitative approach is employed to facilitate workshop discussions and collect data about ocean heritage. Methodologies encouraging in-depth investigations into nuanced ocean connections held by co-researchers were adopted. This approach prompted a thorough understanding and analysis of different ocean heritages shared by co-researchers, further evaluated the role and significance of technology in the context of recording and digitally preserving ocean heritage, and facilitated workshop observation and analysis techniques. This research employed the following methods:

Focus Group Workshops: The focus group workshops included group discussions about ocean heritage; explored digital technologies and AR interaction experiences, co-producing *Efuta Letu Sida Hurib* and testing, evaluating, and refining the co-produced *Efuta Letu Sida Hurib.* The focus group workshops also included reflection sessions for final views and discussions about *Efuta Letu Sida Hurib* and the ocean.

Dialogue Approach: The focus group workshops followed a dialogue-based approach that facilitated conversations about ocean heritage and experiences between author and co-researchers. This approach enabled active participation from co-researchers as they engaged in ocean related debates.

Questionnaire: In phase 3, co-researchers from Swakopmund and Walvis Bay answered the research questionnaire used to gather qualitative data about *Efuta Letu Sida Hurib*'s usability and additional information about ocean heritage.

Participant Observation: The author applied participant observation techniques throughout the workshops to gain an in-depth understanding of the discussions co-researchers held, their contributions and interactions with *Efuta Letu Sida Hurib*.

Note-Taking: The author attentively took notes during the focus group discussions. This method was used to organise the information and obtain an understanding of the various ocean concepts discussed.

3.3. Research Approach and Workshop Structure

An overview of the 18 workshops conducted during two separate fieldwork trips to Namibia is presented in this section.

- First fieldwork trip: January 2022 to April 2022
- Second fieldwork trip: January 2023 to February 2023

The workshop formats are presented in Tables 3.3 to 3.10, which include the title of the workshops, the towns where they were held, dates and times, number of attendees and the methods used.

The research's design process and workshops were categorised into three distinct phases (see Fig. 3.2), which facilitated the organisation and structure of the research activities while also assisting data gathering and analysis. Each phase contributed to the progression of the research. The different phases are ocean knowledge exploration, design and digital co-production, and evaluation and reflection, each consisting of several workshop sessions.

The phases followed a cyclical flow of five stages (see Fig 3.1), including diagnosis, planning, activity, observing, and reflecting.

- The **diagnosis stage** established the research context (Namibian coastal communities) and examined the topics (see the research questions in Section 1.2) that this research aimed to explore. During the diagnosis stage, a research plan to address the research questions was formulated.
- The **planning stage** focused on the development and structure of the research process and it worked on refining the concepts used while investigating this research's priorities. The planning stage involved outlining the operational procedures for each research phase, including the methodologies and activities that were employed.
- The **implementation stage** executed the plans that had been formulated and incorporated them into the workshop activities.
- The **observation stage** analysed how co-researchers interacted with different digital technologies (see Table 3.3) and gathered necessary information shared by co-researchers about ocean heritage, the different technologies, and their preservation roles.
- The **reflection stage** focused on iteratively refining *Efuta Letu Sida Hurib* and having reflective discussions and opinions about the research, workshops, and co-production

process in order to understand and learn what may have been done differently and then reflect again.

The research phases and workshop names are displayed in Table 3.2, and the methods used for each workshop are explained in detail in Section 3.3.

First Investigative Workshops		
Phase 1		**No. of workshops**
1	Understanding ocean knowledge, cultural heritage, and connection to place	2
2	Exploring different cultural heritage digital technologies	2
3	Exploring ocean relationships signified by ocean objects/materials	2
4	Co-production of *Efuta Letu Sida Hurib.*	2
5	*Efuta Letu Sida Hurib* testing, refinement, and reflections.	3
Second Investigative Workshops		
Phase 2		**No. of workshops**
1	*Efuta Letu Sida Hurib* acceptance testing, refinement, and reflections.	1
2	*Efuta Letu Sida Hurib* demonstrative feedback sessions.	5
Phase 3		**No. of workshops**
3	Final *Efuta Letu Sida Hurib* testing, deployment, and research reflection dialogue.	1

Table 3.2: Names of workshops conducted displayed under the phases they in which they took place.

3.3.1. First Investigative Fieldwork Trip

The first workshops took place from January 2022 to April 2022, and were conducted in Swakopmund at the Swakopmund Municipal Bungalows Restcamp and in Walvis Bay at the Walvis Bay Community Centre. 11 workshops were conducted and executed using the methods

explained in Section 3.2.3. The author incorporated icebreaker activities designed to establish rapport and create an open, relaxed, and comfortable environment for co-researchers to engage with one other, share ideas, and actively participate (Solihat, Astuti and Satriani, 2020). These activities also encouraged collaborative group work as illustrated in Figure 3.2, which shows co-researchers participating in workshop activities. With consent from co-researchers, the workshops were recorded in both audio and video formats, and photographs were also taken.

Figure 3.2: Co-researchers writing down their ocean contributions that indicating why the ocean is important and how it benefits them. Photographs: Marly Muudeni Samuel, 2022.

Inclusive participation options that accommodate all co-researchers were considered, as well as potential challenges that may be encountered, such as language or communication barriers, low engagement or lack of motivation, digital literacy, lack of infrastructure, and maintaining community relationships. During the workshops, different participation and contribution options were presented to co-researchers. Co-researchers could either share opinions in written format or express themselves verbally. The research further considered varying language expressions. Most co-researchers expressed themselves in English, while others used a combination of English and Oshiwambo, or English and Afrikaans. Some co-researchers chose

to express individual opinions verbally because they could not write in English. The author reiterated that contributions could be shared in any format, including writing or speaking in English or any Indigenous language. These options enabled co-researchers to freely express themselves without limitations.

The research also considered the possibility of disruptions and appropriate adjustments. Due to the COVID-19 pandemic, protective regulations implemented by the Namibian government were followed to prevent the spread of the virus. This included social distancing (1-2 metres of space between individuals); wearing of masks; sanitising of hands, surfaces and any shared equipment; contact tracing (writing down ID/mobile phone numbers, to be kept for 30 days and upon request provided to the authorities) and adhering to curfew.

3.3.1.1. Phase 1: Ocean Knowledge and Technology Exploration

The Exploration phase included two workshops, each conducted in Swakopmund and Walvis Bay. For the results of the workshops outlined in this chapter, see Chapter 4 focusing on the exploration of ocean heritage; Chapter 5 addressing the technology exploration and co-production results; Chapter 6 outlining the technical co-production process and development of *Efuta Letu Sida Hurib*; and Chapter 7 which includes the demonstration and engagement results from respondents (local coastal community members, different from the co-researchers, who attended the demonstrative feedback sessions to test and evaluate *Efuta Letu Sida Hurib)*.

Workshop 1: Ocean Knowledge Exploration

The aim of the first workshop was to acquire information from co-researchers about diverse ocean heritage. Firstly, a Participant Information Sheet (PIS) explaining this research's goals was shared with co-researchers. Consent forms were also distributed (see Appendix 1: E-F). The author explained the research process, consent options, activities and data gathering methods, including photography and audio and video recording. Clarification was given that collected data could be used in publications, presentations, reports or examinable formats (thesis) for the purposes of research and teaching. Co-researchers were informed of their right to withdraw from the research study if they were no longer interested in participating. Following this, co-researchers asked questions, read through the PIS, and gave fully informed consent.

The different workshop details and methods employed in Workshop 1 are explained in the table below:

Workshop Name	Understanding ocean knowledge, cultural heritage, and connection to place	
Town	Walvis Bay	Swakopmund
Date	10 January 2022	17 January 2022
Time	12h00 – 14h30	12h00 – 14h30
No. of Attendees	3 co-researchers	6 co-researchers
Methods	At the begin the workshops the author asked several open-ended questions about ocean heritage: 1. In your own opinion, how would you define culture and heritage? 2. Why is the ocean important to you and in what ways does the ocean sustain and provide for you? 3. Do you think much more can be done to protect and conserve the ocean? If yes, what more can be done to protect and conserve the ocean? 4. How would you describe the Namibian coast? 5. What is your relationship with the ocean or how are you connected to it? 6. Are you familiar with any ocean related cultural customs, traditions, beliefs, or practices? 7. Does culture influence your view on oceans? Co-researchers engaged in a discussion, sharing various viewpoints and perspectives on ocean heritage, literacy, conservation, and management. At the end of the workshop, co-researchers wrote a letter or poem dedicated to the ocean, which they shared in the following workshop.	

Table 3.3: Information and methods employed during the workshop focused on understanding the ocean, cultural heritage, and connection to place.

Workshop 2: Technology Exploration

The technology exploration workshops enabled the author to examine co-researchers existing knowledge of digital technologies, whether they had engaged with them before and their awareness of both traditional (through books, songs, storytelling, art, and museums) and technological approaches to sharing, recording, and preserving knowledge and cultural heritage.

Workshop Name	Exploring different cultural heritage digital technologies	
Town	Walvis Bay	Swakopmund
Date	11 January 2022	18 January 2022
Time	12h00 – 14h30	12h00 – 14h30
No. of Attendees	3 co-researchers	6 co-researchers
Methodology	Five pre-existing digital technologies, each with different functionalities and objectives, were presented to co-researchers for them to learn about the advantages and disadvantages of digital technologies, with a focus on AR applications and how they function and are used across different contexts. This approach allowed co-researchers to familiarise themselves with technologies that support and promote digitalisation and preservation of knowledge and cultural heritage, learning and experiencing how digital technologies work and the limitations they face. At the end of the workshop, co-researchers were asked to bring an object or material that symbolised how they connected with the ocean to the third workshop.	

Table 3.4: Illustrates the methods employed in the workshops for technology exploration.

The following five digital technologies were explored by co-researchers (see Figure 3.3 showing co-researchers engaging with technologies). These technologies are further explained in Section 5.1.

- San Cultural Heritage AR Fridge Magnets, Namibian San community context (Winschiers-Theophilus et al., 2020).

- Making sense of the past AR Fridge Magnets, Namibian youth context (Kambunga, Winschiers-Theophilus and Smith, 2020).
- StoryBeads digital capturing, South African BaNtwane people context (Smith et al., 2011).
- Badenoch the storylands, Scotland context (Badenoch The Storylands, 2021) (https://badenochstorylands.com/).
- Prototype AR application developed by the researcher.

Figure 3.3: Top-right, co-researcher engaging with different digital and immersive technologies. Photographs: Marly Muudeni Samuel, 2022

It is imperative to highlight that the above digital technologies were explored because of the context in which they were created and their potential to support the preservation of knowledge and cultural heritage. The prototype was developed by the author to give an example of an AR application that is cognisant of the challenges posed by financial limitations and lack of technological infrastructure within Namibian informal and formal community settings. The prototype, which included markerless AR functionalities, was designed to be adaptable and function on both low-end and high-end smart digital devices. The technology exploration workshops facilitated discussions about the importance of digital technologies and how they can be used to preserve knowledge and cultural heritage.

3.3.1.2. Phase 2: Design and Digital Co-production

The design and digital co-production phase is divided into two workshops.

Workshop 1: Familiarity with Ocean Relationships

The objective of the workshops was to reveal, examine, and understand the significance of the ocean and the intricate relationships that exist between co-researchers and the ocean. It further investigated ways in which the ocean benefits coastal communities and revealed the importance of ocean Indigenous, experiential and cultural knowledge for co-researchers.

Workshop Name	Exploring ocean relationships signified by ocean objects/materials	
Town	Walvis Bay	Swakopmund
Date	31 January 2022	07 February 2022
Time	12h00 – 14h30	12h00 – 14h30
No. of Attendees	5 co-researchers	8 co-researchers
Methodology	As indicated during the previous workshop, co-researchers were asked to bring an object or material that represented their ocean connections. Some co-researchers shared the objects/materials symbolising their relationships and that reflect the importance of the ocean for them, while other co-researchers had forgotten. However, this did not pose any challenge because new co-researcher had joined workshop and the assignment was moved to the following workshop to accommodate and give the new co-researchers adequate time to bring their objects/material representations of the ocean. Because of the new co-researchers, the author once again explained the research's objectives, PIS and consent forms. After the explanation and signing of consents, co-researchers (new) explored, and engaged with the digital technologies explored during the previous workshop, and they also shared their perspectives regarding the importance of the ocean and how they connect with it. Before the end of the workshop, co-researchers who brought objects/materials presented them to the group, explaining why they	

	chose to bring those specific objects/materials and how they symbolise their ocean connection. The primary goal of this workshop was to reveal the different relationships that coastal communities share with the ocean, which prompted a discussion about ocean related topics, including culture, history, education, fishing, pollution, and conservation.

Table 3.5: Illustrates the methods employed in the workshops about familiarity with ocean relationships.

Workshop 2: Co-creation, Co-design, Co-production

This workshop facilitated the collaborative creation, design, and surfacing of co-researchers' personal narratives about ocean heritage. This workshop also focused on understanding and creating strategies to integrate these narratives onto *Efuta Letu Sida Hurib*.

Workshop Name	Co-production of *Efuta Letu Sida Hurib*	
Town	Walvis Bay	Swakopmund
Date	01 February 2022	08 February 2022
Time	12h00 – 14h30	12h00 – 14h30
No. of Attendees	5 co-researchers	8 co-researchers
Methodology	Co-researchers presented the objects/materials they brought (see Figure 3.4). The presentations incorporated various methods, including verbal explanations, written descriptions, role-playing, and musical performances. Within their presentations, co-researchers explained why they brought their specific objects/materials and the significance that the items held in relation to the ocean. With co-researchers consent, the presentations were audio and video recorded. Following the presentations, the majority of co-researchers wrote and audio recorded their explanations using an audio recorder provided by the researcher. Other co-researchers who were not comfortable writing or recording their explanations during the workshop chose to go and write or record their explanations at home using WhatsApp audio messages, while some co-researchers asked the author to audio record	

	their explanations. These written and audio explanations were then incorporated on *Efuta Letu Sida Hurib* alongside the co-researcher's object and material ocean representations. The author provided an explanation detailing how the ocean objects were going to be converted into 3D models, and co-researchers who were comfortable with participating in the process of creating 3D models took photographs of their objects, and the author took photographs of the other co-researchers' objects. These photographs were then imported into 3DF Zephyr and converted into 3D models (see Section 5.1.1 for an explanation of the 3D conversions). Finally, co-researchers discussed and came up with ideas about different key development features and functions to be incorporated onto *Efuta Letu Sida Hurib*. This discussion focused on the application name, colours, icons and photograph options, page layouts, application structure, and other features that co-researchers wanted integrated onto *Efuta Letu Sida Hurib*. The data, ideas and opinions included on *Efuta Letu Sida Hurib* were contributed by co-researchers based on their knowledge and experience, which reflected their connection to the ocean, its benefits and importance, how and why it should be conserved and ways in which other people can learn about the ocean.

Table 3.6: Illustrates the methods employed in workshops about Co-creation, co-design, co-production 1.

Figure 3.4: Co-researchers presenting ocean objects/materials, symbolising individual ocean heritage. Photographs: Marly Muudeni Samuel, 2021

3.3.1.3. Phase 3: Testing, Refinement and Reflection

The refinement and reflection phase comprised one workshop conducted in both towns.

Workshop 3: Application Testing, Refinement, and Reflections

This workshop evaluated and enhanced *Efuta Letu Sida Hurib's* content and functionality. Drawing upon the work of Jake-Schoffman et al. (2017), this evaluation process identified potential usability concerns related to navigation and primary features. By doing so, detected challenges were addressed and corrected to ensure design appropriateness, efficiency and alignment with co-researcher's requirements and vision. The workshop provided a platform for co-researchers to reflect on the methodologies employed, which enabled mutual learning about the ocean and digital technologies.

Workshop Name	*Efuta Letu Sida Hurib* testing, refinement, and reflections		
Town	Walvis Bay	Swakopmund	Windhoek (Walvis-Bay co-researchers)

Date	16 March 2022	17 March 2022	24 March 2022
Time	12h00 – 14h30	12h00 – 14h30	13h00 – 14h00
No. of Attendees	3 co-researchers	6 co-researchers	2 co-researchers
Methodology	The final refinement and reflection workshops were held at a different venue. Rather than meeting at the usual community halls, the co-researchers proposed that the workshops be held at the local town beaches. A separate workshop was arranged in Windhoek on a different date for two co-researchers from Walvis Bay who were unable to attend the workshop scheduled in Walvis Bay. In these workshops, co-researchers interacted with *Efuta Letu Sida Hurib*. They evaluated their individual ocean contributions, the colours incorporated, photographs provided, pages and functionalities, and they offered new suggestions aimed at refining and improving *Efuta Letu Sida Hurib*. Moreover, co-researchers engaged in reflective dialogue, and discussed and offered individual feedback about the research approach, and they further shared perspectives and knowledge gained throughout the course of the workshops.		

Table 3.7: Illustrates the methods employed in the refinement and reflection workshop.

3.3.2. Second Investigative Fieldwork Trip

The second fieldwork trip took place from January 2023 to February 2023, with two workshops conducted with co-researchers.

3.3.2.1. Phase 2: Design and Digital Co-production (Application Acceptance testing, and refinement)

Workshop 1: *Efuta Letu Sida Hurib* Acceptance Testing and Refinement

For this workshop, all co-researchers gathered for a joint workshop in Swakopmund and reflected on the research process, networked, and exchanged knowledge. Building upon the amendments implemented to *Efuta Letu Sida Hurib* by the researcher, the group conducted additional testing of the application and offered subsequent feedback. This workshop identified

potential usability and design concerns found on *Efuta Letu Sida Hurib* and determined whether it met the expectations of co-researchers.

Workshop Name	*Efuta Letu Sida Hurib* acceptance testing, refinement, and reflections
Town	Swakopmund
Date	09 January 2023
Time	09h00 – 12h00
No. of Attendees	8 co-researchers (six from Swakopmund and two from Walvis Bay)
Methodology	Co-researchers engaged with *Efuta Letu Sida Hurib,* testing its usability and functions and they provided feedback on how it looked and worked and provided refinement suggestions. Co-researcher completed the questionnaire to gather additional information about *Efuta Letu Sida Hurib* and their ocean relationships (questionnaire feedback and suggestions outlined in Chapter 7). Following the completion of the questionnaire, co-researchers engaged in a discussion about the upcoming demonstrative feedback sessions and provided suggestions for potential groups and organisations where *Efuta Letu Sida Hurib* could be demonstrated.

Table 3.8: Illustrates the methods employed in the refinement and reflection workshop.

3.3.2.2. Phase 3: Testing, Refinement and Reflection

Workshop Session 3: Final *Efuta Letu Sida* Hurib Testing, Deployment, and Research Reflection Dialogue

The final workshop took place in Swakopmund, where all co-researchers gathered to reflect on the research, co-production process and the final AR application (see Figure. 3.5). This workshop focused on analysing feedback received from co-researchers and respondents (see Chapter 7 for respondents' contributions) about *Efuta Letu Sida Hurib* and discussed similarities and differences presented in these contributions. It further served as a concluding reflective workshop where co-researchers summarised collective views about *Efuta Letu Sida Hurib*, the value of the ocean, the importance of conserving it, and the role of digital technologies in supporting and preserving ocean heritage.

Figure 3.5: Co-researchers engaging in discussions during the final workshop session. Photographs: Marly Muudeni Samuel, 2022

Workshop Name	Final *Efuta Letu Sida Hurib* testing, deployment, and research reflection dialogue
Town	Swakopmund
Date	08 February 2023
Time	09h00 – 12h30
No. of Attendees	7 co-researchers (five from Swakopmund and two from Walvis Bay)
Methodology	The author provided feedback to co-researchers about the suggestions provided during the demonstrative feedback sessions (see Chapter 7). The workshop concluded with a reflective discussion about the importance of the ocean and research approach and culminated with deliberations on future work and the way forward for *Efuta Letu Sida Hurib*.

	Efuta Letu Sida Hurib was then shared and deployed to co-researchers. Co-researchers with compatible mobile devices received *Efuta Letu Sida Hurib's* Android Package Kit (APK) on their mobile phones, while co-researchers with mobile phones that did not support *Efuta Letu Sida Hurib*, received the APK file on a memory stick (see Section 6.3.3 for a discussion about the compatibility of mobile devices).

Table 3.9: Illustrates the methods employed in the final reflective workshop session.

3.4. Approach to Handling and Managing Data

When collaborating with communities, researchers have to consider and follow ethical approaches to research. Therefore, this research diligently managed the workshops, as well as the collected data in accordance with ethical considerations as indicated in Section 1.5.

The audio recordings collected during the workshops were transcribed by the researcher, omitting any information (their names) that co-researchers did not wish to share. Additionally, the written contributions in Oshiwambo were translated into English by an Oshiwambo/English teacher and verified by the author. The Kheokhoegowab contributions were translated by the co-researcher who shared them (see Section 1.3). Given that some contributions in Oshiwambo and Kheokhoegowab were rich in metaphors, clarification about their meanings was requested from co-researchers. The author was mindful of correctly representing collected research data and ensured that presented information about names and terminologies related to culture, traditions, and practices was not misrepresented.

This research notes that in some instances when co-researchers were unsure about answering a certain question, they chose to respond only after reflecting on it during the workshops or later at home. In cases where they chose to reflect and deliberate at home or consult with other people, they shared their reflections during the next workshop.

3.4.1. Data Capture and Knowledge Preservation

Data capturing in this context refers to surfacing and recording shared information and knowledge related to ocean relationships, cultural practices, traditional customs, wellbeing, and objects/materials shared by co-researchers. Knowledge preservation aims to safeguard Indigenous and modern knowledge and promote cultural heritage and identity (ECOSOC, 2019; Kotut, 2021), as well as encourage the continuation of culture within societies. It focuses on recording shared data through knowledge management systems, in this case through *Efuta*

Letu Sida Hurib, to support and promote long-term knowledge accessibility. The documented knowledge, including the customs of the *onyoka* jewellery and the traditions related to it; the uses of the !Nara plant, seaweed, seal oil, and ocean spiritual practices (further outlined in Chapter 4) offer insight into the importance and diverse uses of ocean resources. McCarty and Nicholas (2014, p. 122) argue that "*customary cultural practices remain efficacious mechanisms for contemporary youth and families…to maintain continuity of identity while adapting to modernity—thus enabling them to sustain historical and metaphorical connections to the past*". By recording and preserving knowledge and cultural practices, connections to the past are consolidated, as communities retain, learn and share their cultural practices and traditions. This strengthens cultural grounding and identities, ensuring that cultural heritage remains relevant and promotes inclusive practices in the digital era.

Data capturing and knowledge preservation were investigated. Data gathering was the initial step in which ocean knowledge and information was collected and documented. The process also allowed reflections on the relationship between co-researchers and the author. Following data collection, the data was evaluated using qualitative content analysis (QCA) (see Section 3.5.1), to understand and arrange the knowledge into themes.

3.4.2. Two Types of Preservation Explored

The primary objective of this research was to explore the preservation of ocean heritage and relationships through *Efuta Letu Sida Hurib (*a digital platform). However, this research also recognised and addressed the need for long-term software perseveration and maintenance of *Efuta Letu Sida Hurib* to prevent it from becoming outdated and redundant. Consequently, *Efuta Letu Sida Hurib* and data collected during this research are being preserved at the Glasgow School of Art open-access data repository. The author will continue maintaining the application in accordance with software updates and co-researchers' suggestions. The research output will also be accessible to One Ocean Hub researchers in accordance with consent provided by co-researchers. Individuals interested in learning more about this research and its outcomes can access the thesis, including supporting digital data, on the GSA repository. Outside institutions interested in learning more about this research and conducting similar research will need to identify a suitable repository to preserve the content and the digital platform they will produce.

3.5. Methods and Procedure of Data Analysis

Two qualitative analysis methods, namely Qualitative Content Analysis and Thematic Analysis are used to investigate, interpret, structure, and analyse words, phrases, descriptions, concepts, and ideas shared by co-researchers. The benefits and challenges of these two analysis approaches are discussed below.

3.5.1. Qualitative Content Analysis (QCA)

Qualitative content analysis (QCA) is adopted to evaluate similar input patterns of contributions shared by co-researchers. Hsieh and Shannon (2005, p. 3) define QCA as "*a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns*". QCA is thus utilised to construct meaning from the contributed content of text through word coding (see also Berelson, 1952; Mayring, 2000; Patton, 2002; Hsieh and Shannon, 2005; Schreier, 2012). QCA fundamentals focus on investigating the view of speech or text in specific contexts, which allows researchers to understand social realities in a subjective but scientific manner.

Because QCA works with a wide range of data, it is critical that the research being conducted has specific questions and a set goal for grounding. If not, researchers are at risk of being overwhelmed as they group large amounts of text into different codes and summarise these codes into thematic categories.

Hsieh and Shannon (2005) define three types of QCA approaches: conventional, directed, and summative. These approaches are used to construct meaning from research content text data using various text coding strategies. When using conventional QCA, coding categories are derived directly from the text data. When using directed QCA, the research analysis begins with a theory or relevant research findings to guide the coding strategy. Summative QCA counts and compares research keywords and content before interpreting it.

This research utilises conventional and summative QCA to evaluate text content patterns, while also grouping the text data content into themes. The author analysed co-researchers' contributions including the significance of ocean heritage and ways of sustaining the ocean. This research further investigated the significance of the objects/materials brought by co-researchers, analysing how and why they represent co-researchers ocean relationships. Lastly, this research examines the photographs, written, audio and video data, poems, and love letters to the ocean shared by the co-researchers, further surfacing the intricate connections they have with the ocean.

After gathering and structuring data provided by co-researchers, this research employed the above-mentioned approaches to recognise the frequency with which an idea, word or phrase is shared or spoken to identify and guide patterns for deeper interpretations.

3.5.2. Thematic Analysis

Thematic analysis is an efficient yet adaptable method for analysing qualitative data that can be used in a diverse array of epistemological or paradigmatic orientations and is an adequate method of analysis for attempting to understand experiences, behaviours, thoughts (Jansen and Warren, 2020) and interpreting patterns of meaning (themes) across a data set. As asserted by Clarke and Braun (2017, p. 1) thematic analysis is "*unusual in the canon of qualitative analytic approaches, because it offers a method – a tool or technique, unbounded by theoretical commitments*".

Thematic analysis was employed and guided by the descriptions provided by Kiger and Varpio (2020) and Clarke and Braun (2017) in which collected data is grouped, analysed, and interpreted. Recognising that ocean relationships are shaped by individual and collective subjective experiences and contexts; six thematic steps were followed:

Six thematic steps

This research concentrated on the six steps analysis approach described by Braun and Clarke (2012) that has been frequently used in numerous qualitative literature. It is worth noting that Clarke and Braun's thematic analysis is intended to be an iterative, not linear, process in which subsequent steps may compel researchers to return to earlier steps in the context of new data or emerging themes that require further investigation. As evidenced in section 3.4.1., this research project was executed iteratively, transitioning between two research phases.

Step 1: Familiarising yourself with the data

Data sets relating to ocean heritage and relationships were collected using the methods defined in section 3.4. Active and repeated reading of the data ensured familiarisation.

Step 2: Generating initial codes

Qualitative data codes were generated based on data extracts from workshops, and written and recorded transcripts. Prominent phrases, words, ideas and questions provided the basis of diagnostic analysis. These terms of interest were recorded in initial code groups depending on thematic similarities.

Step 3: Searching for themes

Following code generation, possible themes were identified. Analysing, merging and comparing codes in relation to one another revealed that the themes were reflective of the original data.

Step 4: Reviewing themes

After data familiarisation, code generation, and theme searching, constructed themes were reviewed as well as all relevant codes and data citations under the themes, ensuring that each theme has adequate supporting data, with adequate similarities and consistency, and that data between themes are different enough to justify. The themes were then re-sorted and modified to better reflect and capture the coded data.

Step 5: Defining and naming themes

Definitions and narrative descriptions were created for each theme, explaining their importance to the research questions and focused on important aspect of each theme and which factors of the collected dataset it covered.

Step 6: Producing the report/manuscript

The author rounded up her analysis by providing a description with a clear and logical explanation of how data was interpreted, how selected themes were derived and why they are important. Narrative descriptions and representative data extracts, such as direct quotations from co-researchers, were included to describe data.

This research attempted to use Nvivo to generate research codes and themes. However, this presented challenges given the diverse language phrases found in the qualitative dataset, including broken English and Indigenous metaphors. Due to this fact, it was more effective to manually generate codes and themes. While software applications such as Nvivo offer substantial benefits, including boosting the accuracy of data, saving researchers from time consuming transcriptions and speeding up the analysis process (Zamawe, 2015), it is also important to recognise their limitations. For example, it is not easy to learn how to use the application and sometimes it cannot interpret data correctly (Dollah, Abduh and Rosmaladewi, 2017), particularly when dealing with data in multiple languages or the use of metaphors. Consequently, this research adopted the six-step analysis approach outlined by Braun and Clarke (2012) to extract textual codes and themes from the data.

3.5.3. Constructed Themes

Themes were manually conceptualised to capture the importance of the codes and relevant data extracts. The author ensured that each theme had adequate supporting data, that the themes are

not excessively large or diverse, that the data included within each theme has adequate similarities and consistency, and that datasets between themes are different enough to justify separation. The following themes were constructed from the codes generated through thorough reading and in-depth analysis of the collected data. These themes represent an amalgamation of ocean heritages and relationships contributed by co-researchers.

Though the themes collectively group similar shared data, the author acknowledges that co-researchers relationships with the ocean and its resources are quite entangled and present themselves in multiple themes. Therefore, some ocean objects/materials expressions do not necessarily fit into one defined theme because they have multiple facets of meaning for co-researchers. For example, artistic home decorations created with/from ocean resources could also have spiritual meaning. Consequently, some ocean expressions are represented in more than one theme. Detailed explanations of these themes and their representations can be found in Chapter 4.

3.5.3.1. Cultural and Historic Relationships

This research describes cultural and historic ocean relationships as innate ocean knowledge, heritage and connections with the ocean relating to traditions, history, customs, and beliefs passed down over generations. For example, the Aawambo people's ocean heritage and cultural relationships, where they collect seashells to make traditional jewellery such as *onyoka* and the Topnaar ǂAonin people's cultural and historic ocean songs and poems passed down through generations, which they recite as a way of respecting, remembering, and acknowledging their ocean roots.

The Cultural and Historic Relationships theme is constructed with the following data codes: cultural practices, history, beliefs, traditions, and customs.

3.5.3.2. Wellbeing Relationships

Ocean wellbeing is defined as distinctive relationships with the ocean that reflect through people's spirituality, health, emotional, psychological and physical wellbeing. Wellbeing relationships promote peace, health, growth, stability, and physical and psychological development. For example, some people believe that the ocean and its resources have healing powers and can be utilised for spiritual protection. Other people go to the beach to relax and destress, while others use the ocean for family gatherings, to exercise, to keep fit and to have fun.

The Wellness Relationships theme is constructed with the following data codes: health, spirituality, emotions, relaxation, stress reliever, and wellbeing.

3.5.3.3. Artistic Relationships

Artistic ocean relationships refer to creative expression inspired by the ocean and/or created using ocean resources. These artistic representations vary from seascape paintings and drawings, sculptures, crafts, jewellery, photographs, poems, songs, and dances. Artistic representations promote cultural and traditional customs, beliefs, and practices; they maintain psychological wellbeing and are also sold commercially for economic gain. In addition to encouraging creativity, artistic relationships also tell narratives of the past and present. For example, the Topnaar ǂAonin people sing songs and recite poems of appreciation to honour the ocean for the resources it provides (see Section 4.1.2, Figure 4.16).

The Artistic Relationships theme is constructed with the following data codes: art, songs, jewellery, *onyoka*, home decorations, crafts, driftwood, seashells, sea sand, and ocean rocks.

3.5.3.4. Economic and Livelihood Relationships

The Intergovernmental Oceanographic Commission (2021, p. 8) emphasises that "*the ocean plays a crucial role in sustainable and equitable development. Ocean-based industries directly employ more than 30 million people and benefit many hundreds of millions more, including informal or part-time workers and households who derive all or part of their livelihoods from the ocean and its resources"*

This research describes ocean economic and livelihood relationships as ocean connections and activities that benefit the livelihoods of Namibian coastal communities, and promote economic growth and sustenance. For example, Walvis Bay and Swakopmund community members rely on the ocean for fishing (for themselves, their families, and for profit), collecting seashells for traditional purposes, creating arts with driftwood, sea sand, seashells, and seaweed, painting, and organising ocean related activities and events.

The Economic and Livelihood Relationships theme is constructed with the following data codes: Income, provision, food, and ocean benefits.

3.5.3.5. Ocean Sustainability Relationships

According to a report by the OECD (2016), healthy oceans and marine ecosystem services support the ocean economy by providing critical life support functions on which human beings rely for their health and wellbeing. The ocean ecosystem provides numerous benefits ranging

from pollution control, storm protection, shoreline stabilisation and species habitats, to climate mitigation and food provisioning.

This research describes ocean sustainability relationships as the process of conserving and sustaining the ocean by incorporating knowledge and teachings that guide people to safeguard the ocean and the benefits it provides. For example, people can conserve and sustain the ocean by fishing responsibly, reducing pollution and waste and creating ocean sustainability and cleanliness awareness through mediums such as radio, TV, newspapers, posters, social media and digital innovations.

The Ocean Sustainability theme is constructed with the following data codes: Ocean sustainability, protection, governance, conservation.

3.6. Discussion

The methodologies employed in this research played a pivotal role in surfacing, exploring, and understanding ocean heritage and relationships and the co-production process of *Efuta Letu Sida Hurib*, which aimed at supporting, recording, and preserving intricate relationships between co-researchers and the ocean. By employing these methods and processes, this research effectively grounded the workshops in PD practices, exploring topics of ocean significance, digital technologies with a focus on AR, and the preservation of ocean heritage. This all-inclusive approach facilitated the analysis and understanding of the intricate connections and relationships that exist between co-researchers and the ocean. Additionally, it provided the author with an opportunity to reflect on her own connections with the ocean and her cultural heritage (the Aawambo cultural and traditional practices).

Through the diverse dialogues and exchanges, both author and co-researchers gained knowledge about individual and collective ocean relationships, the fundamentals of the ocean for people in relation to benefits, and the importance of ocean conservation and ocean heritage preservation through the use of digital technologies.

CHAPTER 4

WORKSHOP RESULTS: EXPLORING OCEAN HERITAGE AND RELATIONSHIPS

Chapter 4 explores research questions 1, 2, and 3, drawing on empirical results obtained during workshops with co-researchers. It includes a detailed outline of the research data expressing co-researchers' individual and collective opinions about their ocean heritages. Research findings, substantial and representative responses collected during the workshops and ocean derived themes, including cultural and historical wellbeing, artistic, economic and livelihood, and ocean conservation relationships, are examined.

During the focus group workshops, co-researchers discussed and shared individual and collective expressions of ocean heritage. After carefully analysing the results, the data was divided into themes:

- Cultural and historic relationships;
- Wellbeing relationships;
- Artistic relationships;
- Economic and livelihood relationships;
- Ocean conservation relationships;

The different themes, reflecting co-researchers' perspectives, are illustrated in Figure 4.1. Each theme includes various activities and practices that inform co-researcher's connections with the ocean.

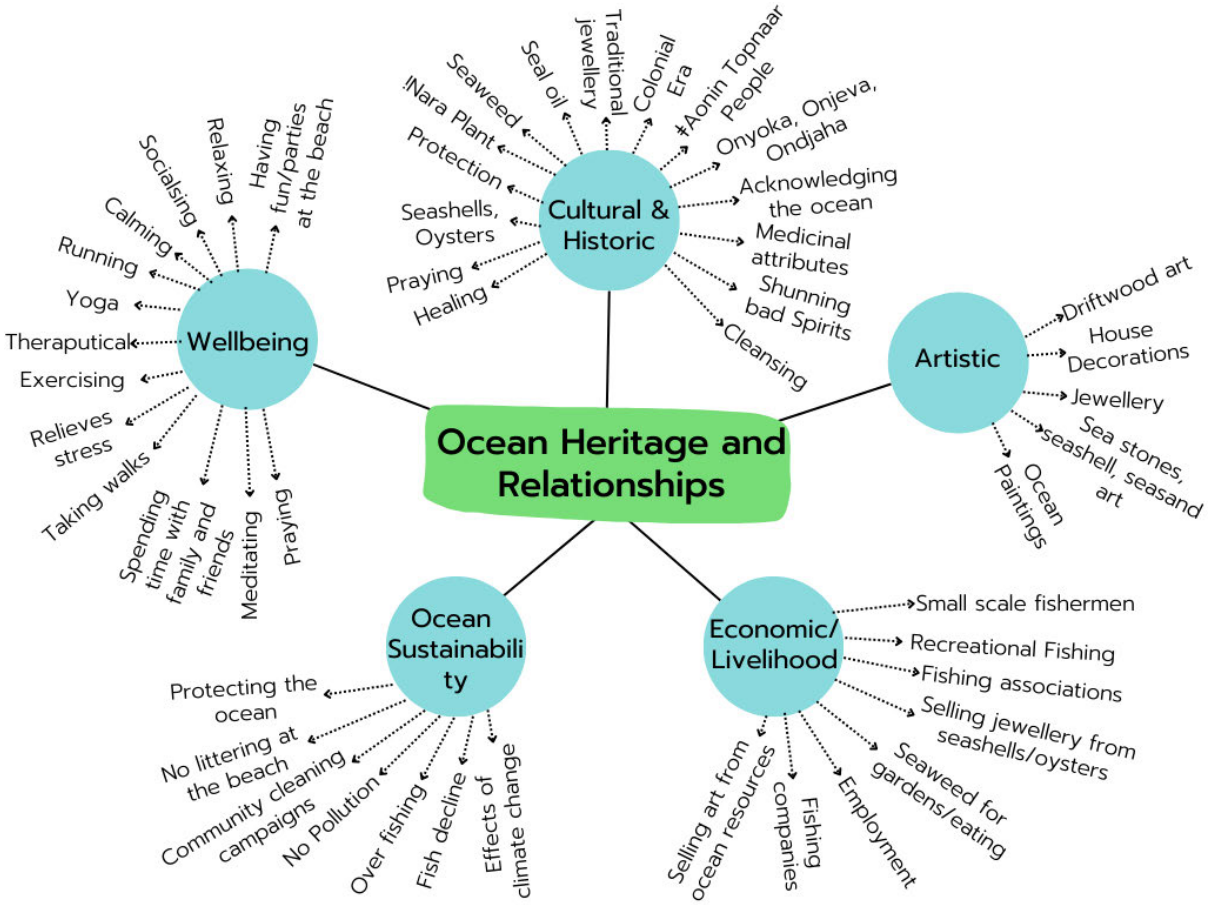


Figure 4.1: Ocean connections and relationships shared by co-researchers. Diagram: Marly Muudeni Samuel, 2022.

Co-researchers discussed the benefits of the ocean and how it provides for them, their communities, and the world. Existing ocean relationships and the ocean's role in contributing to economic growth and sustaining humanity were explored. Co-researchers demonstrated Indigenous and experiential knowledge and strong connections to the ocean and indicated that the ocean is important to them, their identities and communities. For some co-researchers, these diverse connections include hearing the ocean waves from their homes, appreciating, being afraid of or despising the ocean, visiting the beach for fun or meditation, and spending time with friends and families. For other co-researchers, these relationships are demonstrated by collecting oysters, mussels, seashells, and driftwood to create jewellery and art, by collecting seawater to sprinkle and seaweed to hang in homes to ward off bad luck and evil spirits, and by collecting seaweed to use as fertiliser and medicine and for nutritional purposes. The different themes are explained in the below sections.

4.1. Cultural and Historic Relationships

Unique perspectives about ocean culture and historical heritage were revealed during the workshops. Co-researchers emphasised that cultural heritage and history encompass customs,

traditions, nature, identities, and diverse ways in which people are connected to and feel about the ocean. On this point, Morangie noted:

> *"I am connected to the ocean because of my heritage, my people. It was not a choice to be connected to the sea. I come from a lineage that has a strong history with the sea, so now I have a strong connection to the sea because of that. This culture and history dates back hundreds of years, and though I did not create it, I must still follow it because of my roots. I also have the responsibility of carrying it on."* (Morangie)

The centrality of ancestral connections to the sea emerged as a fundamental component of ocean heritage, with co-researchers affirming the importance of Indigenous and experiential knowledge, especially that held by elders. For example, grandparents and elders have a wealth of knowledge about intrinsic cultures and traditions that can be passed down to descendants. Co-researchers affirmed that descendants have a responsibility to protect and continue cultural heritage legacies and the Indigenous way of life. Regarding this, two co-researchers from the Topnaar ǂAonin community further expressed that:

> *"When you talk about culture and heritage, it is something you cannot separate from, it is something to which you are deeply connected and feel strongly about... If you do not really know where you came from, it is as if you are not truly rooted in who you are. When we talk about heritage and culture, it is important to remember that they are rapidly disappearing in today's world, so it is important that we narrate our stories so that they can be preserved for future generations. And if we do not stand up, who will stand up for us. We must be the solution."* (Morangie)

> *"If you do not know your culture and heritage or your history, you are lost as a person. Then you do not know which way to go because you do not have certain cultural values to follow and live by."* (Sara-Leigh)

Morangie stated how he enjoys conversing with his grandmother, asking questions about ways the Topnaar ǂAonin ancestors interacted with and survived from the ocean, how the Topnaar people were driven from the seashores and into the Namib desert, how land displacement occurred, and about his family tree and lineage. He further mentioned that to date, you find house remains (see Figure 4.2) at the seashores of Sandwich Harbour, where the Topnaar ǂAonin used to reside decades ago.

Figure 4.2: Remains of a house (believed to be a Topnaar house) by the seashore at Sandwich Harbour. Photograph: Marly Muudeni Samuel, 2020.

Co-researchers also discussed their cultural and emotional relationships with the ocean in terms of the beauty of the sea, childhood beliefs and stories (such as those about mermaids and sea monsters that were heard of but not seen), the power of the ocean and the wonders of how God created something very unique. Sara-Leigh explained that as a child, she was told stories about the ocean's consciousness and how it senses everything around it. She shared that the ocean would be harsh if a menstruating woman visited the sea and would not reward the fisherman with fish or that it would bond with someone who has close connections with it. However, she did not not specify what or how close ocean connections are signified. The discussion about ocean culture and heritage revealed that co-researchers diverse cultural knowledge is informed by ethnic identities and affiliations and the historical, cultural, and traditional customs that connect them to the ocean.

4.1.1. Oshiwambo Ocean Cultural Context

The Aawambo people of Namibia have always performed ceremonies while wearing traditional jewellery and ornaments commonly made from oysters and seashells. Previously, Aawambo women wore jewellery and belts made with ostrich eggs, accompanied by big buttons made of *ekipa* (ivory bones) (Brasche, 2003) (see Figure 4.3). However, as years passed, ostrich eggs and ivory became scarce. Consequently, Aawambo people started creating traditional jewellery

and ornaments with oysters and seashells. In the Aawambo tribes, these jewellery and ornaments bear distinct names, such as *onyoka*, *oshinyeye*, and *ondjeva* (these are different Oshiwambo dialectic names for the necklace jewellery). They are specifically made for various age groups, from babies and children to older women. Some Aawambo co-researchers went into great detail and shared knowledge about the significance of traditional jewellery and ornaments and how they are used in specific ceremonies. The importance of the ocean to the Aawambo culture was also explored in relation to traditional jewellery and beads made from mussels, oysters, and seashells (mostly cockle shells) associated with healing, protection, and spirituality.

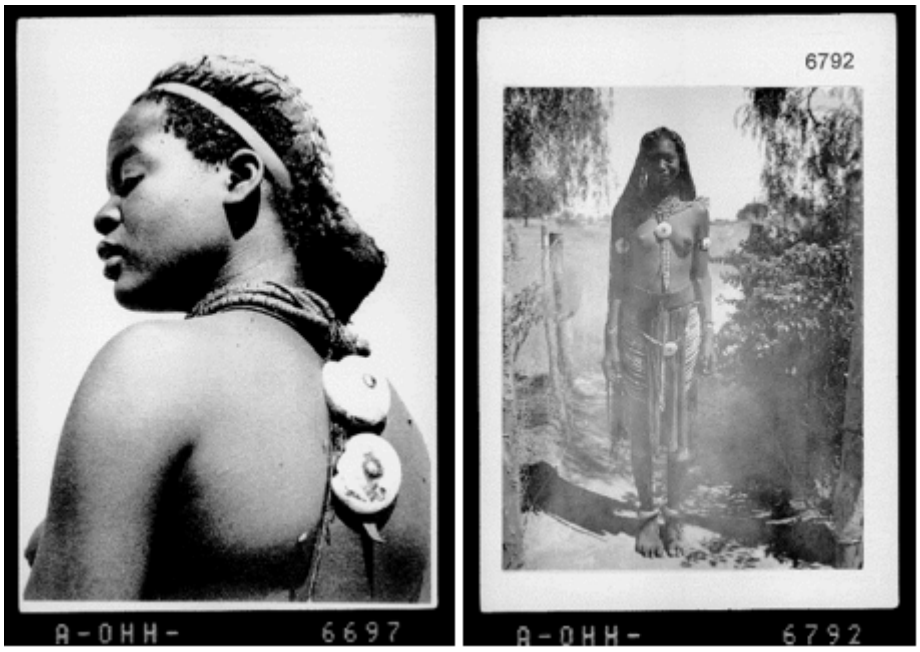


Figure 4.3: Aawambo women wearing traditional jewellery made of ostrich eggs accompanied by ornament buttons made of ekipa. Photographs: Courtesy of the Sam Cohan Library, 2022.

Sara-Leigh shared a memory of her walking on the beach early one morning on her way to school and seeing people (primarily women) collecting seashells to create jewellery that the women sell to sustain themselves. She expressed that the ocean is highly beneficial in this regard. Rejoice, an Owambo girl, further indicated that the use of seashells is valuable to her tribe because of the traditional jewellery created with them. She added that a few months after an Owambo baby is born, they are usually adorned with neck and waist beads made from oysters or glass beads representing family connections and protection. The beads are generally removed for boys at the age of three and are altered to fit women's waists as they grow. Rejoice further explains:

> *"The ocean benefits us in terms of culture. Me being an Owambo girl, I have to wear beads around my waist. These beads are made from seashells. The girl child normally wears white seashell beads…… Alternatively, we can wear modern, colourful ones made of glass beads. According to culture, when the beads are worn around the waist, they are not supposed to be seen by people or displayed on top of clothing. They should not be seen for traditional etiquette reasons and because they are a representation of you."* (Rejoice, authors translation (AT))

Two older Aawambo co-researchers who are seashell collectors and traditional *onyoka* jewellery makers, Mee (a term of respect commonly used to address female elders) Sofia and Mee Leticia, explained the significance of seashells in terms of ancestral connections. They enlightened that, by collecting oysters and seashells and making jewellery, they can sustain their traditions and livelihoods:

> "*we collect seashells from the ocean and use them to make necklaces and earrings and big belts that are worn with traditional clothing that we sell for an income. In our tradition, babies are required to wear a traditional necklace referred to as oshilanda or oshinyenye. These necklaces are also made with mussels and oysters, and they are worn for protection."* (Leticia, AT)

At a certain age, Aawambo babies and children receive and are dressed in traditional jewellery pieces, such as *onyoka* traditional necklaces and *oshilanda* (the name of traditional waist beads). Through a short role-play, Mee Leticia demonstrated the customary approach of adorning babies with the traditional *onyoka* jewellery. Mee Sofia assisted her in the role play and acted as the baby/child being presented and dressed with *onyoka*.

Mee Sofia and Mee Leticia explained that babies wear these necklaces in the Aawambo culture to ward off evil spirits and keep them from becoming ill. Another co-researcher noted that babies born into an Aawambo tribe are usually presented with two sets of *onyoka* necklaces and *oshilanda* waist beads. One set represents protection from the mother's side, while the other set represents protection from the father's side:

> *"The father's side is usually the one who makes and presents the child with the traditional necklace that they wear for a few years. It's a way of demonstrating that the child truly belongs to that father. If the father's family places the traditional necklace around the baby's neck and the baby does not belong to him, the baby becomes ill. Now, according to tradition, if the baby is sick for two months, the baby is returned to the*

presumed father's family so that they can remove their onyoka, which means that the child does not belong to the lineage of that family." (Leticia, AT)

Another co-researcher recounted hearing of such a practice, explaining that when a mother is informed of the consequences of falsely accusing a man of fathering her child, she often recounts any lies and tells the truth:

"I heard that this happens. When a mother falsely accuses a man of being the father of her child, his family will dress the baby with the traditional necklace, and the child will become ill in some way. This implies that the mother lied about the identity of the father." (Rejoice)

For further elaboration, Mee Sofia and Mee Leticia acted out the roleplay illustrating why and how babies are presented with Aawambo traditional jewellery. The roleplay was enacted in Oshiwambo, the Indigenous language of the Aawambo people. The different types of traditional jewellery, their names, the food, and ululations that take place during the custom ceremony were described. Mee Sofia and Mee Leticia further stated that the child must face East when presented and dressed with the *onyoka*. Additionally, the adults performing the ceremony should not be asked questions because they are carrying out a culturally significant custom and reaching out and conversing with ancestors. Mee Leticia acted out the roleplay as an aunt presenting a necklace, and Mee Sofia acted as the baby receiving the jewellery:

"Please sit down, my girl, so that I can dress you with this, your oshinyenye that your paternal kuku [grandmother] *bestowed to you. This oshinyenye will stay around your neck.*

At some point during the roleplay, the *oshinyenye* clip was not opening properly, and in response to that, Mee Leticia asked:

"Why is the clip not opening? Are you sure you want the jewellery? It should open so that I can place it around you..."

-After successfully opening and putting the *oshinyenye* on Mee Sofia's, she continued:

"Now take your oshinyenye that your grandmother made and gave to you for you to grow and mature into a big strong girl so you will be able to wake up early in the morning to kanga oshikwila [baking a traditional bread made with Mahangu flour]. *The girl child should also wake up early in the morning to pound omahangu* [wheat maize],

bake bread nde nokulima meepya [and ploughing and Cultivating in the vegetation fields mostly to harvest mahangu maize].*"*

-When it is a male child, the ceremony praises are related to masculine activities-

"I am putting this oshinyenye around your neck, my boy so that you can grow into a strong man that knows how to herd livestock such as cows and goats."

The babies are not only presented with one *oshinyenye*; they are presented with two because they are descendants of two different lineages. One is from the paternal family, and the other is from the maternal family; thus, Mee Leticia explained that babies are bestowed with a second *oshinyenye* from the maternal side. The father's side presents the baby with an *oshinyenye* set with iron coils (depending on different families) placed around the baby's neck, and the mother's side presents the baby with another set that is placed around the baby's neck or waist. The two *oshinyenyes* are a symbol that shows that a child has a mother and a father. She alluded that the *oshinyenye* is not presented and placed around the baby's neck by anyone; an aunt from the paternal family must present it.

Following the role-play, Mee Leticia explained the meaning of the customs expressed in the roleplay and why, culturally, Aawambo people wear jewellery and ornaments made with seashells. She talked about Aawambo brides and why they should wear a full traditional outfit complete with *onyoka* the night before the wedding:

"According to the Oshiwambo tradition, every girl or woman has to have onyoka around their neck or waist, whether they are a baby or a grown-up. Onyoka is important because when a woman gets married, she needs to wear onyoka around her neck. Since the onyoka is made from crushed seashells, they appear white, and we then apply oshive [traditional dye, similar to olukula (see glossary for olukula definition)] *or olukula so that they acquire a vibrant pink colour. Oshive or olukula is a colour agent made from pink dye obtained from tree extracts mixed with cow butter. When a woman is getting married, she wears onyoka smeared with oshive* [Mee Leticia starts ululating in demonstrations]. *The bride-to-be receives the onyoka to wear* because she has grown *up and become a women. That's why seashells are an important part of our culture and tradition because they are the products used to create our onyoka. If a woman does not have them, then you are not a woman. When a lady wears her odelele* [women's traditional attire]*, she must also wear onyoka around her neck."* (Leticia, AT)

Traditional jewellery is also worn by grooms the night before their wedding:

> *"…according to our culture, when a man gets married, he also has to wear jewellery called onjaha made from seashells. The onjaha is placed diagonally around the groom like a sash, and he will be dressed by one of his aunts. This onjaha is placed in an oshimbale* [basket weaved with makalani tree leaves]*, and the groom is dressed pOoshoto* or olupale* [welcoming area in a homestead]*. This dressing ceremony happens after sunset and occurs while other family members are present."*

*i.e. POoshoto detailed explanation: "*a central place within the homestead where visitors are welcomed and served a meal and is occasionally used for storytelling and games amongst many other activities in the Ovawambo culture*" (Billawer and Nel, 2024, p. 168). It is used for negotiations and welcoming guests into the house/homestead, with permission and directions from the head (usually a male individual) of the household/homestead or the owner of the house/homestead).

To explain in detail, Mee Sofia and Mee Leticia acted out another roleplay, the latter assuming the role of the groom, to demonstrate him being dressed with *onjaha*:

> *"I am going to put this onjaha around you because you have grown and matured into a man like your forefathers…"*

She explains that the *onjaha* is removed from the *oshimbale*, and while it is being removed, the people *pOoshoto* will be singing, dancing, and ululating:

> *"After the groom is dressed with the onjaha, the people will continue singing and dancing pOoshoto for most of the night. When it is late and time to go to bed, he must remove the onjaha because he cannot sleep with it. His aunts and other people spend the night pOoshoto, and they do not necessarily sleep because, culturally, they have to sing and dance for the groom the whole night because he has matured into a man. When he wakes up the next morning, he has to wear the onjaha again."* (Sofia, AT)

During the demonstration, Mee Sofia sang and danced to one of the songs sung on these occasions. Lastly, she explains that in the *Oshiwanbo* culture, *onyoka* is especially important because it is linked to ancestors and customary practices:

> *"If we did not have the onyoka, we would not be able to practise many of our beliefs."* (Sofia)

Other co-researchers were fascinated by the role plays and had numerous questions. One co-researcher asked who makes the *onjaha* that the groom wears. Mee Sofia and Mee Leticia explained that they are made by the groom's aunts and his father's sisters. They further explained that the elders who engage in the dance ceremony are individuals and family members who grew up with the groom's father and those who were initiated through the *etanda* ceremony (*Etanda,* or circumcision, is a coming of age male initiation ceremony believed to be a physical and spiritual intervention meant to connect young man to the spiritual realm of his ancestors to ensure his fertility).

Mee Leticia explained that *onyoka* is usually made with oyster shells as they are not very brittle; however, other seashells can also be used. Oysters/seashells are collected, cleaned, and crushed into small pieces that are later shaped into small circular discs. A hole is drilled into the discs, and the discs are inserted onto a wire (see Figure 4.4), after which the edges of the circular shell pieces are refined to give a smooth edge. The shell pieces are then transferred from the wire to a strong thread made of cotton (the thread is commonly bought in merchant stores), which is later converted into an *onyoka*, *ondjeva* or *oshilanda:*

> "*These jewellery are not easy to make, and the seashells beads we use do not come looking the way they look as you see them on the onyoka. It takes time and effort."* (Sofia, AT)

Figure 4.4 (a-b top- c-d bottom), Seashells and oysters in buckets, crushed seashells on wires and machines and tools used to refine and drill holes in shell pieces. Photograph: Martha Jonas in, 2020

Co-researchers explained that seashell collectors do not work in silos but rather work heterogeneously, and anyone with the knowledge of how to create these traditional jewellery and ornaments can make them. Mee Letisia and Mee Sofia are part of a community collective of women in the Democratic Resettlement Community (DRC) (an informal settlement in Swakopmund) that creates jewellery. On occasion, the group collectively goes to the ocean to collect oysters and seashells, and when they return, they sit together preparing the shells. The refining and drilling machines and tools belong to one of the ladies and are readily available for the women to use. Mee Letisia explained that anyone interested in learning how to make these traditional jewellery is welcome to join the group and learn from the women. Mee Anna, a co-researcher who recently moved to Swakopmund, joined the group and learned how to make traditional jewellery. This collective jewellery-making practice, where women invite other women to learn how to create these essential traditional jewellery, is grounded in the concept of Ubuntu, the practice of "humanity towards others" and learning together with the belief that "*I am*, *because you are*" (Nicolaides, 2022, p. 1). Mee Letisia stressed that no payment is needed because all the women in the group are trying to make an income by selling the jewellery. But importantly, they are maintaining their cultural practices. She added that she

would be happy to see younger Aawambo girls learning how to create traditional jewellery so that the tradition is passed on and continues being practised.

4.1.2. Topnaar ǂAonin Ocean Cultural Context

The Topnaar ǂAonin people, the first recorded inhabitants to have settled in Walvis Bay along the Kuiseb River in the early 1700s (Kinahan, 2017), hold deep historical, traditional, and spiritual connections with the sea. The Topnaar ǂAonin were once divided into clans based on where they lived. Those who were located close to the Atlantic Ocean were referred to as the Hurinin, people who live along the coast (Köhler, 1969; Sydow, 1973; Sullivan, 2021) and their livelihoods partly depended on the ocean; those who were located in the Namib Desert referred to as the !Naranin and mostly survived off the !Nara plant and livestock herding; and those who lived near the lower Kuiseb river, in central Namibia, referred to as the !Khuisenin, who depended on the river for sustenance and livestock herding:

> "*Within the Khoi-khoi nucleus of the tribe, an ancient duality is still recognized by the people. They differentiate between the !Khuisenin or "Khuiseb people", and the Hurinin or "people of the sea*"" (Budack, 1983, p. 1).

The Topnaar ǂAonin lived as nomadic herders for nearly a hundred years in the Namib Desert along the Kuiseb River, in the Namib-Naukluft National Park (see Figure 4.5). Their location in the desert and park resulted in multiple social and ecological difficulties that constrained their livelihoods, including food shortages, wildlife challenges, limited economic opportunities and social infrastructure, and insufficient access to information and transportation (Snorek et al., 2020). Due to inter-tribal wars and later impacts of colonial land disposition, the Topnaar Hurinin people who formerly occupied larger areas and some living close to the ocean were displaced deeper into the Namib-Naukluft Park, close to the Kuiseb River (Gagnon et al., 2016), limiting the areas where they could live and exercise customary rights.

Figure 4.5: Picture of a homestead at Utuseb, Topnaar settlement. Photograph: Marly Muudeni Samuel, 2022.

In 1907, the Namib-Naukluft Park was declared a Namib Desert National Park under German colonial rule. Bridgeford (2018, p. 13) notes that the Park was initially named "*Game Reserve No 3*", situated east of the British reserve of Walvis Bay and south of Swakop River. The declaration forbade hunting and prevented communities from herding their livestock and practising other activities within the set boundaries of the park (Van Damme and Van Den Eynden, 1992). Discussing the impact of the declaration on the Topnaar ǂAonin, Sullivan, p. (2023, p. 1) states:

> *"Without consultation, the reserve restricted the lifestyle and mobility of people living along the !Khuiseb, ruling hunting in the park illegal, although ǂAonin* [Topnaar people] *already controlled hunting through an established traditional hunting season (!amis). Importantly, herding and all other activities became restricted to the !Khuiseb and Swakop Rivers, and official ownership of the land and resources was shifted to the state."* (see also Budack, 1977; Botelle and Kowalski, 1997).

This declaration disrupted the way of life for the Topnaar ǂAonin people, particularly as their traditional practices were centred on hunting and livestock herding. In 1963, the apartheid regime, an extension of South African policies into Namibia, issued another declaration under the Odendaal Plan (Short, 1977; United Nations, 1977). Through this declaration, the then

Namibian government purchased farms to relocate Topnaar ǂAonin people from the Namib-Naukluft National Park. However, the Topnaar ǂAonin resisted relocation from their traditional lands and areas with natural resources, such as the !Nara plant that had sustained their ways of life for centuries:

> *"They refused, to leave their territory, which they claim as their traditional tribal area as they have already occupied it for several centuries. Their culture is linked to the !nara [sic] and they depend on the sea and its food resources. There also exist legal treaties respecting their traditional rights to the use of the !nara plants"* (Van Damme and Van Den Eynden, 1992, p. 220).

As evidenced above, the !Nara plant (acanthosicyos iwnidus) and the ocean are essential aspects of Topnaar ǂAonin ways of life. Morangie explained that there was a time when other tribes migrated into Topnaar ǂAonin territory, causing conflict over the Kuiseb River area and seashore lands. The Topnaar ǂAonin believed that these conflicts caused the ocean to become angry. He elaborated that some tribes later united to ensure that all tribes benefit equally from the ocean (see Gagnon et al. (2016) for further reading on Kuiseb River area tribal disputes).

Considerable conversations about the variety of uses and benefits the !Nara plant (see Figure 4.6) (a thorny bush that grows in the desert and bears fruits) took place during the workshops. Van Damme and Van Den Eynden (1992) describe it as a melon that is prevalent on the coast of Namibia and naturally grows in the wild, providing food to the Topnaar ǂAonin people and wild animals. Namibia is a dry country with little rain; as a result, many desert plants have adapted to the harsh conditions by storing and requiring little water to survive. Some of these plants take in water from underground channels through their long roots (Gurera and Bhushan, 2020), while others absorb the ocean's mist through their leaves. As a desert plant, the !Nara also survives from underground water (Cole, van Schalkwyk and Lorck, 2014). Its tough root system can extend over 50 metres underground and efficiently draw underground water.

Figure 4.6: !Nara plant bush with thorns and fruits. Photograph: Marly Muudeni Samuel, 2020.

Co-researchers further added that !Nara plants have two genders, recognised by the plant's flowers. This assertion is similarly supported by Cole, van Schalkwyk and Lorck (2014), who explain that the !Nara plant is unisexual (female and male flowers on distinct plants), with male flowers blooming all year and female flowers mainly blooming in spring. The male !Nara plant inseminates the female !Nara plant for it to bear fruits, with mating taking place via root connections. The plant will also sprout flowers when the fruits are about to develop.

Sara-Leigh highlighted that the !Nara plant is unique to the Topnaar ǂAonin people. It is versatile, and each part can be used in various ways. The root is harnessed for its medicinal properties, while the inner core of the !Nara fruit is either cooked or pressed to extract milk. The seeds are edible, usually boiled or baked and eaten like nuts (see Figure 4.7). Furthermore, when the fruit is cooked, the remaining soup extract can be spread onto a clean surface for drying. Once dried, it becomes sweet and can be eaten like candy. Specific components of the !Nara plant are also used to make a leather-like material (see Figure 4.8) (see Dentilger (1977) for further details on the Topnaar and !Nara plant).

The !Nara plant fruits are protected, and it is illegal for non-concession rights holders to harvest them without a permit (The Namibian, 2015). It is mostly harvested by the Topnaar ǂAonin people for sustenance and remains one of their essential foods. Act No. 2 of 2017: Biological

and Genetic Resources and Associated Traditional Knowledge Act (Ministry of Environment and Tourism, 2021) of the Namibian constitution permits the Topnaar ǂAonin people to harvest the !Nara, under customary and traditional rights (Van Damme and Van Den Eynden, 1992). However, it is important to note that no law or decree formally allows the Topnaar- ǂAonin community to harvest the !Nara because the constitution and legislation have yet to declare the community as marginalised. The Topnaar ǂAonin are the traditional holders of !Nara knowledge and reside in the Namib-Naukluft National Park, and as such are permitted to harvest it as part of their customary rights.

Figure 4.7: Baked !Nara seeds usually eaten as nuts. Photograph: Marly Muudeni Samuel, 2022.

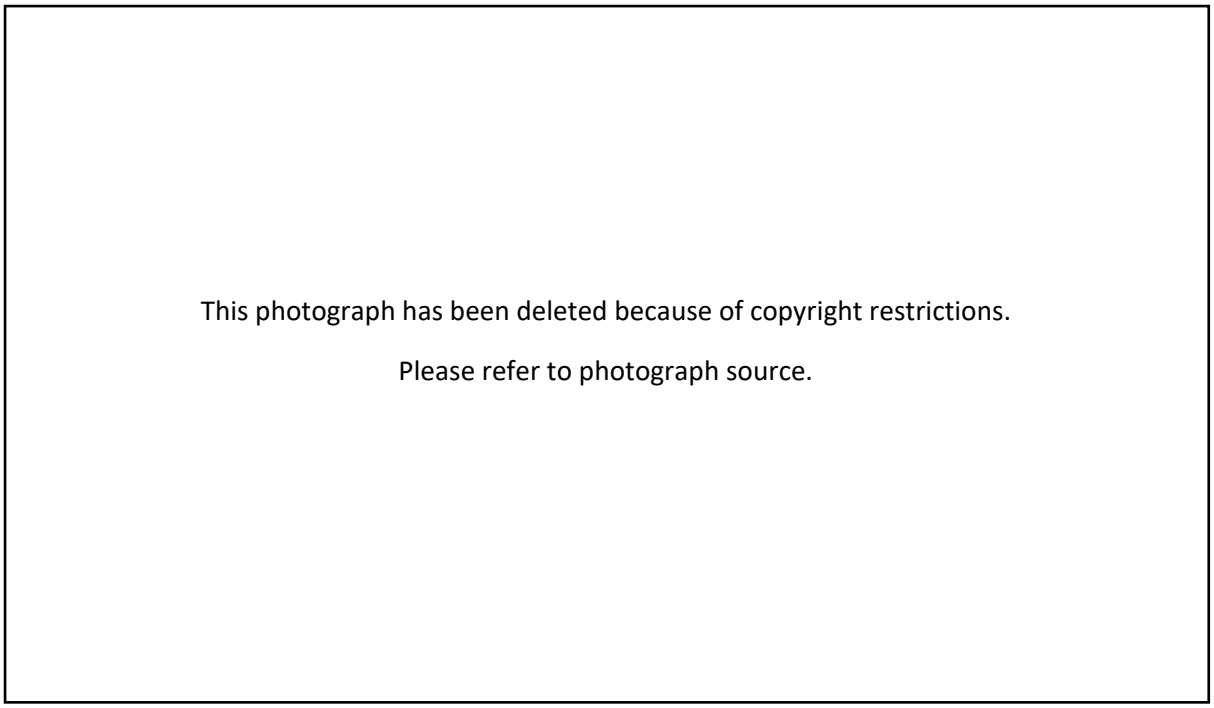


Figure 4.8: A young girl proudly displays a sun-dried #hoagaribeb made from boiled !Nara fruits after the seeds have been removed. Photograph: Desert Research Foundation of Namibia, Gallo Images and Peter Tarr, (Henschel et al., 2004).

!Nara seeds are especially popular in coastal communities, where they are eaten as snacks. The seeds are currently being commercialised (see https://nara.com.na/) and sold on the international market. One co-researcher mentioned that she was unaware that the seeds she grew up eating came from the !Nara plant and expressed how glad she was to have learned this information.

The workshop discussion moved on to ocean practices. One co-researcher shared that the Topnaar ǂAonin previously believed that the day before men went fishing, wives were not allowed to socialise or visit other huts for fear of bringing bad luck and preventing the men from catching any fish. The women were to remain indoors until their husbands went fishing. The ocean was regarded as female; because of that, husbands were also not permitted to have sexual relations with their wives the night before or make up their beds on the day of fishing. It was believed that if a man had sexual relations with his wife the night before or made up his bed that morning, the ocean would become jealous and would not reward them with fish. Other tribal men would also know, based on how the ocean reacted to their visit and request for it to bless them with fish. Moreover, before men departed from their homes to go fishing, they would sing songs and recite poems (see Figures 4.10 and 4.11) for the ocean as a form of communication, acknowledgement, and respect.

Co-researchers also mentioned that interaction with the ocean was gender-based in the past, with women often discouraged from going close to the ocean. This conjecture emerged from the belief that if women visited the sea, it might result in unfortunate fishing outcomes or a death in a family. According to these beliefs, the ocean did not relate or agree with women; only men could communicate with it. Thus, women would sing songs about the ocean and for the ocean while men went fishing. The writings and paintings of Thomas Baines (1964), an English-born artist and explorer, indicate that there were occasions when women went to the ocean (see Figure 4.9). The painting photograph shows boats, houses and men fishing with spears in the distance. It also illustrates women sitting together at the shore cleaning fish while two figures are walking away carrying what looks like fish hanging on sticks. It remains unclear to this research whether the belief that women could not go to the ocean was seasonal, occasional, or depended on female menstrual cycles. Or if the belief changed over time and women were later allowed to go to the ocean. It is possible that in the past, women's interaction with the ocean involved maintaining a certain distance. However, existing literature provides limited insights on this topic.

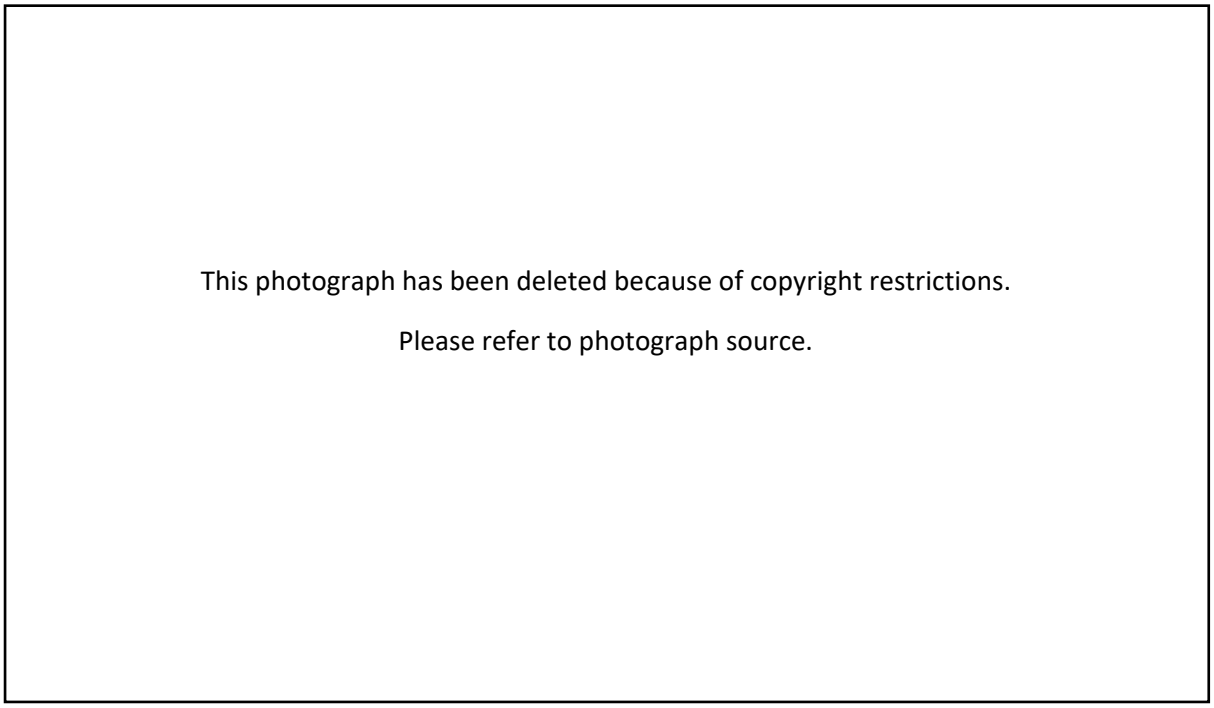


Figure 4.9: Topnaar Hottentots spearing fish painting by Thomas Baines (1964).

Co-researchers elaborated that Topnaar ǂAonin people have strong bonds with the ocean, resulting in deep love and respect for it. In those years, the Topnaar ǂAonin inherited, practised, and followed fishing methods and laws that emphasised the value of coexisting peacefully and sustainably with the ocean. Another example of customary fishing laws is that of the Luo

fisherfolk of Kenya, who reside in close proximity to Lake Victoria, rely on Indigenous fishing and preservation methods and have their own fishing management system, rules and regulations known as "*Chike Lupo*", which is followed to promoted sustainable fishing (Obiero et al., 2023, p. 130).

Some of these shared beliefs and practices are no longer exercised. One reason is that colonial laws relocated and displaced the Topnaar ǂAonin (Febrica et al., 2022), moving them further away from the ocean, and another reason was inter tribal conflicts. However, Topnaar ǂAonin co-researchers clarified that, though most of their beliefs and customs are no longer practiced, the Topnaar ǂAonin community still gathers at cultural events to sing songs and recite poems in honour of the ocean and their heritage:

> *"…we no longer come to the sea to practice our beliefs because we have been suppressed by colonial laws……. But, when there are cultural events, we come together to sing songs and recite the poems about the ocean… Although we are no longer in close proximity to the ocean, there are customs that we still practice to appreciate our ancestors and reaffirm that we do really come from the sea. Even though we do not benefit from the sea as much as we used to. So, we gather to sing songs, recite poems, and perform cultural dances."* (Morangie, AT).

Such is their admiration for the ocean and !Nara that Topnaar Topnaar ǂAonin recite a poem of appreciation highlighting the plant's roots in their culture and heritage (Berry, 2009) and honouring the ocean for the resources it provides. Figures 4.14 and 4.15 illustrate Topnaar ocean poems adapted from "Harvesting People *of South Atlantic Coast*" (Budack, 1983).

This photograph has been deleted because of copyright restrictions.

Please refer to photograph source.

Figure 4.10: Topnaar poem for the !Nara plant retrieved from 'A Harvesting people of South Atlantic Coast' (Budack, 1983, p. 7).

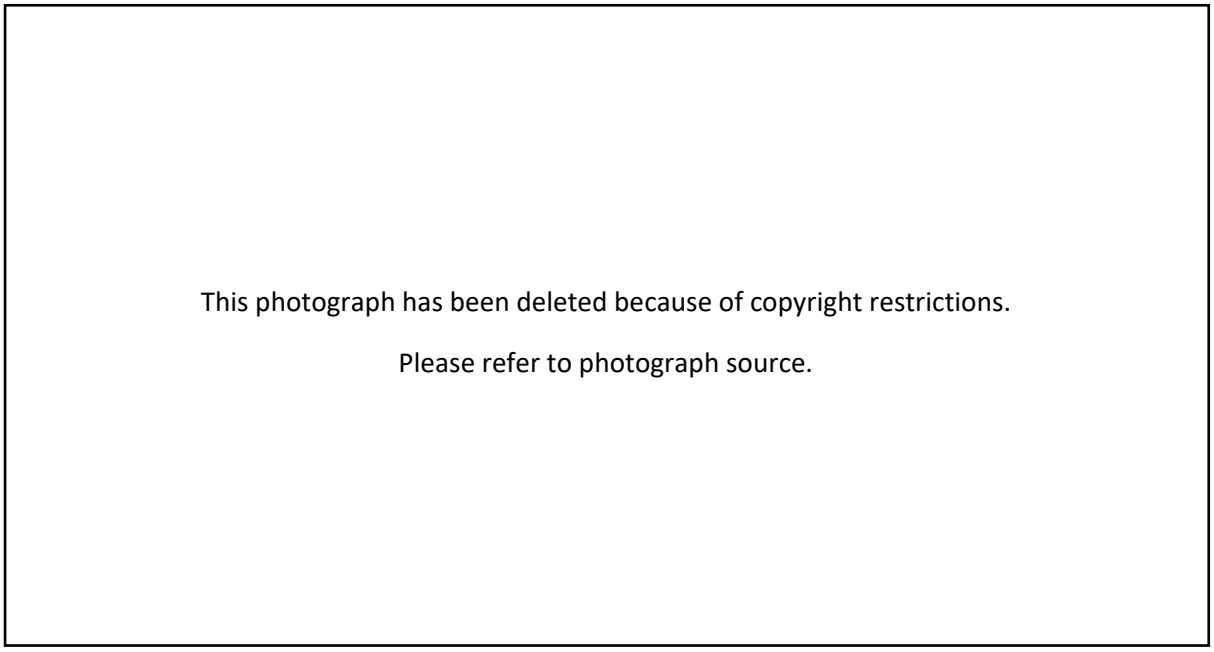


Figure 4.11: Topnaar poem celebrating the ocean. Retrieved from 'The ǂAonin or Topnnar of the Lower !Khuiseb Valley and the Sea' (Budack, 1977, p. 38).

4.2. Wellbeing Relationships

The ocean is a source of many rooted relationships within coastal communities. Allison et al. (2020b, p. 2) explain that "*human relationship with the ocean is diverse and complex. It is built on values that are often non-monetary, and which contribute to non-material dimensions of wellbeing*". These values are necessary for overall human advancement and include contributions to cultural, social, and artistic identity, a sense of place, occupational pride and self-esteem, spirituality, psychological and physical health, and human safety (Allison et al., 2020). Andaya (2017) argues that the lives of people who rely on the ocean are unpredictable; thus, to ensure good fortune and protection, they believe in and appeal to sea gods and spirits. In this regard, co-researchers engaged in conversations about individual connections to God through the ocean (Namibia is a Christian-majority country, with 97% Christian denominations, while other religions account for the remaining 3% (United States Department of State, 2020)), experiences of being baptised in the ocean, and connecting with ancestors. This discussion explored how these beliefs related to the lives and identities of co-researchers. Mee Sofia and Mee Letisia shared that the ocean has always played a significant role in the development of human spirituality:

> *"when visiting the ocean, especially in the morning, I can say that God really exists because of this magnificent ocean that he has created.…It has spiritual and protective*

powers that are manifested through its resources. For example, if you have bad dreams, you can hang seaweed in your room and the bad dreams will go away." (Sofia, AT)

"When I think of the sea, I am reminded of how big God is... It is believed that the seawater has healing powers. The ocean has seals that we get seal oil from. The oil is medicinal and is used to heal ear infections and burns… If you are feeling stressed and go to the sea, you will start feeling better." (Letisia).

Co-researchers explained that apart from jewellery purposes, seashells are also used for spiritual protection. They are usually collected, washed, and placed in house corners close to the front door to keep away evil spirits, as indicated by Ousitjie:

"I took a job for a while, as a housekeeper, for a white family, they used to put seashells behind their doors. That was a way of protecting the house against bad spirits." (Ousitjie, AT)

Co-researchers also explained that saltwater is used for healing and protection. People collect the water in bottles and sprinkle it around their homes. Some co-researchers admitted to practising these customs and added that before they travel back to their hometowns, they collect seawater to sprinkle in their homes. Similarly, there are times when their relatives request seawater, which they collect and send through public transportation. Mee Anna shared that when people visit coastal towns, they are usually advised to go to the ocean/beach on the same day or the next to ward off 'bad luck'. If they do not, it is considered bad luck, and they can get sick, or things will not go well for them in the future:

"I recall, as a child, my parents would send me to the ocean to get water in 5L bottles so that they could send it to people inland who would use it to wash themselves to wash the bad luck off. It goes back to the belief that the ocean has healing and spiritual protective powers." (Haba)

"We collect seawater in bottles and take it with us to our hometowns. We sprinkle the water around our houses for protection. Another thing is when someone travels to the coast from the northern part of Namibia, they have to go to the ocean. If they do not go, they can get sick or catch a cold. But if they go to the ocean, they will be fine." (Anna, AT)

Rejoice shared that when she first moved to Walvis Bay, she was told that in the Aawambo culture, when a baby is born or moves to a coastal town, the baby is taken and presented to the

sea. Depending on the culture or tribe, the baby is also given a taste, and their faces are washed with seawater. This practice is thought to keep one from becoming ill or attracting bad luck and spirits:

> *"There is this thing that I heard, when I first came to Walvis Bay, that when a baby born or comes here, it is a must that you take the baby to the ocean and let them have a sip of the water. I do not know what it has to do with the sea water, but it is a believe."* (Rejoice, AT)

Some people who live in other towns without a coastline also practice this custom by tasting the town's sand. It is believed to be a form of protection and being welcomed in those specific towns. Haba concurred that the Damara/Nama people practice the same custom. However, instead of tasting the water or sand, the baby is symbolically anointed with the water or sand on the forehead. The ocean also benefits our health, with co-researchers stating that its resources have healing powers. Water, including springs, wells, and rivers, is also believed to be the home of deities. It possesses divine healing powers and amplifies processes of spiritual transformation (Porta and Wolf, 2021). Haba provided an example, explaining how her parents utilised seaweed for its healing properties. The seaweed was sun-dried or grilled before being finely ground into powder and mixed with petroleum jelly. The resulting mixture was applied to the wounds of children for healing purposes:

> "*In the olden days, our parents used to put seaweed salve on our sores when we hurt ourselves in any way.*" (Haba, AT)

Another example is found in South Africa, where various ethnic groups, such as the Khoikhoi Hottentot and San Bushmen, have long used seaweed and sea bamboo for medicinal purposes (van Wyk, 2008; Pérez-Lloréns et al., 2023). The Khoikhoi Hottentot and San Bushmen used these ocean resources to treat glandular swellings, make hot poultices (van Wyk, 2008) and iodine herbal medicine used to treat goitre, scrofula and bronchocele (Pérez-Lloréns et al., 2023). For additional reading on seaweed medicinal uses, see also Pappe (1857) and Stirk et al. (2003).

The ocean also contributes to healthy lifestyles by providing healthy food and being a place for outdoor physical and exercise activities (Allison et al., 2020). Seafood contains considerable amounts of essential nutrients, making it a significant part of the human diet (Erasmus et al., 2021). Regarding fish consumption in Namibia, Erasmus et al. (2021) found that the average Namibian consumes fish once a week or month, preferring hake or horse mackerel over other

fish species. This average falls short of the twice-weekly intake recommendation. Erasmus et al. (2021) state that the affordability and accessibility of fish species influence fish consumption and preference.

The ocean is a place of tranquillity, and the relationships people have with it have significant benefits to psychological and physical health, with the oceanside sometimes being referred to as therapeutic (Finlay et al., 2015) and relaxing. Co-researchers discussed emotional and psychological relationships with the ocean, adding that ocean relationships are influenced by the ocean's beauty, its ability to provide relief for stress and sadness and energy when one is tired:

> *"The ocean is a stress reliever. It is the cheapest stress reliever there is, you do not have to pay anything. It just calms you down. After a long day, if I go to the ocean, it helps me relax, and when I go home, it feels like I was out of town. I feel new again. I feel revived."* (Jota)

> *"For me, it's the waves; when they move and, they bring calmness to you. It is like there is a connection between you and the ocean. One cannot know how the ocean is created; there must be a creator who created it if you see how the ocean is. And the thing is, some people just see the ocean as big water, but when you really connect with it and experience it, you realise that it is really alive. It can hear, it can see, it can feel, it can do anything."* (Morangie, AT)

For co-researchers, the ocean provides a sense of culture, security, food, familiarity, and comfort while also being a refuge from psychological and physical challenges. While some co-researchers formed ocean connections through shared cultural knowledge, arts, history, and spiritual expressions, for others, the ocean held emotional influence as a source of peace, relaxation, and healing. These diverse ocean relationships were established through co-researchers ocean heritage and lived experiences, such as the feeling of the wind blowing, hearing the sounds of the waves and sea birds, watching the sunset (see Figure 4.12) or having fun and engaging in family and friend events at the beach (see Figure 4.13). These ocean connections indicate the role played by the ocean in contributing to the wellbeing of co-researchers, answering this research's second sub-question (see Section 1.2), which explores the oceans in contributing to the wellbeing of Namibian coastal communities.

Figure 4.12: Sun setting over the Swakopmund jetty: Beach Jetty Sunset photograph: Idda Angaleni Shikangala, 2022.

Figure 4.13: Men having fun at the beach. Photograph: David Maja, 2021.

Co-researchers expressed that people need to understand that the ocean is a safe place and companion when there is no one to talk to or when you need to cry. Co-researchers expressed that the ocean offers inner peace and that merely looking at the sea surroundings, appreciating

its colours, and observing its aquatic life enables people to establish a deeper connection with the ocean and uplift one's spirit:

> *"I was born here in Swakopmund and when I was young, I used to go to the sea when I was sad. I would sit there and cry……. I would watch the sea and feel good...*" (Haba)

> *"My connection to the ocean is the colour of the ocean. When I come to the ocean and see its colour blue, it makes me happy. It takes all my stress."* (Kapandu)

The subject of safety similarly emerged, and co-researchers emphasised that while the ocean's beauty and benefits are undeniable, it can also be intimidating and potentially dangerous, particularly for individuals with limited knowledge about it or who have no connection with it. Therefore, people should exercise caution when visiting and engaging with the ocean, especially in activities such as swimming.

The discussion transitioned to the subject of love, and co-researchers discussed how the ocean creates a romantic meeting place. Lucio shared that during his frequent visits to the beach, including the day before, he observed couples holding hands and spending time together. He elaborated that:

> "*the ocean brings people together and it creates connections between people*." (Lucio)

Therefore, the ocean is also interpreted as a conduit for individuals to form and strengthen relationships with each other.

4.3. Artistic Relationships

Art inspired by the ocean was another shared relationship. Allison. et al. (2020) explain that the sea, its ships, and the fish and mammals that inhabit it provide an endless source of artistic inspiration. Artistic representations of the ocean trigger emotions similar to when humans feel, see, hear, smell, and interact with the ocean. Maritime art holds importance in various regions across the globe, and it has been critical in achieving self-determination and sea rights for Australian Indigenous people (Middleton, 2013). Indigenous expressions, such as African prehistoric rock paintings that portray marine mammals and fish (van Riet Lowe, 1947), provide evidence of the fact that relationships with the ocean have existed for centuries.

Within this artistic framework, Ousitjie explained that her love of the ocean inspires her to create art. She collects driftwood for crafts and occasionally goes to the beach to create paintings inspired by the ocean. Another facet of artistic significance is the creation of

Aawambo traditional jewellery and belts made from seashells, discussed in Section 4.1.1. These jewellery and ornaments hold significant cultural value and serve as a testament to the artistic talents of co-researchers, exemplifying the intersection between culture and creativity. They are an integral element of the distinctive fashion style worn by Aawambo women. Their significance is such that when the traditional attire is worn without these customary adornments, it may appear incomplete. This is because, when combined, the attire and adornments collectively symbolise the importance of the Aawambo culture and effectively convey the depth of customs and traditions adhered to by the Aawambo people.

Co-researchers shared insights into the diverse methods employed to creatively decorate homes using sea rocks, seashells, and sand (see Figure 4.14). These decorative elements not only serve as ocean artistic expressions but also play a role in creating a sense of homeliness within homes. The use of ocean resources highlights how the sea is intertwined with co-researchers' daily lives and contributes to the beauty of living spaces.

Figure 4.14: Glass plate with sea sand, rocks and shells used to decorate homes. Photograph: Marly Muudeni Samuel, 2023.

4.4. Economic and Livelihood Relationships

For centuries, the ocean played a part in the development of human society (Alan Simcock and Inniss, 2016). For example, fishing, an ancient practice that dates back 42,000 years

(O'Connor, Ono and Clarkson, 2011), has sustained communities for years. Today, fishing remains one of the grounding occupations and a primary economic booster for coastal individuals, companies and global society. It has long provided jobs and sustained economic growth for coastal communities (World Bank, 2023).

A discussion was held about the value, benefits, and diverse ways the ocean supports co-researchers' livelihoods. Jota elaborated on this and stated that fish represent the most important connection to the ocean for numerous individuals within Namibian coastal communities. Co-researchers talked about individual participation in fishing activities, particularly by small-scale fishermen, and how some individuals and companies have fishing quotas used to fish on a large scale. The discussion about fishing quotas initiated a dialogue about the misallocation of fishing quotas and the unsatisfactory management of ocean resources. This discourse highlighted how governing entities in Namibia executed unethical changes to fishing policies that, regrettably, resulted in the exclusion, marginalisation, and displacement of numerous members from coastal communities. Adding to the discussion, Rejoice explained how a family friend was displaced as a result of these changes:

> *"I know one fisherman who is a family friend of ours, whose job was affected by fishrot. He used to rent out one of the rooms in the house. He worked as a chef on one of the fishing trollers, and he would go out to sea for two or three months. Their company was one of the companies that received low fishing quotas, and to my understanding, the quotas that were taken from their company were allocated to companies that were associated with fishrot. Because of the decrease in quotas, their company had to scale down, and many people were retrenched, including him. After the retrenchment, they decided to protest against what happened, and I think that protest went on for about three years."* (Rejoice)

Co-researchers discussed the value of seals, highlighting their abundance of omega-3 and the various uses of their fur, oil, and meat. Co-researchers explained that some individuals consume seal meat, whereas others gather and sell seal oil in community markets, which is used for medicinal purposes. Mee Letisia shared her regular practice of acquiring seal meat in Swakopmund and then selling it koOwambo (the northern part of Namibia) (see Figure 4.15) due to the demand for it among the local residents. Seal fur is also used to make traditional waist belts (see Figure 4.16) for personal use or generating income.

The northern part of Namibia with the majority of Aawambo people comprising of Omusati, Ohangwena, Oshana and Oshikoto regions.

Figure 4.15: Map of Namibian illustrating where the Aawambo people reside. Photograph: Public domain (CC-O).

Figure 4.16: Belt made from seal fur. Photograph: Marly Muudeni Samuel, 2022.

One of the co-researchers, who is a real estate agent, shared that the ocean has also created various opportunities in the real estate and property management sectors. The architecture, beach, and coastal activities found in Namibian coastal towns (particularly Swakopmund), as well as the favourable weather (not very hot and not very cold), have resulted in an influx of tourists and community members who either relocate or go there for vacation and as a result purchase or rent properties for their stay. This influx has boosted the real estate sector and contributes to the economic and livelihood relationships of coastal communities.

Co-researchers further discussed individual perspectives on ocean access and resources, with Ousitjie mentioning that Namibians do not have the same access to the ocean and its resources as people in other countries. She provided an example of the wide range of ocean related activities, trade, and exchange processes taking place along the coastlines and rivers of countries like Kenya, Tanzania, and Angola. She elaborated on the partnerships where women in Kenya and Tanzania receive fish from fishermen to sell as raw or cooked products at markets. According to Ousietjie, collaborative fish activities and ocean resources trading and exchange do not happen in Namibia. Melber (2003) explains that it is because individuals and large fishing corporations monopolise the fishing industry.

Another important topic discussed was customary ocean rights and access to the ocean and its resources. This initiated a conversation about government management approaches and how they fail to adequately support fishermen and coastal communities. Co-researchers stated that

many coastal members do not have access to information (see Section 2.3.1) needed to assist them in learning about fishing regulations and correct fishing methods:

> "*I usually ask myself whether the current fishing policies are actually effective? The inspectors do not really engage with the community in regard to how community members fish or interact with the ocean. They do not consult communities regarding fishing activities or give them pointers on ways to fish*." (Jota)

In addition, members of the community have to acquire a one-month fishing permit, which costs N$14.00 (approximately 0.77 USD) or a one-year fishing permit, which costs N$168.00 (approximately 9.22 USD) (Nghipunya, 2012; Van Der Walt, 2021). Co-researchers commented that, though permits are not expensive, fishermen still face challenges. Most fishermen and coastal community members in Swakopmund, Walvis Bay, and Henties Bay reside in informal communities and work multiple jobs to make a living, including fishing. Sometimes, fishermen can spend an entire day fishing and return home without catching fish. Because of the decline in fish, some community members have turned to working in fish factories on a full-time, part-time, or temporary basis.

Co-researchers discussed a time when a decision to increase the fishing permit fee was made without proper consultation of coastal community members. They emphasised that an invitation to a consultation meeting was issued and advertised through several media channels (WhatsApp, Facebook, radio, newspapers, and television); however, because many people living in informal settlements such as DRC do not have access to these channels, information about the consultation meeting did not reach them. Consequently, a decision was made to increase the fee from N$14.00 (approximately 0.77 USD) a month or N$168 (approximately 9.22 USD) per year to an exorbitant amount of N$1500 (approximately 81.70 USD) per month, which negatively impacted community members and small-scale fishers who could not afford the new rate. The new rates caused local, national and international outrage, with locals expressing that the new rates were extremely expensive (Namib Times, 2017). Following protests and complaints from community members, the decision was reversed. In light of management decisions such as this and others about the blue economy, co-researchers emphasised the importance of equitable ocean management decisions, inclusive of the interests of both small-scale fishermen and large-scale fishing companies. These regulations should similarly benefit the ocean.

Another challenge shared was access to different fish. Co-researchers emphasised that a significant number of fish species are expensive to purchase from markets and stores, resulting in people being unable to buy them because of financial limitations (see Erasmus et al. (2021) for a discussion about fish consumption and preferability in Namibia). The different fish species co-researchers are familiar with include galleon, hake, steenbras, angelfish, and horse mackerel, mostly known as maasbanker. Many of the co-researchers grew up eating, and still eat, maasbanker. It is both accessible, affordable and a delicacy for most coastal households. Jota added that she grew up eating maasbanker but does not particularly enjoy it because it has too many bones, making it difficult to eat. And now, as an adult, she refrains from buying it herself. The discussion also included different ocean activities in Swakopmund and Walvis Bay, such as visiting the aquarium, skydiving, desert excursions, fishing, boat riding and various fishing festivals. These activities attract many tourists and contribute to economic growth.

Overfishing caused by large-scale companies is another challenge impacting the livelihoods of coastal communities. Commercial marine fisheries dominate the fisheries sector in Namibia, holding the largest share of these activities (International Labour Organization, 2022). The fisheries sector engages in fishing activities such as demersal fisheries, midwater fisheries involving trawlers and purse seine vessels, purse seine fishery, deep-water fishery, tuna fishery, rock lobster fishery, and crab fishery (ILO, 2022). Despite the fishing industry being one of Namibia's most prominent economic sectors, there has been a significant decrease in fish stocks in recent years (Paterson, Kirchner and Ommer, 2013; Belhabib, Willemse and Pauly, 2015). This decline is attributed to climate change and intensive large-scale fishing practices, which, as elaborated by co-researchers, have made it challenging for small-scale fishing communities to sustain livelihoods. Co-researchers emphasised that to mitigate these challenges, decisions and policies pertaining to ocean management and governance must consider the wellbeing, needs and impact on coastal communities (see Section 4.5 for a discussion on mismanagement of ocean resources). Co-researchers further highlighted that the government and town municipality should collaborate with communities to create platforms that provide advice and recommendations on fishing methods, financial assistance, donations, and skill training for various community projects.

Different stories about childhoods and upbringing in coastal towns were shared with co-researchers who were born in Swakopmund during colonial rule, expressing how, in 1974, due

to segregation laws, they were not allowed to go to the ocean, even when they stayed at mile 4, an area close to the ocean:

> *"Many years ago, we were not allowed to go to the ocean. My first ocean experience was in the late 90s* [after independence], *and that was during the time I lived in Germany. Imagine, my first ocean experience was abroad, though I was born in a coastal town. The colonial government did not allow black people to go to the ocean and I grew up thinking that black people were not allowed to go to the ocean. Also, because of the stigma in those times that the ocean was dangerous, black elders were very scared of the ocean. They didn't allow their kids to go visit the ocean, and another contributing factor was because they couldn't swim."* (Ousitjie, AT)

As demonstrated above, the impacts of coloniality are still apparent in how people perceive and engage with the ocean today. Co-researchers attribute the stigma and perception of adults viewing the ocean as very dangerous (primarily because of drowning incidents) to the colonial era. People were not allowed to go to the beach and as such, were not exposed to the ocean, could not/did not learn how to swim and feared the ocean. See Section 7.3.8 for more impacts caused by coloniality.

4.4.1. Blue Economy Discussions

During the conversation about ocean relations, co-researchers explained how vital the ocean is to human survival, and as a result, everyone is directly or indirectly connected to it. Thus, to build an inclusive Blue Economy, governments have a responsibility to guarantee that the interests of citizens are equitably considered for future ocean economic development (Allison et al., 2020).

The blue economy concept is a global approach which aims to meaningfully multiply and harness the monetary value of the ocean in an ecologically sustainable way (Remmert, 2018). Hunter (2015) explains that the concept correlates with the green economy movement, which provides global evidence and creates awareness about how human activities have been damaging the ocean. Thus, through the blue economy approach, nations are trying to develop inclusive frameworks that support socio-economic development and contribute to economic growth, environmental protection and social advancement (Remmert, 2018). Namibia is also establishing a blue economy policy under the economic advancement pillar of the Harambe Prosperity Plan. On this subject, co-researchers shared that there is a potential for positive blue economy opportunities to arise through the implementation of inclusive and equitable blue

economy policies. However, concern was expressed about the mismanagement of resources and revenue from blue economy initiatives, as experienced through Fishrot activities. See also (Kleinfeld, 2019; Bjarnadóttir, 2020; Coetzee, 2021; Winters, 2021; Hanns Seidel Foundation, 2022) regarding the Fishrot scandal.

4.5. Ocean Conservation Relationships/Context

The topic of ocean ecosystems initiated a discussion about how the ocean has not been adequately conserved in the past five decades, which has led to serious environmental consequences. Co-researchers focused on Walvis Bay, highlighting its role as a hub for some of the country's largest fishing factories, such as Erongo Marine Enterprises, Tunacor, and Esja Fishing. These factories provide employment opportunities for many, which is an advantage, especially since Namibia grapples with increasing unemployment rates (Amakali, 2018; Nthengwe, 2022; Vatileni, 2023). The Namibian Chamber of Environment (2021) recently reported that after years of overfishing combined with environmental and climate factors, Namibia's sardine (pilchard) population collapsed. Due to the collapse, fishing conditions changed over time. Unlike in the 1990s, small-scale fishermen cannot catch fish near the town's seashores and must travel long distances by boat or car to fish. Thus, fish migration away from town coastlines has negatively affected small-scale fishermen, particularly those who lack the resources and boats required for offshore fishing practices:

> *"…But people are misusing the ocean for the benefits it provides. They are not making efforts to sustain it…. The ocean is giving us something but we are not giving back to the ocean. Lets at least give the ocean a chance to bring more species or to just breathe a little bit. Because it is alive also, it needs to breathe, and it needs to like rest also but we are taking advantage of it…. We just don't really value the ocean, despite the fact that the ocean has a lot to provide and has always been providing for us…"* (Morangie, AT)

Morangie, a Topnaar ǂAonin descendent, expressed the importance of conserving and sustaining the ocean for posterity and described the ocean as a living being that must be treated and respected in the same way humans treat and respect each other. Because of the challenges facing the ocean, critical steps must be taken to combat ocean misuse and mismanagement. He expressed a desire to educate people about traditional ways of connecting with the ocean practised by the Topnaar ǂAonin in the past. He emphasised the importance of understanding past ways in which the ocean was respected and conserved. He argued that while people may not want to return to the old ways of life, they can learn from Indigenous ocean knowledge and practices.

The discussion on ocean conservation prompted a conversation about current methods to protect and sustain the ocean and its resources. Co-researchers acknowledged that some coastal inhabitants are aware of existing rules and regulations dedicated to ocean protection, including no littering, the use of appropriate fishing gear and the number of certain fish species (mussels) to capture in a day (Ministry of Fisheries and Marine Resources, 2001). Some fishermen also adhere to the recreational fishing guidelines outlined in the Namibian Gazette Notice issued by the Ministry of Fisheries and Marine Resources (2001). These practices reflect a culture of ocean conservation and preservation at a local level.

Co-researchers also discussed ocean pollution within Namibian coastal communities. Ocean pollution poses significant risks to the ocean's ecosystem, human health, and wellbeing, and it is intensifying, as well as poorly managed in most countries (Landrigan et al., 2020). Co-researchers added that it harms the ocean ecosystem and negatively impacts the ocean's/beach appearance. As a result, some people stop going to the beach, affecting their wellbeing. The pressing need for ocean sustainability is increasingly urgent, and the need for a shift toward sustainable practices is more compelling. Without immediate action to alter the trajectory of ocean conservation, there is a risk that the ocean may physically and biologically collapse (Intergovernmental Panel on Climate Change, 2019). In response, Mee Letisia, a pre-primary school teacher, shared her commitment to guiding and educating children about the ocean:

> *"We have to teach our children the value of keeping the ocean and environment clean. They need to learn and understand from an early age that this is our ocean, and we must protect it…. I occasionally seek funding and sponsorships to take the children on excursions to the sea, the aquarium…so that they can personally experience these environments."* (Letisia, AT)

Co-researchers stressed the importance of educating young children and teenagers about ocean conservation, cleanliness, and safety, whether at school or home. Another co-researcher, who is currently studying to be a teacher, further noted that while subjects such as environmental studies cover topics about the ocean, they need more substantial content on ocean conservation. She added that in addition to schools grappling with insufficient resources, teachers are overloaded with work and do not get time to take children on excursions to the ocean or other attractions.

Ocean pollution can be controlled by implementing strategies based on technology, law, and policy (Landrigan et al., 2020) and by teaching and creating awareness about ocean

conservation. Co-researchers recommended increased ocean awareness to ensure that people are well-informed about various fishing practices and activities and how to maintain the ocean's cleanliness. For instance, teachings about different methods of utilising resources such as seaweed, seal products, driftwood, and seashells. These practices significantly benefit coastal individuals, exposing them to new knowledge about effective ways to utilise ocean resources for personal and economic gain. Co-researcher further emphasised that information dissemination can be facilitated through printed materials, poster advertisements, and digital technologies similar to *Efuta Letu Sida Hurib* to raise awareness and share information about the use and sustainability of ocean resources. Information can be broadcast on television, radio, and social media to reach a greater audience, and communities can organise clean-up campaigns and beach walks to increase ocean conservation responsiveness. Co-researchers highlighted that although the local municipality often arranges clean-up campaigns, these efforts are not always inclusive, as individuals, particularly those from informal communities, are frequently uninformed about these events (see Section 2.3.1). There is a need to ensure that local clean-up initiatives are inclusive and consider the interests of all communities. Additionally, co-researchers noted that communities should not solely depend on the municipality to organise conservation or clean-up events. Instead, community members should also step up and actively preserve their surroundings by initiating community beach clean-up campaigns, amongst other community growth and development initiatives.

4.5.1. The Weight of Climate Change

This section emphasises the consequences of climate change for coastal communities and co-researchers' insights and perspectives on the climate change challenges encountered within communities. It also analyses how this challenges impact ocean heritage and livelihoods.

Climate change has been a growing concern caused by human activities through pollution and greenhouse gas emissions. These activities have caused global temperatures to rise, resulting in immense global warming (IPCC, 2023). Caney (2015) notes that climate change will have harmful impacts on humanity, especially on the most disadvantaged populations, and will cause flooding, drought, food insecurity, heat stress, and increased vulnerability to diseases.

Tadesse (2010, p. 1) argues that even though the world's poorest countries contribute the least to pollution, it is these nations that suffer the most from the impacts of climate change, exposing them to severe environmental challenges such as "*higher temperatures, the drying up of soils, increased pest and disease pressure, shifts in suitable areas for growing crops and livestock,*

increased desertification in the Sahara region, floods, deforestation, and erosion… all of which could affect much of its population" (see also Mendelsohn et al., 2000; Nordhaus and Boyer, 2000; Tol, 2002, 2009). The United Nations agrees that climate change poses a significant threat to disadvantaged countries, affecting the livelihoods of communities. Some of these communities identified ways and methods to adapt to these environmental changes:

> "*The impact of climate change will fall disproportionate on the world's poorest countries, many of them here in Africa. Poor people already live on the front lines of pollution, disaster, and degradation of resources and land…For them, adaptation is a matter of sheer survival.*" (United Nations, 2007, p. 24)

A good example of climate change effects is the severe storms, rainfall, and flooding incidents caused by cyclones Idai and Kenneth in 2018. These affected and displaced various communities in Malawi, Zimbabwe and Mozambique (UNICEF, 2019; Emerton et al., 2020). Similarly, Namibia is also experiencing climate change challenges that have influenced coastal and inland communities. Over the past two decades, Namibia has encountered severe droughts and flooding in some regions, which have been recorded as some of the most severe weather patterns in recent Namibian history (Konrad-Adenauer-Stiftung, 2021; Liu and Zhou, 2021). In addition to severe droughts, Namibia has experienced heavy rainfall, resulting in increased flooding, affected movement between places, and displaced various people and communities (Lendelvo et al., 2018; Niipare, Jordaan and Siyambango, 2020).

Given the context of climate change and its effects, co-researchers who collect seashells expressed concerns about the diminishing durability and hardness of oysters and seashells. Voicing worry over the increasing fragility and brittleness of shells and fearing that in a few years, the traditional practice of creating jewellery like *onyoka* using oysters or seashells may no longer be possible, impacting Aawambo cultural traditions. Co-researchers also raised concerns about small-scale fishermen who voiced concerns about the impact of climate change. In addition to competing with large-scale fishing companies, climate change has caused shifts in sea temperatures, which disrupts the balance of the ocean's ecosystem, resulting in a decline of fish populations as the fish migrate farther away from the coastlines. As a result, small-scale fishermen catch zero to limited amounts of fish, which affects their livelihoods (see Monnier et al., 2020; Ilosvay, Molinos and Ojea, 2022). These observations reiterate the importance of environmental and ocean conservation to safeguard resources, ensuring the sustainability of both the ecosystem and human livelihoods.

4.6. Conclusion

Discussions during the workshops covered unique ocean contributions ranging from cultural to historic, wellbeing and artistic, economical, and ocean conservation relationships. Contributions went beyond conventional ocean heritage and included subjective opinions as evidence in this chapter.

Beneficial, insightful, and positive outcomes concerning ocean heritages were revealed. Apart from ocean relationships and activities, co-researchers also shared opinions about weather patterns in coastal towns and how they change drastically from hot one minute and cold to rainy or misty the next, drawing parallels between human characteristics and mood swings. The discussions highlighted the differences between coastal towns and their coastlines. Swakopmund's coastline experiences turbulent waters, requiring swimmers to exercise caution because of strong undercurrents that pose a drowning hazard. In contrast, Walvis Bay's ocean is typically tranquil, allowing people to swim with minimal risks of drowning incidents. Finally, Co-researchers reiterated that the ocean can be dangerous, as it may give the illusion of calmness at the surface while concealing rough conditions below. This research takes note of the different conceptions of the ocean of danger and protection. While the ocean is considered to be dangerous, it is also thought to be a protector that can ward off bad luck and evil spirits.

The workshops served as a learning experience for the author and co-researchers. One co-researcher acknowledged that, before participating in this research, she had not given much thought to the ocean; for her, it was merely a body of water. She has since developed a new perspective on the ocean and acknowledged that it extends beyond the ocean, encompassing the broader significance of ocean resources, activities around it and other water bodies like ponds, rivers, and streams. Co-researchers were also grateful for the opportunity to engage in the workshops, as some were not typically outspoken but found a means to express themselves during the workshops. Mee Anna shared that during the workshops, she experienced personal growth regarding confidence and presentation skills. Another co-researcher elaborated on the ocean knowledge and cultural practices he learned through the workshops, which he had previously only heard of but now had the opportunity to experience:

> "*I learned a lot about the Oshiwambo culture, things I use to wonder about and did not know. I feel like I am even more connected to the ocean now because I learned so many*

interesting facts about it. And now I am going to learn and explore more about the ocean." (Edwin)

Rejoice shared that the concept of the ocean had always been boring for her, but her perspective changed because of the discussions and interactions with other co-researchers. Co-researchers willingly exchanged knowledge among themselves and with the author. Results revealed the importance of the ocean and co-researcher's passion for cultural heritage, evidenced through discussions about cultural beliefs and practices. These practices include paying homage to the ocean, washing one's face or feet in/with ocean water, sprinkling ocean water and hanging dry seaweed in houses, and traditional practices linked to *onyoka* jewellery and ornaments. During the workshops, a profound place attachment (see Section 2.5.4) and collective appreciation for the ocean emerged among the co-researchers. The interactions also revealed numerous commonalities and synergies between diverse opinions, beliefs, and cultural backgrounds. These cultural backgrounds and connections are further demonstrated through co-researchers' ocean heritage contributions on *Efuta Letu Sida Hurib.*

CHAPTER 5

TECHNOLOGY EXPLORATION AND CO-PRODUCTION RESULTS OF *EFUTA LETU SIDA HURIB*

Chapter 5 outlines the development and design process, including functionality and content, of *Efuta Letu Sida Hurib*. The Chapter explores insights, ideas and suggestions provided by co-researchers regarding the importance of the ocean and includes objects/materials symbolising ocean heritage shared during the workshops. This Chapter concludes by providing an explanation of navigation through the pages on *Efuta Letu Sida Hurib*.

5.1. Investigating Technology Exploration, Testing and Reflections

Drawing from PD and rapid ethnography methods, this research conducted co-production workshops focusing on ocean heritage and augmented reality (AR) (See Chapter 3 for methodologies utilised in the workshops). During the technology exploration workshop, co-researchers discussed different technologies with which they were familiar, including mobile phones, the Internet, WhatsApp, Facebook, Twitter, Instagram, and TikTok, as well as machines and robots. Subsequently, the author inquired whether co-researchers were familiar with digital and immersive technologies, such as AR. The majority of co-researchers were not familiar with it or other immersive technology applications.

The author inquired if co-researchers ever took selfie pictures with augmented effects, for example, adding flowers, lipstick, and glitter to a picture using edit features provided on most social media platforms. Most of the younger co-researchers acknowledged their familiarity with these features. Older co-researchers were not familiar with these AR features found on social media platforms because they mostly used Facebook to share photographs and content related to their personal lives and businesses. Some older co-researchers only recently started using WhatsApp to exchange messages, share multimedia, send voice notes, and post pictures and information on their statuses. This is the extent to which the older co-researchers engage with social media platforms.

The author explained immersive technologies and used TikTok, a recent social media platform that gained popularity during Covid-19 (van Dijk, 2021), as an example to demonstrate what AR is, how it operates and how it enhances user experience. Figure 5.1 illustrates an example of a spider augmented onto someone's face.

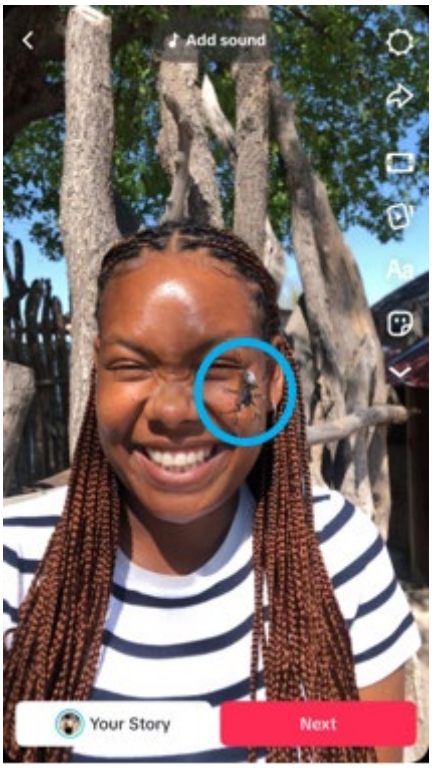


Figure 5.1: Photograph of a walking spider augmented walking on a face. Screenshot: Aletta Batista Elly, 2024.

Co-researchers then engaged with five different immersive and digital technology applications, which enabled them to better understand AR. The applications were explored sequentially, beginning with the StoryBeads video created by Smith et al. (2011) that demonstrated a digital technology project that used eBeads and an input system referred to as StoryTeller (see Figure 5.2) to digitally document knowledge of the (see Sections 2.1.1 and 5.1). Co-researchers watched the video on various devices, including a laptop, three mobile phones, and one tablet (see Figure 5.3). Anticipating potential sound distractions as co-researchers watched the video individually and in pairs, earphones were provided for some co-researchers while other co-researchers sat separately in different areas of the workshop room.

This photograph has been deleted because of copyright restrictions.

Please refer to photograph source.

Figure 5.2: BaTwana StoryBeads video. Source: Smith et al. (2011). Retrieved in 2022.

Figure 5.3: Co-researcher watching the BaTwana StoryBeads video. Photograph: Marly Muudeni Samuel, 2022.

Following the BaNtwana StoryBeads video, co-researchers explored ‘San Cultural Heritage’ a project that had developed image marker-based fridge magnets (see Figure 5.4 and 5.5), co-designed in collaboration with Donkerbos, a Namibian San community (Winschiers-

Theophilus et al., 2020). The application features information about the cultural heritage of the San people.

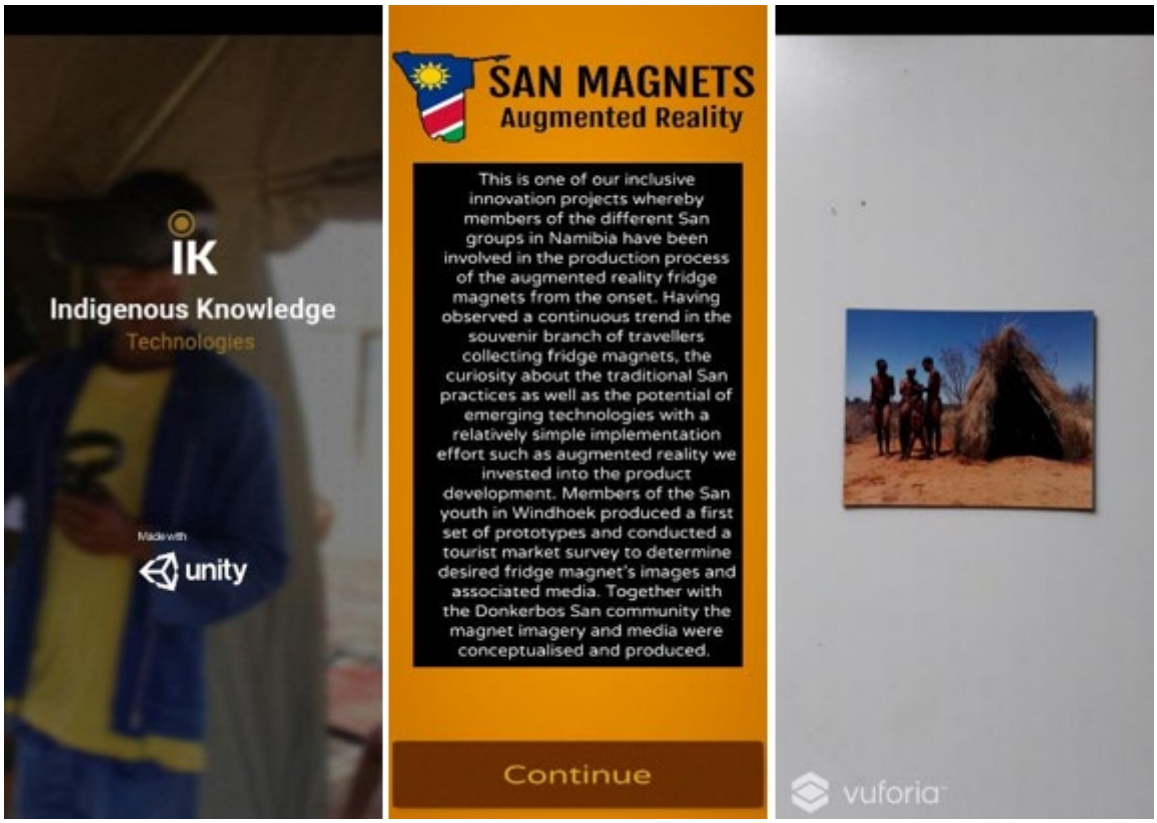


Figure 5.4: (a) Starting page photograph for the San cultural heritage fridge magnet App; (b) Home page photograph for the San cultural heritage fridge magnet with an explanation about the App; (c) AR scene with the marker target: San cultural heritage fridge magnet App. Source: San Cultural Heritage Augmented Reality App. Retrived in 2022.


Figure 5.5: (a) Walvis Bay and (b) Swakopmund Co-researchers exploring the 'San Cultural Heritage' fridge magnets. Photograph: Tangi Hangula, 2022

The third application was 'Making Sense of the Past' – a project that produced image marker-based AR fridge magnets (see Figure 5.6), adapted from the 'San Cultural Heritage' project. Co-designed in collaboration with ten Namibian born-free youth (term explained in Section

2.4.1) (Kambunga et al., 2020), these magnets facilitated the exploration, perception, and comprehension of Namibia's history before and after independence.

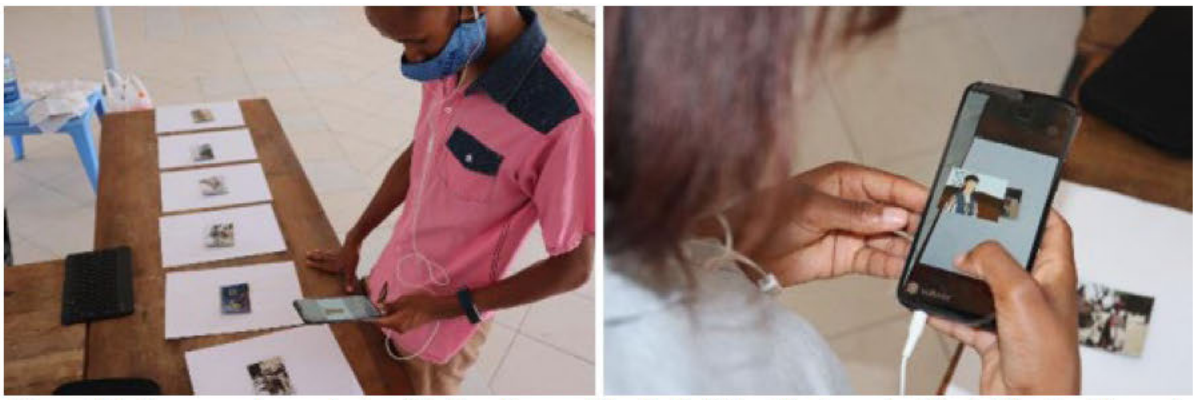


Figure 5.6: Co-researcher exploring 'Making Sense of the Past' fridge. Photographs: Marly Muudeni Samuel, 2022

The fourth application was 'Badenoch the Storylands', a markerless AR project (see Figure 5.7 and 5.8) designed to demonstrate the history and heritage of Badenoch, a district now part of Badenoch and Strathspey in Scotland (Badenoch the Storylands, 2021). The application enables users to navigate, explore, and read about Badenoch's historical places.

This photograph has been deleted because of copyright restrictions.

Please refer to photograph source.

Figure 5.7: (a) Badenoch the Storylands home page; (b) Badenoch the Storylands AR experience page

These photographs have been deleted because of copyright restrictions.

Please refer to photograph source.

(c) Badenoch the Storylands AR 3D model scene; (b) Badenoch the Storylands explanation pane. Source: Badenoch the Storylands AR application. Retrieved in 2022.

Figure 5.8: Swakopmund co-researcher exploring Badenoch the storylands. Photograph: Marly Muudeni Samuel, 2022

The fifth application co-researchers engaged with was a prototype markerless AR application developed by the author (see Section 6.4.2 for an explanation of the prototype). The application featured various 3D models and ocean information. The original inspiration for the content included on the prototype AR application was provided by insights shared by coastal residents during exploratory workshops conducted by researchers from University of Namibia and the author, which were held in December 2021 in collaboration with the One Ocean Hub.

For some co-researchers, it was the first time they had experienced these digital technologies. Questions were asked, including how and where the applications were created, how long it took to create them, and whether co-researchers could also create similar applications. The cultural heritage fridge magnets were liked most by co-researchers because of the cultural

content and videos that told stories. One co-researcher highly praised the San videos, appreciating the opportunity to gain insights into the San people's culture,

> *"It was my first time experiencing this type of technology and I didn't have any problems using it. It was an eye-opener for me. The information being shown on the applications is really important and of great worth because you see the people themselves talking about their culture and explaining it in the video."* (Haba)

Co-researchers also liked the prototype application and the 'Bodenoch the Storylands' because of their markerless AR feature (see Section 6.2.1.1 for an explanation of markerless AR). The prototype AR application was enlightening, as it featured various ocean objects, including seaweed and seals. Co-researchers highlighted that the 'Badenoch the Storylands' application stood out for its uniqueness, particularly because it guided users through an immersive journey to explore Badenoch using a mobile device. It also incorporated descriptive texts that provided explanations about the content being viewed. Morangie noted that the appearance of the 3D models on 'Badenoch the Storylands' looked very real, creating an immersive experience that made it feel like he was physically present in the simulated environment. Co-researchers liked the 3D models that popped up and how they could interact with them by zooming in, out, and rotating them. Some co-researchers needed assistance navigating through the applications due to digital literacy challenges, and some co-researchers were not proficient in English, which prevented them from understanding the text descriptions on the applications. Where necessary, the author translated and explained the text to them. Co-researchers were happy with the inclusion of visual elements on all the applications, as it significantly enhanced their ability to gain an understanding of the included content.

Co-researchers expressed willingness to explore the possibility of creating a similar application. Co-researchers also noted that such digital technologies could be employed in various other contexts, including educational settings or the tourism industry. Lucio, a university student, emphasised the prospects of using digital technologies to teach in schools and universities, mainly because books can sometimes be overwhelming. Given the prevalent technological and financial challenges within the communities, Jota highlighted the potential difficulty schools might encounter in acquiring the necessary technological infrastructure and equipment for developing similar applications. She noted that most schools lack adequate resources, and maintaining these technologies will also demand resources and expertise that may not be available.

> *"This could be a great way to teach in schools. But resources are scarce. Some schools still struggle with the basics, they don't even have projectors to teach with. Yes, technology can be used, but at the moment they are not attainable and cannot be sustained."* (Jota, AT)

During the discussion, co-researchers pointed out that the video explaining the BaNTwana Storybeads was unclear. It was difficult to understand how the recording process worked because the technology was not visible and clearly explained. Instead, all co-researchers observed were women sitting near a woven basket with a small bead on top of it, narrating stories. The author clarified how the technology worked and the methodology employed, elaborating that the conversation was being recorded using an eBead audio recording device and input system positioned beneath the basket (see Smith et al., 2011). Morangie further explained that he could not connect with the video because it only displayed the basket, adding that if the video had shown visuals of the women conversing, laughing, and creating the beads, he would have connected and understood the process more clearly.

Edwin commented positively on the San magnets, describing them as 'really great'. However, he felt that besides the cultural explanations, the videos should have provided more information about the magnets and how they were created. He asked whether the AR platform used was exclusively designed for fridge magnets. The author explained that the San Magnets project team chose this particular method and process but clarified that AR can be used in various ways and for different projects. The author further explained that when developing digital technologies such as these, several factors must be considered, including the technology, context, compatible devices, and the intended audience for the application.

Co-researchers inquired whether they could download and install the applications on their mobile phones. The author explained that the applications can only be installed on mobile devices with functions that are compatible with ARCore (see Section 6.3.3 for an explanation of device requirements and compatibility). Co-researchers then showed the types of phones they had access to. The features of these mobile phones varied, with some only being able to support marker-based AR, similar to the fridge magnets, and not markerless AR like the 'Badenoch the Storyland's' application. Some supported both marker-based and markerless AR and others did not support either technology. Co-researchers were disappointed that some of their phones could not support markerless AR. Despite this limitation, co-researchers still chose to co-produce a markerless AR application.

Co-researchers expressed overall satisfaction with the immersive and digital applications, emphasising that technologies provide an effective platform for learning, sharing, and preserving culture and knowledge. Co-researchers highlighted that the technologies explored were exciting to use because they were different from other conventional applications,

> *"I've seen this type of technology on the television being used in movies and documentaries. Today, I got to experience it myself and I loved it. If we can have access to such technology, many things will become easy for us. For instance, as a teacher, you would be able to create lessons that are captivating through technology for the children. It will resemble something close to reality for the kids in class. This could be a way for them to experience something different."* (Jota)

> *"While exploring the technology, I realised that a person can just have a small piece of paper and when it is scanned, a video can play from it. That is really interesting and if my phone supported this type of technology, I would be using it."* (Kapandu)

Co-researchers found the videos about cultural heritage featured on the San fridge magnets meaningful, given their dissemination of information about various cultures. Mee Sofia noted,

> *"The technologies were amazing and just going through them was an experience. This is what we call ehumokomesho* [development]. *Seeing how other people like the San evolved and how they were able to take part in the technology. We do not live in the olden days anymore; we cannot just go and hunt because the world has developed, and animals are now under government protection. But it was wonderful seeing the San re-enact their cultural traits and showcasing the way they lived many years ago. Technology can preserve culture, and because of that, future generations will be able to experience cultural heritage through digitalisation. It also means that with technology, culture does not have to die. It will stay forever."* (Sofia, AT)

Mee Letisia emphasised that the San Cultural Heritage magnets promoted cultural pride. For instance, in one of the fridge magnets videos, the San women demonstrated using herbs as perfume. This inspired Mee Letisia because, in her culture, using herbs is frowned upon and associated with witchcraft, despite formally having been a part of the Aawambo people's cultural practices. Consequently, she gained a new appreciation for herbs (see Figure 5.9) and felt inspired to continue using them,

"We don't need to always buy perfume, we can use our cultural herbs for perfume. The herbs also have an important significance as they were also used to ward off evil spirits. Now people just use perfume, though it does not protect you against anything. And people do not even know the symbolism behind the perfumes they use. What is its essence? But I can use my oshidimba [traditional crushed herbs used as perfume and for protection against bad spirits] *with the knowledge that it symbolises heritage, protection, and courage. After using it, I will know that when walking around, I am protected."* (Leticia, AT)

Figure 5.9: Traditional herbs. Photograph: Marly Muudeni Samuel, 2022.

Mee Letisia expressed that the digital technologies she explored provided her with a different perception and demonstrated that they can be used to share and preserve knowledge and culture for posterity. The information shared through the digital technologies taught her the importance of following and practising cultural customs as they represent roots and help people stay connected to their heritage. She narrated a story from her childhood, shared by her uncles and aunts, highlighting a cultural belief that water should not be thrown inside homesteads. While she admitted not knowing the specific reason behind this practice, she believed there must have been a meaningful cultural explanation. She expressed that technology could share and preserve such cultural practices, beliefs, and stories.

The AR technologies explored encountered challenges or stopped working at some points when co-researchers engaged with them. These challenges occurred particularly when attempting to play the videos linked to specific image markers on the fridge magnets. These challenges were mostly linked to stability issues caused by the image markers (colour and texture contrast) being used (see Sections 6.2.1.1 and 6.4.1 for an explanation of image markers). Because of the marker challenges, co-researchers had to click on the mobile device multiple times to get a response or exit and reload applications.

Lucio emphasised that while technology offers numerous advantages, it also presents accessibility challenges. He stressed that practitioners must ensure that the audiences intended to use digital applications have access to technology infrastructure and the necessary knowledge required to engage with digital applications effectively. Co-researchers discussed effective methods such as sharing information about *Efuta Letu Sida Hurib* on social media platforms to ensure it reached a broader audience. Lucio further highlighted his involvement in various youth groups and suggested raising awareness through local organisations and community groups. Following the digital technology exploration and discussions, co-researchers decided to co-produce a markerless AR application because of its ability to effectively capture ocean heritage. The development and implementation of the AR application are explained in Chapter 6.

5.1.1. Phase One: Ocean Heritage Contributions. Ocean Objects and Material Symbolism

The following three sections present results obtained during the workshops detailed in Section 3.3.

During the workshops, co-researchers shared different objects/materials (digital materials, photographs) that represented individual and collective ocean relationships (see Figure 5.10).

Figure 5.10: Co-researcher presenting different objects she brought, including driftwood art, seaweed, onion plant, and seaweed water extract. Photograph: Marly Muudeni Samuel, 2022.

The following tables summarise the object/material representations that were shared as a symbolism of co-researcher's relationships with the ocean. The first column shows the number of the object/material, the second column includes a photograph and the title and description of the object/material, and the third column includes explanations about the object/material.

No	Object/Material representing ocean relationship	Ocean relationship explanation
1	 Figure 5.11: Piece of driftwood. Photograph: Marly Muudeni Samuel, 2022. A piece of driftwood picked up at the beach.	*"A piece of natural artwork that connects me to the ocean because of its spikes. It also symbolises the type of person that I am. I am adventurous, and I like finding out new things and meeting new people. It reminds me of my bubbly and adventurous spirit. I like seeking opportunities wherever I go, just like its venturesome spikes. It's dark and vibrant colour reminds me of the ǂNukhoe* [another name for the Damara/Nama people of Namibia. Direct translation: black people] *and their activities, our*

	Object Title: Venturesome Radicle	*activities, such as hunting and gathering veldkos* [Afrikaans word meaning field food] *and of course living a nomadic lifestyle. This radicle, found at the shore of the sea, can also be used as decorative items in remembrance of the Nukhoe people."* (Edwin)
2	 Figure 5.12: !Nara seeds. Photograph: Marly Muudeni Samuel, 2022. Seeds from the !Nara plant which plays a significant role in the lives of the Topnaar ǂAonin people. Object Title: !Nara Seeds	*"This are !Nara seeds. They come from the !Nara fruit itself. It is prepared by cooking and drying it. It connects me to the ocean because the !Nara plant is found in the Namib desert and the fog of the ocean helps to keep it hydrated. Yesterday, I sat down and I was thinking, that the ocean has not forgotten about the Topnaar people. They were chased away from the sea, but the ocean continued giving the Topnaar people new ways of living, a new livelihood, through the !Nara plant* [for further details on the history and displacement of the Topnaar people, see Sullivan, (2021, 2023) and Section 4.1.2]. *So that is how it connects me to the ocean. After the Topnaar were forcefully removed from the ocean, they meditated on a verse from the bible: 1 Samuel: This far the Lord has gotten me* [Correct Bible verse: Thus far the Lord has helped us. New King James Version]. *Meaning that God has helped us up to this point and time in life. It is a monument that we have at our home in Utuseb."* (Morangie, AT)
3	 Figure 5.13: Seashell at the beach. Photograph: Marly Muudeni Samuel, 2022.	*"When I was named by my parents and grandparents, I also received waist beads that I wear around my waist up until now. These beads are made from seashells and that is how and why I am connected to them and the ocean. The waist beads distinguish us young people who do not have children from the women and elders who have kids. The beads are usually made by our elders. They*

	Seashells used by the Aawambo people to create traditional beads, jewellery, and ornaments. Object Title: Seashells	*crush the shells into small pieces, they make small holes in the middle and they put a rope into the rounded shells to make jewellery beads. These beads are placed around our waist. I've been wearing my beads since I was a baby, through my childhood until now. We also wear them if we have a wedding or an event with our traditional attire odelela."* (Rejoice, AT)
4	 Figure 5.14: Dried !Nara plant roots. Photograph: Marly Muudeni Samuel, 2022. !Nara roots used by the Topnaar ǂAonin for a variety of purposes, including medicinal purposes. Object Title: !Nara Seeds	*"This is the root of the !Nara plant. Representing the start. My roots, and the heritage that I come from are linked to the !Nara plant. The Topnaar people used to live and survive of the sea and the sea provides water for the !Nara plant through its roots, and through the !Nara plant we have a livelihood. We also use it as medication* [for further details about the uses of the !Nara plant see Van Damme and Van Den Eynden (1992)]. *But my grandmother told me that it is dangerous for pregnant women and can also be dangerous for children if not used correctly. The water extract from the roots is used for some illnesses such as asthma, kidney problems and high blood pressure. You boil it and drink the water."* (Sara-Leigh)
5	 Figure 5.15: Seagull feather. Photograph: Marly Muudeni Samuel, 2022. A seagull feather symbolising inspiration and free-	*"The seagull feather connects me to the ocean because it is a representation of the calm, free spirit of the seagull and ocean for me. Whenever the seagull is mid-air, it flies with freeness and calmness, and I feel the same way about the ocean. It is a calm free-spirited place for relaxing, refreshing and simply forgetting your problems. The seagull survives from the ocean, and just like me and my community and generations before us, we survive from the ocean through its minerals and fish.*

	spiritedness, similar to a seagull. Object Title: Seagull feather	*Therefore, I connect with the seagull because we have something in common and that is how it connects me to the ocean."* (Lucio)
6	 Figure 5.16: Picture from an ocean video portraying its waves. Photograph, Marly Muudeni Samuel, 2021. Material: Ocean Waves video Ocean waves illustrating co-researcher's admiration for the ocean and its ecosystem. Material Title: Ocean Waves	*"The ocean is important because of the lives it represents, such as the fish and plant life, and the mineral resources we find in the ocean. I also believe that it plays an important role in the ozone layer. It helps keep the air clean and cleanses it from pollution. The waves of the sea are my representation. I chose the waves of the sea because of the way they move and how they are driven by the ocean current. The waves and wind portray a level of authority, and it is the driving force behind the cleansing of the ocean."* (TheOne)
7.1	 Figure 5.17: Seaweed on blue plate. Photograph: Marly Muudeni Samuel, 2021. Seaweed sustains coastal livelihoods. The co-researcher expressed that the ocean is a part of her identity, and her livelihood relies on it. Object Title: Seaweed	*"In Swakopmund we have gardens, and we use seaweed that we collect at the seashore as fertiliser for our gardens. The seaweed extract is organic and the gardens grow faster and they are organic. People can survive from the food produced in their gardens, especially women. I use the seaweed fertiliser for my garden, and these are onions that I grow in my garden with seaweed extract* [Figure 5.10 illustartes all the objects brought by Ousitjue]. *I made this seaweed water extract last night, that is why it is light. Normally you must keep it for 4-5 months to get a good nutritious extract. Seaweed targets a wide range of skincare. It has extra vitamin C. If you feel*

		nausea you can chew on seaweed a little bit and it will help." *"The seaweed trunk becomes dark after a while, it is then dried and burned and applied onto burned wounds. Even if a child has a cut, you can put the seaweed and it will help. People from other towns used to ask us to bring seaweed when we visit. We also learned that our ancestors used seaweed. They would dried and burned or crush and use the end product medically. It has many uses usable and the youths can also use it for economic gain."* (Ousitjie)
7.2	 Figure 5.18: Driftwood art stand that dabbles as a jewellery holder or a Christmas tree. Photograph: Marly Muudeni Samuel, 2022. Driftwood piece symbolising how some people depend on the ocean for artistic inspiration. Object Title: Driftwood art	*"I am an artist and the ocean is important to me because it has opened doors for us to use its resources for our benefit. These driftwoods were washed out by the sea when the Swakopmund river met the ocean. It is clean to use and durable. I use it to make lamps, jewellery stands and Christmas trees. It is very strong and you can just pick it up and use it. Currently, some companies buy driftwood from us. We just collect it and sell it to them."* (Ousitjie)
8	 Figure 5.19: Fish tank. Photograph: Marly Muudeni Samuel, 2022.	*"I brought my fish tank with its fish to symbolise my ocean connection. The ocean is important because of the air we breathe. It produces most of the oxygen in the world. I also love the ocean because of its weather. Also because the food that we get from the sea and the jobs that are created because of the sea.*

	The fish tank symbolises the joy it brings the co-researcher when she is caring for the fish. Object Title: Fish tank	*Many people in coastal towns are employed by fish companies. That is why the ocean is important."* (Haba)
9	 Figure 5.20: Sea sand, seashells, and stones in a glass plate. Photograph: Marly Muudeni Samuel, 2022. Glass display plate with sea sand, seashells, and sea rocks. Object Title: Sea sand and seashells	*"Seashells and human beings have similar characteristics. They can be beautiful and full of life on one end, but they can also be rough around the edges on the other end. Like human beings, seashells are subjected to a variety of harsh realities, and those realities shape who they are."* (Lato, AT)
10	 Figure 5.21: Oyster shell used to make traditional jewellery. Photograph: Marly Muudeni Samuel, 2022. Oyster shell used to make traditional jewellery. Object Title: Oysters and seashells	*"The ocean is important because it helps me relax when I have problems. It is like medicine, when something is wrong, I go there to feel better. But it also provides for me because I am seashell collector"* (Anna, AT)

11	 Figure 5.22: Onyoka, a necklace made from oysters and seashells. Photograph: Marly Muudeni Samuel, 2022. The co-researcher brought a variety of objects to symbolise her relationship to the ocean, including *onyoka* cultural jewellery (also known as *onduwi* or *oshinyeye* in some tribes), seashells used to create the above-mentioned traditional jewellery and *oshidimba* (traditional herbs) which is applied on clothes as perfume. She explained why the objects are significant in the Oshiwambo culture. Object Title: *Onyoka*	*"The ocean is important because of our traditions. This is Oshinyenye, a traditional necklace created with seashells which is worn by children because of our traditions and customs. When a child is young in the Aawambo culture, the child should be given a name, and we give them this neckpiece as a symbol of welcoming the child into the two families. This neckpiece should come from the father's side of the family. In our tradition if a child is not presented with this traditional neckpiece, it is believed that the child can get gets sick. We believe the neckpiece protects the child from bad spirits or spiritual attacks."* (Leticia, AT)
12	 Figure 5.23: Oshiwambo traditional belt adorned with seashells and beads. Photograph: Marly Muudeni Samuel, 2022.	*"The ocean is alive and I think that on its own is very important. We get different species in the ocean for example fish, seashells, seaweed, ocean water and seals. Seals are important to us the Aawambo people because we eat them. We also use seal oil as a medicine. Seal oil can treat bad knees, heart problems, and stomach aches. It can be applied to an affected area or added to water to drink. If you have access to seal meat, it's the best. 'Oto teka ashike*

	Traditional *eepaya* (belt) worn with Aawambo traditional dress. Object Title: *Omuthigululwakalo* Cultural Heritage	*nayo'* [An idiom that means you will enjoy doing something or eating a certain food. Direct translation: you will just break with it.]. *I also brought this eempaya (belt) made with seashells, which is part of the Aawambo traditional attire won by women"* (Sofia, AT)
13	 Figure 5.24: Co-researcher having fun at the beach. Photograph: Marly Muudeni Samuel, 2022. The ocean contributes to emotional wellbeing and psychological stability for individuals. Object Title: The Ocean And I	*"The ocean is important to me because of the emotional attachment I have with it. Its physical features wake up emotions inside of me, such as calmness, happiness and it relaxes me. It evokes different emotions in me that I would not be able to describe at this moment but will only be able to describe them when I am at the beach."* (Jota)

Table 5.1: Illustrates the different ocean objects/materials brought by co-researchers

5.1.2. Phase Two: Application Co-production. Content Creation

During the second *Design and Digital Co-production* workshop, co-researchers discussed the visual effects of *Efuta Letu Sida Hurib*, considering factors such as how the AR application should look, colour outlines, photographs, language choices, the presentation of ocean heritages, and, importantly, the selection of an appropriate name for the application. Co-researchers drew inspiration from the immersive and digital technologies explored in phase one. Suggestions included expanding *Efuta Letu Sida Hurib's* content beyond the ocean representations presented on it. Co-researchers proposed incorporating an author page containing biographies, an ocean facts section highlighting information about the ocean, details about various fish species found in Namibia, and a section to include love letters and poems dedicated to the ocean (see Section 5.2 and Appendix 2: E). Co-researchers emphasised that by

including additional information, *Efuta Letu Sida Hurib* would include inclusive information about the ocean, its benefits, and its significance to coastal communities. More content would enable others to understand *Efuta Letu Sida Hurib's* objective.

Co-researchers suggested including photographs of the ocean and its beautiful scenery from Namibia, such as the beach, the !Nara plant and the Namib desert, as well as a Namibian flag with a particular emphasis on the colour blue of the flag to symbolise the ocean. Text descriptions to explain different 3D models representing ocean heritages were also included. Similar to the 'Badenoch the Storylands' application, the text descriptions were included to offer additional context to viewers, enhancing their understanding of the 3D models and individual ocean relationships. For future work, co-researchers recommended adding a page that addresses challenges and threats facing the ocean due to human activities.

A thorough discussion was held concerning the name of the AR application. Co-researchers emphasised the importance of choosing a name that clearly communicated the objective and significance of the AR application, which would represent the ocean and the ocean content included on it. Co-researchers suggested that the name be inclusive and relatable, taking into account the fact that the country and coastal community members are multilingual. Deliberations over an appropriate name were held, with some co-researchers preferring an Indigenous name, while others an English name,

> *"Everyone should understand the meaning of the app through the name. It should not be linked to tribes. We should consider that everyone should be able to read and understand the name."* (Haba)

Concern was expressed that an Indigenous name might not be universally understood, while others thought an Indigenous name would be context-unique. It was further suggested that, for clarity, the Indigenous name's meaning be included on the AR application. Co-researchers reached a consensus and chose an Indigenous name. The name chosen was *Efuta Letu Sida Hurib* (directly translated: Our ocean, Our ocean, in Oshiwambo and Khoekhoegowab (language spoken with click sounds), two Namibian Indigenous languages). For co-researchers, the name highlighted the connection between people and the ocean. Ousitjie further expressed that the name symbolised togetherness and embodied Ubuntu principles (see Section 2.5.1 for an explanation of Ubuntu). Alongside the AR application name *Efuta Letu Sida Hurib's*, a slogan called 'One with the Ocean' was created to emphasise that co-researchers are one with the ocean. Primary colours to be used on *Efuta Letu Sida Hurib* were

chosen, including blue, white, green, and yellow, representing the colours of the ocean and its environment. Co-researchers provided explanations for the colours, with blue representing the ocean and the horizon, white representing the waves, green representing the flora and plankton within the ocean, and yellow representing the sun. These colours were also symbolic of the Namibian flag.

5.1.3. Application Testing: Evaluation, Refining and Reflections

Reliant on suggestions provided by co-researchers, the author developed the first phase of *Efuta Letu Sida Hurib* and presented it to co-researchers during the *Application Testing, Refinement, and Reflections* workshop. Two mobile phones and a tablet were made available to facilitate engagement with *Efuta Letu Sida Hurib*.

The *Application Testing, Refinement, and Reflections* engagement workshop enabled co-researchers to test and evaluate the content and functionality of *Efuta Letu Sida Hurib* and provide suggestions for improvement. Co-researchers actively engaged and explored with *Efuta Letu Sida Hurib*, navigating through individual ocean contributions (Figure 5.25 shows a co-researcher engaging with *Efuta Letu Sida Hurib*). The overall experience was positive, and co-researchers were pleased with *Efuta Letu Sida Hurib* and the ocean representations,

> *"I am impressed by the app, especially our bio pages. And the AR 3D objects, are extraordinary. I love the picture and 3D model of my roots; the picture is very clear and the roots look real."* (Sara-Leigh)

> *"The app is something unique and different. It is actually good to know that it is an initiative that came from me, from us and that it is ours."* (TheOne)

> *"In all honesty, I do not know how I managed to interact with the technology because I am not very literate. but I did it and it was great. This research and workshops were able to invoke emotions and feelings of conviction that we are really part of the coast."* (Leticia, AT)

After engaging with *Efuta Letu Sida Hurib*, co-researchers discussed and reflected on its importance, particularly its potential to provide and share information about ocean heritage. Co-researchers noted that because of its potential, *Efuta Letu Sida Hurib* can be customised and used in other industries, including education, business, and tourism. The author also highlights that because the tools used to develop the application are free, *Efuta Letu Sida Hurib* can easily be adapted for different contexts. Additionaly, co-researchers mentioned that if *Efuta*

Letu Sida Hurib was accessible online, it could be an information source for anyone interested in experiencing or visiting Namibia.

Figure 5.25: Co-researcher engaging with *Efuta Letu Sida Hurib* and the author taking a photograph of her. Photograph: Kuundjuaune Kavari, 2022.

For refinement purposes, co-researchers suggested improvements to specific functions, colours, and 3D objects on the AR application. While sharing thoughts about the 3D models that represented their ocean heritage, co-researchers expressed that despite 3D models being virtual, when they were displayed on the mobile phone, they appeared as if they were visible in reality. After reviewing the 3D models and ocean representations, some co-researchers suggested changing their respective ocean representations (see Section 6.4.3.3 for Ocean materials titled 'The Ocean and I' and 'Seagull Feather' for details on these changes).

Mee Anna expressed that she appreciated how the size of 3D models scaled in response to proximity, becoming bigger as she approached them and smaller as she moved away, similar to real life. Co-researchers were particularly pleased with TheOne's 3D model representation. A video of the ocean represented his ocean relationship with the wind blowing, waves crashing, and sunlight glistening on the water's surface. Co-researchers expressed that the video appeared and sounded very authentic, creating an illusion and sensation of being close to the ocean (see Section 6.4.3.3 for an outline of the different 3D model representations).

While discussing the different ocean representations on *Efuta Letu Sida Hurib*, Ousitjie shared an interesting contribution about the spirit realm. She believed that the ocean has the power to take people's spirits. She provided an example, stating that people usually contemplate suicide by jumping into the sea during periods when the ocean is raging and turbulent, and their spirits are perceived to be colliding with the sea.

> *"…The ocean can also take people's spirits. For example, when the ocean is angry*, it's around that time that people commit suicide and it happens because their spirits are colliding with the ocean."* (Ousitjie)

*i.e. Rough or stormy

This research states that the accuracy and validity of this belief is unknown. In 2022, the World Health Organisation Namibia office reported that Namibia has the fourth highest suicide rate on the African continent, with a rate of 9.7 in a 100,000 population (WFO, 2022) (see also Ministry of Health and Social Services, 2018). These suicides could be attributed to psychological, socioeconomic and cultural challenges that individuals face from day to day. Therefore, the connection between instances of people taking their lives by jumping into the ocean versus the nature and state of the sea (e.g. angry) may or may not be related.

The *Design and Digital Co-production and Application Testing, Refinement, and Reflections* workshops were a learning experience for most co-researchers as they co-produced and learned more about the AR application, how 3D models are created, and ocean heritage. During the workshop interactions, co-researchers became a community. They created a platform to engage with each other, learning about immersive and digital technologies, ocean heritage, and ways to preserve and share ocean knowledge with a broader audience.

> *"this experience was a learning curve for me. Since we started the workshops, I started to see the ocean differently. And now whenever I am invited out I hope that it is at a restaurant with a view of the ocean. I don't just think about it as a place to get food or for resting, I started to see the bigger picture. Understanding that different things can come out of the ocean and that we as human beings are also connected to it. That is beautiful."* (Ousitjie)

> *"The cherry on the cake for me was learning about ocean knowledge from the other participants."* (Edwin)

Co-researchers highlighted that the author followed the specific requirements and suggestions provided and correctly and respectfully recorded and represented ocean heritages on *Efuta Letu Sida Hurib*. Co-researchers asserted that *Efuta Letu Sida Hurib* can be a valuable platform that enables people to learn more about the ocean while providing virtual access to it—especially for those who cannot physically visit the ocean. Importantly, co-researchers expressed their engagement with the immersive and digital technologies examined during the technology exploration workshop, and *Efuta Letu Sida Hurib* demonstrated that technology is a great conduit for supporting, sharing and preserving ocean heritage. Expressing pride in the co-produced AR application, co-researchers hoped that other people would have the opportunity to experience *Efuta Letu Sida Hurib* and other immersive technologies.

The challenge of access to digital and technological infrastructures was discussed. After learning that *Efuta Letu Sida Hurib* could not be installed on some mobile devices, co-researchers pointed out that most people in coastal communities, particularly those residing in informal settlements, do not have digital mobile devices. Those with digital devices mostly have low-end devices that would not support applications like *Efuta Letu Sida Hurib.* This digital gap is further exacerbated when commercial companies develop digital applications that can only be installed and utilised on specific digital devices. Therefore, though we are in a global digital world, we must acknowledge that digitalisation has yet to disseminate equally to most of the world. While some countries and communities (Global North) are already using 5G networks, Chitamu and Ismail (2024) note that other countries, such as Tanzania, are still facing challenges moving from 2G to 3G/4G networks (Global South) because of lack of technological infrastructures. As a result, multiple people are cut off from accessing, engaging with, and learning about different digital technologies.

5.2. *Efuta Letu Sida Hurib* Pages and Functions

To promote inclusivity, *Efuta Letua Sida Hurib* incorporates images, audio, and text descriptions to enable effective and enhanced inclusive user experience. *Efuta Letu Sida Hurib* includes five primary pages: home page, AR page, author page, ocean facts page, and a gallery page. The AR page is the primary page, including 3D models of ocean representations. Please note that names included in the photographs below are aliases, as explained in Section 3.2.2.

The relationships between the different pages are illustrated in the relationship map shown in Figure 5.26:

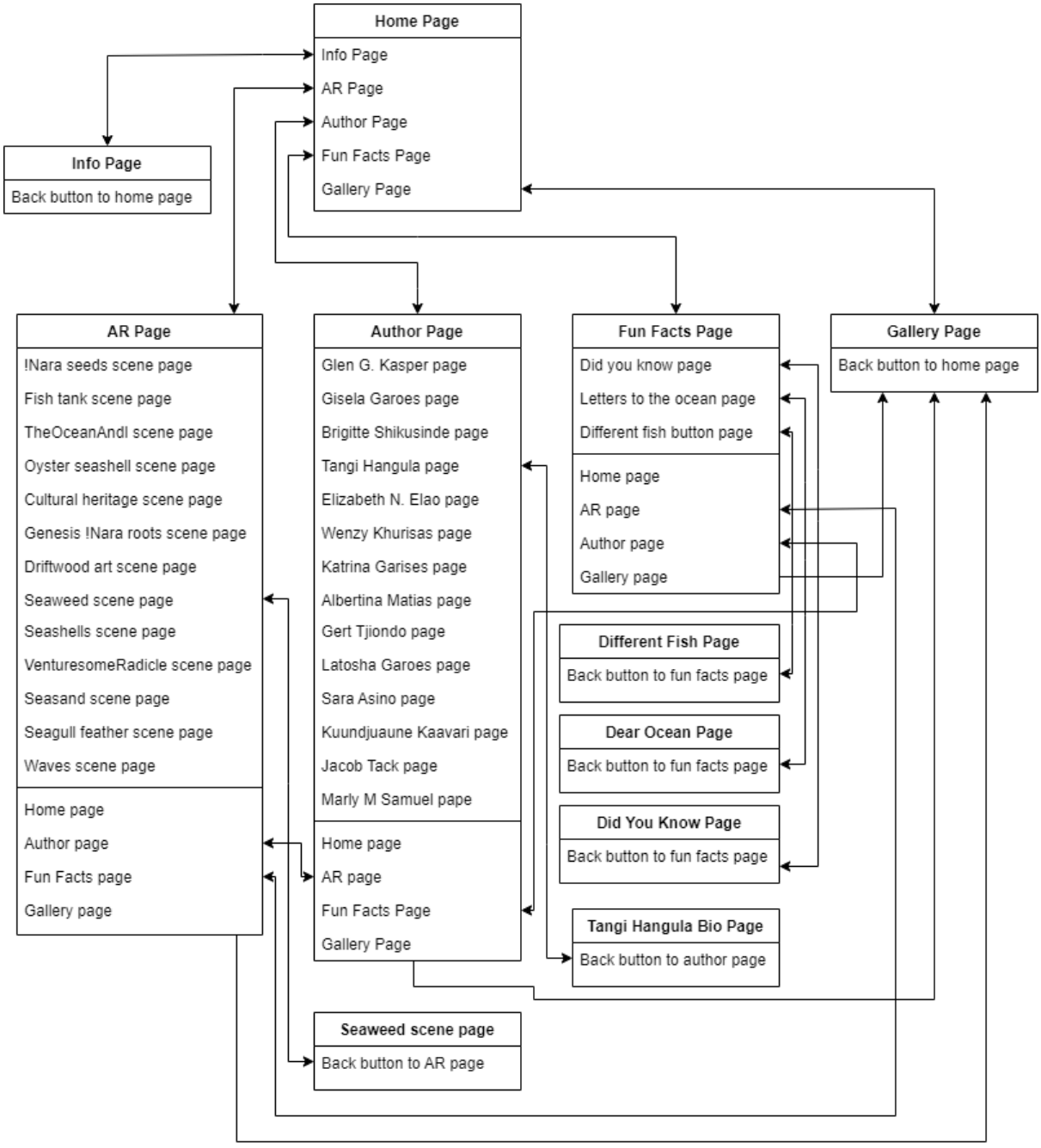


Figure 5.26: Application relationship map showing how the different pages on *Efuta Letua Sida Hurib* are connected—diagram created on https://app.diagrams.net/.

5.2.1. Opening and Home Page

The opening page appears when *Efuta Letu Sida Hurib* is launched and takes the user to the home page. The **home page** (see Figure 5.27) is *Efuta Letu Sida Hurib's* landing page, and it includes the application name and slogan, a cartoon ocean photograph, and five buttons at the bottom that, when prompted, direct users to the different pages found on the application:

- The first button represented by a Unicode character ⓘ is the About button. When prompted, it directs users to the About page, where users can read more about *Efuta Letu Sida Hurib*.
- The second button, represented by a 3D cube icon, is the AR button. When prompted, it directs users to the AR page where they can interact with and explore different 3D models representing ocean heritage.
- The third button represented by a person icon is the Author button. When prompted, it directs users to the author page, where users can read about the co-researchers who co-produced *Efuta Letu Sida Hurib*.
- The fourth page, represented by a lightbulb icon, is the Ocean Facts button. When prompted, it directs users to the ocean facts page, where they can read interesting ocean facts, poems, and letters about the ocean and learn about different fish found around Namibia's coastline.
- The fifth page, represented by a camera icon, is the Gallery button. When prompted, it directs users to the gallery page. Here, users can see different photographs illustrating the co-production process and various photographs of the ocean.

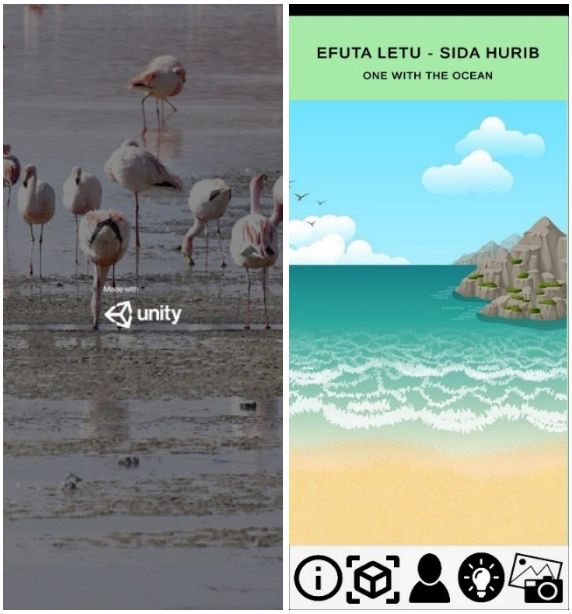


Figure 5.27 (a) and (b): *Efuta Letu Sida Hurib* opening launch screen and home page. Pelican birds photograph: Marly Muudeni Samuel, 2021. Ocean photograph source: Beach Sea Sand Beira - Free image on Pixabay. Screenshots: Marly Muudeni Samuel, 2023.

5.2.2. About Page

About *Efuta Letu Sida Hurib* (see Figure 5.28) is the title of the About page. It displays a photograph taken at the Swakopmund beach, with blue-sky horizons and the ocean. This page includes a description of *Efuta Letu Sida Hurib*, explaining its purpose and the rationale behind its creation. Co-researchers composed the description, each providing individual descriptions about *Efuta Letu Sida Hurib*, which were then summerised into one collective description by Lucio. The back-arrow button at the bottom of the page returns users to the home page.

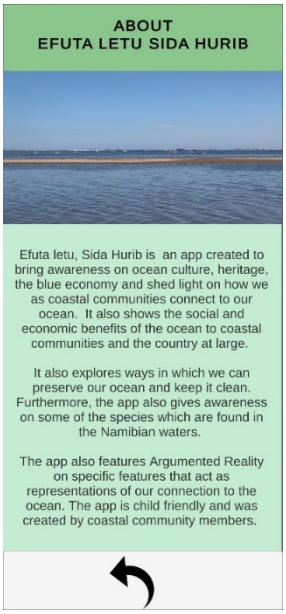


Figure 5.28: *Efuta Letu Sida Hurib* about page. Screenshot: Marly Muudeni Samuel, 2022.

5.2.3. AR Page

The **AR page** (see Figure 5.29) features several buttons. At the top, users find an instruction manual button that redirects users to the AR instruction manual page. It also includes the 14 different ocean heritage contributions shared by co-researchers. The photographs of the objects/materials, complemented with corresponding titles, are buttons that direct users to individual AR scenes. Within the AR scene, users can interact with the different 3D models and access the audio and text descriptions that provide and explanation for the 3D models. The bottom of the page includes four buttons that direct users to the home, author, ocean facts and gallery pages.

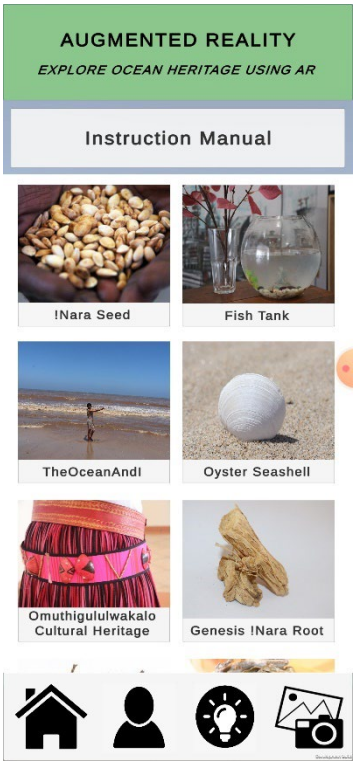


Figure 5.29: *Efuta Letu Sida Hurib* AR page. Screenshot: Marly Muudeni Samuel, 2022.

5.2.4. AR Instruction Manual Page

The **AR Instruction Manual page** (see Figure 5.30) features a video illustrating how to interact and navigate through the AR pages. It includes a play button that, when prompted, plays or pauses an instruction video. It has an info ⓘ button that provides the navigation instructions in written format. The back-arrow bottom at the bottom of the page directs users back to the AR page.

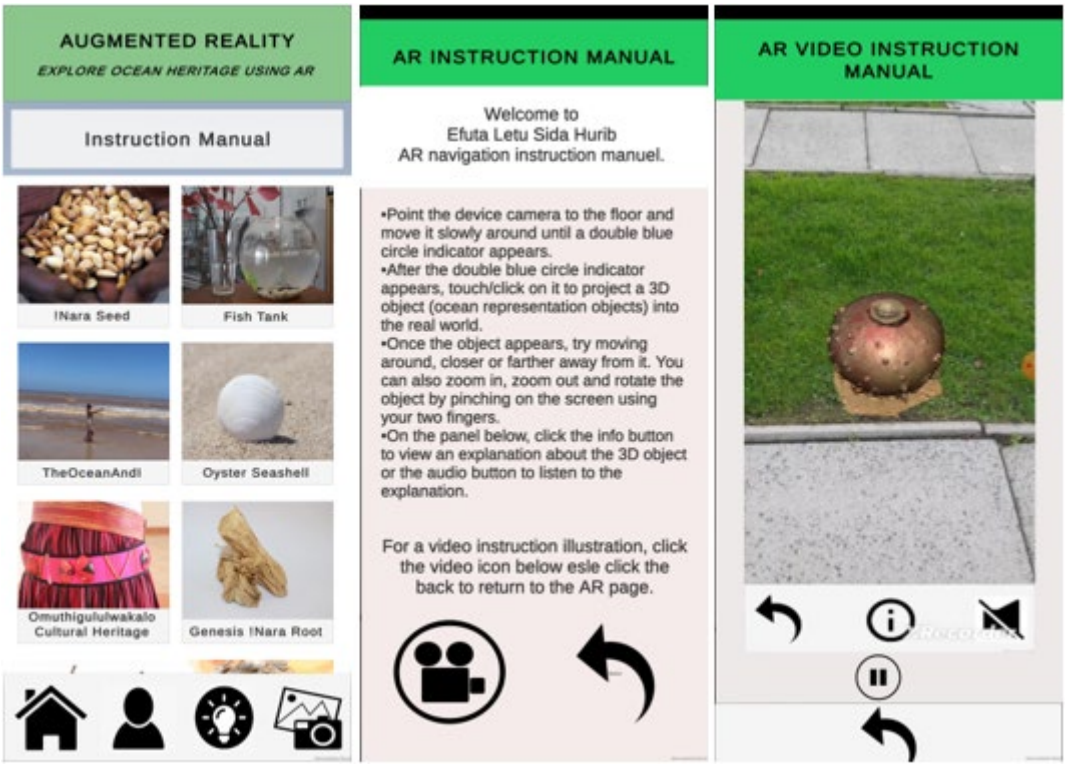


Figure 5.30: Navigation Explanation page. Screenshot: Marly Muudeni Samuel in 2022.

5.2.5. AR Scene Page

On the **AR scene page**, users can prompt a 3D model to appear (see Figure 5.31). This is done by pointing the mobile device camera to the ground or any flat surface area and the application scans and detects a ground plane and generates a blue placement circle. When the user clicks on the blue placement circle, a 3D model appears. Users can then engage with the 3D model by moving closer or further away from it, zooming in and out, or rotating it. The experience is further improved by clicking on the buttons below. The back-arrow button returns users to the AR page. When the Unicode character icon button is clicked, it opens a textbox display with a description that expalains the significance of the 3D model and its connection to the ocean, and when it is clicked again, the textbox display disappears. When the audio/mic icon button is clicked, an audio message emphasising the importance of the 3D model plays, and when it is clicked a second time, the audio stops playing.

Figure 5.31: *Efuta Letu Sida Hurib* AR scene displaying the blue placement indicator circle and !Nara seeds 3D model. Screenshot: Marly Muudeni Samuel, 2022.

5.2.6. Authors Page

Co-researchers requested an accreditation page featuring the 13 co-researchers and author. The On the **Authors page** (see Figure 5.32) users can read more about the co-researchers and author who co-produced *Efuta Letu Sida Hurib*. Their profile photographs are embedded with a button that, when prompted, opens an individual author page with a brief bio description of each co-researcher. The bottom of the page includes four buttons that direct users to the home, AR, ocean facts and gallery pages. All author information was included with consent from the co-researchers.

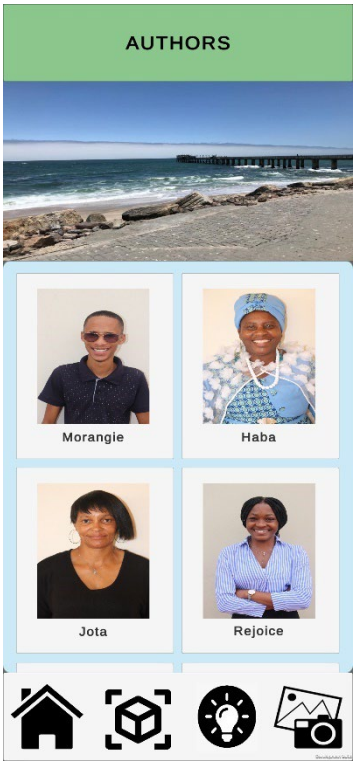


Figure 5.32: *Efuta Letu Sida Hurib* authors page. Screenshot and profile photographs: Marly Muudeni Samuel, 2022.

5.2.7. Author Bio Page

The **Author Bio pages** (see Figure 5.33) are titled after each featured co-researcher and includes a profile picture and a short values and interests bio description. The back-arrow bottom at the bottom of the page directs users back to the author page.

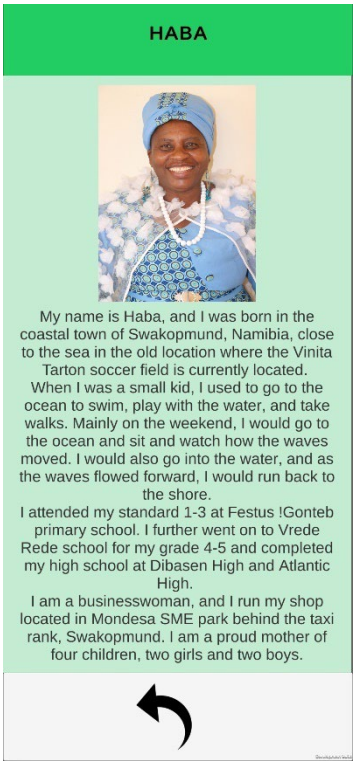


Figure 5.33: *Efuta Letu Sida Hurib* individual author bio page. Screenshot and profile photograph: Marly Muudeni Samuel, 2022.

5.2.8. Ocean Facts, Did You Know and Letters to the Ocean Pages

The **Ocean Facts page** (see Figure 5.34 a-c) includes three main buttons titled "Did you know", "Different fish", and "Letters to the ocean", with corresponding photographs. These pages provide users with ocean facts, letters and poems about the ocean, and show different Namibian fish. The bottom of the page includes four buttons that direct users to the home, AR, author, and gallery pages.

Did you know page offers interesting facts about the ocean, enabling users to learn more about the ocean. The back arrow at the bottom of the page returns users to the ocean facts page.

Dear Ocean page includes letters and poems about the ocean written by co-researchers. This page further demonstrates the importance of the ocean for co-researchers through artistic and creative words. The back arrow at the bottom of the page returns users to the ocean facts page.

On the **Different fish page** users can learn more about different fish and sea species found on the Namibian coastline. The pictures and videos were taken at the Swakopmund Aquarium. The back arrow at the bottom of the page returns users to the ocean facts page.

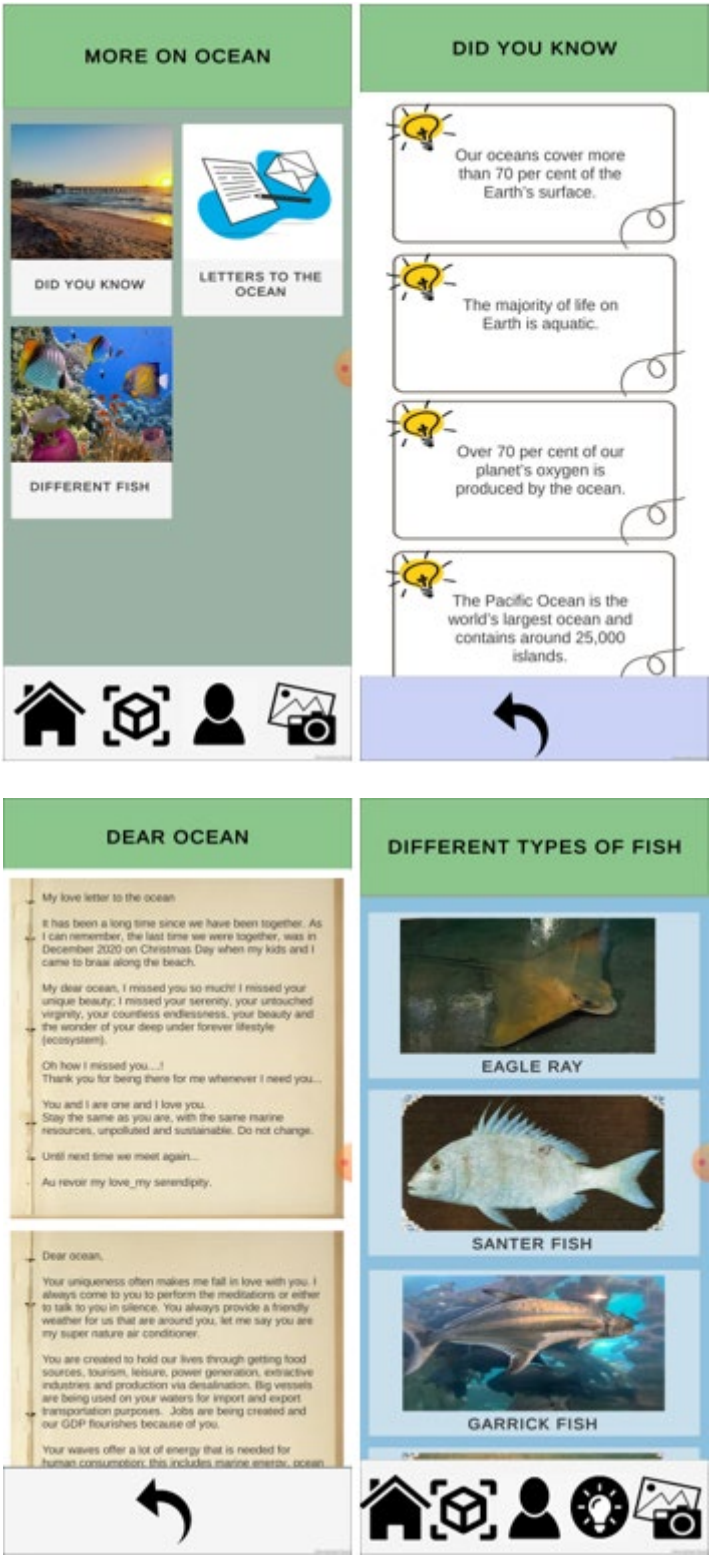


Figure 5.34: (a) More on the Ocean page; (b) Did You Know page; (c) Dear Ocean; and (d) Different types of fish page. Screenshots: Marly Muudeni Samuel, 2022.

5.2.9. Gallery Page

The **Gallery page** (see Figure 5.35) displays photographs of Namibian coastal towns, communities, and ocean scenery. It features photographs taken during the research's workshops, capturing moments shared with co-researchers throughout this research, as well as photographs of objects/materials contributed by co-researchers. The back arrow at the bottom of the page directs users back to the home page.

Figure 5.35: *Efuta Letu Sida Hurib* gallery page. Screenshot: Marly Muudeni Samuel, 2022.

5.3. Conclusion

Co-researchers reflected on the workshop structure and methods employed, expressing satisfaction with the overall format. Expanding on this, co-researchers explained that smaller workshops facilitated open communication, enabling strong relationships to be built both among themselves and with the author. Appreciation for the workshops not being rushed was also conveyed, with co-researchers emphasising that there was always ample time for questions and dialogue. Additionally, the author's thorough explanations facilitated a comprehensive understanding of the topics discussed within the broader research context.

The exchange of ocean heritage and information during the workshops enabled co-researchers to gain diverse knowledge about intricate relationships people have with the ocean, the various benefits and uses of seaweed, seashells and driftwood, and different cultural and spiritual

practices. Co-researchers proposed to continue communicating and sharing ocean related information with one another beyond the workshops. A WhatsApp group named after *Efuta Letu Sida Hurib* was created to facilitate this collective communication and information sharing.

Motivated by their individual learning experiences about ocean heritage, AR technologies and the co-production process, co-researchers expressed a desire for more people to interact with *Efuta Letu Sida Hurib*. They believed this would enable this research to gain and incorperate different viewpoints and feedback (see Chapter 7) about *Efuta Letu Sida Hurib*, facilitating a comprehensive analysis of the applications ability to support and preserve Namibian ocean heritage.

CHAPTER 6

TECHNICAL CO-PRODUCTION PROCESS AND DEVELOPMENT OF *EFUTA LETU SIDA HURIB*

Chapter 6 addresses the main research question from the perspective of technology development. It explores whether and how AR can support Namibian coastal communities in recording and preserving ocean heritage for posterity. The development of the AR application builds upon an agile methodology which started with an exploration of various immersive technologies, weighing their benefits and challenges. The chapter explains why AR was used and provides insights into the co-production phases, technological equipment requirements, user requirements, 3D model development, and implementation of *Efuta Letu Sida Hurib,* the AR application. Finally, it concludes with the deployment of *Efuta Letu Sida Hurib* among co-researchers.

Over the past decades, mobile technologies have become more portable, accessible, efficient, and cost-effective. These advancements led to transformations in various societal sectors, including communications, transport, finance, healthcare, education, automation, and manufacturing (Melvin, 2019). Technology advancements in the field of computer graphics have also promoted ubiquitous access to enhanced information through advanced visualisation platforms such as immersive and augmented display interfaces. These technologies have been shown to have the potential to disrupt current practices within the field of cultural heritage digitalisation and preservation, opening up new possibilities and avenues for exploration, as observed in this research and explained in Chapter 1.

Throughout this doctoral research, an AR application prototype entitled *Efuta Letu Sida Hurib* has been created in collaboration with co-researchers from Swakopmund and Walvis-Bay, Namibia. The information presented in this chapter provides an overarching explanation of AR and how it can be utilised to surface, support, and preserve ocean heritage for posterity.

6.1. Application Development Methodology

In addition to the research methodology presented in Chapter 3, this research adopted an agile methodology process, adapted from Fagarasan et al., (2021) and Trivedi (2021), to guide the development and co-production process of *Efuta Letu Sida Hurib*. Agile methodology is a project management approach that emphasises the completion of projects through short-term iterative steps. This approach "*embraces flexibility, speed, and above all else, continuous improvement*"

(Trivedi, 2021, p. 92). The adopted agile methodology incorporated iterative steps, including the definition of the user and system requirements, design, development, testing, deployment and review of *Efuta Letu Sida Hurib*, as illustrated in Figure 6.1. This chapter expands on four key development stages of agile methodology: requirements, design, development, and deployment. The testing and review stages are elaborated on in Chapter 7 where the results and feedback from the demonstrative and testing sessions of *Efuta Letu Sida Hurib* are outlined and analysed.

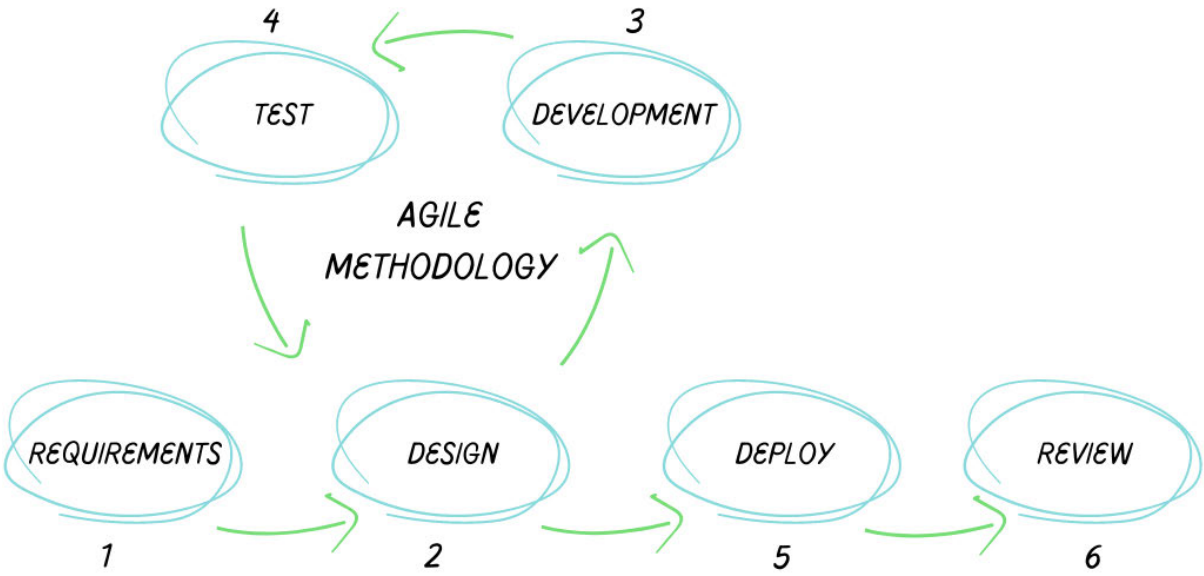


Figure 6.1: Agile development methodology illustration showing five development steps followed during the research application development process. Adapted from the Agile Methodologies (Fagarasan et al., 2021; Trivedi, 2021).

Aligning with the aforementioned agile methodology, this chapter focuses on phases two and three (see Figure 6.2 for an illustration of the phases) of the co-production process of *Efuta Letu Sida Hurib,* which are also discussed in Section 3.3.

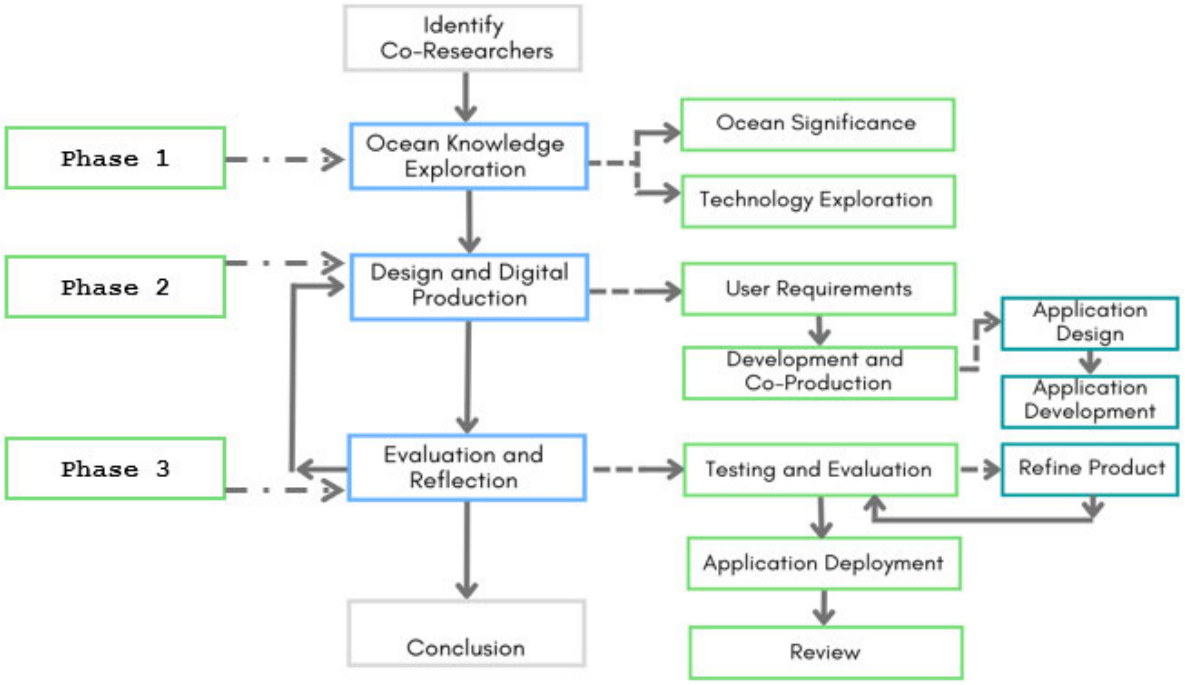


Figure 6.2: Research process and development process. *Design and digital Production and Evaluation and Reflection elements of phases 2 and 3 are where agile stages 1-6 were deployed.

Efuta Letu Sida Hurib was iteratively refined, building upon the feedback and suggestions provided by co-researchers and respondents during the co-production and development process. This approach not only encouraged in-depth discussions about the significance of the ocean for co-researchers but also the exploration of various existing digital technologies designed to support the preservation of knowledge and culture.

The development process employed different hardware (see Figure 6.3), which enabled the successful implementation of *Efuta Letu Sida Hurib.* The development process focused on elements such as gathering user requirements and knowledge content; *Efuta Letu Sida Hurib* application design; production of photographs; production of 3D models; Development of *Efuta Letu Sida Hurib* in Unity and Visual Studio; audio recordings; deployment on Android mobile devices; *Efuta Letu Sida Hurib* deployment. The development process elements are further expounded in Sections 6.3 and 6.4.

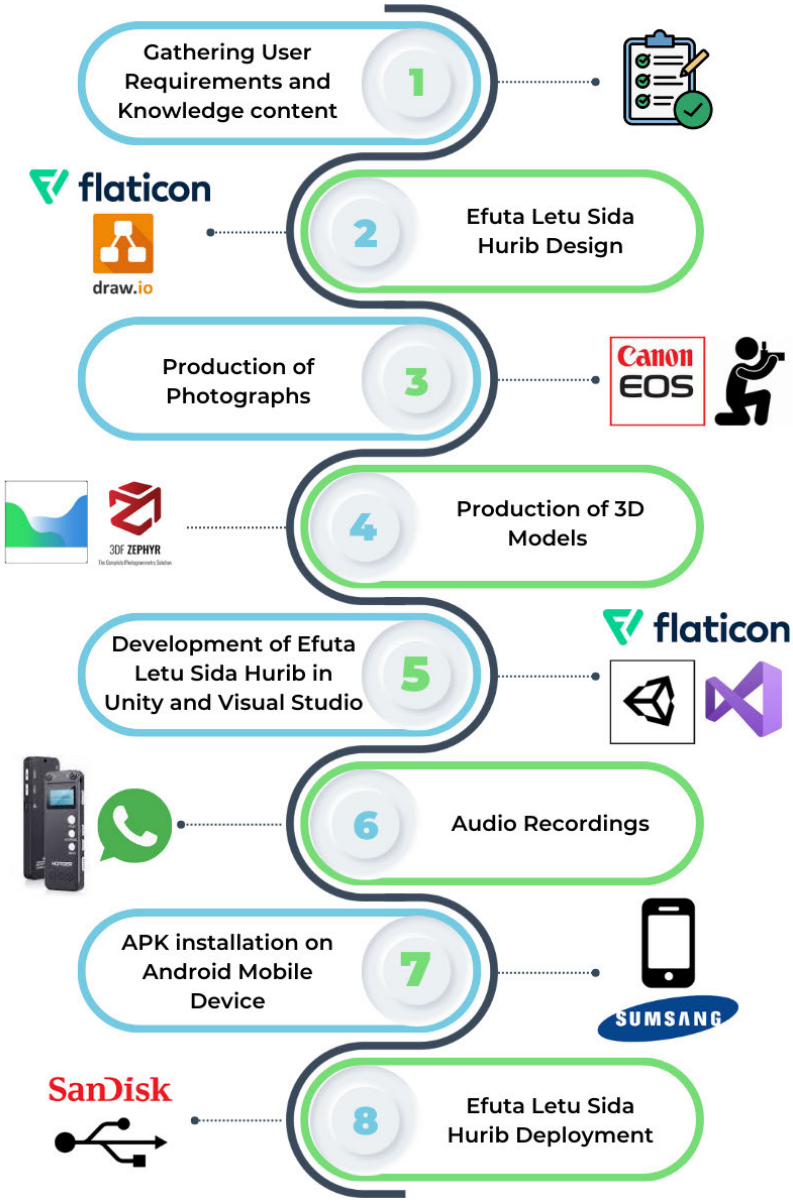


Figure 6.3: Development process diagram illustrating the co-production process and the different platforms and technologies used during the development of *Efuta Letu Sida Hurib*.

6.2. Review of Immersive Technologies

In this section, different immersive technologies were critically analysed to assess their suitability for facilitating engagement with co-researchers with different backgrounds, technical knowledge and abilities. Three immersive technologies were investigated to identify a digital technology that aligned with this research's objective of digitally surfacing, recording, and preserving ocean heritage. Suh and Prophet define immersive technology as "*technology that blurs the boundary between the physical and virtual worlds and enables users to experience a sense of immersion*" (Suh and Prophet, 2018, p. 77). An immersive digital environment's ability to successfully immerse a user depends on a number of elements,

including realistic 3D computer graphics, sound quality, interactive user input, and other aspects like clarity, ease of use, and functionality (Handa, Aul and Bajaj, 2012). The investigated technologies are AR, virtual reality (VR) and mixed reality (MR). Each digital technology encompassed several advantages and disadvantages that were weighed in the research context, including the country, region, community, and participants. The primary factor in deciding what technology would be suitable for use was the accessibility of digital technological infrastructure. It also depended on how that specific digital technology could be deployed and utilised by individuals in various communities, including those in informal communities with low-end digital devices.

6.2.1. AR

AR refers to a real-time view of a physical, real-world environment that has been enhanced or augmented by the addition of digitally created virtual information. Real and interactive virtual objects are combined in AR to form a hybrid reality (Carmigniani and Furht, 2011). Its guiding principle is to overlay computer-generated digital elements and virtual information, such as 3D models, images, text, music, and video, on a view of the real world using real-time tracking and registration (Chen et al., 2019). The real world is enhanced as a result of the interaction between the real and the augmented (Chen et al., 2019) enabling users "*to see the real world, with virtual objects superimposed upon or composited with the real world*" (Azuma, 1997, p. 2).

AR technologies have been used to support users with various tasks by introducing virtual information to their immediate surroundings and presenting them with a hybrid (virtual and real) view of the real-world environment. For example, AR has been used as a marketing tool in real estate (Lang and Sittler, 2013), interior design (Chang et al., 2020), to expand educational platforms by providing more learning possibilities (Jumani et al., 2022), gaming (Kerdvibulvech, 2021) and cultural heritage digitalisation (Galatis et al., 2016).

A popular example of an AR game is Pokémon Go, which created and overlaid virtual 3D Pokémon interactive models into the physical world, enabling players to walk in the real world and battle virtual interactive Pokémon models (Kerdvibulvech, 2021). A cultural heritage AR example is the KnossosAR application (Galatis et al., 2016), which is an outdoor mobile AR guide designed for the UNESCO World Heritage site of Knossos, which is the largest Bronze Age archaeological site in Crete, Greece and is widely regarded as the oldest city in Europe. KnossosAR uses mobile AR technology to facilitate guided tours of individual or collective

secondary school learners during educational visits to outdoor archaeological locations (Galatis et al., 2016).

6.2.1.1. Types of AR

AR is categorised into three types: marker-based, markerless, and GPS/location-based AR. AR systems require a registration mechanism to locate and trigger the delivery of content spatially (Cheng, Chen and Chen, 2017; Schroeder et al., 2023). Marker-based AR, additionally known as image recognition AR, requires a trigger marker or QR code to activate the AR content. Users can scan the marker with their mobile device or webcam camera to access the content, and move it around to observe the content overlaid at specific locations visible through the mobile device. However, it is critical to understand that for an AR experience to be launched, the trigger marker (QR code or picture) must be available (Zvejnieks, 2022). Markerless AR is portable and can be accessed and used at any time and location. It only requires a user to access a mobile device that supports ARCore. It is important to note that ARCore is not available on all digital devices (see Section 6.3.3 for further reading on AR function requirements). Location-based AR mainly depends on GPS, accelerometer, and digital compass to determine the accuracy of a mobile device's geolocation and positioning. It enables the placement of objects in a specific spot, and users with location-based AR applications can use them at any time of day, regardless of weather conditions (Zvejnieks, 2022).

AR provides users with visual content, sound, and other information by leveraging two types of technology devices. The first involves overlaying digital content onto a mobile phone's or tablet screen through its camera (Hakkarainen, Woodward and Billinghurst, 2008). In this setup, users can view the real world through their device's camera, and the AR technology adds a layer of digital information or objects onto the camera feed displayed on their screen, as illustrated in Figure 6.4.

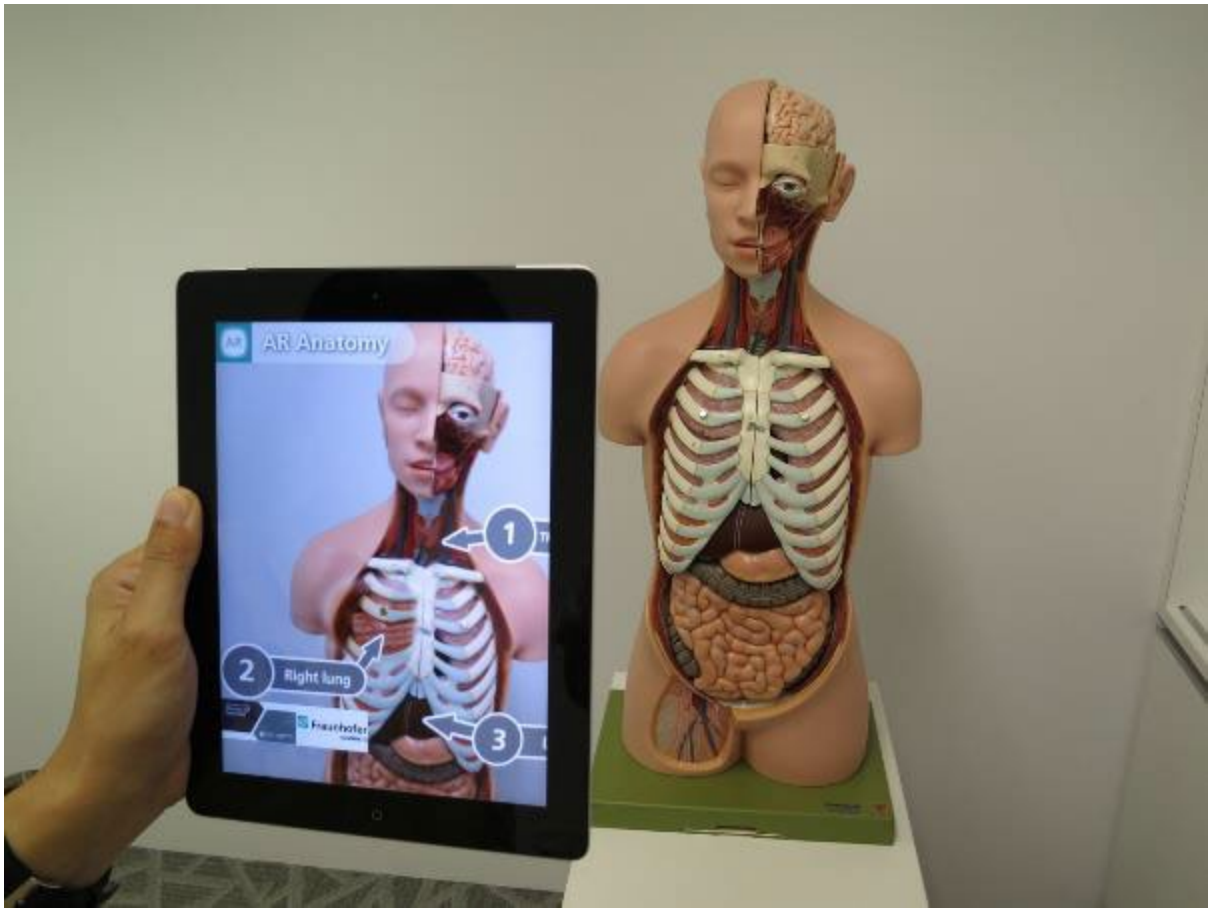


Figure 6.4: Anatomy augmented reality. Photograph: zedinteractive.in (CC-O)

The second way to experience AR is through smart AR goggles or glasses (Henrysson, 2007) (see Figure 6.7). These wearable devices are designed to provide users with a hands-free AR experience and offer the advantage of providing a highly immersive experience by overlaying digital content directly onto the user's field of vision (Mutis and Abhijeet, 2020). However, AR glasses are usually more expensive compared to mobile devices, which can restrict their accessibility to a wider audience.

Figure 6.5: Man wearing AR Glasses on his head. Photograph by Maxibu retrieved from https://commons.wikimedia.org/wiki/File:Wearing_AR_Glasses.jpg (CC-BY).

6.2.1.2. AR Benefits

Technologies similar to AR are increasingly impacting our everyday experiences, changing the way we perceive the world by blurring the distinction between physical and digital realities (Hadi and Park, 2024). AR is contributing to change in many industries, such as healthcare, entertainment, tourism, education, and e-commerce (Arena et al., 2022) and has also proven helpful in managing and preserving cultural heritage (Boboc et al., 2022). One universal advantage of AR is that it can be experienced on different mobile devices, even some of the most affordable digital mobile phones (Johnston et al., 2020) and is widely available to most digital mobile device owners without the need for specialised hardware, which facilitates mass adoption and engagement.

In the gaming and entertainment industry, AR can facilitate more interactive and participatory experiences, enabling new degrees of interaction and immersion (Chowdary and Hemasri, 2022). It can also provide cost-effective employee training. For example, in the medical field, AR has been employed in practical lessons to teach medical staff and improve medical procedures through automated services and facilitating surgical training (Hampiholi, 2023). AR can additionally enhance customer experience by enabling individuals to interact with

products, for example, through interactions with AR advertisements. It can also be used to improve weather forecast predictions by overlaying simulations of weather precipitations such as rain, hail and snow (Harish, Vollala and Saheb, 2023). In the educational field, it can facilitate skills, knowledge, learning and sharing opportunities in engaging ways, further encouraging enhanced technology interaction and promoting motivation to learn (Jesionkowska, Wild and Deval, 2020). It can also improve independence for people with disabilities (Kanuganti, 2019). Furthermore, it can create platforms for personalisation. For instance, anyone with a digital mobile device can create unique AR visualisation with their own identity. The AR camera functions available on most social media apps, such as Snapchat, Instagram, and TikTok, are an excellent example of AR personalisation. Users can use these AR personalisation functions to overlay cartoons, make-up filters, or text on a selfie or conventional (see Figure 5.1) and change background environments to suit their preferences.

6.2.1.3. AR Challenges

Accurate object registration is one AR challenge encountered when utilising it, especially when using mobile AR devices to register objects outside in open spaces (Blanco-Pons, Carrión-Ruiz and Lerma, 2019). For the object registration to be activated between a digital representation and the reference photographs, the object must be approached or scanned from different angles to get the best possible results (Johnston et al., 2020). Precise object registration challenges are typically experienced when interacting with image recognition objects within heritage sites. To optimise the user experience, photographs incorporated and saved on an AR database to create digital objects should have high precision while preventing dormancy (Marques, Roca and Tenedório, 2017). The Vuforia engine is an AR development cross-platform application development tool that enables the simultaneous tracking of image targets and objects while performing on a wide range of mobile hardware devices (Unity, 2018). Vuforia is a good example of a platform that supports AR image recognition and enables users to upload photographs as image markers. Vuforia uses a star rating system to assess image recognition capability (see Figure 6.6). Five stars means the image quality is high, suggesting a high probability for a mobile device to recognise the image, while one star indicates poor quality, suggesting a low probability for a mobile device to recognise the image effectively (see Figure 6.7). If the quality and rate are inadequate, the software encounters difficulties recognising the image marker, which, in turn, will not process and trigger the augmented digital object associated with that specific image marker. For an image to be of good quality, it should be rich in detail, asymmetrical, have good contrast, and not have repetitive patterns. The image

format should also be 8- or 24-bit PNG/JPG, and the size must be less than 2 MB for it to be effectively processed in Vuforia. It is recommended that users utilising Vuforia should work with photographs that have a quality rating of three stars or above.

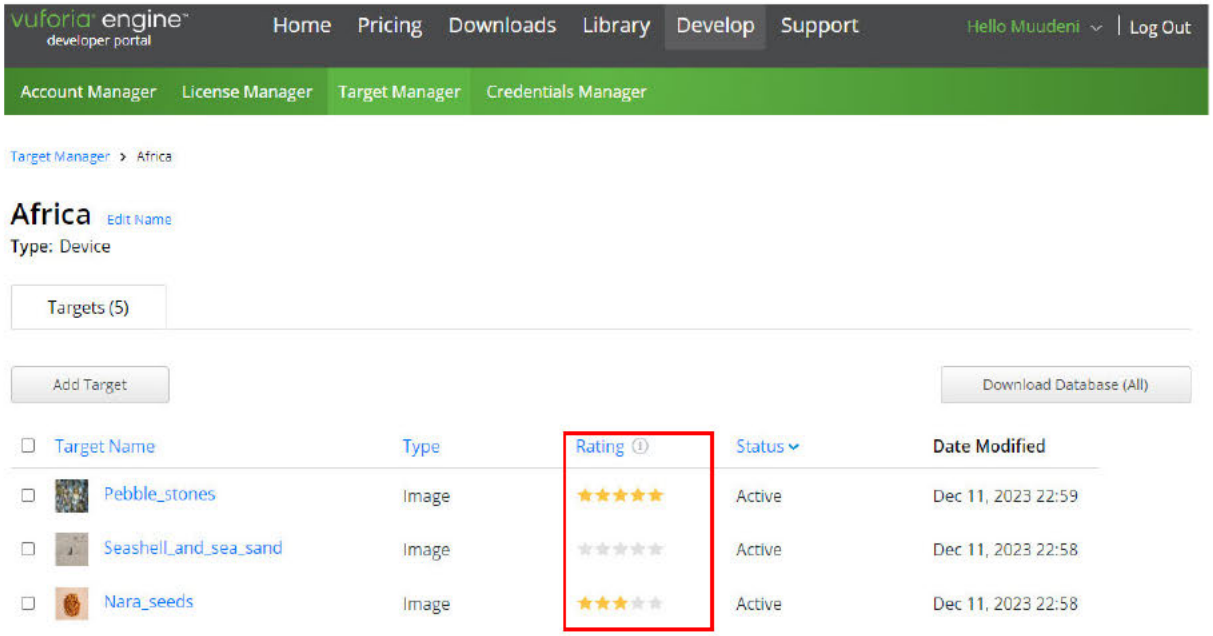


Figure 6.6: Vuforia target manager illustrating uploaded photographs' colour and contrast ratings. Screenshot photograph: Marly Muudeni Samuel, 2022.

Figure 6.7 (a): Left, Pebble stones. Example of a picture with a high-quality Vuforia rating. Photograph retrieved from https://pxhere.com/en/photo/1263691; (b): Middle, Seashell and sea sands Example of a picture with a low-quality Vuforia rating. Photograph: Marly Muudeni Samuel, 2022; (c): Right, !Nara seeds. Example of a picture with moderate quality Vuforia rating. Photograph: Marly Muudeni Samuel, 2022.

When using mobile phones, AR also presents challenges, including limitations in processing power, restrictions with display technologies used in the development of AR systems, motion-tracking inaccuracy (Mutis and Abhijeet, 2020), camera quality, and the fact that ARCore, a Google platform used for developing AR experiences is not supported by all mobile phones (visit https://developers.google.com/ar/devices for a list of mobile devices compatible with ARCore).

Other AR challenges have to do with environmental and outdoor factors, such as brightness (little to no light), the presence of shadows interfering with the recognition of an image or pattern, colour uniformity of outdoor materials and potential issues with cellular network signals in location-based AR scenarios (Tzima, Styliaras and Bassounas, 2021). These factors negatively affect outdoor AR marker processing (Rao et al., 2017).

Other challenges involve logistic considerations, such as the need for digital devices utilised for AR to meet specific technical requirements (see Section 6.3.3 for device requirements) to support AR functionalities (Johnston et al., 2020). Additionaly, regular technology updates can sometimes depreciate specific functions on mobile devices, rendering applications developed with previous versions, obsolete.

6.2.2. VR

VR has been described as a computer-generated simulation that mimics a physical environment. In a simulated VR environment, an individual becomes a part of the virtual world or is immersed in it. While there, they can virtually move around, engage with, touch, reshape and handle objects or perform a series of actions. Users can also view the environment and its objects from different viewpoints (Al-Ansi et al., 2023). In VR, specific equipment such as headphones, omnidirectional treadmills, joysticks, or special gloves are used to interact within a digital world (Isdale, 2003).

VR technologies are capable of activating our senses to create an illusion of reality and presence, as explained in Section 5.1. However, VR faces challenges, including decreased accuracy when tracking users' movements (Chong, Lim and Tan, 2018), VR streaming over the internet with little caching of regularly used data, and high purchase costs (Gandhi and Patel, 2018). Other challenges include latency of interacting with a virtual environment (Brunnström et al., 2020) and limitations with eye range tracking data quality (Adhanom, MacNeilage and Folmer, 2023), leading to exclusion and inaccurate experiences for users. Interaction paradigm limitations and inaccuracy in user interaction input can disrupt the user experience, resulting in lower engagement and a diminished sense of being present (Chong, Lim and Tan, 2018). Additionally, the isolation of the user while immersed in a VR environment can also be an issue and pose certain health and safety challenges, including eye strain, headache, mental exhaustion, nausea, and radiation, and it may trigger neurological illnesses such as epilepsy (Grega, Nečas and Lancik, 2021). On the other hand, 360-degree videos are more comfortable to use and cost-effective than developing simulated environments

(Pirker and Dengel, 2021). However, with 360° videos, users are unable to interact with the virtual environment and can only experience the point of view tracking on 360° freedom. Additionally, providing a high-quality experience to viewers while streaming 360° videos over the internet can be especially difficult due to the incredibly high bandwidth requirements (Wong et al., 2022). This challenge is further intensified when operating within communities, such as informal communities with limited digital technology infrastructure and unreliable and limited bandwidth.

6.2.3. MR

MR includes and utilises elements of AR and VR to create interactive virtual experiences within the real world. This technology combines both the physical and virtual/digital worlds, creating an environment where physical and 3D digital objects coexist and interact in real time. Unlike VR, MR users are not entirely removed from their real environment. MR differs from AR in that it enables users to physically interact with and manipulate virtual objects overlayed in the real world (Shen, Zhou and Wang, 2023), whereas AR interaction occurs through the device being used. Essentially, when using MR, users can see 3D projections of digital objects integrated into their real environment and can manipulate these objects by changing their positions, altering their sizes and shapes, and rotating them (Aloqaily, Bouachir and Karray, 2022). MR has been used in large-scale industries such as the manufacturing industry to speed up quality control processes and reduce call-out time maintenance (Watson, 2020). However, it is expensive to develop (Watson, 2020), sometimes it is hard to make the virtual projections align with real-world objects, and users can experience a restricted projection field of view, which restricts head movements (Filipenko et al., 2020).

6.2.4. Immersion and Presence

While immersive technologies provide interactive, stimulating, and believable digital experiences that involve increased sensory immersion and spatial engagement, they also enable a sense of presence. Different immersive technologies provide varying levels of immersive experiences depending on the medium facilitating the experience. The first level is engagement, in which a user has to like the product they are engaging with. For example, if a user does not like a product, they do not engage with it. The second level is engrossment, in which a user has to engage with the content, functions, activities and visuals provided on a product while remaining conscious of their real-world surroundings. The third level is total immersion when a user is fully immersed in a virtual world and unaware of their real-world surroundings (Pasch et al., 2009).

Presence in the digital immersive world can be defined as the feeling of being in one place while physically situated in another (Witmer and Singer, 1998; Salanitri, Lawson and Waterfield, 2016) or as Slater (2009, p. 3551) describes it as the feeling of "*being there*". In other words, an individual becomes psychologically engaged in the virtual experience that they no longer perceive the technology that is facilitating the experience. Corey et al. (2009, p. 3) describe it as "*experiences like….VR can be so absorbing and compelling that the observer loses some sense of their physical surroundings (i.e., including the medium itself), and responds physically and emotionally in a way that is analogous to actually being in the mediated (i.e., represented) place*". The sense of presence is achieved when an immersive system achieves the ideal balance of hardware, software, and sensory synchrony (Slater et al., 2009; Weber, Weibel and Mast, 2021). Lessiter and Freeman (2001) explain that presence can be achieved across media platforms, further describing presence as a continuous, instead of a polarised, construct that is effectively associated with physical immersion and can consequently be applied by various types of media (such as VR, and MR) to multiple degrees. It is worth noting that in VR, presence is a validated concept. However, this concept is still being assessed in AR. Research also suggests that the definition of presence in AR would imply a shift from the psychological sensation of being there to the sensation of having the display content here (Regenbrecht and Schubert, 2021). Regenbrecht and Schubert (2021, p. 2) further explain that the sense of presence in AR is prompted differently and can be referred to as '*It is here*' presence.

This research adopts the concept of AR presence explained by Regenbrecht and Schubert (2021) as it co-produced an immersive AR application that surfaces, records and preserves ocean heritage. Accordingly, this research analysed whether *Efuta Letu Sida Hurib* can foster effective engagement within coastal communities and explored whether interaction with 3D models of ocean objects/materials can trigger a sense of significance and meaningfulness of shared ocean heritage for co-researchers and respondents.

6.3. Development Process: Materials

6.3.1. Development Platform

This research employed Unity as the development platform. Unity is a cross-platform game engine for integrated development environments (IDE) (Sinicki, 2021). It can be free and available to anyone interested in creating games, applications or dynamic 3D/2D content (Vakaliuk and Pochtoviuk, 2021). It includes built-in features such as 3D/2D objects, 3D rendering, and collision detection that make it possible to create interactive applications

(Sinicki, 2021). It offers developers various development options and functions that allow the integration of specific application programming interfaces (API) packages, such as AR foundation and software development kits (SDKs), such as Vuforia.

Moreover, Unity provides access to an Asset Store, where developers can download 3D fixtures and functionalities to populate their projects with free and paid resources.

6.3.2. Photogrammetry 3D Modelling Platforms: 3DF Zephyr and Agisoft Metashape

This research initially considered using Agisoft Metashape, a photogrammetry platform used to digitally reconstruct artefacts from a collection of snapshots captured from different angles. However, when the author imported the photographs of the different objects into the software, a processing challenge was encountered. For each attempt, the software stopped processing the photographs midway, displaying an error message stating that there was an inconsistency with the imported photographs. Due to these processing challenges encountered, the author decided to use 3DF Zephyr, which was compatible with the research context. 3DF Zephyr is a photogrammetry software platform that creates 3D models from a collection of photographs. "*It enables 3D reconstruction from both photos and videos by automatically extracting frames and selecting the most suitable ones for computation*" (Budău et al., 2023, p. 366). 3DF Zephyr has a free trial version capable of processing a maximum of 50 photographs at a time (Setiyadi, Mukhtar and Cahyadi, 2021). When photographs are imported into 3DF Zephyr, the software evaluates and selects photographs that are clear enough to use. After that, the photographs are subjected to dense point cloud generation, mesh extraction, and texture mesh production to position and generate the 3D model. The model can further be modified with 3DF Zephyr tools (see Figure 6.8). Following the successful modelling of the 3D model, it is exported as a 3D model with a .OBJ file format. The OBJ file can then be imported into Unity or any other development platform. In this instance, the 3D models created for this research (see Section 6.4.3.3) were imported into the co-researchers' respective Unity scenes.

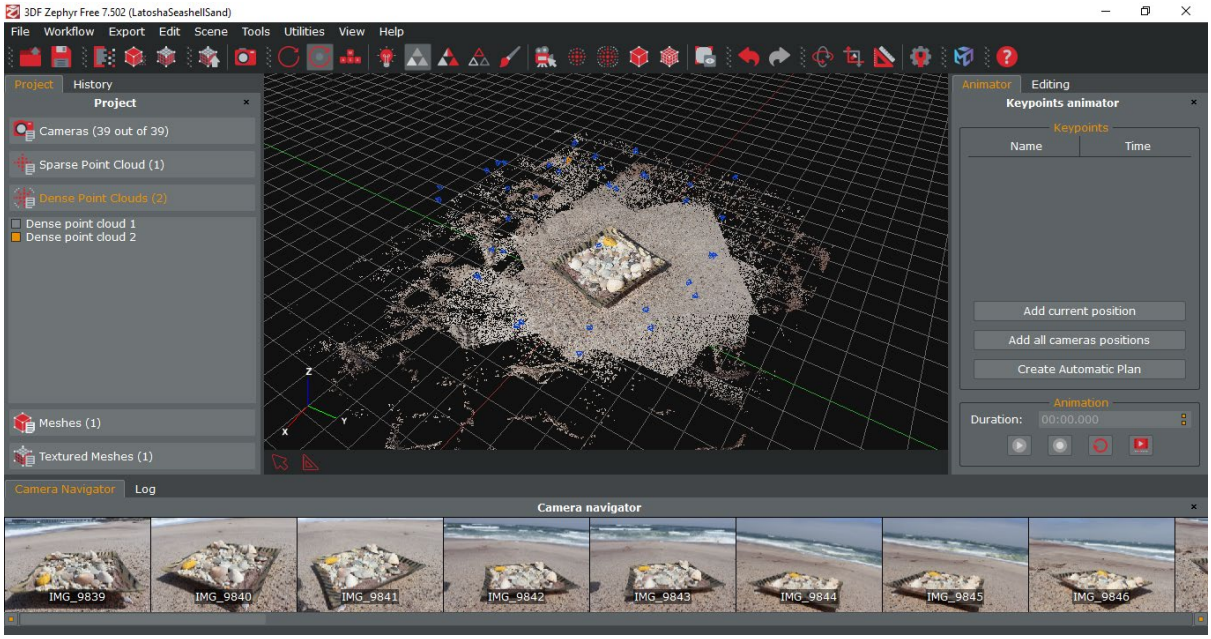
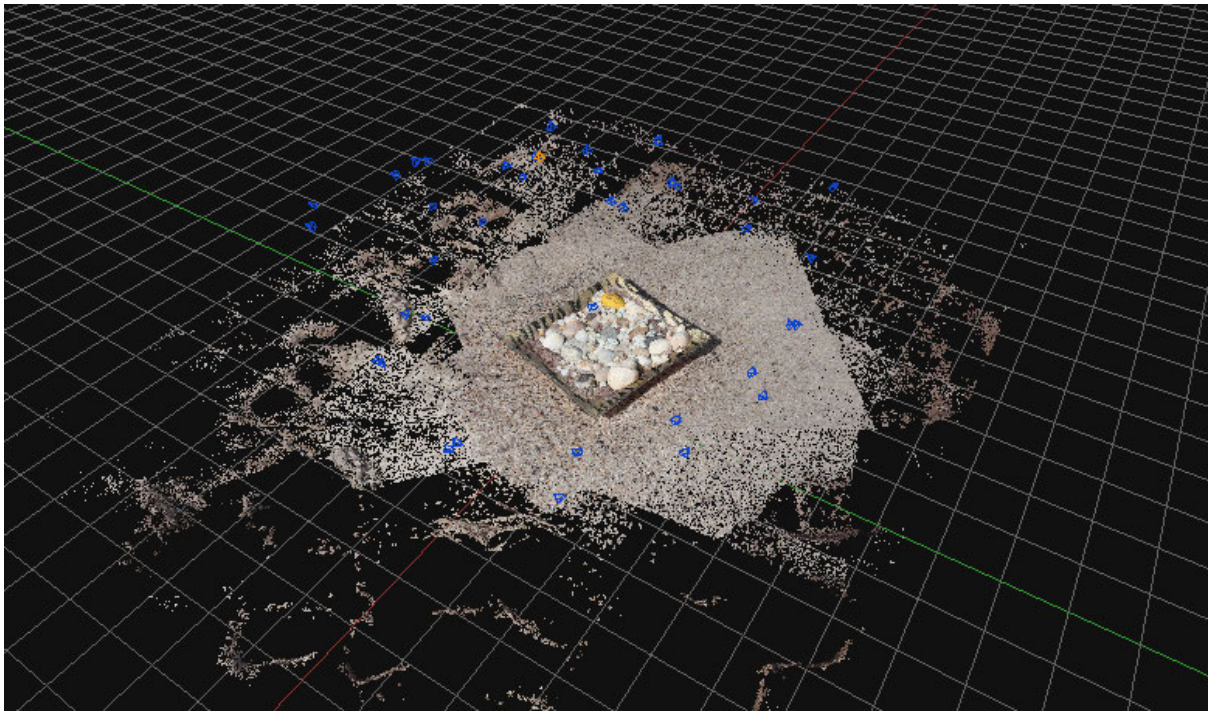
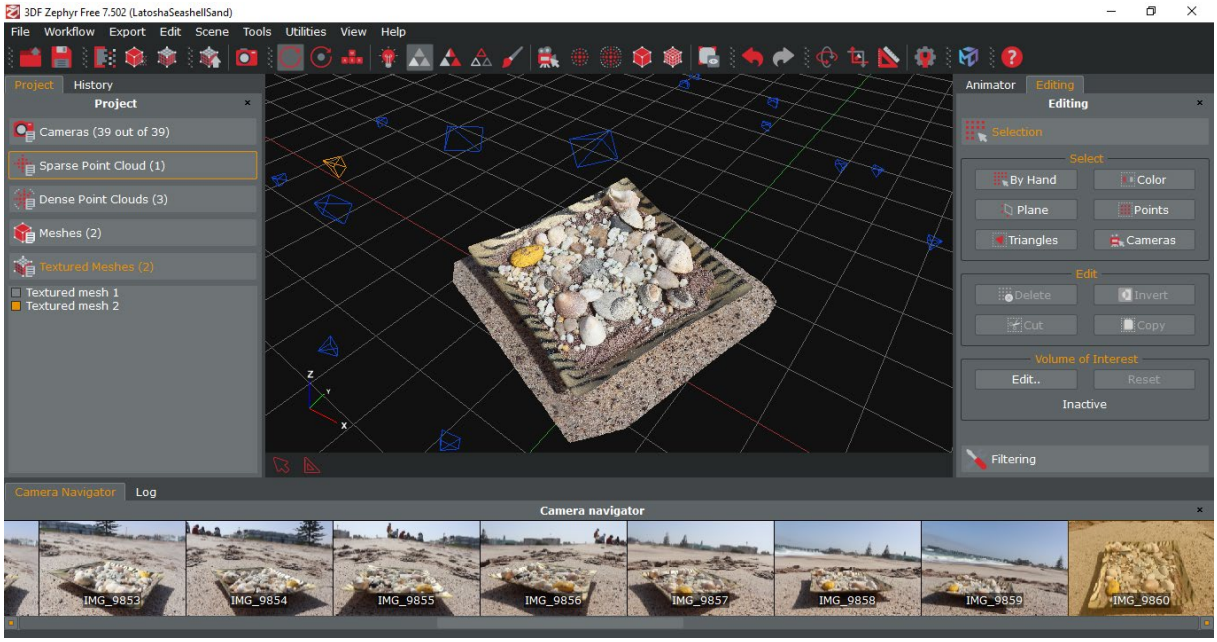


Figure 6.8 (a): Top, 3D model generated in 3DF Zephyr after the software processed sea sand and stones images.



(b): Middle, 3D model generated in 3DF Zephyr after the software processed sea sand and stones images.



(c): bottom, Final 3D model generated in 3DF Zephyr after refinement, dense point cloud generation, and texture mesh generation were applied. Screenshots: Marly Muudeni Samuel, 2023.

While using photogrammetry to create 3D models, the illumination, colour and texture of the object being photographed must be consistent. 3DF Zephyr and most photogrammetry software work by comparing and matching pixels in photographs. They recognise where specific corresponding pixels are located on a photograph (see Section 6.4.3.3.2.). For example, when 30 photographs are being processed, the software works to identify the corresponding colour pixels in each one of the 30 photographs. If a slight shine or glossiness is found on the photographs, it causes processing issues when generating the 3D model because photographs of shiny, glossy, transparent and reflective objects impede the software from accurately creating 3D model meshes. The photographs must be captured in the same environment because the slightest environmental change, such as light or weather (as stated in Section 6.2.1.3), might create processing issues. This research encountered various processing challenges related to photograph object colours and textures. For example, Anna brought an oyster to symbolise her ocean connection (See Figure 6.9a). However, because of the different and glossy colour contrast of the oyster photographs, the oyster 3D model was not processed successfully in 3DF Zephyr. The oyster consisted of white colour contrast on one end, black/brown colour contrast on the other end, and other colours. Because of the conflicting colour contrasts, the software could not process the white part of the oyster; it only processed the black/brown side. Haba brought a fish tank to represent her connection (see Figure 6.9b). The fish tank photographs were also not processed in 3DF Zephyr because the tank was transparent, with water and fish. Because of the transparency, it was difficult for the software

to process the photographs. For this reason, the oyster and fish tank objects were not converted into 3D models; instead, they were displayed as photographs on 3D boards. The Figures below show photographs of ocean objects that were not converted into 3D models because of their colour contrasts.

Figure 6.9: Ocean objects brought by co-researchers that were not converted into 3D models. (a): Left- oyster, Object Credit: Anna; (b): Middle- fish tank, Object Credit: Haba; (c): Right- !Nara roots, Object Credit: Sara-Leigh. Photographs: Marly Muudeni Samuel, 2021.

6.3.3. Equipment Requirements for AR Implementation

This section elaborates on the specific hardware utilised to implement and deploy *Efuta Letu Sida Hurib,* a markerless AR application.

6.3.3.1. Computer System

Efuta Letu Sida Hurib and associated AR features were implemented on a personal computer with the system specifications provided below. These specifications are the minimum requirements needed to use the different tools and applications (see the complete list of software and applications utilised in Section 6.3.1.4) involved in developing the AR application.

- Computer: HP laptop ProBook 640 5G
- Processor: Intel(R) Core (TM) i5-8265U CPU @ 1.60GHz 1.80 GHz
- RAM: 16 GB
- System type: 64-bit operating system, x64-based processor
- Operating system: Windows 10 Enterprise, version: 22H2, build: 19045.3693
- Hard Drive: 475 GB

To avoid potential slow processing experiences when developing immersive technologies, it is recommended to use a computer with higher system performance specifications.

6.3.3.2. Android devices

Due to the research context, technological limitations, and financial constraints faced within Namibian communities and drawing on suggestions provided by co-researchers, this research focused on working with mobile device-based AR because mobile devices are more widely available, and the majority of co-researchers had access to one.

AR applications typically work on ARCore or ARKit, two frameworks that render AR for specific mobile operating systems. ARCore is a development toolkit provided by Google to promote AR experiences on Android devices, while ARKit supports AR experiences for Apple devices. Both AR frameworks encompass features which achieve almost similar AR environment objectives (Mfundo A. and Omowunmi E., 2023). Building upon an analysis of predominant smartphone usage patterns, this research found that the majority of the African population uses Android-based smartphones (Alvin, 2021; Jay, 2021). Drawing from the analysis of mobile device usage in Africa, this research works with ARCore, which is supported by Android devices. However, another challenge arises in this context, as some AR applications cannot successfully be installed on Android mobile devices that do not support the Google Play Services required to run ARCore, as illustrated by the error example in Figure 6.10.

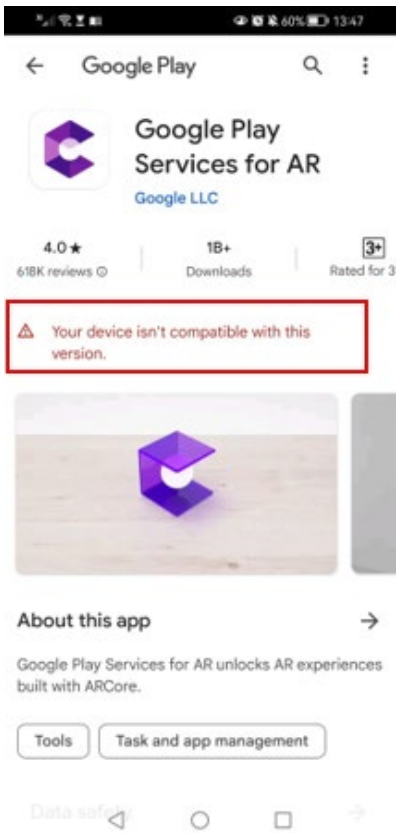


Figure 6.10: Error message displayed after attempting to install Google Services on Huawei P30 Lite. Screenshot: Marly Muudeni Samuel, 2022.

For Android devices to support ARCore, they should meet the following requirements:

- The device should run on Android 7.0 or higher; however, some devices would require Android 8.0 for ARCore to operate.
- The device should support the Google Play services (Nowacki and Woda, 2020; Kubity, 2021).
- The device should have access to the internet for regular ARCore updates.

Considering the abovementioned requirements, the author asked the co-researchers about the type of mobile phones they owned. In response, co-researchers stated that they had access to different types of Android devices, including a Huawei MediaPad T3 running on Android 8.0, an Android tablet running on Android 7.0, an Itel p37 Pro running on Android 10, a Huawei Y7 prime running on Android 7.0, and a Samsung A32 running on Android 11. It is important to note that *Efuta Letu Sida Huribs* Android Application Kit (APK) (standard file format that an Android operating system uses to install and distribute mobile applications) would not be installed on some co-researchers' mobile devices as some devices did not support ARCore, as observed with the Huawei P30 Lite (see Sections 2.3.1 and 8.4 for further deliberations about technology access).

6.3.3.3. Camera for Photogrammetry

This research utilised an EOS Canon camera to capture photographs. The camera had an electro-focus short back focus (ef-s) focal length lens ranging from 18-55 mm, a 25 cm minimum focus distance and a magnification capability of 0.34x. While the EOS Canon camera properly captured high-quality photographs, it experienced lens focus challenges when recording videos. When the author attempted to record videos of the ocean and coastal areas, the camera's lens struggled to maintain focus for an extended period. After a few seconds of recording, the lens lost focus, blurring some sections within the videos. As a result, a Huawei P30 Lite and Samsung A40 mobile phone were used to take the videos utilised during the research and included on *Efuta Letu Sida Hurib*. When using a mobile device to record videos, it is recommended to use a device with a camera resolution of a minimum of 12 megapixels or higher to attain high-quality video results.

6.3.4. Application Software, Hardware

The table below presents the software and hardware used for development throughout the research process.

6. Software	Publisher	Use
3DF Zephyr 	3DF Zephyr https://www.3dflow.net/	Used to generate 3D models and textures
Adobe Audition 	Adobe Audition https://www.adobe.com/	Used to edit audio descriptions of ocean heritage
Agisoft 	Agisoft https://www.agisoft.com/	Used to generate 3D models and textures
Drawio 	Drawio https://app.diagrams.net/	Used to design application storyboard and page flow
Flaticon 	Flaticon https://www.flaticon.com/	Used to download application icons

Skatchfab 	Skatchfab https://sketchfab.com/	Used to download 3D models
Unity 	Unity https://unity.com/	*Efuta Letu Sida Hurib* application development
Visual Studio 	Microsoft https://code.visualstudio.com/	Used to script in C# (C# is an object-oriented programming language developed by Microsoft used to develop applications such as website, desktop, mobile, and game applications).
Vuforia 	Vuforia https://developer.vuforia.com/	Pre-pilot markerbased application development
WhatsApp 	WhatsApp https://www.whatsapp.com/	Used to communicate with co-researchers regarding application development

Windows 10 	Microsoft https://www.microsoft.com/	Operating system

Table 6.1: Illustrates the software platforms employed to develop *Efuta Letu Sida Hurib*

Hardware	**Publisher**	**Use**
EOS Canon Camera 	Canon.com https://store.canon.co.uk/canon-eos-4000d-body-ef-s-18-55mm-iii-lens/3011C006/	Used to take images featured on *Efuta Letu Sida Hurib*
External Hard drive: 1TB 	Amazon Warehouse Amazon.com	Used to store and backup 3D models and *Efuta Letu Sida Hurib* files and
Homder Digital Voice Recorder 	Amazon Warehouse https://www.amazon.co.uk/Homder-Professional-Dictaphone-Rechargeable-Lectures-Black/dp/B09NW2GRNJ	Used to record voice audios used on *Efuta Letu Sida Hurib*
Logitech Bluetooth Mouse	Logitech https://www.logitech.com/	Portable pointing and selecting

		
Samsung A40 (API level 21) 	Samsung Samsung.com	Used to run and test AR application
Samsung Galaxy Tab A7 (API level 3) 	Samsung Samsung.com	Used to run and test AR application
Huawei P30 lite (Android 9 Pie) 	Huawei https://www.huawei.com/	Used to run and test AR application
Personal Computer (PC): HP intel core i5 8th Gen 	Hewlett-Packard https://www.hp.com/gb-en/home.html	Computer used for development

SanDisk USB 8GB SanDisk	Amazon Warehouse Amazon.com	Used to store and disseminate *Efuta Letu Sida Hurib* APK to co-researchers
USB Cable 	Amazon Warehouse Amazon.com	Used to transfer *Efuta Letu Sida Hurib* files from PC to mobile devices

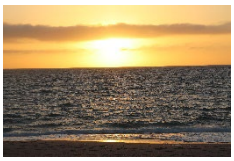
Table 6.2: Illustrates the hardware employed to develop *Efuta Letu Sida Hurib*

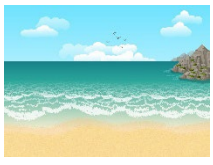
6.3.5. Application Source Data

The table below presents the source data used for the development of *Efuta Letu Sida Hurib*.

Source Data	Publisher	Use
3D models 	Photographs used to model objects by Marly Muudeni Samuel and some Co-researchers 3D: Modelled with 3DF Zephyr	3D models representing ocean relationships
3D model textures 	3DF Zephyr Generated in 3DF Zephyr	Textures used on 3D models
3D model with images	Photographs displayed on 3D model board	3D Cube used as a backboard for image ocean representations.

	3D board created with Unity assets (Cube, sphere, cylinder)	
Seaweed 3D model 	SkatchFab https://sketchfab.com/3d-models/scan-of-kelp-and-seaweed-on-sand-beach-c9b5ef07047a4b7a90a4ffd6930ec22c	Seaweed 3D model used in markerbased AR app.
Mussels 3D model 	SkatchFab https://sketchfab.com/3d-models/mussels-at-wilder-ranch-6b1c5b9378e44cde8dca4a89eebdfdbb	Mussels 3D model used in markerbased AR app.
Seashell 3D model 	SkatchFab https://sketchfab.com/3d-models/conch-seashell-0e3a24bd38a5430ab7bd333bb95afc1a	Seashell 3D model used in markerbased AR app.
About Image: Pelican birds flying at the beach 	Photograph by Marly Muudeni Samuel	The image on “About page”

AR page images 	Photograph by Marly Muudeni Samuel	Reference images to “AR Scenes”
Author images 	Photograph by Marly Muudeni Samuel	Reference co-researcher images to “Author Page”
Button icons 	Iconscout.com and Unity Asset Store https://iconscout.com/icons/	Reference icons to change between pages
Did you know image: Beach jetty sunset 	Photograph by Idda Angaleni Shikangala	Reference image to “Did You Know Page”
Different fish image: Sea, fish and coral	Pxhere.com https://pxhere.com/en/photo/638167	Reference image to “Different Fish Page”

		
Efuta Letu Sida Hurib colours: Pastel colours 	Unity.com Default Unity colours	Colours used on *Efuta Letu Sida Hurib* app.
Font: Ariel Headings: Size 55 Normal text: size 50 	Default Unity Font https://unity.com/	*Efuta Letu Sida Hurib* font
Gallery Images 	Photograph by Marly Muudeni Samuel	Images taken during the course of the co-production process
Landing Image: Beach Sea sand 	Pixabay.com https://pixabay.com/illustrations/beach-sea-sand-beira-mar-landscape-2960959/	Landing page image on “Home Page”

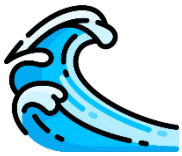
Letters to the ocean image: Letter and envelope 	Vectorportal.com https://vectorportal.com/vector/handwritten-letter/34833	Reference image to "Dear Ocean Page"
Loading Image: Pelican birds 	Photograph by Marly Muudeni Samuel	Image used when *Efuta Letu Sida Hurib* loads
Application Icon 	Flaticon.com https://www.flaticon.com/free-icons/wave	Image used as *Efuta Letu Sida Hurib* application icon.

Table 6.3: Illustrates the source date employed to develop *Efuta Letu Sida Hurib.*

6.4. Design and Development Process

6.4.1. Marker-Based Prototype AR Application Development

During the technology exploration phase, both marker-based and markerless AR were explored. A pilot marker-based AR prototype was developed by the author to assess its feasibility (see Figure 6.11). This section briefly outlines how this prototype worked.

The marker-based AR prototype application was built with Unity and included 3D models of various ocean resources. The image targets linked to the 3D models were created with Vuforia. Vuforia empowers users and developers to create and deploy user-friendly, accessible AR experiences without the necessity of complex programming. The integration of Vuforia with Unity facilitated the development of the pilot AR prototype application that utilised image targets to display 3D models sourced from the Unity asset store. The prototype was built,

processed in Unity, transferred, and saved on a mobile phone that supports ARCore (see Figure 6.11).

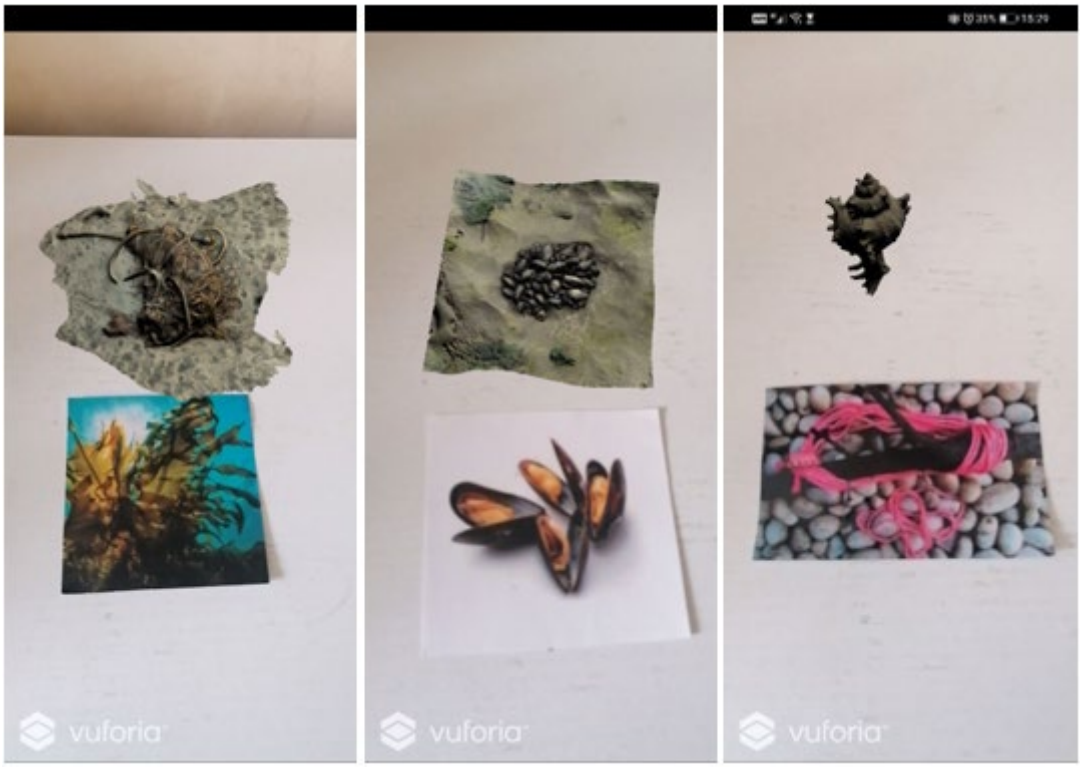


Figure 6.11 Image AR targets for the first pilot prototype application. (a): Left, marker-based AR application embedded with a seaweed 3D model. Marker photograph: Albert Bridge; (b): Middle, Marker-based AR application embedded with a mussel 3D model. Marker photograph: Albert Bridge; (c): Right, Marker-based AR application embedded with a seashell 3D model. Marker photograph: Albert Bridge. Screenshots: Marly Muudeni Samuel, 2021.

The 3D model positioning of the pilot prototype marker-based AR application was stable because they were registered onto the image targets. One challenge of working with marker-based AR is that users need to have access to printed photographs of the image markers or display them on another device to scan and trigger the display of 3D models on the prototype application. The image targets could have been provided at the workshops, on an online platform or made available on the prototype application for people to print or use on screens. However, that would mean giving users a list of tasks to accomplish before using the application, potentially reducing the engagement, ease of use, determination, and excitement of using the prototype application. This was the reason why marker-based AR was finally discarded for this research.

6.4.2. Markerless Prototype AR Application Development

This research also developed a markerless AR prototype. The markerless AR prototype was demonstrated during the technology exploration phase workshop (see Section 3.3, which

expounds on the different workshops). The markerless AR prototype application (see Figure 6.12) set the groundwork for the final co-produced *Efuta Letu Sida Hurib* AR application. It provided the author with a platform to become acquainted with markerless AR development. During the technology exploration phase (see Section 3.3.1.1 technology exploration phase), co-researchers engaged with five technologies, including the San Cultural Heritage AR Fridge Magnets, Making sense of the past AR Fridge Magnets, StoryBeads digital capturing, Badenoch the storylands and a markerless AR Prototype application developed by the researcher (The five application explored are further explained and discussed in Sections 3.3.1.1 and 5.1). After exploring these different technologies, co-researchers decided to adopt and create a markerless AR application.

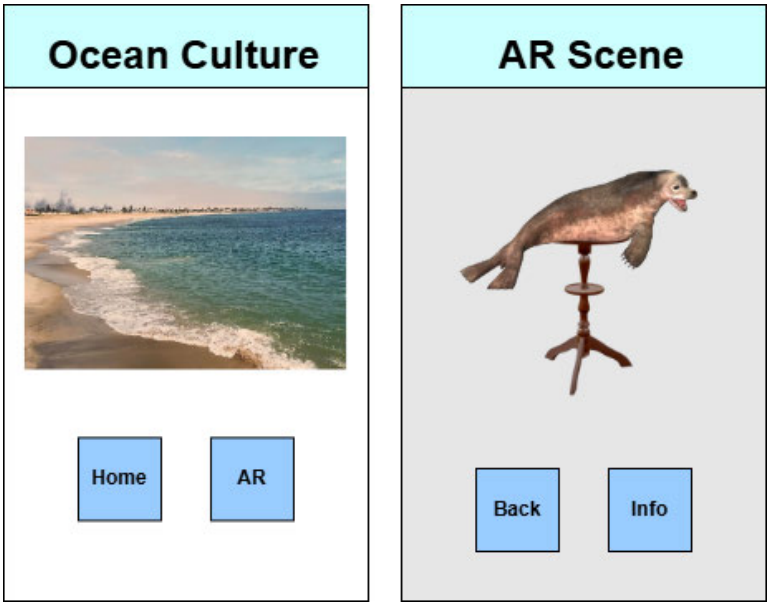


Figure 6.12: Design illustration of the makerless prototype. Diagram: Marly Muudeni Samuel

Markerless AR has been utilised in gaming, online shopping (Paladini, 2018) and heritage visualisation (Hammady, Ma and Powell, 2018). It uses AR plane detection algorithms and requests user input to position anchor points on the detected surface planes. User input is usually captured by tapping or clicking on the mobile screen (see Figure 6.13 for an example of ground detection).

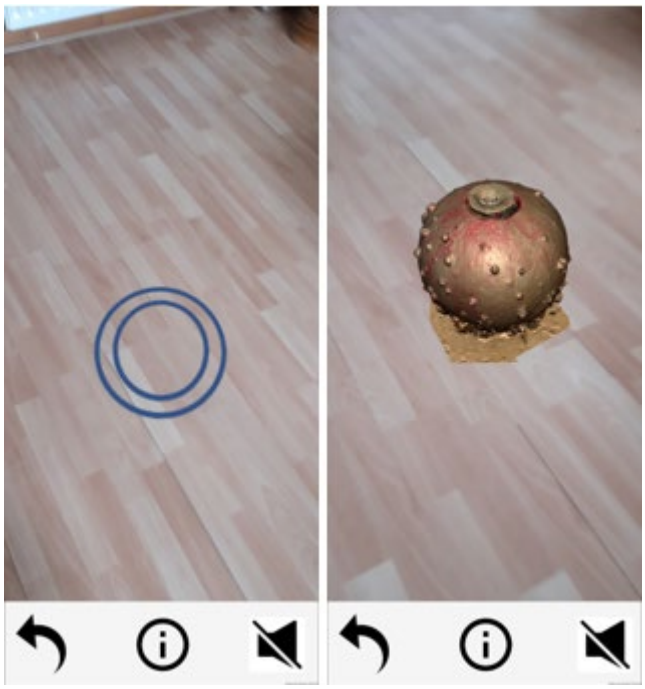


Figure 6.13: Illustrates a marker placement indicator that, when clicked, triggers an action, and a 3D model is placed in its position. Screenshot Photographs: Marly Muudeni Samuel

Paladini (2018) and Zvejnieks (2022) proposed using markerless AR for AR experiences because they are accessible anytime and from any location. However, sometimes, the primary challenge in incorporating virtual 3D models within any AR environment lies in the potential difficulties experienced with precision and accuracy of object placement between the real and virtual worlds (Paladini, 2018; El Barhoumi et al., 2022; Zvejnieks, 2022). This occurs because the placement of AR information in the actual world requires 3D tracking, real-time interactivity, and precise placement to establish a successful 3D model overlay between the virtual and real world (El Barhoumi et al., 2022). Another challenge is that registration on uniform surfaces is usually poor, and as a result, it takes very long (in some cases it does not register at all and the user is required to move to a different location) for surface registration to occur and overlay the object. These challenges were considered during the co-production of *Efuta Letu Sida Hurib.*

6.4.3. *Efuta Letu Sida Hurib* Co-production and Design Development

After deciding on AR technology, co-researchers focused on creating, designing and developing the application's content (see Figure 6.14). The co-production process and methods used are elaborated in Chapter 3. *Efuta Letu Sida Hurib's* results and other research outcomes are detailed in Chapters 4, 5 and 7.

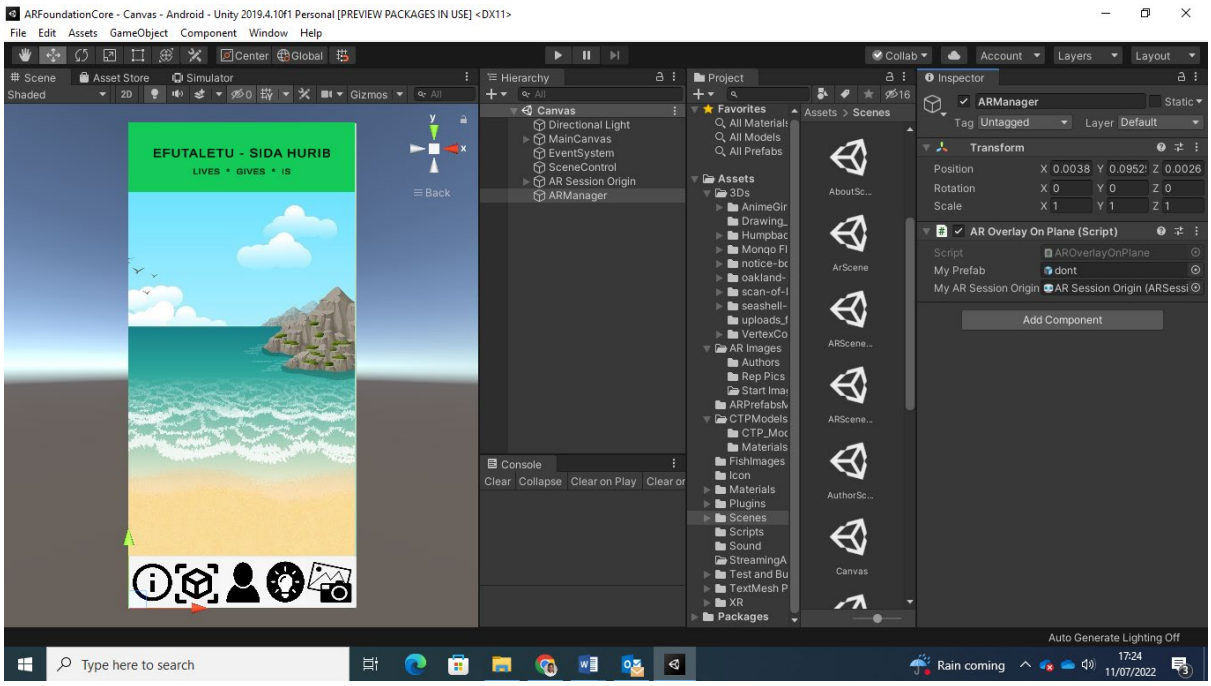


Figure 6.14: Unity software development environment. Image name: Beach Sea Sand Beira retrieved from https://pixabay.com/illustrations/beach-sea-sand-beira-mar-landscape-2960959/. Screenshot: Marly Muudeni Samuel, 2023.

The design process adopted follows an approach similar to Winschier-Theophilus et al. (2020), where co-researchers actively collect objects/materials which were digitally recorded and inserted into *Efuta Letu Sida Hurib*. The following sections analyse the development and co-production process of *Efuta Letu Sida Hurib*.

6.4.3.1. User Requirements Gathering

User requirements are essential for digital application development projects (Hussain, Mkpojiogu and Kamal, 2016), especially in an agile methodology (see Section 6.1), throughout which their completion is iteratively verified. User requirements "*deal with how a user will interact with a system and what that user expects*" (Kraeling and Tania, 2019, p. 38), and they serve as a guide throughout the co-production/development process. During the workshops (see Section 3.3 for workshop details), the author and co-researchers discussed ways to digitally present and preserve ocean heritage. Co-researchers discussed the look and the functional and non-functional requirements of *Efuta Letu Sida Hurib*, as detailed in Table 5.4.

Functional requirements define what a system or application must do and, in the case of this research, what it should output. Non-functional requirements address how a system or application should operate and deliver a specific function. Functional requirements include

specific functions and features of an application, whereas non-functional requirements focus on the quality of experience of an application (Kurtanovic and Maalej, 2017).

Functional Requirements	Non-Functional Requirements
Respond to user input	Record and preserve ocean heritage.
Button clicks.	Validating information shared.
Used without an internet connection.	Include ocean fun facts and educational content.
Work on Android devices	Colours that reflect ocean colours.
Display AR 3D models and texts.	Access to the final product.
AR scenes should move from one scene to another.	Include a co-researcher author page.
	Include both descriptive text and audio of 3D models.
	Include different fish found on the Namibian coastline.
	Include letters and poems about the ocean.
	Include the Namibian flag on the home page.

Table 6.4: Illustrating the functional and non-functional requirements of *Efuta Letu Sida Hurib*.

Functional and non-functional requirements were further classified into four categories, following the MoSCoW approach, which prioritises requirements as Must Have, Should Have, Could Have and Will not Have (Miranda, 2022). Table 5.5 below includes this research's requirements categorised using the MoSCoW approach.

MoSCoW Category	Requirements
Must Have	Record and preserve ocean heritage.
	Application colours should reflect ocean colours.

	Display AR 3D models and texts and play audio.
	Validating information shared.
	Respond to user input.
	Button clicks.
	Used without an internet connection.
	Work on Android devices.
	Pages should load within 5 seconds of clicking on buttons.
	Include descriptive text and audio of 3D models.
	Access to the final product.
Should Have	Include letters and poems about the ocean.
	Include ocean fun facts.
	Include a co-researcher author page.
	Include different fish found on the Namibian coastline.
	Colours that reflect ocean colours.
Could Have	Namibian flag on the home page.
	AR scenes should move from one scene to another.
Will not Have	Include educational quizzes and content.

Table 6.5: Illustrating the MoSCoW requirements of *Efuta Letu Sida Hurib*.

Because *Efuta Letu Sida Hurib* did not require users to input data, the functional requirements mostly detailed what *Efuta Letu Sida Hurib* should do regarding specific features and responsiveness, which allowed for a more concentrated effort on the non-functional aspects. The non-functional requirements optimised *Efuta Letu Sida Hurib's* appearance and enhanced its usability features, delivering a user-friendly experience for both co-researchers and users. The non-functional requirements highlighted important factors such as reliability and overall usability, which influenced the design and development process of *Efuta Letu Sida Hurib*.

6.4.3.2. Application Storyboard

A storyboard built from user requirements provided a visual representation template of how the application should perform, and work. The storyboard additionally assisted with identifying the correct design structure (Timothy, 2015) that the application will adapt. For this research, the author designed the first low-fidelity storyboard on paper (see Figure 6.15) and later improved it into a detailed second low-fidelity storyboard (see Figure 6.16 a-b) using Draw.io, an online storyboard development platform (see Figure 6.17). Truong, Hayes and Abowd (2006) elaborate that although storyboarding is a low-fidelity prototype technique, they must highlight details of the specific interface and higher-level aspects such as user motivation. They must also demonstrate a user's engagement process with an application. Therefore, the storyboards design for this research illustrate the application engagement process and includes relevant information, multimedia content, and interactive functions incorporated onto *Efuta Letu Sida Hurib*.

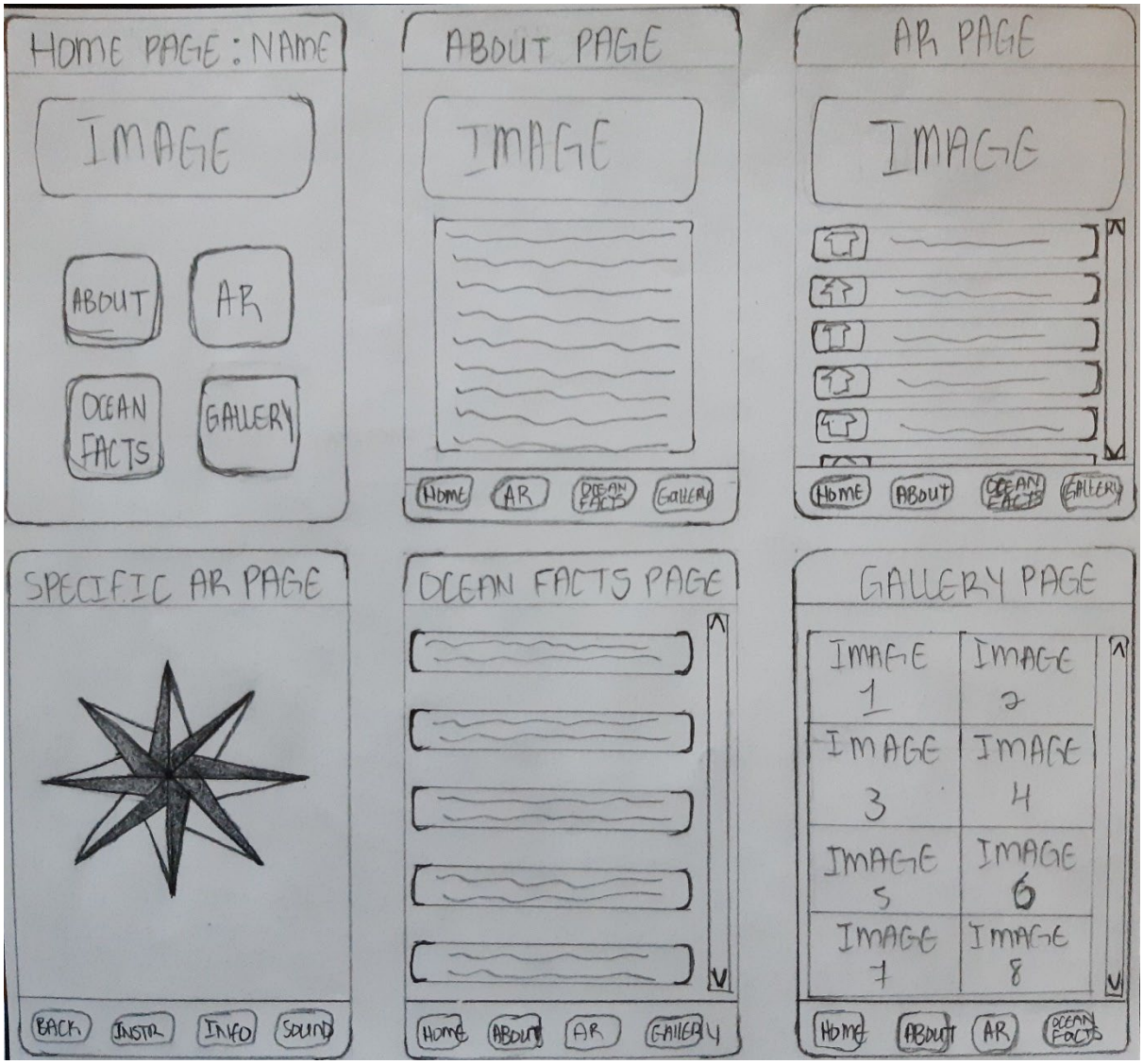


Figure 6.15: First low-fidelity paper storyboard of *Efuta Letu Sida Hurib*. Photograph: Marly Muudeni Samuel, 2022.

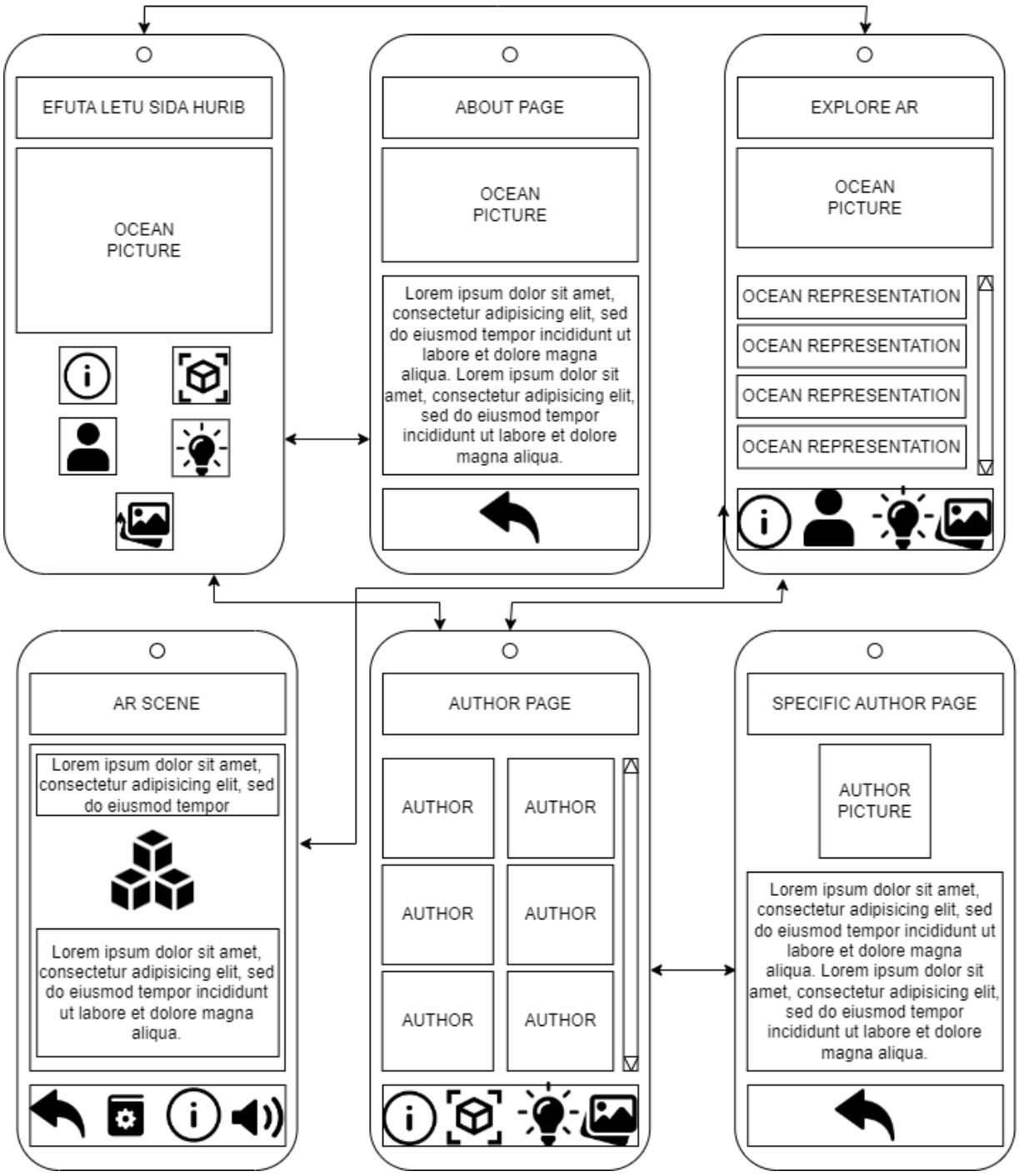
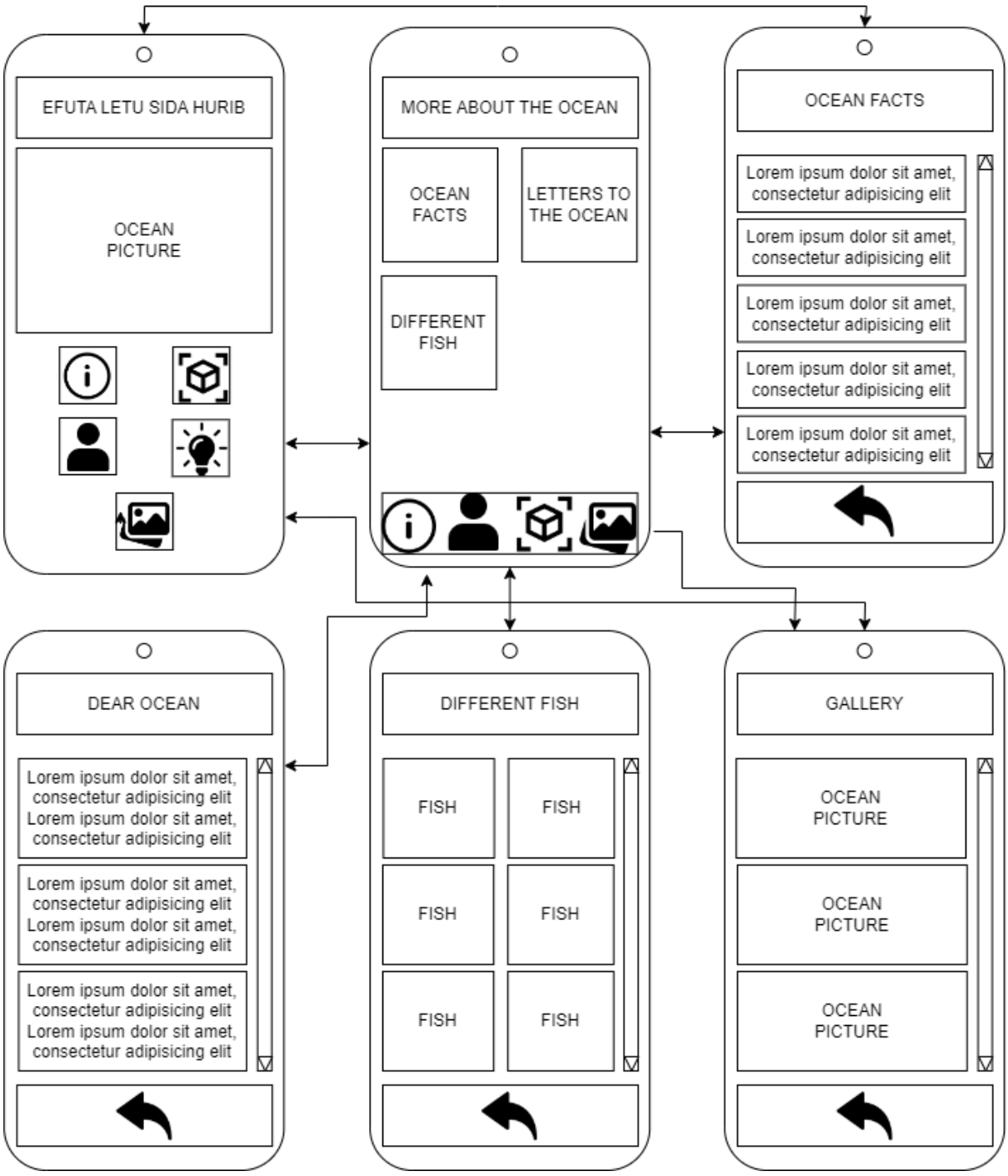


Figure 6.16 (a): Top, High fidelity Storyboard illustrating the different pages on *Efuta Letu Sida Hurib*.



(b): Bottom, low-fidelity Storyboard illustrating the different pages on *Efuta Letu Sida Hurib*.

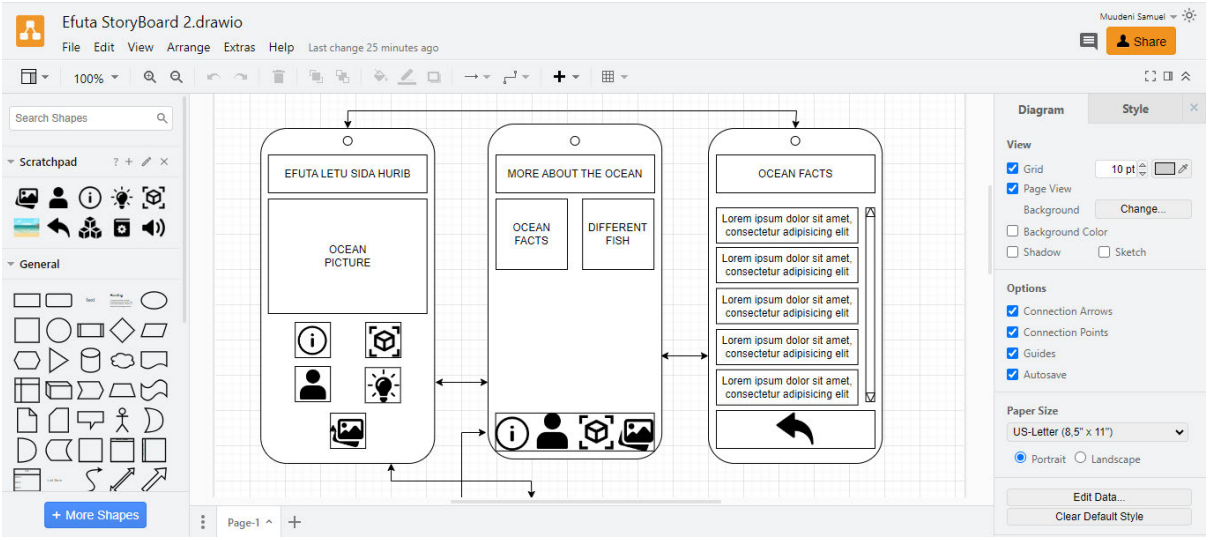


Figure 6.17: Screenshot of Drawio, where the second-high fidelity storyboard was designed. Screenshot: Marly Muudeni Samuel, 2021.

6.4.3.3. Converting Ocean objects into 3D models

Photographs of co-researchers' ocean objects/materials were imported into 3DF Zephyr and converted into 3D models.

6.4.3.3.1. 3D Models and Original Representing Objects

This section presents the 3D models of the ocean object/materials (symbolising the ocean relationships between the co-researchers and the ocean) shared by co-researchers, which were created using 3DF Zephyr.

Efuta Letu Sida Hurib provides photographs, text, and audio explanations for users to fully engage, understand and learn about the 3D models and why they are essential to co-researchers. It includes fourteen objects and materials. Eight objects were converted into 3D models, while four objects (the fish tank, seagull feather, !Nara roots and oyster) and two materials (TheOceanAndI and Ocean Waves) were not converted because of technical challenges that had to do with the colour texture of the objects and because the shared materials where photographs and videos. These objects were photographed and displayed on 3D boards (3D cubes) instead. The different objects/materials are highlighted below (see Section 5.1.1 for object/material explanations of significance):

Driftwood: Radicle venturesome

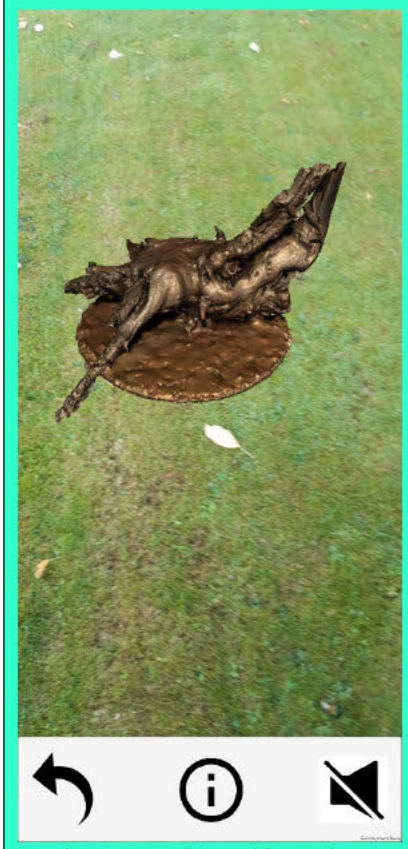
3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.18 (b): Driftwood 3D model. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.18 (a): Driftwood piece object. Object Credit: Edwin, photograph: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	Edwin's ocean relationship representation was a piece of driftwood (see Figure 6.18a). The author photographed it, and the images were processed and converted into a 3D model (see Figure 6.18b). The 3D model photorealistically resembled the driftwood; however, some branches were processed as one branch, and the author utilised 3DF Zephyr editing tools to separate some of the branches. The final 3D model (see Figure 6.18b) was inserted into Edwin's AR scene.

Table 6.6: Edwin's 3D and object ocean representation.

!Nara seeds object titled: !Nara seeds

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.19 (b): !Nara seeds 3D model. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.19 (a): !Nara seeds object. Object Credit: Morangie, photograph: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	Morangie's ocean relationship was represented by seeds from the !Nara fruit (see Figure 6.19a). Morangie stems from the Topnaar ǂAonin community and the !Nara plant is a big part of their livelihood. The author photographed the seeds, and the images were processed and converted into a 3D model. The 3D model of the seeds was successfully processed, but the colour texture of the model was different from that of the original seeds (see Figure 6.19b). The original !Nara seeds were yellow, and the 3D model was processed with a goldish-looking texture colour. Regardless of the colour differences, Morangie was happy with the final 3D model, which was inserted into his AR scene.

Table 6.7: Morangie's 3D and object ocean representation.

Fish tank object titled: Fish Tank

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.20 (b): Fish tank photograph displayed on a 3D model board. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.20 (a): Fish tank object. Object Credit: Haba. Photograph: Marly Muudeni Samuel, 2022. **Object/Material Technical Explanation** Haba brought her small home fish tank to represent her ocean relationship (see Figure 6.20a). The fish tank was not converted into a 3D model using 3DF Zephyr because the glass was transparent (see Section 6.3.2 for an explanation). As a result, a photograph of the fish tank was used to symbolise Haba's ocean relationship. The photograph was displayed on a 3D display board created in Unity (see Figure 6.20b) and inserted into Haba's AR scene.

Table 6.8: Haba's 3D and object ocean representation.

Ocean material titled: Ocean Waves

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.21 (b): Video of ocean waves displayed on 3D model board. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.21 (a): Swakopmund beach and jetty. Material Credit: Rodney. Photograph: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	TheOne did not bring a physical object to represent his ocean relationship. His ocean relationship representation was the ocean itself, particularly ocean waves. The author and Rodney captured a video and picture (see Figure 6.21a) of the ocean. The video was displayed on a 3D board (see Figure 6.21b) and inserted into his AR scene. When users go into TheOne's AR scene, they can watch the video of the ocean waves.

Table 6.9: TheOne's 3D and material ocean representation.

Ocean material titled: The Ocean and I

<table>
<tr><th>3D Ocean Representation</th><th>Object/Material Ocean Representation</th></tr>
<tr><td rowspan="3"> 
Figure 6.22 (b): Slideshow of co-researcher at the beach displayed on a 3D model board. Screenshot: Marly Muudeni Samuel, 2022.</td><td> 
Figure 6.22 (a): Photograph of co-researcher at the beach. Photo Model: Jota. Photographed: Marly Muudeni Samuel, 2022.</td></tr>
<tr><th>Object/Material Technical Explanation</th></tr>
<tr><td>Jota did not bring a physical object to represent her ocean relationship. Her relationship was symbolised by the distinct emotions that the ocean evoked in her. She used photographs of herself at the beach, captured by the author, to serve as her representation (see Figure 6.22a). One of her photographs was initially displayed on a 3D board to demonstrate her ocean relationship. She later requested that the image be replaced with a slideshow of photographs of her by the beach. Her relationship with the ocean was symbolised not by a single moment or photograph but by all the memorable moments she spent with the ocean. The slideshow of her photographs was displayed on a 3D board and inserted into her AR scene (see Figure 6.22b).</td></tr>
</table>

Table 6.10: Jota's 3D and material ocean representation.

Seagull feather object titled: Seagull Feather

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.23 (b): Seagull flying video displayed on a 3D model board. Video: Marly Muudeni Samuel, 2022.	 Figure 6.23 (a): Seagull feather object. Object Credit: Lucio. Photograph: Marly Muudeni Samuel, 2022. **Object/Material Technical Explanation** Lucio brought a seagull bird feather to symbolise his ocean relationship (see Figure 6.23a). The author photographed the feather and processed it in 3DF Zephyr; however, similar to the fish tank, the application could not generate a 3D model of the feather because of the feather's white and black colour contrast. As a result, Lucio decided to use a photograph of the feather as his representation. Lucio later requested that the image be replaced with a video of flying seagulls recorded by the author (see Figure 6.23b). The final video representation was displayed on a 3D board and inserted into his AR scene.

Table 6.11: Lucio's 3D and material ocean representation.

Seashell object titled: Seashells

<table>
<tr><th>3D Ocean Representation</th><th>Object/Material Ocean Representation</th></tr>
<tr><td> 
Figure 6.24 (b): Seashells 3D model. Screenshot: Marly Muudeni Samuel, 2022.</td><td> 
Figure 6.24 (a): Seashell at the beach object. Object Credit: Rejoice. Photograph: Marly Muudeni Samuel, 2022.

Object/Material Technical Explanation

Rejoice chose seashells to represent her ocean relationship (see Figure 6.24a). Rejoice comes from the Owambo tribe, which utilises seashells and oysters to create traditional jewellery and ornaments. She brought three seashells, which the author photographed and converted into a 3D model. The 3D model was successfully processed; however, because of the uniform white colour of the seashells, the appearance was not photorealistic, resulting in the colour texture of the model being different from the original seashells (see Figure 6.24b). Regardless of the colour differences, Rejoice was happy with the final 3D model, which was then inserted into her AR scene.</td></tr>
</table>

Table 6.12: Rejoice's 3D and object ocean representation.

!Nara plant root object titled: Genesis

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.25 (b):!Nara plant roots displayed on a 3D model board. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.25 (a): !Nara plant roots object. Object Credit: Sara-Leigh. Photograph: Marly Muudeni Samuel, 2022. **Object/Material Technical Explanation** Sara-Leigh's ocean relationship was represented by the roots of the !Nara Plant (see Figure 6.25a), which is part of her heritage as a Topnaar ǂAonin descendent. She brought two !Nara plant roots that were photographed and processed in 3DF Zephyr. However, similar to the seagull feather, the application could not generate a 3D model of the roots because of the uniform colour contrast of the roots. Sara-Leigh decided to use a photograph of the roots as her representation (see Figure 6.25b). The photograph was displayed on a 3D board and inserted into her AR scene.

Table 6.13: Sara-Leigh's 3D and object ocean representation.

Oysters object titled: Oysters and Seashells

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.26 (a): Photograph of oyster displayed on a 3D model board. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.26 (b): Oyster object. Object Credit: Anna. Photograph: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	Anna brought an oyster to represent her ocean relationship (see Figure 6.26a). The oyster was photographed, and the images were processed in 3DF Zephyr. However, similar to the seagull feather and !Nara roots, the application did not generate a 3D model of the oyster because of its white and black glossy colour contrast. The application only processed and generated a model of the dark part of the oyster, leaving the white side unprocessed. Consequently, Anna used a photograph of the oyster (see Figure 6.26a), which was displayed on a 3D board and inserted into her AR scene.

Table 6.14: Anna's 3D and object ocean representation.

Seashells Olukula holder object titled Omuthigululwakalo - Cultural Heritage

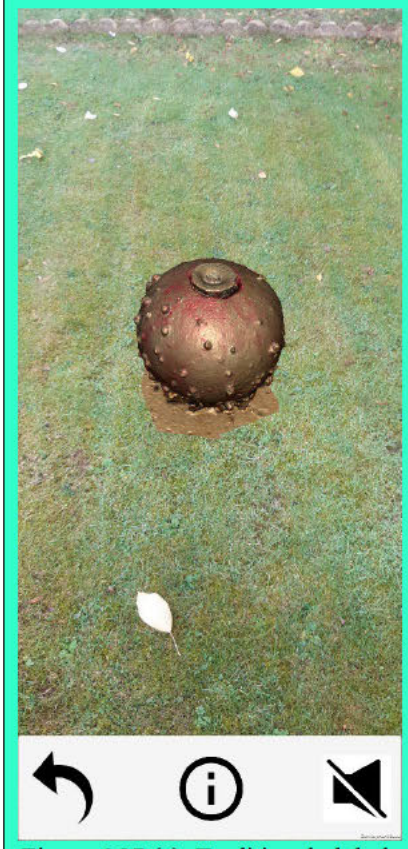
3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.27 (c): Traditional olukula holder 3D model. Screenshot: Marly Muudeni Samuel, 2022.	  Figure 6.27 (a): Traditional olukula holder object; (b): Traditional onyoka necklace. Object Credit: Letisia. Photograph: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	Letisia brought different artefacts to symbolise her ocean relationship, including an *olukula* container, which she selected to represent her ocean relationship (see Figure 5.27a). The *olukula* holder is a container used to store olukula (see glossary for olukula definition) made from dried !Nara fruit. *Olukula* is customarily used to colour traditional Oshiwambo jewellery (see Figure 5.27b). The author photographed the *olukula* holder, and the images were converted into a 3D model that photorealistically resembled the actual object (see Figure 5.27c). The final 3D model was inserted into Letisia's AR scene.

Table 6.15: Letisia's 3D and object ocean representation.

Seaweed object titled: Seaweed

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.28 (c): Seaweed 3D model. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.28 (a): Seaweed in blue plate object, (b): Seaweed found at the beach. Object Credit: Ousitjie. Photographs: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	Ousitjie brought seaweed to symbolise her ocean relationship (see Figure 5.28a). The seaweed was photographed and processed in 3DF Zephyr. However, the application failed to properly process the seaweed 3D model because of its uniform colour contrast. It only processed the blue plate the seaweed was in, and the seaweed on the plate was not processed correctly. Because of this, Ousitjie agreed to use photographs of seaweed on the beach (see Figure 5.28b), which were processed in 3DF Zephyr, and a 3D model was generated. The same challenge encountered with the seaweed Ousitjie brought to the workshop was experienced with the photographs of the seaweed at the beach. Because of the seaweed's colour contrast and outdoor light variables, it was not effectively converted into a 3D model, and its appearance was not photorealistic (see Figure 5.28c). Ousitjie agreed to use the seaweed 3D model as her representation and suggested it be replaced in the future. The seaweed 3D model was inserted into her AR scene.

Table 6.16: Ousitjie's first 3D and object ocean representation.

Driftwood object titled: Driftwood Art

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.29 (b): Driftwood art 3D model. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.29 (a): Driftwood art object. Object Credit: Ousitjie, photograph: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	Ousitjie brought a piece of driftwood art crafted to look like a Christmas tree or jewellery hanger as her second object (see Figure 5.29a). The author photographed the driftwood art, and the images were converted into a 3D model that photorealistically resembled the actual object (see Figure 5.29b). The software processed some branches as one branch, and the author utilised 3DF Zephyr editing tools to separate some branches. The final 3D model (see Figure 6.29b) was inserted into Ousitjies's AR scene.

Table 6.17: Ousitjie's second 3D and object ocean representation.

Sea sand and Seashells object titled: Sea sand and Seashells

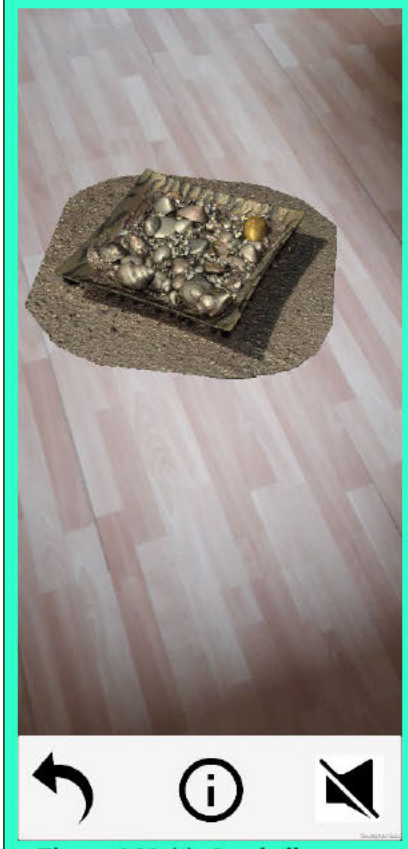
3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.30 (c): Seashells, ocean rocks and sea sand 3D model. Screenshot: Marly Muudeni Samuel, 2022.	  Figure 6.30 (a): Seashells and sea sand objects in transparent glasses; (b): Seashells, ocean rocks and sea sand object on colourful plate. Objects Credit: Lato, photographs: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	To demonstrate her ocean relationship, Lato initially brought sea sand in miniature glass bottles and seashells in a glass vase (see Figure 6.30a). The objects were photographed and processed in 3DF Zephyr. However, similar to the fish tank, the photographs were not processed effectively because the sand and seashells were in transparent glass containers. The glass bottles filled with sand were not filled to the brim, and the glass areas without sand were not processed, resulting in the top part of the 3D model appearing fragmented from the bottom part (see Figure 6.31a). The seashell glass vase object was also not converted into a 3D model. Because of its transparent nature the vase did not convert into a 3D model. Only fragments of the seashells inside the jar were converted into a 3D model (see Figure 6.31b). Lato decided to change the presentation of her objects during the following workshop. She presented the same objects arranged on a colourful glass plater plate (see Figure 6.30b). The author photographed the objects, and the images were converted into a photorealistic 3D model (see Figure 5.30c). The final 3D model was inserted into Lato's AR scene.

Table 6.18: Lato's second 3D and object ocean representation.

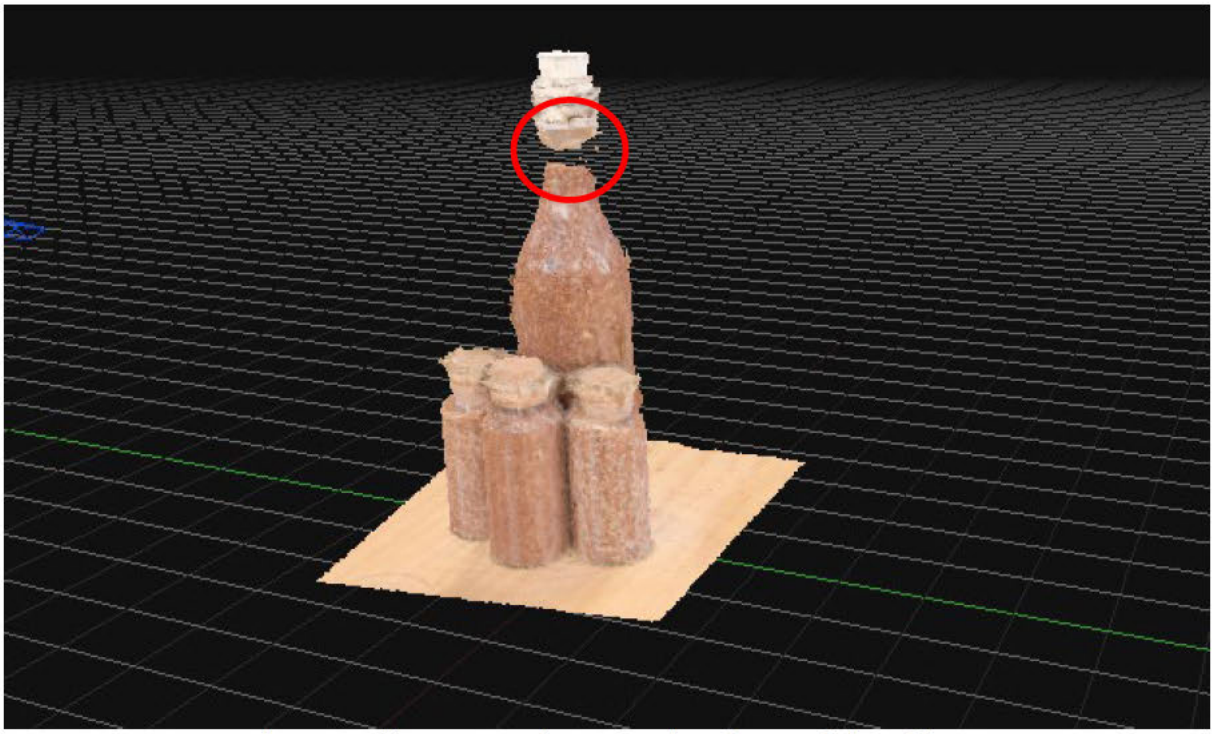
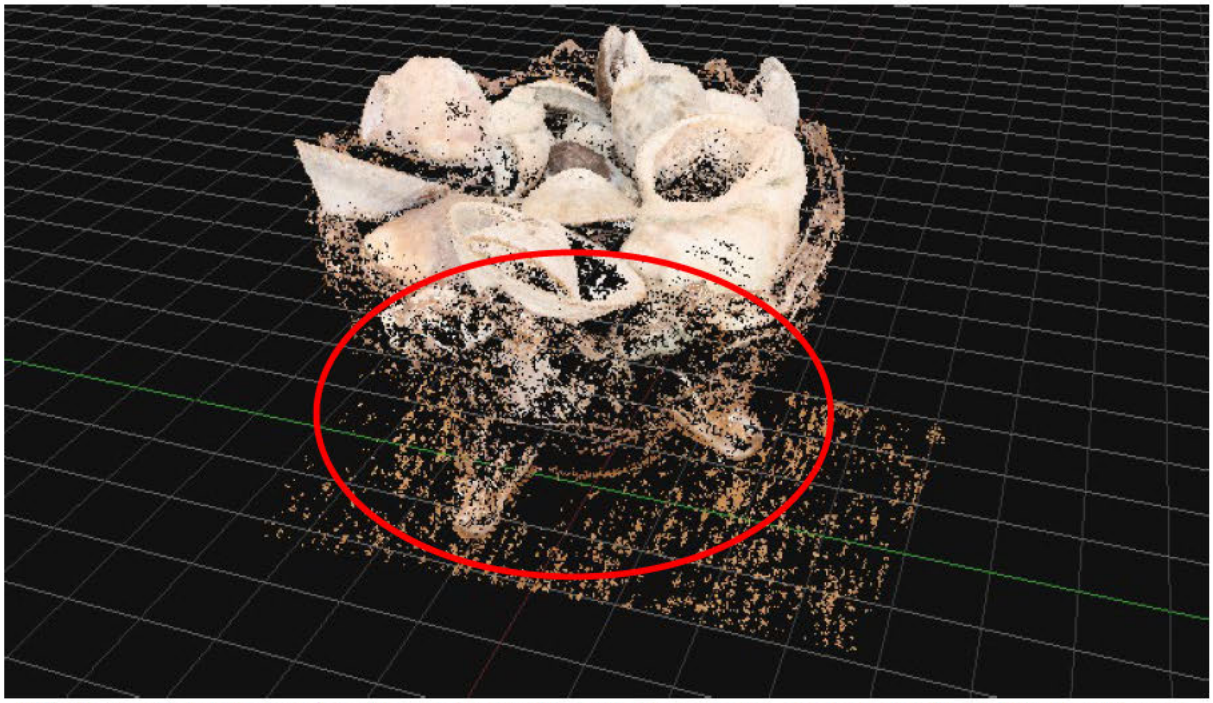


Figure 6.31 (a): Fragmented 3D generation of sea sand glass object;



(b): Fragmented 3D generation of glass stand with seashells and rocks. Photographs: Marly Muudeni Samuel, 2022.

Belt created with seashells object titled: Eepaya LyoOEkosa – Seashell belt

3D Ocean Representation	Object/Material Ocean Representation
 Figure 6.32 (b): Oshiwambo traditional skirt and belt made with seashells 3D model. Screenshot: Marly Muudeni Samuel, 2022.	 Figure 6.32 (a): Oshiwambo traditional skirt and belt object. Object Credit: Sofia, photograph: Marly Muudeni Samuel, 2022.
	Object/Material Technical Explanation
	Sofia brought a traditional seashell belt to symbolise her ocean relationship (see Figure 6.32a). The author photographed the belt while Sofia was wearing it, and the images were converted into a moderate photorealistic 3D model. Sofia's belt and traditional skirt were pink, and the 3D model replicated the colour correctly (see Figure 6.32b). While the 3D model colour resembled the skirt and belt, the outline of the skirt was not perfectly generated and included dents and protrusions different from the actual object. Sofia was still happy with the final 3D model, which was inserted into her AR scene.

Table 6.19: Sofia's 3D and object ocean representation.

The objects/materials shared were diverse and represented the significance of ocean heritage for co-researchers. Though some objects were not correctly converted to 3D models using 3DF Zephyr, they still embodied and portrayed ocean significance. This research reiterates that 3DF Zephyr was used because it provides access to a free version that enables anyone to utilise it, and co-researchers and anyone interested in creating 3D models using photogrammetry can utilise it to develop their own 3D models or projects. This research also notes that there are many other photogrammetry 3D scanning applications that may be used to create 3D models,

such as Polycam, RealityCapture, PixPro, and ReCap. However, most of these software require users to subscribe to paid versions to create and download 3D models.

6.4.3.3.2. 3D models Appearance

For 3DF Zephyr (or any other photogrammetry software) to accurately generate 3D models, photographs of ocean objects had to be captured from different angles. The author photographed the objects by moving step by step around them, taking pictures from as many angles as possible and ensuring that sections of the previous photograph overlapped with the following one. The triangles in Figure 6.32 illustrate every point where a picture of the object was captured. This approach enabled 3DF Zephyr software to identify and connect photographs during the 3D model conversion process. The photographs (only 50 photographs of each object are allowed to be processed in the free 3DF Zephyr version) were imported into 3DF Zephyr for processing, and the software generated 3D models with mesh and texture vertices. These 3D models were exported as .OBJ files and inserted into *Efuta Letu Sida Hurib* on Unity.

Some 3D models looked different from their corresponding objects in terms of colour, texture, and shape. This occured because photo-reconstruction platforms sometimes experience challenges in accurately reproducing colour textures. This challenge arises due to the shift in colours and transition from one source image to another when multiple pictures are used to generate a model (Maggiordomo et al., 2020) (see Figure 6.32). This also happens when the surrounding area lighting changes or causes a reflection/brightness on the photographs, altering the photorealistic colour appearance of 3D models. For example, the texture colour of the seaweed 3D model was processed with holes and empty sections and of the !Nara seeds 3D model was processed with a goldish colour and not the original yellow/orange colour of !Nara seeds. Chapter 7 provides further feedback from co-researchers and respondents regarding the 3D models explored in this research. See Appendix 3: A: 3 for the 3D model's vertex counts.

Figure 6.33: The triangles illustrate every point (n=number of points) where a picture of the object was captured. Screenshot: Marly Muudeni Samuel, 2021.

Co-researchers' 3D models were exported into Unity and inserted into *Efuta Letu Sida Hurib*. When a user opens *Efuta Letu Sida Hurib* using a mobile device, they have to hover the device over a ground/flat surface until a blue placement circle appears (see Figure 6.12). When the blue circle appears, the user has to click on it (on the screen) with their finger. The application would then register and process the touch input to overlay the selected 3D model on any ground/flat surface.

6.4.3.4. *Efuta Letu Sida Hurib*: Photograph, Text, and Audios explanations

6.4.3.4.1. Photographs on *Efuta Letu Sida Hurib*

Ballenger (2014, p. 1) explains that "*photography powerfully communicates artistically that which words cannot convey*". Photographs, therefore, played an essential role in expressing co-researchers' voices and illustrated the place attachment and meaning created by the ocean. The photographs included on *Efuta Letu Sida Hurib* consist of images of the ocean, its resources, coastal towns, the co-production workshops, and objects/materials provided by co-researchers. They conveyed the unspoken, complimenting co-researchers' perspectives, views and ideas and uniquely expressed intricate ocean heritages, and illuminated the ocean's role in the lives of co-researchers and coastal communities, speaking volumes about the importance and benefits of the ocean.

6.4.3.4.2. Text and Audio Explanations

Efuta Letu Sida Hurib integrated text descriptions written by the co-researchers that provided an explanation of the objects/material 3D models (see Figure 6.33). To access the text explanations, users have to click the information button on the AR scene pages, and a pop-up textbox with the explanation appears, further enhancing users' experience. These text

explanations are designed bearing in mind the principles of inclusion for individuals with hearing impairments and reading difficulties.

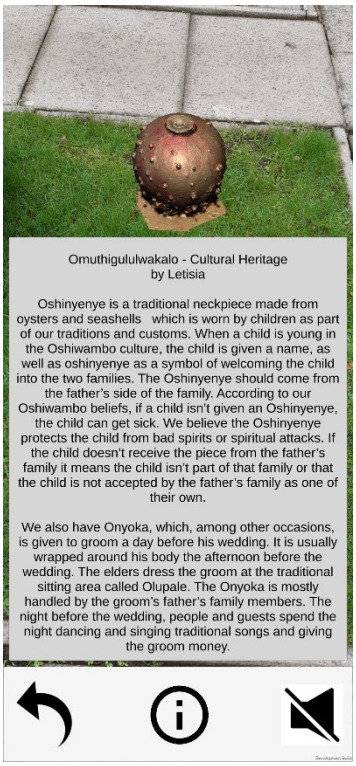


Figure 6.34: Text description explaining the significance of *onyoka*

Based on co-researchers' language preferences, three AR scenes include two language options: English and Oshiwambo. Additionally, audio explanations for 3D models were recorded in English, Oshiwambo or Kheokhoegowab (the latter two are Namibian Indigenous languages). The explanations written and recorded in Oshiwambo were translated into English by an Oshiwambo/English teacher, and the explanations written and recorded in Kheokhoegowab were translated into English by the co-researcher (see Section 3.4).

Text descriptions were recorded using three methods. Some co-researchers recorded with a Homder digital voice recorder during the workshop; a few co-researchers recorded using WhatsApp voice notes and forwarded them to the author; and other co-researchers asked the author to record on their behalf. The files were transferred from the recorder or downloaded from WhatsApp onto the author's computer and converted to .mp3 files using convertio, an online audio-converting website (https://convertio.co/audio-converter/). Audios that required editing were modified using Adobe Audition and imported into co-researchers' respective scenes in Unity and on *Efuta Letu Sida Hurib*.

6.4.3.5. *Efuta Letu Sida Hurib* User Acceptance Testing

User Acceptance Testing (UAT) was the final stage of the development cycle of *Efuta Letu Sida Hurib* before it was deployed and disseminated to co-researchers. The primary purpose of UAT is to validate the usability of the application (Tong et al., 2022), which means assessing whether the application is a working, fully functional product. The UAT stage aimed to determine whether *Efuta Letu Sida Hurib* functioned efficiently and how effectively it accomplished its intended function.

Efuta Letu Sida Hurib went through three testing phases. The first and second testing phase was conducted with co-researchers, and they provided feedback and suggestions about *Efuta Letu Sida Hurib* (see Section 3.3.1.3 for feedback from co-researchers and Chapter 5 for output results). During the third testing phase, five demonstrative feedback sessions were conducted with respondents from Swakopmund and Walvis Bay communities, who engaged with *Efuta Letu Sida Hurib* to facilitate additional UAT testing and assess its usability and efficiency (see Chapter 7 for feedback from respondents). Following their engagement with *Efuta Letu Sida Hurib,* co-researchers and respondents provided individual perspectives, feedback, and suggestions for improvement. Co-researchers further reviewed changes implemented on the application to assess whether they aligned with the requirements and objectives established at the beginning of the research.

6.4.3.6. *Efuta Letu Sida Hurib* Deployment Strategy

Following the UAT and subsequent refinement phase, *Efuta Letu Sida Hurib* was prepared for deployment. Application deployment consists of installing, configuring, and enabling a specific digital application to be successfully shared with users or placed on an open or private application store, such as Google Play Store for Android devices (Barhate, 2022). Application deployment enables intended users to access digital applications.

Efuta Letu Sida Hurib is still in the pilot stage and unique to the co-researchers. It is still undergoing experimental adjustments, and co-researchers want to include more improvement features to enhance its functionality and effectiveness before deploying it on any public domain. The application APK was built directly from the Unity Android building environment and transferred onto some co-researchers Android mobile devices using a USB cable connected to the author's computer. Co-researchers with Android phones that did not support ARCore requested to receive the application APK on a memory stick, so when they acquired/accessed mobile devices that supported ARCore, they could install the APK from the memory stick onto

the mobile devices. It was also emailed to co-researchers and collaborators who requested it, and instructions on how to install the APK on an Android digital device were similarly provided via email.

6.4. Conclusion

Technologies such as AR and VR are becoming more prevalent in our daily lives (Suh and Prophet, 2018). They create possibilities that connect people and contribute to the protection of cultural heritage. The immersive digital technologies explored in this research presented both advantages and disadvantages about how and the kind of context they can be used. Therefore, when developing digital applications, it is imperative for developers to understand the context they are engaging in and the type of technological infrastructure available. After conducting a critical examination of the immersive technologies discussed in this Chapter and considering the research context, this research determined that immersive technologies such as VR were not suitable. This decision was primarily influenced by the high costs of equipment required for development and use, such as VR headsets.

Following an evaluation of the different types of AR and feedback from co-researchers, this research chose to work with markerless AR. Though markerless AR presented accessibility challenges, it was favoured by co-researchers and held potential advantages for future engagement. It can also be used in any location where physical ground/surface reference points can be registered and used to overlay digital objects within the real world (Comport et al., 2006). In contrast, marker-based AR relies on an image trigger for which a physical version of an image is required.

Furthermore, agile development methodology allowed this research to conduct iterative cycles throughout the co-production process, testing and refinement stages. During the development of *Efuta Letu Sida Hurib*, co-researchers engaged in design discussions to determine the features, functions, content, colours, and photographs to be included. Unique objects/materials symbolising co-researchers' ocean heritages were modelled in 3D and integrated on *Efuta Letu Sida Hurib*. However, the !Nara, seaweed and oyster 3D models were not accurately replicated due to different colour texture variations in the photographs. The driftwood models were generated with conjoined branches, which the author fixed using 3DF Zephyr editing and refining tools. Moreover, materials that could not be accurately reconstructed as 3D models were displayed on 3D boards as photographs, videos, and slideshows. The co-production process yielded positive ocean heritage results, which played an essential role in developing

Efuta Letu Sida Hurib. It is, however, important to highlight that while *Efuta Letu Sida Hurib* supported, recorded, and preserved ocean heritage, its dependence on digital devices that only support ARCore contributed to the digital divide by excluding co-researchers with digital devices that do not support ARCore.

CHAPTER 7

RESPONDENT ENGAGEMENT AND USER TESTING SESSIONS: *EFUTA LETU SIDA HURIB* DEMONSTRATION AND FEEDBACK RESULTS

Building upon findings from Chapters 3, 4, 5 and 6, Chapter 7 analyses feedback from respondents (local coastal community members who were not co-researchers) about *Efuta Letu Sida Hurib* and the ocean knowledge it presents. This Chapter includes the methods followed and comments provided by respondents through workshop discussions and a research questionnaire answered during demonstrative feedback sessions. Questionnaire responses are further examined to explore similar and dissimilar opinions about *Efuta Letu Sida Hurib*. Respondents' perspectives and user experience are evaluated and compared to contributions shared by co-researchers. The Chapter concludes by providing observations and reflections based on feedback received.

7.1. *Efuta Letu Sida Hurib* Demonstrative Feedback Sessions Approach

During the author's second period fieldwork, five demonstrative feedback sessions were conducted with respondents from Swakopmund and Walvis Bay (see Figure 7.1) to facilitate additional testing of *Efuta Letu Sida Hurib* and evaluate its usability and efficiency. Such an approach enabled this research to evaluate the effectiveness of the application (and digital technologies in general) as a means of supporting and preserving ocean heritage in Namibia. The respondents who expressed interest in participating in this research were members of different organisations and institutions, including the Ministry of Fisheries and Marine Resources, Dantago Women's Group, Shalom Youth Choir, Accounting Society, Junior City Council, Business Dome Group, and local community members.

Figure 7.1: Walvis Bay respondents engaging in a discussion about the ocean and with *Efuta Letu Sida Hurib*. Photographs: Kuundjuaune Kaavari, 2022.

The sessions took place at various venues, including the Dantago Community Centre in DRC, Ministry of Fisheries and Marine Resources offices, Swakopmund MTC Dome, Walvis Bay Community Centre, and Walvis Bay ELCRN Shalom Parish. The same introductory and consent processes explained in Section 3.3.1.1 were followed and methodologies similar to those outlined in Section 3.2.3 were employed. Some co-researchers also volunteered to assist during these sessions. The sessions, which lasted one-to-two hours, were divided into four sections: (1) introducing the research project and its objectives; (2) respondents engaging with *Efuta Letu Sida Hurib*; (3) respondents answering the research questionnaire; and (4) focus group discussions about the ocean and *Efuta Letu Sida Hurib*. The focus group discussions enabled respondents to verbally express opinions not captured through the questionnaire. In addition to the questionnaire and focus group discussion, the author observed as respondents engaged with *Efuta Letu Sida Hurib*.

The following table includes session information and methods employed:

Session Name	*Efuta Letu Sida Hurib* demonstrative feedback sessions				
Town	Swakopmund	Swakopmund	Swakopmund	Walvis Bay	Walvis Bay
Date	12 January 2023	17 January 2023	19 January 2023	20 January 2023	20 January 2023
Time	12h00 – 15h00	09h00 – 10h30	10h00 – 11h00	10h00 – 13h00	13h00 – 16h00
No. of Attendees	9 respondents	3 respondents	1 respondent	8 respondents	13 respondents
Methodology	Respondents interacted with *Efuta Letu Sida Hurib* and thereafter engaged in a discussions, sharing individual opinions about the content and ocean knowledge presented therein, the photorealism of 3D models and the importance of the ocean (see Figure 7.2). Following the discussion, respondents filled out the questionnaires (details of the questions are explained in Section 7.2 and the questionnaire is available in Appendix 2-C).				

Table 7.1: Methods employed in the application demonstrative feedback sessions.

Figure 7.2: Respondents attending demonstration workshop in Walvis Bay. Photograph: Kuundjuaune Kaavari, 2023.

7.2. Questionnaire Engagement Approach

The questionnaire had multiple objectives. Firstly, it collected a range of viewpoints and perspectives about *Efuta Letu Sida Hurib* and the ocean content that may, or may not, have been expressed during the workshops conducted with co-researchers. Secondly, it was used to assess the overall satisfaction of respondents and evaluate whether *Efuta Letu Sida Hurib* provided information that aided respondents to appreciate and learn more about the ocean, its benefits and the ocean representations shared. Thirdly, it determined if respondents were familiar with the language and terminologies used on *Efuta Letu Sida Hurib*.

Questions 1, 2, 5 and 10 investigated the role of digital technologies in representing and preserving knowledge and cultural heritage. These questions asked respondents to validate whether *Efuta Letu Sida Hurib* or other technologies are good heritage preservation platforms. These questions are unpacked by the following sub-question:

- Is AR—or technology in general—capable of preserving knowledge and cultural heritage?

Questions 3 and 5 investigated respondents' connection with the ocean content on *Efuta Letu Sida Hurib* and explored the photorealism of 3D models and whether they authentically represented ocean heritage. These questions were unpacked by the following sub-questions:

- Which particular 3D models are favoured more than others and why?
- Do the respondents recognise the 3D model depictions on *Efuta Letu Sida Hurib* as representations of ocean heritage?

Questions 7, 8 and 9 investigated the values that respondents placed on the ocean, as well as individual ocean relationships. These questions were unpacked by the following sub-questions:

- How is the ocean acknowledged, recognised, understood, valued, and appreciated by different people?
- To what extent do the majority of respondents relate and agree with the ocean heritage shared on *Efuta Letu Sida Hurib*?

The questionnaire was voluntarily and anonymously completed by a total of 42 respondents (see Table 7.1), including 34 women and 8 men. The respondents were aged 18-62, with an average age of 28 years. These figures are reflective of the broader demographics of Namibia, which, like many other African countries, has a majority female (Moodley et al., 2019) and predominantly youth population (African Development Bank, 2012; Camilla Rocca and Ines Schultes, 2020).

Town	Respondents
Swakopmund	22
Walvis Bay	20

Table 7.2: Number of respondents who completed the questionnaire by town.

7.3. Questionnaire Questions and Responses

7.3.1. Likert Scale Table Questions

The questionnaire was prepared in English with three yes-or-no questions and seven open-ended questions related to digital technologies, *Efuta Letu Sida Hurib*, ocean knowledge and heritage. It also comprised 5-point psychometric Likert scale (Joshi et al., 2015) close-ended questions. A 5-point scale enabled respondents to answer questions by selecting a suitable choice ranging between 'strongly agree' to 'strongly disagree':

1 – strongly agree

2 – agree

3 – neutral

4 – disagree

5 – strongly disagree

The Likert scale questions focused on the interface and usability of *Efuta Letu Sida Huribs* and gathered feedback from respondents. The questions evaluated the application's performance, user experience, ease of navigation, appreciation of the information included, and design consistency.

One Likert scale question asked about the clarity of the text, gathering suggestions about the font used and determining if respondents found the text size too small, too large, difficult to read, or overly complicated. These attitude and usability testing questions enabled the author to analyse respondents' levels of engagement with *Efuta Letu Sida Hurib* in relation to terminologies while also gathering inputs on how to improve ease of use and user satisfaction. The majority of respondents enjoyed interacting with the application, as evidenced by high rates of 'strongly agree' and 'agree' on the Likert scale. The tables below highlight the Likert scale responses:

Question Statement	Response Scale	No. of responses
I enjoyed using this application	Strongly Agree	27
	Agree	8
	Neutral	3
	Disagree	1
	Strongly Disagree	0

Table 7.3: Responses to whether respondents enjoyed using *Efuta Letu Sida Hurib*.

The majority of respondents were satisfied with their overall experience of *Efuta Letu Sida Hurib*. The first question, which asked whether respondents enjoyed using *Efuta Letu Sida Hurib*, received the highest score, with 27 'strongly agree' responses:

> *"It was a really good experience and I gained a lot of knowledge on the ocean"* (Walvis Bay resident, Female, 19 years of age (YoA))

> *"...All I can say is I love the app…"* (Swakopmund resident, Female, 21 YoA)

"I think the app is a great idea and I'm so proud that young people participated in this amazing project." (Walvis Bay resident, Male, 19 YoA)

This question received 3 'neutral' responses and 1 'disagree' response, indicating that, while most respondents enjoyed using *Efuta Letu Sida Hurib*, a small percentage of others did not. It is unclear why 3 respondents were neutral, while 1 did not enjoy using the application, as no further comments were offered by these individuals. However, the question statements and responses below provide an overview of reasons why some respondents were dissatisfied with the application.

Question Statement	Response Scale	No. of responses
The application was easy to navigate	Strongly Agree	18
	Agree	12
	Neutral	8
	Disagree	1
	Strongly Disagree	0

Table 7.4: Responses to *Efuta Letu Sida Huribs* navigation.

Question Statement	Response Scale	No. of responses
I felt confident using the application	Strongly Agree	14
	Agree	19
	Neutral	2
	Disagree	1
	Strongly Disagree	0

Table 7.5: Responses to whether respondents felt confident using *Efuta Letu Sida Hurib*.

The questions about ease of navigation, difficulty of use and confidence received positive responses, with the majority of respondents indicating that the application was easy to navigate. However, eight responses were neutral and one indicated that *Efuta Letu Sida Hurib* was difficult to navigate. Respondents who experienced difficulties with navigation were provided

with extra instructions to facilitate independent use. Respondents with prior technical and AR experience independently navigated *Efuta Letu Sida Hurib* without assistance.

The application also incorporated text and audio explanations that served as an additional guide for respondents and explained the 3D model's value and significance shared by co-researchers, encouraging respondents to analyse the 3D models beyond their visual appearance (see Figure 7.3).

For example, Morangie wanted to communicate a message about his ancestors, history, the ocean and how the !Nara plant has benefited the Topnaar ǂAonin people for centuries (see Section 4.1.2). On the other hand, Ousitjie shared knowledge about the various benefits and ways people can use ocean resources (see Section 5.1.1). The information contributed by co-researchers expressed deep connections with the ocean and addressed the significance and role of the ocean in their lives.

The text and audio descriptions included several key components:

- The name of the 3D model.
- The name of the co-researcher who presented it.
- A brief explanation of the 3D model, including what the model is.
- What the 3D model represents for co-researchers and its ocean significance.
- What the 3D model (the physical representation of the model) could be used for.

Figure 7.3 below demonstrates an example of a 3D model and its accompanying description.

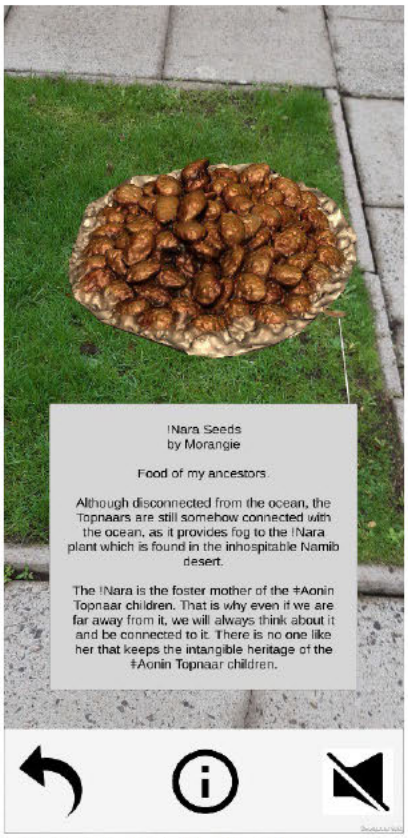


Figure 7.3: Example of text explanations detailing the significance of an ocean representation. Screenshot: Marly Muudeni Samuel, 2022.

Consequently, the following question sought to gather feedback regarding the text used in the application.

Question Statement	Response Scale	No of responses
The text is clearly written and easy to read	Strongly Agree	23
	Agree	10
	Neutral	6
	Disagree	1
	Strongly Disagree	0

Table 7.6: Responses to the clarity of text on *Efuta Letu Sida Hurib*.

The majority of respondents found the text clear and easy to read, although some expressed concerns regarding text clarity, stating that the text was too small to read. Recommendations were made to increase the text size, particularly the 3D model descriptions on the AR page:

"Make the text clearly written and easy to see and read. Make the text bigger." (Swakopmund resident, Female, 18 YoA)

"The text should be short and the font size should increase." (Walvis Bay resident, Female, 19 YoA)

Respondents engaged in a discussion about the length of the 3D model's text descriptions. While some argued that the text length was too long to read:

"*I think the descriptions should be short and not so long because some people won't want to read all of that text*" (Walvis Bay resident, Female, 20 YoA),

Other respondents contended that it was sufficient and effectively explained the significance and relevance of the 3D models:

"For me, the descriptions were fine; I liked it like that. I enjoyed reading the descriptions." (Walvis Bay resident, Female, 19 YoA)

Question Statement	Response Scale	No. of responses
The photographs and ocean representations helped me appreciate ocean knowledge	Strongly Agree	23
	Agree	9
	Neutral	5
	Disagree	1
	Strongly Disagree	0

Table 7.7: Responses to whether *Efuta Letu Sida Hurib* helps with ocean appreciation.

Efuta Letu Sida Hurib fostered a sense of ocean appreciation for the majority of respondents, with some indicating that it would do the same for other people:

"I think the app is a way for people to appreciate the ocean more. If they look at the importance of the ocean for many, what comes out of it and how it benefits people, I think they will pollute it less and they will help to take care of it." (Walvis bay resident, Female, 19 YoA)

"A lot of people live near the ocean but do not know what benefits they can get from it. So, it's important that the knowledge can be shared." (Walvis Bay resident, Male, 18 YoA)

Respondents shared concerns about ocean pollution challenges and how they negatively impact the ocean (see Section 7.3.5 for more ocean pollution contributions), expressing that increased awareness of the ocean and its benefits through applications such as *Efuta Letu Sida Hurib* can encourage people to take better care of the ocean.

Question Statement	Response Scale	No. of responses
I would recommend or tell someone about this application	Strongly Agree	21
	Agree	15
	Neutral	3
	Disagree	0
	Strongly Disagree	0

Table 7.8: Responses to whether respondents would be willing to recommend *Efuta Letu Sida Hurib*.

The question asking whether respondents would recommend *Efuta Letu Sida Hurib* to other people received 21 'strongly agree' and 14 'agree' responses, demonstrating that respondents were willing to inform other people about the application. The question received 3 'neutral' responses and did not receive any 'disagree' responses, indicating that *Efuta Letu Sida Hurib* was well received and respondents did not have any reason not to share it. This illustrates people's motivation to share information they believe may benefit other people (for example, see Section 4.1.1 for a discussion about how seashell collectors collaborate).

Question Statement	Response Scale	No. of responses
I would like to have access to this application on my phone	Strongly Agree	21
	Agree	12
	Neutral	3
	Disagree	2
	Strongly Disagree	1

Table 7.9: Responses to whether respondents would like to have *Efuta Letu Sida Hurib* on their phones.

The majority of respondents were willing to have access to the application on their phones. Three respondents remained neutral on this matter, while three preferred not to have access.

Respondents did not provide reasons why they preferred not to have access to it. This demonstrates that while digital technologies are accepted by many, some people still prefer not to have access to or use them.

One respondent particularly expressed her interest in being able to access *Efuta Letu Sida Hurib* on her mobile phone. However, following a discussion with the author, she discovered that her mobile phone did not support the application (see Section 6.3.3 for requirement specifications needed to run AR on Android mobile devices):

> *"What can I do to have the app on my phone? The app is running fine on my phone, but the augmented reality part of the app is not working. I wanted to show it to people at home..., but that part is not working. It gives that error saying that the function is not supported..."* (Swakopmund resident, Female, 55 YoA, AT)

She was disappointed that her phone was not compatible with *Efuta Letu Sida Hurib*, as she eagerly wanted to share it with her children and friends. This response reinforces the technological challenges and digital infrastructure divide that certain communities still face, excluding people from accessing and experiencing the full potential of digital technologies (as discussed in Sections 2.3.1 and 8.4).

Question Statement	Response Scale	No. of responses
In the future, I see myself contributing knowledge to be shared through a similar application	Strongly Agree	25
	Agree	8
	Neutral	2
	Disagree	1
	Strongly Disagree	2

Table 7.10: Responses to whether respondents would be willing to contribute their knowledge to be included on a similar application.

Interest in contributing to similar digital applications was demonstrated. Respondents suggested that an add button be added to *Efuta Letu Sida Hurib* to enable people to contribute their views (discussion further down in this section):

"It could be important to have a button that allows viewers or users to input their thoughts and also journal through the application." (Walvis Bay resident, Female, 19 YoA)

Two respondents remained neutral, while three preferred not to contribute. Respondents did not provide reasons why they preferred not to contribute.

Question Statement	Response Scale	No. of responses
This application/ technology is a good way of capturing and sharing ocean knowledge and culture	Strongly Agree	25
	Agree	7
	Neutral	2
	Disagree	1
	Strongly Disagree	0

Table 7.11: Responses to whether *Efuta Letu Sida Hurib* is a good way of sharing ocean knowledge and culture.

When respondents were asked if technology or the use of *Efuta Letu Sida Hurib* was an effective way of recording, sharing, and preserving ocean knowledge and culture, the majority of respondents 'strongly agreed':

"It is important because it would be a great teaching tool for the upcoming generations. It can also help in ways to preserve the ocean." (Swakopmund resident, Female, 42 YoA)

"I think it is a great way to introduce people to cultures that they are not aware of." (Swakopmund resident, Female, 28 YoA)

"If I have to talk in terms of the Damara/Nama people, our culture is getting extinct. Like it's dying out. So, it is good to document these things and show the world for them to experience and to see that a tribe like this exist and they do this and that as part of their culture." (Walvis Bay resident, Female, 20 YoA)

Respondents emphasised that technology is a valuable tool for teaching, recording, and preserving knowledge and cultural practices for continuity of use, particularly in an era where traditions and practices are declining (see Sections 1.1 and 2.1.1). Respondents expressed that through technology, people will be able to access and learn about various knowledge and

cultural practices. Two respondents remained 'neutral' on the use of technology, while one respondent 'disagreed' with digitally documenting knowledge and cultural practices.

Question Statement	Response Scale	No. of responses
I thought the application design was consistent throughout	Strongly Agree	12
	Agree	13
	Neutral	13
	Disagree	0
	Strongly Disagree	0

Table 7.12: Responses to whether *Efuta Letu Sida Huribs* interface design was consistent.

The question about interface design consistency received 12 'strongly agree' and 13 'agree' responses. Indicating that the majority of respondents were happy with the application interface design. 13 respondents remained 'neutral' on the matter, indicating that some respondents did not have a strong opinion about the design consistency. This question did not receive any 'disagree' response, indicating an overall positive response to the interface design.

Question Statement	Response Scale	No. of responses
The ocean is important to me	Strongly Agree	23
	Agree	10
	Neutral	1
	Disagree	1
	Strongly Disagree	2

Table 7.13: Responses to whether the ocean is important to respondents.

When asked about whether the ocean is important, the majority of respondents 'strongly agreed' stating that it is a space and place where they go to clear thoughts, relax and be calm:

> *"I like the sound of the waves and the seagulls and the animals that are in the ocean. The ocean is an open area where I can sit with my thought and think clearly."* (Walvis Bay resident, Female, 19 YoA)

"*The ocean is a place/symbol of calmness and tranquillity for me.*" (Walvis Bay resident, Female, 24 YoA)

These responses are similar to those shared by co-researchers in Section 4.2. On this matter, one respondent remained 'neutral', while three indicated that the ocean was not important to them.

Question Statement	Response Scale	No. of responses
I want to learn more about augmented reality and immersive technologies	Strongly Agree	15
	Agree	12
	Neutral	6
	Disagree	0
	Strongly Disagree	1

Table 7.14: Responses to whether respondents would like to learn more about AR.

The final question asked if respondents were interested in acquiring more knowledge about AR and immersive technologies. Most respondents 'agreed', while six respondents remained 'neutral'. One respondent 'strongly disagreed' and a reason was not provided. Once again, these responses indicate that people have different views about technology and not everyone is inclined towards it.

7.3.2. Yes or No Questions

The following question asked respondents if it was their first time experiencing AR. The purpose of this question was to determine if respondents were familiar with AR or immersive technologies.

Is this the first time I am using an immersive technology or augmented reality application?	No. of responses
Yes	31
No	7

Table 7.15: Responses to whether this was the first time respondents used AR.

During this discussion (see Figure 7.4), the majority of respondents were first-time users of AR or immersive technologies, while seven respondents indicated having previous experience.

Other respondents mentioned that although it was their first time using an AR application, they had read about or encountered it on TV or the internet. One respondent mentioned that they learned about AR through an oral exam they had at school.

Figure 7.4: Respondents engaging in a group discussion. Photograph: Gert Tjiondo, 2023.

When asked about potential improvements for *Efuta Letu Sida Hurib*, respondents provided insightful suggestions, addressing features such as the texture of the 3D objects, the objects that were presented as images rather than 3D models, including more ocean content, the volume of the audios and readability of the texts:

> *"Increase the number of facts* [the did you know]. *Use fewer pictures and videos… Also, make the quality of the 3D depiction better."* (Walvis Bay resident, Female, 20 YoA)

> *"The colour of the 3D !Nara seeds, does not look very realistic. Maybe there is a way for you to change the colour so it does not look so gold."* (Walvis Bay resident, Female, 19 YoA)

> *"More realistic 3D modelling would be appreciated and more engaging."* (Swakopmund resident, Female, 27 YoA)

Based on these responses, the author further explored the reason why respondents disapproved of some 3D models. Respondents shared that the photorealism and visual quality of the 3D models were not satisfactory, leading to a perceived lack of authenticity. Respondents further noted that regardless of how visually appealing or functional an application is, if its content is not meaningful to users, the application will not be engaging. Indicating that appearance and photorealism are important and play a role in how people connect or engage with digital products. McKay (2013, p. 131) also argues that people react emotionally to the visual appearance of a product and that a *"product should look the part—it should look like it fulfils its purpose well. But if instead your product's visual appearance is of questionable quality, users will naturally assume that the rest of the product has the same level of quality"*. This argument fits with the photorealism feedback provided about some 3D models (realism and authenticity discussed in Sections 2.4.2 and 8.5).

For example, while respondents appreciated the inclusion of the !Nara seeds, some disapproved of the colour, expressing that it appeared too bright and golden. In contrast, other respondents indicated that even though the visual appearance of some 3D models was not photorealistic, they still represented the value and significance of the actual objects being represented (this viewpoint is discussed in Section 7.3.4). A small percentage of respondents objected to the use of photographs 3D model presentations (see Figure 7.5), suggesting that they preferred all objects to have been modelled in 3D. One respondent indicated that she was already familiar with and used to photographs and liked the 3D models because they were unique to her. The author explained why some objects were not modelled in 3D (see Section 5.1.1 outlining why some objects were not modelled in 3D) while also noting that some co-researchers preferred to present their ocean objects as images rather than 3D models.

Figure 7.5: Ocean heritage representation 3D model displayed as a photograph. Screenshot: Marly Muudeni Samuel, 2023.

Some respondents expressed that the audio volume was very low and suggested it be increased. One respondent (see Figure 7.6) pointed out that to clearly listen to the audio explanations, she would have to use earphones, which she considered an inconvenience as she preferred to listen without earphones.

Figure 7.6: Respondent engaging with *Efuta Letu Sida Hurib*. Photograph: Kuundjuaune Kaavari, 2023.

Respondents recommended that more engaging information and educational content be added to the application to make it more multipurpose:

> *"Include quizzes so that the app can be more educative and engaging."* (Swakopmund resident, Male, 38 YoA)
>
> *"We should be shown how the ocean looks on the inside and the fish as well."* (Walvis Bay resident, Female, 20 YoA)
>
> *"Add more information about the fish found in the ocean and different ocean resources."* (Swakopmund resident, Female, 55 YoA)

Respondents believed that this approach would encourage continued usage of *Efuta Letu Sida Hurib* and would prompt parents to recommend it to their children. These responses indicate that respondents recognise the importance of ocean education and further highlight the existing gap in ocean education at a national level. Respondents mentioned the scarcity of ocean educational materials, particularly for learners from inland towns who may have limited exposure to the ocean and can only learn about it through second or third-hand sources such as books, pictures, videos or television. One co-researcher, who is a teacher, reiterated the need for more and improved ocean education methods of teaching, saying, *"I will really want to*

have something like this in class so that I can teach my students more about the ocean and about technology.". One respondent further added that some learners, especially those from informal and marginalised communities residing in coastal towns, have spent their entire lives without ever visiting the ocean and inquired why schools do not organise excursions for school learners. Another co-researcher, who is a teacher, addressed this inquiry and explained that schools often lack the necessary funds to organise excursions for learners. The respondent proposed that if both learner households and schools have limited resources and there is an interest in learning about the ocean, why not bridge the gap by digitally bringing the ocean to different communities using applications like *Efuta Letu Sida Hurib*? This response supports the primary research question, indicating that AR can support coastal communities in surfacing and recording ocean heritage for posterity while also serving as an educational and knowledge sharing tool. (For further information on AR and VR in Education see Pantelidis et al., 2018; Godoy Jr., 2020; Jumani et al., 2022).

Respondents recommended the inclusion of an 'add' button on certain pages of the application to enable other users to contribute ocean information, poems, journals, or love letters*:*

> *"add a section for the users to able to add fun facts or their own love letters to the app."* (Walvis Bay resident, Female, 18 YoA).

One respondent specifically expressed an interest in sharing her ocean heritage by converting her own object/material ocean representation into a 3D and integrating it on *Efuta Letu Sida Hurib*. This viewpoint indicates that some respondents wished to have a participatory role in *Efuta Letu Sida Hurib*. These suggestions demonstrated that the *Efuta Letu Sida Hurib* and the 3D model representation contributions were meaningful to respondents.

An add option was, however, not included on *Efuta Letu Sida Hurib* for this research because it presented technical challenges related to data validation. In contrast to some digital applications that have user-generated input functions (for example, Wikipedia), incorporating an 'add' function on *Efuta Letu Sida Hurib* would require an active administrator to fact-check and continuously monitor information being added to prevent the inclusion of unreliable, misleading, and inaccurate information. Therefore, at this point, this research did not implement an 'add' button function. This suggestion will be explored for future work. Co-researchers also suggested that an online platform, extending the capabilities of *Efuta Letu Sida Hurib* be developed to enable users to add and share information and engage in discussions about intricate ocean heritage and other ocean information.

The following Yes or No inquiry on the questionnaire asked respondents if they owned or had access to smart mobile phones. This question determined the number of respondents who had access to smart digital devices, given that AR and immersive technologies are exclusively compatible with smart digital devices. Their responses are highlighted below:

Do you own or have access to a smart mobile phone?	**No. of responses**
Yes	28
No	12

Table 7.16: Responses to whether respondents have access to digital devices.

The majority of respondents indicated that they have access to smart mobile phones. However, when asked about the specific type of mobile phones they owned, it became apparent that the majority of their digital devices were incompatible with ARcore (see Section 6.3.3). Some mobile devices could install *Efuta Letu Sida Hurib*. However, people would only be able to interact with other pages on the application but would not be able to access the AR page. The restricted compatibility of AR and immersive technologies on some digital devices highlights how current digital inequalities exclude some populations (from the Global South) from accessing and engaging with certain digital technologies. Most of these technologies are developed in the Global North and are primarily accessible on high-end, expensive mobile devices, which are financially unattainable for some individuals in the Global North. Communities in the Global North grapple with socio-economic challenges, including unemployment, low literacy, inadequate education, and food and housing insecurities (Centers for Disease Control and Prevention, 2023), which are leading factors as to why people in the Global South cannot afford certain devices. These challenges further expand the digital divide and limit access to information and digital infrastructure (see Section 2.3.1 and 8.5 for a discussion about the digital divide).

Similarly, 75% of co-researchers had access to digital devices. However, 60% of these devices were not compatible with ARCore, which excluded them from accessing *Efuta Letu Sida Hurib*. In this regard, the author poses the question of why system specifications required for running AR and immersive technologies are mostly compatible with high-end and not low-end digital devices. What more can be done to ascertain inclusive system specification compatibility for most digital devices, especially for people in the Global South? For AR and

immersive digital inclusion to be possible, companies responsible for developing immersive digital application device requirements and specifications have to engage in collaborative efforts with communities from both the Global North and South when developing applications. This will enable these companies to understand different contexts and provide inclusive requirements and systems specifications that function for both contexts or create requirements and systems specifications that can be adapted depending on context.

7.3.3. Questions About Visual Representation of 3D Model

Question: Which 3D model did you like and which one did you not like?

The next question asked respondents to choose one or more 3D model representations that they liked. The purpose of this question was to explore and analyse if respondents had any preferences among the 3D model representations.

Question	Ocean representations liked most.	No. of responses
Is there one or more ocean knowledge and culture representations that your particularly like? Please select your choice/choices?	!Nara Seeds representation	10
	Fish Tank representation	6
	The Ocean and I representation	3
	Seashell representation	7
	Aawambo Heritage representation	7
	Genesis: !Nara Roots representation	4
	Driftwood Art representation	6
	Seaweed Representation	3
	Oyster representation	3
	Venturesome Radicle Driftwood representation	2
	Seagull Feather representation	2
	Sea sand representation	3
	Ocean waves	7

Table 7.17: Responses to which 3D ocean representation respondents liked most.

All 3D model representations were favoured by at least one respondent. The !Nara seeds representation received the highest number of likes, followed by Aawambo heritage, Sea sand, and Ocean waves representations, which received the second-highest likes. Several respondents expressed that the reason they liked the !Nara seeds, roots and seaweed representations because of their diverse uses, including medicinal, nutritional, and wellbeing benefits. However, commentary was not provided on whether their preferences were linked to the 3D models or the actual objects represented by the 3D models:

> *"!Nara seeds: The participant clearly outlined how the seeds through the plant are connected to the ocean through the fog."* (Walvis Bay resident, Female, 18 YoA)
>
> *"!Nara seeds: they are edible and are very delicious and healthy to eat. It also helps with stress."* (Swakopmund resident, Female, 49 YoA)
>
> *"!Nara seeds: because !Nara seeds are also used as a medication for people that are sick."* (Walvis Bay resident, Female, 18 YoA)
>
> *"!Nara seed and roots: because it promotes my culture. My elders used these elements for their living and they made medicine and other stuff out of them."* (Walvis Bay resident, Male, 19 YoA)
>
> *"Seaweed: we use seaweed as a remedy if someone is having a wound so we use it to make the wound get better."* (Swakopmund resident, Female, 27 YoA)

A recurring topic during the discussion was ways in which the !Nara plant is utilised for medicinal purposes. Some respondents mentioned that their grandparents and elders continue to use it to this day. One respondent elaborated on how her grandmother still uses !Nara *!oma* (the roots of the !Nara plant) as a medicinal remedy, stating, "*When my grandmother or one of us is sick, she uses the !Nara !oma as medicine.*". She further expressed an interest to learn more about the !Nara plant's uses and emphasised the importance of documenting this knowledge. These responses indicate that the !Nara plant holds significant value and importance in the lives of several coastal community members as it serves as both a source of food and medicine, reflecting the contribution provided by co-researchers. Another respondent discussed the benefits of seaweed, which her elders use as a medicinal remedy for wounds. The majority of respondents were happy with the incorporation of Indigenous knowledge, particularly that of the !Nara seeds and roots and the Aawambo heritage representation, stating

that *Efuta Letu Sida Hurib* provides an opportunity for individuals who do not know about them to visually explore and gain an understanding of their significance and uses.

Multiple respondents expressed how the Aawambo Ocean heritage representations effectively conveyed the importance of culture and tradition, highlighting the fundamental role played by the ocean concerning these cultural beliefs and practices:

> *"Aawambo heritage: It helped me realise how important it is to know more about my tradition and how things were done differently before."* (Walvis Bay resident, Female, 19 YoA)

> *"Aawambo heritage: I liked the Aawambo one because I really learned a lot about the culture and how they make the beads. It was educative."* (Swakopmund resident, Female, 55 YoA)

> *"Aawambo heritage: How a community not so close to the ocean links itself and its culture to the ocean is amazing. It shows that no matter how far you are or live, one is connected to the ocean in many ways."* (Walvis Bay resident, Female, 19 YoA)

> *"Onyoka necklace representation: It is amazing to see what type of jewellery can be made from shells."* (Walvis Bay resident, Female, 19 YoA)

Some respondents commented that they were previously unaware that Aawambo traditional jewellery were made with oysters and seashells, emphasising *Efuta Letu Sida Hurib's* role in facilitating cross-cultural learning. One respondent expressed that having a relationship with the ocean does not require people to reside in close proximity to it. She further added that environmental connections can be forged in different ways, just like the Aawambo people, who mostly reside in the northern part of Namibia (see Figure 4.15). Despite their geographical distance from the ocean, they maintain intricate relationships with the ocean through the practice of collecting mussels and seashells to create traditional jewellery like the *onyoka*. These jewellery are important to cultural practices and express pride in the Aawambo cultural heritage, which in turn contributes to individual and cultural identity.

In addition to discussions about food, medicinal and cultural ocean representations, respondents also liked the ocean waves presentation, stating that the ocean is a source of happiness, comfort, peace, and tranquillity (see Figure 7.7). These emotions were attributed to the calming sound of ocean waves and the resources found in the ocean:

"Ocean waves: ocean waves make me relax whenever I go sit by the ocean." (Swakopmund resident, Female, 21 YoA)

"The ocean waves: It always calms my anxiety." (Walvis Bay resident, Female, 19 YoA)

"Ocean waves rep: Because the sound of the waves makes me feel comforted." (Swakopmund resident, Female, 18 YoA)

"Fish tank, the ocean and I, and ocean waves: because it represents the beautiful ocean." (Swakopmund resident, Female, 21 YoA)

"Fish tank: I am fascinated by the different types of fish we have." (Walvis Bay resident, Female, 20 YoA)

The portrayal of the ocean as a place that triggers feelings of comfort, tranquillity, peace, and wellbeing documented by numerous scholars (Nichols, 2014; Allison et al., 2020; White et al., 2020; Olive and Wheaton, 2021) was reaffirmed through co-researchers and respondent's contributions.

Figure 7.7: Person taking a stroll along the beach. Photograph: Tangi Hangula, 2022.

Severin et al. (2022) conducted a research project investigating "*Emotions Experienced at the Coast and Their Influence on Wellbeing"*. The project revealed that the sight and sound of the ocean raises different emotional responses in people, including feelings of calmness, sadness, fear, beauty, and relaxation. One respondent revealed that she struggles with anxiety and encountered challenges in finding a solution on how to manage it. However, the ocean has become a place that provides her with comfort, and she visits it regularly to clear her mind. These emotional experiences contribute to the belief that the ocean and other water bodies can provide peace, tranquillity and relaxation.

Respondents expressed satisfaction with the 3D models, noting how realistic some 3D models looked, which enabled them to better connect, experience and engage with them. Responses further revealed that 3D models were favoured because of existing knowledge about the ocean heritage they represented, their digital uniqueness, and the knowledge they conveyed:

> *"Seagull feather representation: It is interesting to read about the relationship between the ocean and the seagulls, and how their lives are similarly sustained by the ocean."* (Swakopmund resident, Male, 42 YoA)
>
> *"!Nara seeds, seashell, driftwood art, seaweed, oyster, sea sand representation: Because they enable me to explore the models extensively."* (Walvis Bay resident, Female, 19 YoA)
>
> *"Seashell representation: because it looked more real and the picture looks more beautiful."* (Walvis Bay resident, Female, 18 YoA)
>
> *"Fish tank, driftwood art and ocean waves: they seemed real and I liked how connected to the ocean I felt when I looked at them."* (Walvis Bay resident, Female, 24 YoA)
>
> *"Venturesome radicle driftwood: Because I learned more about it. Although I knew about it, I do not know what it is used for and this app taught me that."* (Walvis Bay resident, Male, 18 YoA)
>
> *"All of them: Because they represent our ocean heritage and gives us ownership."* (Swakopmund resident, Female, 48 YoA)

Other ocean representations were favoured because of the memories they triggered. One respondent liked the 'Sea Sand and Seashell' representation because it reminded her of how happy she becomes when walking on the beach and how she loves the feeling of the sand under

her feet and between her toes. Another respondent liked the Oyster representation because she loved eating oysters and seafood. These reasons demonstrate the diverse relationships people have with the ocean and how they are formed, answering research question two of this research (see Section 1.2).

Question: Which 3D model did you not like?

In contrast to the previous question, the next question asked respondents to choose one or more 3D ocean representations that they did not like. The purpose of this question was to explore and analyse why respondents disapproved of any 3D model representations:

Question	Ocean representations disliked most.	No. of responses
Is there one or more ocean knowledge and culture representations that you particularly dislike? Please select your choice/choices	!Nara Seeds representation	5
	Fish Tank representation	2
	The Ocean and I representation	0
	Seashell representation	0
	Aawambo Heritage representation	0
	Genesis: !Nara Roots representation	0
	Driftwood Art representation	1
	Seaweed Representation	2
	Oyster representation	1
	Venturesome Radicle Driftwood representation	1
	Seagull Feather representation	1
	Sea sand representation	0
	Ocean waves	1

Table 7.18: Responses to which 3D ocean representation respondents liked least.

A small percentage of respondents expressed that they disliked some 3D models because of individual perspectives and experiences and because some 3D models were not photorealistic.

An interesting observation is that the !Nara seed representation, which received the most likes among respondents, also received the highest number of dislikes. The dislikes were attributed to the fact that the colour texture of the !Nara 3D model did not authentically represent real !Nara seeds (see Figure 7.9). This particular concern was voiced earlier in the session when respondents were asked about potential improvements to *Efuta Letu Sida Hurib*, with some suggesting the colour texture of the seeds be changed to a more photorealistic colour. Apart from the !Nara seeds, some respondents also expressed dislike of the 'Fish Tank', 'Driftwood', 'Seaweed', 'Oyster', 'Seagull Feather', and 'Ocean Wave' 3D presentations:

> *"!Nara seeds: Because it is not showing the seeds in good quality."* (Walvis Bay resident, Female, 19 YoA)
>
> *"!Nara seeds: They did not look at all like the !Nara plant seeds."* (Walvis Bay resident, Female, 24 YoA)
>
> *"Fish tank and seagull feather: the fact that they only allow the participant the front view of the model and nothing more."* (Walvis Bay resident, Female, 20 YoA)
>
> *"Seaweed: I didn't like it because it came out looking nothing like actual seaweed."* (Walvis Bay resident, Female, 20 YoA)

One respondent shared that she disliked the 'Seaweed' representation because it also, did not resemble real seaweed. However, she indicated that she liked the seaweed description, as it demonstrated the diverse ways in which seaweed can be utilised.

The results indicate that the photorealism, visual appearance and colour textures of some 3D models did not accurately represent actual objects, which resulted in respondents criticising some 3D models. Respondents expressed that for the ocean representations to effectively represent their objects, they should appear more photorealistic, further reiterating McKay's (2013) argument on quality visual representations (see Section 7.3.2). On the other hand, there were respondents who were happy with the ocean representations, irrespective of how the 3D models appeared. When asked why the appearance of the 3D models did not matter, respondents explained that the value and symbolic representation of the actual objects emerged and were represented by the 3D models. These responses indicated that despite the criticism of the !Nara seeds 3D model, many respondents still favoured it because of its historical, traditional, and medicinal significance of the !Nara plant. This research adds that another reason why some respondents liked the 3D models could have been because it was the first

time they engaged with 3D models and were intrigued by them. Other respondents did not like certain 3D models because they were not clearly explained or because respondents did not like the actual objects they represented:

> *"Driftwood art: I do not really see its use."* (Swakopmund resident, Female, 18 YoA)
>
> *"The ocean waves: it is not so interesting."* (Walvis Bay resident, Female, 18 YoA)
>
> *"The driftwood: It was not so clear to me as to the origin of the driftwood and the connection."* (Walvis Bay resident, Female, 19 YoA)
>
> *"Oyster representation: I don't like oysters and I have never tried them."* (Swakopmund resident, Female, 21 YoA)

These criticisms are understandable because interests differ. For example, one respondent showed no interest in the video of the ocean waves, while other respondents liked it. Another respondent did not like the oyster representation because she generally does not like oysters. Another respondent expressed that some representations did not reflect real connections with the ocean, they were just normal human connections, indicating that ocean connections are viewed and defined differently by people. The perspectives on how much respondents learned and liked the ocean representations, their interest in adding individual ocean heritage, satisfaction with the knowledge shared and the overall idea and objectives of *Efuta Letu Sida Hurib* highlight the potential of AR to record and preserve ocean heritage. Respondents' contributions further highlighted the importance of digital photorealism. If a digital object does not realistically replicate the object it is representing, the digital object might not be meaningful or connect with people.

7.3.4. Questionnaire Open Ended Responses

Question: Why do you think it is important to capture and record ocean culture and knowledge?

This question concentrated on the preservation of knowledge and culture and asked respondents to share their perspectives on the importance of recording and preserving ocean knowledge and culture. The purpose of this question was to understand respondent's views on ocean heritage preservation. Despite different opinions, the majority of respondents shared that it was important to preserve knowledge and culture for posterity:

"To let us be aware of the importance of the ocean. This actually helps us to conserve our ocean and it also helps us keep our culture alive as our elders used to live from it." (Walvis Bay resident, Male, 19 YoA)

"There is a general perception that Namibians do not have a strong heritage with the ocean, but this research clearly demonstrates otherwise. It also helps with the preservation of knowledge and culture for future generations. It can also help with ocean conservation." (Swakopmund resident, Male, 38 YoA)

"For history purposes and the education of future generations." (Swakopmund resident, Female, 48 YoA)

"I think the new generation that is coming must see these things. Because what if these things and our culture do not exist or are not practiced anymore? At least they will have somewhere to go back to so that they can learn about it…." (Walvis Bay resident, Female, 19 YoA)

Most respondents acknowledged that there is a decline in awareness, learning, and connections to cultural customs and traditions and emphasised the need to preserve them. Respondents further added that through preservation efforts future descendants can learn about these diverse ocean heritages included on the application to understand their heritage, their ancestors and the different practices they engaged in. Respondents also discussed the importance of ocean conservation, emphasising that just like there is a need to preserve knowledge and culture, there is an imperative need to preserve the ocean for future generations (see Section 4.5 for a discussion on ocean conservation):

"It is very important because it will teach people about the ocean. Most people do not know how the ocean looks or works. Some people do not even know what a seashell looks like." (Walvis Bay resident, Female, 18 YoA)

"Because it enables those that are unable to visit the ocean physically to have a more personal relationship with the ocean." (Walvis Bay resident, Female, 20 YoA)

"So as to be able to show and share the knowledge with those that do not have access to the ocean." (Walvis Bay resident, Female, 19 YoA)

"It is particularly important to me because I can share it with people that have not been to the coast before." (Walvis Bay resident, Female, 19 YoA)

In addition to cultural preservation and ocean conservation, respondents discussed the importance of knowledge documentation and sharing to facilitate information access for people without direct access to the ocean to learn more about it, the different ways of utilising ocean resources and protecting and conserving the ocean. These responses indicate that for respondents, platforms like *Efuta Letu Sida Hurib* can bridge the information access gap. While information is widely available in books and on the internet, these infrastructures and platforms are not accessible to everyone. How, then, can information be shared and made available to more people? In response, one respondent shared that technology can be used to encourage information accessibility. He further expressed that, having worked in the marine field for years, he often gives talks about the ocean in different Namibian towns, using papers and flyers to explain the importance of the ocean. He added that access to platforms like *Efuta Letu Sida Hurib* would enable ocean educators to demonstrate the application at events and excursions, enabling people to experience the ocean from a different perspective and learn from diverse Indigenous and experiential knowledge shared on the application. The respondent went on to say that Ministries and institutions can invest in technologies like this and bring them to rural areas during events and excursions for learners and people without access to digital devices to experience and learn about the ocean through the lens of technology.

Respondents also discussed challenges faced by coastal towns regarding ocean pollution, with one respondent expressing the massive impact of beach littering, especially during festive events:

> *"The only importance I see of the ocean is the pretty views and its cold breeze. But when people from other towns come for New Year's Eve or Christmas celebrations, they live it in such a condition that you can't even bear to stand it, which is a big shame. That we live in such a community where people don't look after their own ocean. After these festivities, you won't even want to look at the ocean."* (Walvis Bay resident, Female, 19 YoA)

Respondents shared that disseminating information about the importance of the ocean through applications like *Efuta Letu Sida Hurib* will increase ocean awareness, encouraging people to protect it, starting with actions such as not littering or cleaning up after events. Respondents further stated that access to ocean heritage, such as the 'Ocean Waves' representation, can enable people who have no ocean connections to develop relationships with the ocean.

Question: Do you know of any other application or medium used to capture or share information or knowledge?

A majority of respondents were familiar with such applications and mentioned social media platforms like WhatsApp and Facebook. Other respondents obtained information through events such as community meetings, workshops and training seminars. One respondent shared how, during these events, people from different coastal communities come together to learn, exchange ideas, discuss common challenges, and discover collaborative solutions to those challenges. These events additionally serve as a space for people, particularly women from the community, to acquire inspiration and skills to create art (see Figure 7.8), which is sold for profit. Another respondent shared that he obtains ocean knowledge from radio and television channels such as the National Geographic Channel. These responses demonstrate how, within coastal communities, ocean information and knowledge are shared and acquired through different platforms, including digital platforms. Still, this research recognises these platforms in themselves present accessibility challenges; for example, not everyone has access to radio, television, books and digital technologies or can attend workshops and seminars. Thus, the collective use of all these platforms, including technology, can promote inclusive ocean heritage sharing and access for different individuals and contexts. The application can thus be used to enhance workshops and seminars.

Figure 7.8: Different types of arts and crafts created by Dantago Womens Group. Photograph: Marly Muudeni Samuel, 2023.

Question: How would you describe your relationship with the ocean?

The next question gathered information about respondents' relationships with the ocean and respondents shared the following:

> *"Well having grown up inland, I was always intrigued by the photos of my childhood where I was on the beach with my mom and now while I am residing at the coast, I feel, the coast predestined me to be here before I could even spell the word ocean. There is just that connection with the ocean, I can't put it into words."* (Swakopmund resident, Male, 42 YoA)

> *"Awe-inspiring and uplifting. I am a marine biologist and the ocean has been a source of inspiration, a place where I relax and a place of complex life forms that evolve over millennia. The ocean allows me to reflect deeply on life itself, for example, spiritual connections. It provides me with healthy food and I appreciate the ecosystem service it provides."* (Swakopmund resident, Male, 38 YoA)

> *"I suffer from anxiety. So, when I go to the ocean and I go there very often it is so that I can calm down. And it's very calming for me, it helps very much. I would say the ocean is my therapist. I go there to journal and speak to it."* (Walvis Bay resident, Female, 19 YoA)

Similar to contributions from co-researchers, respondents shared diverse and intricate relationships with the ocean, with emotional relationships being primary connections (see Figure 7.9). For respondents, the ocean symbolised tranquillity and emotional solace, with one respondent describing it as her 'therapist'. A place and space where she feels heard, understood and finds support for her anxiety. For most people, the ocean is a place where they can forget all their worries, where they can laugh, cry, or even scream, as expressed below:

> *"You know, if you are a person that often goes to the lagoon* [beachfront in Walvis Bay]*, you'll see interesting things. You will find people having notebooks, and boxes, burning stuff, throwing them into the ocean and so on. I saw someone doing yoga the other day, but the one thing I saw that stunned me was a girl that was burning notes and books and stuff. I do not know what she wrote in the books, but I think it had to do with things that happened in her life. She was writing and throwing the pages into a*

box with fire while crying. And I think there is a reason she chose the ocean to do that. It was quite emotional." (Walvis Bay resident, Female, 18 YoA)

Figure 7.9: Spirited Seagulls. Photograph: Jonathan Paulus, 2018.

The ocean as a place of peace and calmness is further elaborated by Bell (2016) in his review of 'Blue Mind', a book by Wallace Nicholas (2014). Bells (2016) argues that the human brain is designed to respond positively when we are in, on, or near water. He further articulates that Nicholas takes this 'Blue Mind' notion further and suggests that *"the meditative state characterised by the calm and peacefulness "blue mind" provides not only a sense of general happiness and satisfaction with life but can also be therapeutic."* (Bell, 2016, p. 1). Nichols (2014) further highlights that water provides a sense of drift, which is the opposite of our present state of repetitive pressures and work. This research's findings support this claim and add that the presence of the ocean serves as a safe space and has the potential to calm human emotions, enabling individuals to psychologically escape to a positive place. As one respondent expressed, "*It makes me feel happy and it made me feel like I am in another world"*. This research does not claim that the ocean is universally a safe space for all; however, the findings suggest that, for many, the ocean is a safe space that provides solace. The ocean, through its beaches, additionally serves as a gathering place with some respondents expressing that they organise different engagement events and gatherings at the beach:

"I went to the beach the other day and the wind was blowing beautifully and it calmed me and made me feel good. I am also going to the ocean tomorrow. A group of elders invited each other to go to the ocean and talk and spend time together." (Swakopmund resident, Female, 55 YoA)

"To be honest, it is my safe place. I love how the waves hit the shores, the sound constantly reminds me that everything will be all right." (Walvis Bay resident, Female, 20 YoA)

"My relationship with the ocean is very strong as not only does it calm me down but it also lets me have a clear mind. A place where I can go to vent and release all of my emotions." (Walvis Bay resident, Female, 20 YoA)

In contrast to the responses mentioned above, some respondents expressed that, despite residing in coastal towns, they do not have any relationships with the ocean. For these respondents, the ocean is viewed as water only and does not hold any personal connections:

"I do not have any relationship with the ocean but I think it has a lot to offer." (Walvis Bay resident, Female, 19 YoA)

"My relationship with the ocean is not that great because I am having a phobia of the sea and rain. I'd really like to get over it." (Walvis Bay resident, Female, 18 YoA)

"I am not a good friend of the sea, I don't really like it and I don't have a relationship with it." (Walvis Bay resident, Female, 18 YoA)

"I am not really into the ocean, I only go there with family and friends." (Walvis Bay resident, Female, 19 YoA)

One respondent expressed that despite not having a relationship with the ocean, "*I feel comforted and happy when I am around it*". These contributions indicate that for some people, an ocean relationship is not characterised by how happy or comforted the ocean makes them feel but that relationships are founded on something more tangible. Based on this research's definition of ocean relationships and that of Allison et al. (2020), this research asserts that though not viewed as such, the respondent does have a relationship with the ocean because of the positive wellbeing emotions the ocean triggered for her. Another respondent's reason for not having a relationship with the ocean was rooted in loss, particularly tragic memories of a family member who drowned:

> *"When I was younger it was difficult to see the ocean in a good light. One of our cousins passed away in 2014. He drowned in the ocean, and ever since then, we hardly ever went to the beach because we and especially our parents were afraid and kind of angry at it. It was only when my grandmother visited us and asked to be taken to the ocean, we refused at first, but she told us that we cannot be afraid of the ocean forever because of what happened. That these things happened but we still have to maintain a relationship with the ocean because the ocean is part of us. We then started going to the beach regularly again. Now it brings me peace and allows me to learn."* (Swakopmund resident, Female, 28 YoA)

The respondent expressed that after the traumatic experience, for a while, she struggled to connect with the ocean. However, after years of considerable reflective conversations with her grandmother, she eventually managed to rebuild her relationship and love for the ocean. This experience also it also imparts a broader lesson about facing and overcoming fears. In regard to loss, Barney and Yoshimura express that "*Grief is among the most complicated personal and social experiences people can have*" (2020, p. 80), often leading to the various disconnections experienced in the world. Acknowledging this reality, this research recognises other reasons that some individuals divorce themselves from the ocean. Another ocean disconnection was related to the fear of the ocean and rain (Thalassophobia: "*type of fear that is a constant and intense fear of deep water such as the ocean or sea."* (Fashtami and Darvishpour, 2022, p. 1). However, the respondent acknowledged her fear and expressed that she wants to overcome it by changing her current perception and feelings about the ocean.

A small percentage of respondents emphasised that although the ocean is important to them, they do not have any relationship with it. In light of these responses, this research explored how ocean relationships are formed. Are they influenced by residing in coastal towns, engaging in fishing activities, or simply observing the ocean? This research posits that ocean relationships are not solely determined by aspects such as geographic location or occupation. An ocean relationship is subjective and differs based on context and individual experiences, extending beyond coastal areas to encompass interactions with other water bodies, including rivers, lakes, and dams. For more findings on ocean relationships recorded in this research, see Chapter 4; see also Allison et al. (2020).

The question and discussion about respondents' connections with the ocean also uncovered more contributions relating to ocean customs still practised to date and creatures of the sea. As

explained in Sections 1.2 and 4.1, certain cultures and tribes maintain deep relationships and beliefs associated with the ocean. In some cultures, the ocean is believed to be the dwelling place of both good and evil spirits, while in others, it is the dwelling place of ancestors. In regard to cultural beliefs, one respondent narrated a time when her youth organisation hosted a conference attended by youths from different regions in Namibia. One day, following their sessions, some of their colleagues adamantly asked that they go to the ocean:

> *"…They were very adamant about going to the ocean, and so we went, and they were so excited, I can't explain it. It was at night, and in Swakop the sea gets really rough, so I was kind of concerned. We went there and this other guy wanted to go close to the water. And when we asked him what he was doing? He explained that he was waiting for a gift from the sea. So apparently, what happens is he first throws a stone into the ocean, and after he throws the stone, the ocean would, in return, also give him a gift. So, after he threw the stone, a seashell came out and he took it. We discussed this further and he told us that his grandmother told him that there are people who live under the ocean and he needed to do that."* (Walvis Bay resident, Female, 19 YoA)

The respondent explained that the reason her colleague threw the stone in the water symbolised him greeting and honouring ancestors and people who live in the ocean, and in response, the ancestors/people of the ocean sent him the seashell as a gift. She further added that whenever people leave the ocean dirty, the inhabitants of the ocean become. This topic initiated a discussion about whether there are ancestors living in the ocean, prompting questions about mermaids or ocean people. During discussions with respondents from DRC (see Figure 7.10), this topic surfaced once more, with some respondents expressing belief in mermaids while others disagreed. One of the older respondents expressed that she, too, believed that ocean people existed but was uncertain whether they were mermaids. She referenced one of the songs sung in church that talks about 'praising all living creatures in heaven, on earth and in the water'. She further added that ocean people reside in the depths of the ocean that are beyond our reach.

Figure 7.10: Dantago women engaging in a group discussion. Photograph: Marly Muudeni Samuel, 2023.

This research acknowledges that different cultures have different beliefs, with some cultures believing in ocean beings, often referred to as ocean people, spirits or known as 'mami water' (Okwuosa et al., 2017) in some parts of Africa. These shared beliefs also suggest that the ocean is the resting place of ancestors who serve the purpose of protection. This contribution prompted a discussion of whether there is a connection between ancestors and the belief that the ocean has protective and healing powers, while some respondents attributed the ocean's protective and healing powers to God. Other contributions from respondents mention creatures found in the ocean. However, further commentary was not provided on whether these creatures refer to the fish and organisms in the ocean or ancestors and ocean people or other specific creatures. These are Indigenous beliefs reliant on different spiritual and cultural practices. For example, the Zulu people in South Africa believe that ancestors live in the ocean and that when someone passes away, their souls becomes one of the ocean spirit ancestors (see film by Mthombeni, Moynihan and McGarry (2023)).

Question: Does the ocean contribute to your livelihood?

A majority of respondents expressed that the ocean contributes to their lives in many ways, mentioning how they or family members are employed in fishing companies, have coastal businesses, or engage in small-scale fishing activities:

"Yes, it does contribute to my livelihood. Being in the real estate business, the ocean is contributing to my livelihood because there are a lot of people now migrating to the coast, which is good for my business because they need accommodation." (Swakopmund resident, Male, 42 YoA)

"...I am employed directly in an ocean career, it provides my salary. When at sea, I come back sometimes with fish for my family." (Swakopmund, Male, 38 YoA)

"Yeah, it does contribute to my livelihood because my grandfather would often go fish and he would bring different fish like barbers, massbanker and galleon." (Walvis Bay resident, Female, 19 YoA)

"The ocean plays a huge role in my life, as it is a source of income for one of my parents through a fishing company and with this income, our livelihood is bettered." (Walvis Bay resident, Female, 20 YoA)

"I usually go to the ocean when I am in a dreadful situation, so I go there to meditate and it really helps me." (Walvis Bay resident, Male, 19 YoA)

For most respondents, the ocean generates employment and income opportunities through fishing organisations, factories and small-scale fishing activities (see Figure 7.11). These findings align with co-researcher's contributions, detailed in Section 4.5.

The fishing industry in Namibia, providing over 15,000 direct jobs, is the country's third-largest employer, following the mining and agriculture sectors. Moyo (2022) highlights that on average, fish products contribute to 13% of total exports, making them the second most important export product group after raw material commodity export products. Furthermore, Namibia's inland fishing industry also thrives, with northern regions of the country having large bodies of freshwater, such as lakes and rivers, that facilitate fishing. In their paper, "*Financial Inclusion and the Small-Scale Fisheries Sector in Namibia: A Contemporary Legal Perspective*", Warikandwa, Shakalela, and Libebe (2023) assert that a report by the Food and Agriculture Organisation (FAO) emphasised the important role small-scale fisheries played in the lives of over 40 000 Namibians. This role encompasses livelihoods supported in the production sector (via direct fishing), the post-harvest sector (via fish processing), and through marketing on a local, national, and regional scale (see Section 4.4 discussing economic and livelihood relationships).

Figure 7.11: Small-scale fisherman fishing early in the morning. Photograph: Marly Muudeni Samuel, 2022.

With the fishing industry being a big market and with coastal towns becoming tourist attractions and leisure destinations, many people from around the country migrate to coastal towns in pursuit of better opportunities. However, it is important to recognise that despite the positive growth in the fishing industry and coastal business industries, small-scale fishermen still face livelihood challenges caused by the decline in fish numbers (see Sections 1.1 and 4.4). Respondents and co-researchers attributed this challenge to the mismanagement of ocean resources and stated that governing bodies award excessive fishing rights to large-scale fish trawling companies. Fishermen now encourage children to explore other opportunities due to the diminishing profitability of small-scale fishing.

Respondents additionally deliberated the advantages of the blue economy concept (see Section 4.4.1 to read about the blue economy), viewing it as a good economic opportunity. Mbathera (2022) explains that the blue economy has the potential to promote economic growth, improve livelihoods, and be inclusive while not risking the ocean's sustainability. The anticipated economic opportunities that will emerge through the blue economy include more maritime shipping and fishing opportunities, deep sea mining, water desalination, aquaculture, oil drilling, and coastal trade and tourism (McBain, 2023). Given that unemployment stands as one of Namibia's current pressing challenges (Amakali, 2018; Nthengwe, 2022; Vatileni, 2023), these opportunities have the potential to create employment prospects for coastal town residents and assist with socio-economic growth.

Respondents also favoured and discussed artistic ocean representation that explained the important role of ocean resources and how they can be used to create art and crafts, such as home decorations and contemporary and traditional jewellery and ornaments created with oysters and seashells (see Section 4.1.1). Mussel harvesting was also discussed with respondents explaining that during mussel season, mussel collectors are only allowed to recreationally collect 50 brown, black, or ribbed mussels and 25 white mussels per day, which should be 38mm or less in size (Ministry of Fisheries and Marine Resources, 2001). These mussels are usually sold for income to sustain households.

A discussion about people engaging in different ocean activities was held, with respondents elaborating that people either welcome or avoid specific ocean activities. One respondent explained how swimming is enjoyed by some coastal residents, though not by many due to a fear of drowning. This topic initiated a debate about people's reluctance to swim in the ocean or even in pools or why some people do not participate in other ocean activities. Respondents mentioned several reasons, including limited finances, access to swimming pools, parental restrictions preventing children from going to the beach for fear of drowning, and no ocean relationships. One respondent narrated how he almost drowned in the ocean and has since avoided swimming in it. Another respondent shared her concerns about how people fear engaging with the ocean and offered suggestions on potential solutions to this challenge:

> *"I think there should also be a change in the way the community people interact with the ocean. For example, as a parent if I go to the sea with my kids I am always aware of their movements, because of fear that something might happen. I think there should be more education on safe swimming in the ocean so drowning does not happen so often. For example, all of my kids can swim, but I cannot swim, but up until today when we go to the beach, I always tell them not to go deep into the ocean."* (Swakopmund resident, Female, 62 YoA)

Additional contributions about the fear of the ocean were associated with colonial imprints, with respondents suggesting that some of these fears are psychological and were formed during colonial times, resulting in some individuals not being motivated to engage in certain activities such as swimming:

> *"I think it is a mindset thing. The reason that most black communities here act that way is because the apartheid system has reprogrammed our minds in such a way that until today, we feel inferior to white people, and most of the activities that they used to*

participate in that we could not. We really need to break that mindset, because we are afraid to challenge ourselves with certain things." (Swakopmund resident, Female, 57 YoA)

One co-researcher was in agreement with this comment and mentioned that most community members avoid participating in many water activities because of a lack of confidence. These contributions indicate that, even after independence, psychological colonial imprints of oppression are still present. Maseland (2018, p. 5) notes, "*colonial legacies…not only introduced certain formal institutions to their colonies but also left a strong imprint on the values, norms and cognitions. Even though independence has brought states the formal power to radically change institutions, such informal constraints have largely stopped them from doing so*". As a consequence, the treatment of black people during colonialism influenced Namibian perceptions of the ocean, eliciting emotions of fear. Some of these emotional legacies were later translated into how children were raised and explain why some people are still afraid of the ocean.

7.3.5. Demonstration Reflections

Through the demonstration sessions, respondents' ocean connections were revealed, and novel connections emerged. Respondents provided diverse perspectives on ocean heritage and engaged in discussions about the benefits of knowledge and cultural preservation, existing ocean connections and the importance of ocean conservation. The questionnaire responses about the usability and user experience of *Efuta Letu Sida Huribs* enabled the author to recognise areas that were especially engaging, immersive, or frustrating for users. Respondents provided valuable feedback for improving the application and suggested that in the future, *Efuta Letu Sida Hurib* should include contributions from diverse co-researchers and contributors encompassing a broader range of cultures, ages, and races. In response, the author recognises the importance of inclusive participation: invitations for research collaboration were sent to several coastal institutions and groups, with only 14 individuals agreeing to participate. The group of co-researchers was diverse and included six youths and seven adults, 10 females and four males aged between 18 and 65 years from the Aawambo, Damara/Nama, Topnaar, ǂAonin, and Herero tribes (see Section 3.2).

In terms of the application name, one respondent expressed that she was pleased to see that the name included two Namibian Indigenous languages, Oshiwambo and Kwoekoegowab, making it inclusive and unique to Namibia. This opinion aligns with the justifications provided by co-

researchers for using an Indigenous name (see Section 5.1.2 for an explanation of how the name was chosen).

Lastly, respondents suggested that *Efuta Letu Sida Hurib* be adapted to other platforms, such as a website, and shared with other people to facilitate ocean heritage education and encourage ocean conservation, echoing suggestions from co-researchers (see Sections 5.1.3 and 8.3 for similar contributions from co-researchers).

7.4. Evaluation of Workshop Methodology

Following the demonstrative feedback sessions, a final reflective workshop was conducted with co-researchers (see Figure 7.12). The primary objective was to discuss and explore the views and suggestions provided by respondents during the demonstrative feedback sessions, comparing them to co-researchers' objectives. The workshop assisted in evaluating the efficacy of *Efuta Letu Sida Hurib* and whether it effectively supported and preserved ocean heritage, comparatively drawing from insights of both co-researchers and respondents.

Co-researchers, once again, engaged with *Efuta Letu Sida Hurib* and were informed of new changes implemented based on previous suggestions. The author observed individual interactions with the application and the evolving understanding of it. While the collective co-production process during previous workshops encouraged a general comprehension and ownership of *Efuta Letu Sida Hurib*, because of the time period between fieldwork trips and workshops, some co-researchers had forgotten how to navigate through the application. When conducting participatory research with communities, it is critical to recognise that long wait times between workshops and engagements with community members can lead to detachment or disinterest in the research. Community members may also get other obligations or commitments that will prevent them from participating in the research. The former was not the case in this research as co-researchers participated from beginning to end. However, some co-researchers were unable to attend some of the last workshops because of other commitments. In this context, co-researchers had the liberty to withdraw, attend or not attend the workshops in accordance with ethical considerations and as stipulated in the PIS form (Appendix 1:C-D).

Figure 7.12: Co-researchers from Swakopmund and Walvis Bay engrossed in a group discussion. Photograph: Marly Muudeni Samuel, 2023.

Co-researchers who previously suggested that their 3D model representations be substituted were satisfied with the new amendments. For example, Lucio, who initially had a picture of a seagull feather as his representation, and Brigette, who had a picture of herself at the beach, substituted their photographic ocean representations with videos (see Section 6.4.3.3 for details about 3D models). When asked about current thoughts on *Efuta Letu Sida Hurib*, co-researchers expressed contentment with the outcome and the learning process:

> *"I like the app. It just reminds you of where one is from and where they have been this whole time. And some of the things that you didn't know about, you get to learn about on the app. For example, the shells, I did not know that they were used for the Oshiwambo jewellery and also put on their belts. So that was really helpful and enlightening."* (Walvis Bay resident, Male, 22 YoA)

Again, the concept of learning emerged, emphasising the importance of being informed of ocean knowledge and the ability it has to empower people. Reflections on the value of *Efuta Letu Sida Hurib* and its potential role in information dissemination and preservation were reiterated, with both respondents and co-researchers desiring other people to have the opportunity to engage and learn:

> *"The content of the app and the app itself is great. Going through the app gave me immense pleasure and joy. I am sure it is something that other people would also like to experience. And like me, I think other people will probably also be happy experiencing it."* (Walvis Bay resident, Male, 22 YoA)

The challenge of access to technological infrastructure was discussed, as some co-researchers were unable to install *Efuta Letu Sida Hurib* on their phones. However, the author notes that this challenge did not discourage co-researchers. Co-researchers with mobile devices not supporting the application collaborated with fellow co-researchers whose phones did and made plans to continue demonstrating the application to more people. Co-researchers also explored various alternatives for showcasing *Efuta Letu Sida Hurib* to a wider audience, including the possibility of using a projector to facilitate large group demonstrations.

The enthusiasm of co-researchers to use and share *Efuta Letu Sida Hurib* demonstrates the value of the application, and its agency to promote Namibian ocean heritage. As a result of the co-production process, co-researchers were highly motivated that application users have an opportunity to acquire knowledge about ocean heritages, including history, culture and resource uses (such as uses for seaweed, driftwood, sand and rocks).

7.4.1. Conclusion

As demonstrated in this chapter, several factors contributed to respondents finding *Efuta Letu Sida Hurib* as a meaningful application. In alignment with the views of co-researchers, respondents recognised that the application's content conveyed important ocean information. The 3D models provided education about alternative uses for ocean resources. Katrina's representations titled 'Driftwood Arts' and 'Seaweed' highlighted diverse ways that ocean resources are utilised for art and gardening. Respondents also appreciated ocean representations that incorporated cultural and historical contexts. Wenzy's representation titled 'Genises !Nara Roots,' Kasper's representation titled '!Nara seeds' and Sara's representation titled '*Onthugululwakalo gwaawambo* (Aawambo Cultural Heritage)', highlighted the important role the ocean plays in perpetuating cultural practices. The findings of this research indicate that there is a need to continue safeguarding, promoting, and preserving cultural heritage, especially at a time when customs and cultural practices are perceived to be declining.

Preferences regarding visual photorealism, quality, and consistency influenced responses about the 3D models presented on the application. The !Nara seeds 3D model, which was highly favoured by the majority of respondents, also received criticism because of its inauthentic

photorealistic colour texture, which, according to four respondents, did not accurately represent the colour of !Nara seeds. However, respondents expressed that the value and history of the !Nara plant was conveyed through the audio and text descriptions (see Sections 5.1.2 and 8.5). These descriptions enabled respondents to experience the 3D model representations beyond their visual appearance, which aided comprehension and appreciation of the !Naras importance and value.

The co-production of *Efuta Letu Sida Hurib* communicated co-researchers diverse and unique ocean relationships to respondents. When evaluated holistically, *Efuta Letu Sida Hurib* served as an engaging tool by which to preserve Namibian ocean heritage. The application was identified as a platform by which to bring different voices together to share knowledge, practices and values.

CHAPTER 8

CONCLUSION

This chapter reviews the entire PD and co-production process and research results, acknowledging the challenges and drawbacks encountered and providing recommendations on how these challenges and drawbacks can be addressed in the future. This chapter presents recommendations for researchers interested in conducting similar research on considerations of research context and participatory approaches, community engagement, technologies being employed, and the visual photorealism and representation of digital heritage objects. The outcome of the research objectives and questions are also discussed, and the contribution to knowledge is stated. The chapter concludes with future research prospects.

By exploring and employing digital technologies and collaborating with co-researchers from Swakopmund and Walvis Bay, Namibia, a platform was provided through which co-researchers voiced diverse expressions of ocean heritage and produced *Efuta Letu Sida Hurib*, the primary output of this PD and co-production process. *Efuta Letu Sida Hurib* includes 3D models that represent co-researcher's ocean heritage expressions and aims to investigate mechanisms to support and preserve ocean heritage for posterity. The PD and rapid ethnography methods employed (see Section 3.1) are a combination of approaches developed through the authors personal and experiential practice and from in-depth research of existing literature (as reviewed in Chapter 2). These combined methods encouraged inclusive collaboration between the author and co-researchers while also embracing the research context, co-production process of *Efuta Letu Sida Hurib* and meaningfully facilitated the emergence of co-researcher's ocean heritage expressions. Furthermore, the co-production process created a platform for ocean heritage to be shared whilst, most importantly, also providing a mechanism and discovery process for co-researchers to share and learn about diverse cultural engagements with the ocean from one another.

This chapter provides a summary of how the methods employed and research findings address the following research questions:

Primary research question: **(1)** How can AR support Namibian coastal communities in surfacing, recording and preserving ocean heritage and relationships?

In tandem with the primary research question, the following sub-questions were explored:

(2). What are the connections, relationships, and experiences that coastal communities have with the ocean? How are they formed, why are they important, and how can they re-engage communities with the ocean?

(3). What role does the ocean play in contributing to the wellbeing of coastal communities?

(4). In what ways does PD facilitate a digital co-production and learning process for coastal communities?

It also reflects on how the following research objectives were met:

⇒ Explore how participatory design practices can facilitate a co-production process and create a meaningful platform (physical and digital) for coastal communities to express and share unique ocean heritage and relationships.

⇒ Introduce and explain how digital technologies were used in different cultural contexts for heritage preservation, and to create a platform using immersive and digital technologies for education and engagement.

⇒ Use AR and 3D modelling technologies to surface, share and preserve Namibian coastal communities' diverse ocean heritage expressions and experiences that represent and communicate the importance of the ocean.

8.1. Defining the Research Process

To contextualise the creation and use of digital technologies when collaborating with communities, this research investigated related works including those promoting knowledge practices, decolonising technology design and research practices, ocean relationships and connections, and participatory design with communities. This research also investigated Ubuntu practices with findings revealing that co-researchers, particularly seashell collectors, embody Ubuntu values and work together to create traditional jewellery (see Section 2.5.1 and 4.1.1, where co-researchers talk about the collective way they work together). The concept of Ubuntu is viewed through a lens of social relations that values the opinions of all collaborators, looking to advance together and achieve a collective consensus (Bidwell, 2014). This research also investigated the concept of the production of significance, which emphasises the importance of community engagement and development throughout this research's co-production process instead of only focusing on the significance and value of the end product: *Efuta Letu Sida Hurib*. The fundamental principles of the theories investigated in this research, which are Ubuntu, production of significance, CoP and place attachment and biophilia,

surfaced during the workshops and co-production process as co-researchers worked together to create *Efuta Letu sida* Hurib (as detailed in Chapter 4 and 5).

PD was employed as the overarching methodology and research interventions borrowed from rapid ethnography were applied to guide the research and conduct focus group workshops. Methods including focus group discussions, questionnaire, participant observation, and note-taking were also utilised to engage co-researchers and collect data about ocean heritage (for a fuller discussion on the combined methodological approach, see Section 3.1).

By employing these combined approaches and engaging co-researchers in 18 focus group workshops, this research had three distinct phases: ocean knowledge and technology exploration; design and digital co-production; and evaluation and reflection (for a full explanation of phases, see Section 3.3). Each phase comprised of differently structured workshops designed to explore and reveal ocean heritages, investigate digital technologies focusing on AR, and assess the potential of AR in supporting and preserving ocean heritage.

Co-researcher's contributions were recorded with consent, including photography and audio and video recording. Contributions shared in Oshiwambo were transcribed by an Oshiwambo/English teacher together with the author (see Section 1.3 and 3.4 for an explanation about translations) and analysed using QCA and thematic analysis. Following the analysis process (detailed in Section 3.5), five broad ocean relationship themes emerged: Cultural and Historic, Wellbeing, Artistic, Economic and Livelihood, and Ocean Sustainability relationships. These themes revealed co-researchers' diverse and significant conceptions of the ocean and related heritages. Furthermore, these themes demonstrated that ocean heritages are formed by different cultural, spiritual, historical, artistic, wellbeing and environmental experiences that co-researchers have with the ocean, both individually and collectively.

To ensure that the objectives of this research process aligned with the needs of co-researchers in terms of producing a digital application that supports, shares and preserves (see Chapter 1 and Section 3.4.2 for an explanation of preservation adopted in this research) different ocean heritage expressions, active participation of co-researchers in the co-production process and testing and refinement phase was encouraged. Thus, the process of co-production has been a rigorously structured exploratory journey that facilitated the development of *Efuta Letu Sida Hurib*.

Throughout the workshops, co-researchers openly shared their narratives, opinions, and Indigenous and experiential knowledge relating to the ocean. The included the benefits

provided by the ocean (see Figure 4.1 for different ocean benefits and relationships), ocean access, inclusivity and education, coastal livelihoods, ocean management, gender roles, customary, spiritual, and medicinal beliefs, history, access to information and digital technologies, and ocean conservation. To further express their relationships with the ocean, co-researchers shared ocean objects/materials representing individual ocean heritage. They shared symbolic objects such as oysters, sea shells, sea sand, ocean rocks, jewellery, traditional herbs, driftwood, a fish tank, seaweed, !Nara seeds and roots, and seagull feathers, while the symbolic materials included videos and pictures, each representing community and co-researchers' unique and personal connections to the ocean. Co-researchers also provided different descriptions explaining the intrinsic values and significance attached to the objects/materials. These descriptions, which were incorporated into *Efuta Letu Sida Hurib,* highlighted the importance of the ocean objects/materials within the context of the ocean and their way of life, which is evidence of the essential role the ocean plays in co-researchers lives and their wellbeing.

8.2. Significance of Ocean Heritage for Namibian Coastal Communities

As discussed in Chapter 4, human prosperity and wellbeing depend significantly on natural resources, including those of the ocean (Rudolph et al., 2020). The ocean covers 70% of planet Earth and it connects people, communities, countries, continents, and cultures. It is a space and place with which people form intricate relationships. As described by Allison et al. (2020) and clearly demonstrated in this research, the relationships between people and the ocean are intricate and multifaceted and are founded on values that extend beyond monetary considerations. These relationships contribute to non-material aspects of living and wellbeing and these values play an essential role in promoting overall human prosperity. These ocean connections and values encompass contributions to sustenance, coastal real estate, transport, recreational opportunities (Wozniak et al., 2023), cultural, social, legal and personal identity; a sense of belonging to a specific place; occupational pride, and self-esteem; spirituality; psychological and physical health; as well as human security (Allison et al., 2020) (Examples of many of these perceptions arose in conversations with co-researchers and are discussed in Chapter 4). The diversity of these values and interests does not diminish the great importance they have for individuals, communities and the world, rather they demonstrate the numerous and nuanced ways communities and cultures establish connections with the ocean (see also Pascual et al., 2017).

One of these ocean relationships is associated practices and the belief that the ocean has healing capabilities that benefit not only psychological and physical wellbeing but also the soul. Strand, Rivers and Snow (2022) emphasise that regardless of religious, customary, or cultural background, people recognise the ocean as a sanctuary for restoring and revitalising their spirituality, health and wellbeing. In this context, co-researchers explained how people believe in the ocean's healing and protective powers (see also Charlier and Chaineux (2009) for more information on the healing sea). Some co-researchers expressed that when feeling sad, going to the beach to experience the presence of the ocean and listening to ocean waves provide solace (see Section 7.3.3). Certain ethnic groups such as the Aawambo and Damara/Nama groups (there may be others) also believe that washing one's face or feet in the ocean provides healing and wards off bad luck and spirits, a practice rooted in customary beliefs passed down through generations. These ocean spiritual practices and beliefs extend beyond coastal towns, for example, it was noted that this project's co-researchers habitually send ocean water to relatives in other towns, where it is sprinkled in homes to ward off evil spirits and bad luck. By engaging in these practices, individuals hope to attract good fortune while conveying respect and paying homage to the ocean. Co-researchers also collect seashells and other ocean resources to create art, home decorations, traditional and contemporary jewellery and ornaments worn during important and customary events such as weddings. These artefacts created from ocean resources cover both cultural and historic, artistic and economic and livelihood relationships (see Chapter 4 for ocean relationship themes). In this regard, the author notes that people's connections to the ocean and its resources are entangled in multiple categories and some ocean objects or materials do not fall neatly into a defined theme because they have multiple levels of meaning for people. For example, some ocean objects that are used as home decoration could also have spiritual meaning. As such, entangled ocean relationships can also include, extend to or be a combination of recreational activities, such as swimming, boat ridings, excursions, surfing, sailing, hosting parties or spending time with family members at the beach for peace, companionship, adventure, and to experience a deep connection with the ocean.

Seaweed is another ocean resource used in gardening and healing practices. Co-researchers collect seaweed and dry and crush into a seaweed powder that serves multiple purposes. Firstly, it is used as a natural fertiliser to nourish and promote plant growth, and it holds medicinal properties (see Section 4.2.). Regarding the use of seal oil as a medicinal ointment, Fortuine (2011) mentioned in his research work, *Shamans and Seal Oil: Health and Healing in*

Traditional Alaska Native Societies, that rancid seal oil has been used as a traditional treatment for wounds. Reflecting this knowledge, co-researchers mentioned using seal oil, which is applied on head sores and burn injuries, as it is believed to have healing properties. These findings indicate how ocean Indigenous medicinal knowledge, passed down through generations, is still being practised today, emphasising the importance of Indigenous knowledge and the need for its preservation (see Section 4.2 and quotes in Section 7.3.1). The ocean is also believed to represent a symbolic connection to both ancestral roots (Bernard, 2010) and to God (see quotes in Section 4.2), and jewellery created from resources plays an essential role in rituals and ceremonies (see quotes in Section 4.1.1). For example, when the Topnaar ǂAonin people lived close to the ocean, they engaged in cultural practices passed down through generations that emphasised the importance of living in harmony and sustainably with the ocean. These traditions served as a means to encourage the Topnaar ǂAonin community to have respectful relations with the ocean, which enabled them to protect and preserve the ocean by adhering to Indigenous fishing practices and regulations put in place (as discussed in Section 4.1.2).

Research's findings further indicate that co-researcher's relationships with the ocean move beyond ocean contributions and include relationships such as customary, spiritual, cultural, historical, medicinal practices, psychological and physical wellbeing, and fishing for food. The culmination of these ocean heritage relationships promotes an appreciation of the ocean for co-researchers. This appreciation is grounded in the place attachment theory (Low and Altman, 1992) and Biophilic connections (Fromm, 1973), which explore the psychological, emotional and physical connections that develop between human beings and a physical environment (see Section 2.5.4). Li, Liu and Ito (2021) further assert that human beings have natural desires to connect with specific places and environments, looking for a sense of belonging and attachment. These ocean place attachments and biophilic connections contribute to the wellbeing of coastal inhabitants, as revealed by co-researchers and further detailed in results Chapters 4, 5 and 7.

8.3. Coastal Communities' Ocean Challenges

Longhurst (2010) argues that the ocean and its resources have not been effectively and inclusively managed, especially in terms of including communities. Ocean mismanagement has resulted in a multitude of challenges, including overfishing, marine pollution, conflicts over ocean resources, a lack of inclusivity in decision-making, and climate change (Agarwala, 2022; Issifu et al., 2022). Therefore, while co-researchers benefit from and engage with the ocean in

various ways, they similarly face ocean challenges, such as unequal access to ocean governing decisions and coastal information (see Section 4.4 for a discussion on ocean economic and livelihood relationships). Co-researchers emphasised the importance of inclusive and equitable ocean management decisions and access to information concerning the ocean. There is an imperative for governing institutions to collaboratively engage in efforts to efficiently manage the oceans. Though not directly expressed in the content shared on *Efuta Letu Sida Hurib*, these important points about effective and inclusive ocean management emerged during the co-production process and discussion, further reinforcing the value of the co-production process as noted in Section 8.6. By promoting inclusive and equitable ocean management discussions and access to ocean information and practices, individuals from coastal communities and beyond have a chance to learn about ocean benefits and uses, activities they can participate in, ocean management decisions, policies, and opportunities for growth. More grounded responsibility, transparency, and engaging methods will need to be implemented to clear debates between ocean users and discourage the impartial use of ocean resources (Elkington, 2006). Bollier (2016) calls for all-inclusive decision-making in ocean management, and the participatory community-driven initiatives adopted by this research actively promote the engagement and inclusion of communities in ocean discussions and the creation of beneficial ocean related products/solutions such as *Efuta Letu Sida Hurib* that surface and promote ocean heritage sharing and preservation.

While the Namibian fishing industry is one of the largest economic sectors, there are still many challenges that impact the livelihood of small-scale fishermen brought on by a decrease in fish population in recent years (Paterson, Kirchner and Ommer, 2013; Belhabib, Willemse and Pauly, 2015). Co-researchers attribute the decline in fish population to intensive large-scale fishing practices and climate change. The fishing sector also faces challenges associated with corruption, such as the Fishrot scandal (Bjarnadóttir, 2020; Coetzee, 2021), further exacerbating unethical and unsustainable fishing practices. (see Section 4.5 for a discussion on Fishrot and Section 4.5.1 for a discussion on the impact of fish decline on small-scale fishermen). Therefore, to address ocean governing challenges and exploitations that threaten the oceans ecosystem, the Namibian government and ocean management institutions should establish and promote equitable and transparent procedures and policies that protect the welfare of the ocean, the country and coastal communities.

Additionally, coastal communities (small-scale fishermen and seashell collectors) face ecological and socioeconomic challenges as a result of climate change, particularly in terms of

their dependence on ocean resources. For example, seashell collectors raised concerns about how seashells used to make *onyoka* and other jewellery are gradually becoming brittle. In contrast, small-scale fishermen raised concerns about inconsistent fish migration patterns caused by rising water temperatures. Considering the challenges presented by climate change, there is a critical need to raise awareness about living sustainably and the importance of conserving the ocean (see Halloran and Silver (2022)), with a particular focus on responsible resource extraction from the ocean, which directly links to better ocean management decisions. If not addressed, these challenges will not only continue to impact the ocean's ecosystem but also affect the wellbeing and livelihoods of co-researchers and their communities, particularly those who depend on the ocean for food and income. The following sections discuss how *Efuta Letu Sida Hurib* and its production process address the communities' concerns over these pressing issues and offer a methodology for surfacing and producing significance around individual and community conceptions of the ocean.

8.4. Leveraging Technology: Augmented Reality for Ocean Heritage

The primary research question asked whether AR can support and promote Namibian coastal communities in preserving ocean heritage for posterity. By investigating different digital technologies designed for preservation purposes (see Section 3.4.2 for the definition of preservation used in this research), this research addresses whether the use and adoption of AR supports, preserves and promotes ocean knowledge in Namibia. Through collaborative efforts with co-researchers, this research demonstrated that AR technologies do have the potential to meaningfully support and preserve ocean heritage for posterity, and it created a platform for knowledge sharing with stakeholders and policymakers and, as such, their goals were achieved. AR is especially beneficial when collaborating with disadvantaged and marginalised communities because, unlike high-end technological infrastructures needed to use VR, technological infrastructures (primarily mobile devices) required to use AR are more easily attainable (requirements for using AR explained in Section 6.3.3) (for a broader discussion on Ethical approaches to creative collaboration with communities see Jeffrey and McDonald (2024)). However, AR also has limitations, as evidenced in this research. These limitations and concerns sparked a critical discussion about accessibility, inclusivity and coloniality of digital technologies. Deliberations were held on how digital technology companies set installation requirements that regulate immersive digital technologies (such as ARCore) to only be installed on specific mobile and digital devices. This excludes disadvantaged and marginalised communities because immersive digital technologies, such as markerless AR (see Sections

6.2.1 and 6.3.3 for markerless AR challenges), are generally only supported and function on high-end, expensive mobile devices.

Despite substantial advances in digital technologies, there remains a gap in access to digital applications and infrastructure, which limits disadvantaged and marginalised communities from fully accessing or engaging with immersive technologies such as AR. Financial constraints also exacerbate this digital gap, preventing these communities from acquiring the necessary devices and infrastructure needed to engage with immersive digital technologies. Therefore, while most co-researchers owned digital devices and were interested in using and introducing *Efuta Letu Sida Hurib* to friends and in workplaces, many did not have access to mobile phones that support ARCore (see Section 6.3.3). Consequently, a technology access and inclusivity challenge emerged, creating a divide between co-researchers and the agency of using *Efuta Letu Sida Hurib* outside of the research setting. Two questions emerged concerning digital accessibility concerns: How can communities, particularly disadvantaged and marginalised communities, gain equitable access to different digital technologies using digital devices already owned? What role can commercial digital companies play in guaranteeing equitable digital accessibility or in developing technologies and technology functions that are globally accessible? While these questions were not part of the core research, they have emerged as a key logistical concern as well as a question of equitable access and should form part of the research context for future research in this domain.

Another technological challenge faced was the cost of devices with which to conduct the research (in light of the constraints above). Consequently, the researcher only had access to two mobile phones and a personal tablet, which were utilised for testing and showcasing purposes. As a result, co-researchers and respondents either had to wait to interact with *Efuta Letu Sida Hurib* or interacted with it in pairs. But despite this challenge, co-researchers and respondents effectively interacted with *Efuta Letu Sida Hurib* and provided valuable feedback, contributing to a roadmap for further development. In relation to inclusivity, this research discussed ways to make *Efuta Letu Sida Hurib* more accessible, and co-researchers explored collaborative approaches to improve *Efuta Letu Sida Hurib* and discussed how it can become compatible with a broader range of devices, including laptops and different mobile devices, and on online platforms, such as creating a website for *Efuta Letu Sida Hurib*. This feedback indicates that co-researchers were satisfied with *Efuta Letu Sida Hurib* and wanted to use it outside the workshop context and share it with a wider audience.

8.5. Realism and Authenticity of 3D Models

Visualisation of 3D models was discussed, with co-researchers and respondents providing recommendations for the refinement of *Efuta Letu Sida Hurib*, including criticism of the realism and authenticity (defined in Glossary and discussed in Sections 2.4.2, 7.3.2 and 7.3.4) of 3D models. Inevitably, co-researchers who co-produced and are particularly invested in *Efuta Letu Sida Hurib*, while determined to improve *Efuta Letu Sida Hurib*, did not criticise the realism and authenticity of 3D models as much as the respondents, who viewed *Efuta Letu Sida Hurib* more from a user rather than a creator perspective. Consequently, comments about the authenticity of 3D model representations were mostly provided by respondents.

This research acknowledges the importance of visual realism, especially that of the 3D models representing ocean heritage shared by co-researchers. For example, some 3D models generated with 3DF Zephyr did not realistically resemble their original objects, to which co-researchers and respondents suggested that the 3D models be remodelled at a later stage (see Section 7.3.2 and 7.3.4 on the subject of authenticity). However, co-researchers and respondents argued that the value and significance of these objects were still conveyed through the 3D models and emphasised by the descriptions. Cardozo and Papadopoulos (2021, p. 530) concur that "*engaging experience with the artefacts, via information and interaction, could facilitate the auratic experience and make the objects trustworthy*". Co-researchers and respondents clarified that the actual physical objects carried so much significance and value, and it was transferred to the digital 3D models, though some did not resemble the physical objects. This research highlights that while the visual realism of 3D models is important, the actual value and significance of the objects/materials being represented hold greater importance. This value and significance are thus transferred and conveyed through the digital 3D model representations.

This research highlights that using the 3DF Zephyrs free version, which only imports 50 photographs, resulted in the software unrealistically processing the visual appearance of some 3D models. To produce 3D models with a more realistic appearance, photogrammetry software's have to process over 50 photographs. Thus, this research suggests that the 3DF Zephyr's free version be utilised for testing purposes and small-scale projects; however, premium photogrammetry software's should be utilised for work requiring more authentic-looking, professional 3D models. Despite this, the 3DF Zephyr free version still provided a platform for co-researchers to experiment with the software and learn about how 3D models are created. Applications such as 3DF Zephyr, which offer free edition packages, break down

barriers to digital infrastructure access (see Section 6.3.2), enabling people from low-income communities—which is the case of this research—to use and experiment with digital technologies for learning and development purposes.

8.6. Co-Production Participatory Design Process

Co-researchers demonstrated an appreciation for the co-production process of *Efuta Letu Sida Hurib*, emphasising that new knowledge was acquired. Co-researchers further expressed the importance of sharing the ocean knowledge gained with other coastal individuals. In particular, one co-researcher expressed her intention to utilise the *Efuta Letu Sida Hurib* to educate women in her community about the various methods of utilising ocean resources. Another co-researcher highlighted *Efuta Letu Sida Hurib's* potential in promoting awareness about the importance of the ocean, educating individuals about the diverse ocean benefits and uses, and emphasised the importance of protecting the ocean and preserving knowledge and cultural heritage (see Section 7.3.5). Additionally, two co-researchers, who are teachers, shared their perspectives on *Efuta Letu Sida Hurib* and emphasised its potential for being an effective education platform that can teach students about the ocean (see Section 7.3.2). They further expressed that *Efuta Letu Sida Hurib* could be adapted to include more information that would be valuable for teaching purposes and that can enhance the learning experience for individuals (see Section 7.3.2).

Numerous related works, as outlined in Sections 2.1 and 2.2.2, demonstrate the effectiveness of digital preservation efforts in documenting and safeguarding knowledge and cultural practices. Accordingly, this research findings indicate that the preservation of knowledge and cultural practices further facilitate continuity of use and intergenerational sharing. However, this research does not assert that the PD approaches employed and *Efuta Letu Sida Hurib* or technology, in general, are the ultimate solution for surfacing, preserving, or sharing ocean heritages. Instead, by employing participatory design principles, this research established a platform and safe space where co-researchers mutually engaged, shared, and exchanged knowledge and learned about the ocean, its importance, and how people connect with and depend on it. As a result, co-researchers acquired knowledge, such as different ways of tending to home gardens (see Figure 8.1) using alternative seaweed watering and fertilising methods, ways of creating art for home decorations, and creating important customary and traditional jewellery that uphold and promote cultural beliefs. Co-researchers further shared and learned about the role and significance of the ocean in terms of maintaining psychological and physical wellbeing, as well as the importance of ocean conservation and safeguarding ocean heritage.

On this point, co-researchers shared how people, including some of them, go to the ocean to either exercise, think, release stress and spend time with friends and family (further explored in Sections 4.2, 4.5 and 7.3.7). Challenges of conservation were also discussed, with co-researchers exchanging ideas on how to become responsible stewards of the ocean. They further emphasised that this could be achieved by teaching and exposing younger children more to the ocean, participating in or organising beach clean-up campaigns, and raising awareness about ocean pollution, especially during festive celebrations.

Figure 8.1: Co-researcher tending to her garden. Photograph: Martha Jonas, 2023.

By employing PD principles, this research enabled the researcher and co-researchers to learn and co-produce *Efuta Letu Sida Hurib* together. This research thus supports Samuel's (2023) assertion that to collaboratively develop digital applications that showcase, support, and digitally preserve (for the purpose of continuity of use) intrinsic knowledge and cultural heritage, researchers, designers and practitioners need to employ PD approaches and engage in meaningful partnerships with communities while respecting their perspectives, ideas, and contributions. By embracing PD approaches, positive interactions were encouraged, allowing communities to openly express themselves (see also Sabiescu, 2015) and share their ocean heritage and experiences. The reflections provided by co-researchers, and detailed in earlier

chapters, emphasise the significance of this research, the PD and co-production process itself, and *Efuta Letu Sida Hurib.*

8.7. Contribution to Knowledge

A multidisciplinary intersection between digital technology, the ocean, and diverse ocean heritage and relationships emerged as a result of the co-production process, emphasising the importance of PD approaches and digital technologies in facilitating, supporting and preserving ocean heritage. The co-production process of *Efuta Letu Sida Hurib* facilitated the emergence of diverse ocean heritages that are not normally discussed or in danger of being lost. These heritages are nevertheless demonstrably significant to coastal communities and promote wellbeing and way of life. These diverse ocean heritages are an embodiment of rich values that are "*essential to broader human flourishing*" (Allison et al. 2020, p. 2). Through PD approaches, this research created a platform where expressions of diverse existing and novel ocean heritage and relationships emerged, demonstrating how they are formed and why they are important to Namibian coastal communities. These diverse ocean heritages are part of and are expressions of Indigenous and experiential knowledge passed down through generations and offer insights into the significance of shared ocean heritages. Although generational transmission of knowledge is under threat, as discussed in Sections 2.1.1, *Efuta Letu Sida Hurib* actively promotes new means of transmission between generations.

The co-production process in this research gives rise to recommendations and design reflections for creating and using AR applications such as *Efuta Letu Sida Hurib* aimed at preserving knowledge and cultural heritage within a research context where communities have limited access to digital technology infrastructure. It has been demonstrated that this general approach could support future researchers in effectively conducting research that is cognisant of different technological challenges faced when using immersive technologies within and with disadvantaged and marginalised communities. This perspective also highlights the interactive prospects afforded by immersive technology. More importantly, drawing from the theory of production of significance (Ireland, Brown and Schofield, 2020), it became evident that the co-production process of *Efuta Letu Sida Hurib,* was as significant as *Efuta Letu Sida Hurib* (the final product)*,* because the process enabled individual and collective reflection, resulting in co-researchers establishing a community between themselves and gaining novel ocean knowledge throughout the process (see Section 2.5.2). This research further provides insights into the perceptions and concept of object authenticity and value and demonstrated that digital objects

can also trigger and imbue the value of original objects; the only variables that change are time, context, and lenses used to perceive and experience them.

Co-researchers demonstrated initiative in sharing *Efuta Letu Sida Hurib* with other people and offered suggestions of community groups to engage with *Efuta Letu Sida Hurib*. Therefore, the technology demonstration of *Efuta Letu Sida Hurib* and co-researcher's ocean heritage expressions contributed to sharing ocean heritages with a larger audience, the respondents. As a result, co-researchers aspiration of sharing and enabling more people to experience the ocean and its heritage through technology was realised. Through *Efuta Letu Sida Hurib*, people who were previously unfamiliar or did not have access to the ocean are provided with an opportunity to experience and explore its benefits and resources for personal or community advancement and ultimately contribute their own ocean reflections in the future, as noted in Section 8.8. In a broader Namibian context, research findings and *Efuta Letu Sida Hurib* serve as a bridge between stakeholders, communities and cultural heritage and ocean institutions and promotes multidisciplinary initiatives through the production of digital collaborative solutions that facilitate heritage preservation and awareness.

8.8. Future Work Beyond This Research

Future research work should focus on enhancing the content and functionality of *Efuta Letu Sida Hurib,* remodelling the 3D models representing ocean heritage to create more photorealistic looking 3D models, drawing on suggestions provided by co-researchers and other coastal community members. Future work should also focus on adding ocean educational content, such as quizzes and games, drawing from suggestions provided by co-researchers in the education field. Further research should be conducted into adapting *Efuta Letu Sida Hurib* to use on different digital applications and platforms. For example, one of the suggestions by co-researchers was to convert *Efuta Letu Sida Hurib* into a web page. An add function that enables people to contribute their own reflections and intricate ocean heritages and relationships should also be incorporated onto *Efuta Letu Sida Hurib* for diverse inputs and to facilitate broader ocean engagement and discussions.

Future research should also focus on creating partnerships with cultural heritage institutions with similar heritage preservation objectives, expanding learnings from the co-production process of *Efuta Letu Sida Hurib* and adapting it to create preservation applications that include various knowledge and cultural expressions from different contexts. Another avenue of consideration is leveraging other immersive and digital technologies, such as virtual reality, to preserve cultural heritage and engage communities. These efforts can be implemented on an

institutional level. In this regard, institutions with the capacity to acquire these technologies can facilitate educational events and initiatives, visiting communities and schools to showcase ocean related and cultural knowledge using VR technologies. The author further notes that in the context of Namibia and other Global South regions, the utilisation of technologies such as VR on a personal level could become feasible in the future, as new iterations of technology infrastructure are becoming cheaper and easier to access. However, this research still acknowledges that these technologies will always be easier to access in Global North regions.

Additional future research should investigate ways in which digital ocean heritage, knowledge and relationships can inform ocean management systems to facilitate equitable and inclusive ocean decision-making that considers both the needs of coastal communities and the sustainability of the ocean. By engaging with digital platforms that promote and support ocean heritage, decision-makers and policymakers can learn more about and understand the importance of the ocean for coastal communities, including the role it plays for livelihoods, cultural practices, wellbeing and connection to history.

8.9. Closing Remarks

This research's PD and co-production process was successful as it engaged co-researchers and demonstrated how technology encourages preservation through continuity of use and intergeneration sharing between groups. Through the co-production process of *Efuta Letu Sida Hurib,* intricate ocean heritage and relationships of co-researchers were supported, surfaced and preserved using AR. Drawing on the philosophy of Ubuntu, communities of practice, and production of significance, this research created a platform for mutual ocean related collaborations, contributions, learning and growth for co-researchers, respondents and author.

Moreover, *Efuta Letu Sida Hurib* enabled a broader audience (respondents) to connect, get inspired, and learn about the significance of the ocean, its benefits and connection to humanity through various relationships, as discussed in Chapters 4 and 7. New ocean connections were formed, and existing ones were re-ignited, which allowed for new opinions and perspectives to emerge about the ocean, with some co-researchers and respondents expressing that after the workshop discussions and engagement with *Efuta Letu Sida Hurib,* they now perceive the ocean as not just a body of water but an important element. The positive feedback provided about *Efuta Letu Sida Hurib*, its content, and its objective is evidence of the importance of the ocean to coastal communities, the role it plays for their livelihoods, and that AR can support, preserve, and promote ocean heritage.

The author emphasises the importance of employing methods and theories that are appropriate for the specific research context, while also building long-lasting and trustworthy relationships with participants and creating spaces for participants to resonate with the research and one another. This approach enables participants to openly contribute during and outside the workshop/research context, as demonstrated in this research. PD and rapid-ethnography practices employed in this research facilitated the development of relationships and created a sharing space between co-researchers and the author. As such, a learning ground was established for both stakeholders. The author does, however, acknowledge that challenges can be faced when conducting PD-led research. In this case, this research faced technology accessibility challenges. For example, co-researchers chose the technology they wanted to work with (markerless AR); however, the application could not be installed on some of their mobile phones. This challenge did not stop co-researchers from fully engaging and sharing *Efuta Letu Sida Hurib* and the importance of the ocean with other people. Co-researchers proposed a variety of digitally inclusive solutions, including adapting the application to a website, projecting it from a mobile phone to a larger audience, and planned to meet up with fellow co-researchers who had mobile phones that supported the application, in order to share it with other people. These ideas and enthusiasm for collaboration resonate with the principles of Ubuntu, communities of practice, and the significance of production, further emphasising the value of community social relations and the position that the process of production is as important as the end product.

The effectiveness of the PD methodology employed in this research was further demonstrated when the author was invited to exhibit the AR application at a World Ocean Day celebration that took place in Swakopmund, Namibia, on the 8th of June, 2024. The exhibition titled ‘Experiencing the Ocean Through the Lens of Technology’ provided a platform for coastal community members, particularly students, to experience the ocean through innovative digital platforms and facilitated discussions about the ocean, its ecosystem and organisms, and ocean knowledge and heritage. The exhibition further facilitated future collaboration between the author, co-researchers, community members, the Mayor of Swakopmund and the Erongo Region Education Director, who requested for similar digital exhibitions to be held at schools in the Erongo region.

As indicated by this research results, ocean heritages are the culmination of deep, intricate relationships, histories, and Indigenous and experiential knowledge that co-researchers (and coastal communities and beyond) have of the ocean—making the ocean an important part of

their lives. Therefore, if ocean heritage notions and practices are not preserved to ensure intergenerational sharing and continuity of use, people may forget about them, resulting in their decline. One of the ways to safeguard them is by ensuring that they are constantly supported, shared, used and preserved through applications like *Efuta Letu Sida Hurib*.

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APPENDIX 1

Appendix 1-A: Research Permit (First Fieldwork Session: January – March 2022)

FORM RST/4 Ver.5 (22/04/2021)

NCRST

NATIONAL COMMISSION ON RESEARCH, SCIENCE AND TECHNOLOGY

RESEARCH, SCIENCE AND TECHNOLOGY ACT, 2004

RESEARCH PERMIT
OF
NON-NAMIBIAN-BASED RESEARCH
INSTITUTE/PERSON

(Section 21 and Regulation 22)

Permit Number
RPIV01122021

Name of Non-Namibian-based Research Institute/Person: Marly Muudeni Samuel	Physical Address: 2/1 319 Maryhill Road G20 7XX Glasgow Scotland		
Issue Date: 24 November 2021	Commence Date: 24 November 2021		
Termination Date: 30 November 2022	Sample Collection Authorised:	YES	NO
			✓
Type of Research Authorised Community co-design and augmented reality for ocean heritage: promoting sustainable livelihoods in Namibia. Non-Commercial research and the use of the resources must be limited to what is specified in the research proposal.			
Type and Size of Sample Collection Authorised N/A			
Locations Authorised for Research and/or Sample Collection Swakopmund and Walvisbay			
Intended Use of Samples N/A			
Responsible Person: Marly Muudeni Samuel	Contact No: +447375564153 / +264814364973		

[redacted]

Signed on behalf of the National Commission on Research, Science & Technology

Official Stamp of the National Commission on Research, Science & Technology

National Commission on Research Science & Technology
30 NOV 2021
P/Bag 13253
Windhoek, Namibia

Research / Sample Collecting Permit Conditions

1.You must report to the Park Chief warden and / or Regional Office of the Ministry of Environment and Tourism prior to arrival in fieldwork area, and must present your permit.
2.This permit does NOT entitle the holder to free entry to the protected areas or state land outside protected areas.
3.For Field work in National Parks you have to make arrangement with park management in advance prior to arrival in fieldwork area.
4.Voucher specimens should be deposited with National Museum of Namibia.
5.If you would like to export samples of specimens you must loan them from the National Museum of Namibia.
6.To conduct research work in the rhinos and elephants range all persons listed on the permit must be in possession of a police clearance certificate.
7.The permission of the land owner is required to work/collect on private lands.
8.The permission of the concession holder is required to work/collect in concession areas.
9.The permission of the communal authority is required to work/collect in communal areas.
10.No commercial filming will be permitted without prior approval by the Ministry of Environment and Tourism under this permit.
11.Duplicates of publications and / or final report should be made available to the Ministry of Environment and Tourism and also the final report.
12.The specimens and their derivatives may be used for the purposes of this study only and may not be patented, commercialised, donated or sold to a third party without the written consent of the Ministry of Environment and Tourism.
13.All results (raw materials) or technology derived directly or indirectly from this research must be made available free of charge without reservations to the Ministry of Environment and Tourism.
14.A report on the work conducted under this permit must be submitted to the Ministry of Environment and Tourism not later than one month after the expiry of this permit as well as to regional office in whose area research was conducted.
15.Applications for renewal of this permit must reach this office at least three months prior to the expiry of this permit.
16.Habitat destructive collecting methods must not to be used.
17.Veterinary restriction may apply in the case of movement of samples and it is the applicants' responsibility to obtain such permits.
18.Foreign (or destination) wildlife import, and veterinary import permits may be required.
19.CITES import permit from the country of the destination is required for the application of export permit for CITES -listed species.
20.All field teams must be in possession of the permit and permit copy must accompany the transport of specimens.
21.You are subject to all conditions listed on the entry permit to any of the protected areas, unless specifically exempted.
22.Failure to adhere to the conditions will lead to cancellation of the research permit.
23.It is your responsibility to make the necessary contacts and arrangements as specified above.
24. Applicant to share findings of the research with the National Heritage Council.

Appendix 1-B: Research Permit (Second Fieldwork Session: January – February 2023)

FORM RST/4 Ver.5 (22/04/2021)

NCRST

NATIONAL COMMISSION ON RESEARCH, SCIENCE AND TECHNOLOGY

RESEARCH, SCIENCE AND TECHNOLOGY ACT, 2004

RESEARCH PERMIT
OF
NON-NAMIBIAN-BASED RESEARCH INSTITUTE/PERSON

(Section 21 and Regulation 22)

Permit Number
RPIV01122021

Name of Non-Namibian-based Research Institute/Person: Marly Muudeni Samuel	**Physical Address:** 2/1 319 Maryhill Road G20 7XX Glasgow Scotland		
Issue Date: 30 November 2022	**Commence Date:** 30 November 2022		
Termination Date: 30 November 2023	**Sample Collection Authorised:**	**YES**	**NO**
			✓

Type of Research Authorised

Community co-design and augmented reality for ocean heritage: promoting sustainable livelihoods in Namibia.

Non-Commercial research and the use of the resources must be limited to what is specified in the research proposal.

Type and Size of Sample Collection Authorised

N/A

Locations Authorised for Research and/or Sample Collection

Swakopmund and Walvisbay

Intended Use of Samples

N/A

Responsible Person: Marly Muudeni Samuel	**Contact No:** +447375564153 / +264814364973

[redacted]

Signed on behalf of the National Commission on Research, Science & Technology

Official Stamp of the National Commission on Research, Science & Technology

National Commission on Research Science & Technology
29 NOV 2022
P/Bag 13253 Windhoek, Namibia
CEO Office

Research / Sample Collecting Permit Conditions

1.You must report to the Park Chief warden and / or Regional Office of the Ministry of Environment and Tourism prior to arrival in fieldwork area, and must present your permit.
2.This permit does NOT entitle the holder to free entry to the protected areas or state land outside protected areas.
3.For Field work in National Parks you have to make arrangement with park management in advance prior to arrival in fieldwork area.
4.Voucher specimens should be deposited with National Museum of Namibia.
5.If you would like to export samples of specimens you must loan them from the National Museum of Namibia.
6.To conduct research work in the rhinos and elephants range all persons listed on the permit must be in possession of a police clearance certificate.
7.The permission of the land owner is required to work/collect on private lands.
8.The permission of the concession holder is required to work/collect in concession areas.
9.The permission of the communal authority is required to work/collect in communal areas.
10.No commercial filming will be permitted without prior approval by the Ministry of Environment and Tourism under this permit.
11.Duplicates of publications and / or final report should be made available to the Ministry of Environment and Tourism and also the final report.
12.The specimens and their derivatives may be used for the purposes of this study only and may not be patented, commercialised, donated or sold to a third party without the written consent of the Ministry of Environment and Tourism.
13.All results (raw materials) or technology derived directly or indirectly from this research must be made available free of charge without reservations to the Ministry of Environment and Tourism.
14.A report on the work conducted under this permit must be submitted to the Ministry of Environment and Tourism not later than one month after the expiry of this permit as well as to regional office in whose area research was conducted.
15.Applications for renewal of this permit must reach this office at least three months prior to the expiry of this permit.
16.Habitat destructive collecting methods must not to be used.
17.Veterinary restriction may apply in the case of movement of samples and it is the applicants' responsibility to obtain such permits.
18.Foreign (or destination) wildlife import, and veterinary import permits may be required.
19.CITES import permit from the country of the destination is required for the application of export permit for CITES -listed species.
20.All field teams must be in possession of the permit and permit copy must accompany the transport of specimens.
21.You are subject to all conditions listed on the entry permit to any of the protected areas, unless specifically exempted.
22.Failure to adhere to the conditions will lead to cancellation of the research permit.
23.It is your responsibility to make the necessary contacts and arrangements as specified above.
24. Applicant to share findings of the research with the National Heritage Council.

Appendix 1-C: Participant Information Sheet (First Fieldwork Session: January – March 2022)

PARTICIPANT INFORMATION SHEET

Community Co-Design and Augmented Reality for Ocean Heritage: Promoting Sustainable Livelihoods in Namibia

You are invited to take part in a research research with Marly Muudeni Samuel, a Glasgow School of Art PhD student. The research research is part of One Ocean Hub, a five-year collaborative international research programme working in various countries and territories such as Ghana, Namibia, South Africa, and Pacific Islands, with the aim of encouraging equitable and inclusive ocean governance.

Before you decide to take part in the research research, you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read is not clear or if you would like more information. Please take time to decide whether or not you wish to take part.

What is the purpose of the research?

This research is designed to explore connections with the ocean that are expressed through cultural heritage, including ocean knowledge and sustainability aspirations, shared by participants from selected coastal communities in Namibia. The aim is to further understand how the digitalisation of cultural heritage can support ocean culture, promote sustainable livelihoods and improve ocean conservation. This research investigates the intersections of augmented reality (AR) and cultural heritage to explore the benefits and/or drawbacks of co-creating AR content that represents and symbolises relationships between ocean culture and coastal communities.

Why have I been invited to take part?

You have been invited to take part because you currently reside in a coastal town and have knowledge about the ocean and your cultural heritage, as well as the important role of the ocean as a source of livelihood for your community.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be able to keep a copy of this information sheet and will be asked to sign a consent form. You can withdraw from the research at any time without having to give any reasons for withdrawing.

What project activities will I be involved in if I take part?

You will take part in workshops and interviews that will be held with the coastal communities. The objective of the workshops and interviews is to allow the research to gain insight into ocean knowledge, traits, practices, benefits, and cultural heritage. You may also be invited to

be part of the co-design and production (including evaluation) process of an AR interface that captures knowledge regarding your connection to the ocean. The data collected during the workshops and interviews will be combined and used to create the AR interface.

Will it cost me anything?

No, you will be provided with a transportation allowance to assist you with commuting from your house to the community centre where the workshop sessions will be held. Refreshments will be provided.

What are the possible benefits and risks of taking part?

During the workshops, you will be able to express your views and opinions regarding the ocean, which can be useful in raising awareness of the ocean's significance. Through the co-design methods incorporated by the research, you will be exposed to design thinking skills as we co-design and produce the AR interface.

Participating in the research will not disadvantage or put you at any risk.

Will my participation be kept confidential?

Your personal information will not be included in any reports or publications without your permission. If you give permission, you will be duly credited for your contributions. Any data collected about you during the workshops or interviews will be stored on a secure GSA network and protected by passwords and other relevant security processes. Data collected during the research (excluding personal information) may be shared anonymously with other One Ocean Hub researchers. The workshops and interviews will be recorded to assist with analysis.

How is the project being funded?

The research research is organised by the Glasgow School of Art (GSA) and funded by UK Research and Innovation (UKRI) through the Global Challenges Research Fund (GCRF), in association with One Ocean Hub. GCRF is a key component in delivering the UK aid strategy and puts UK-led research and the heart of efforts to tackle the United Nations Sustainable Development Goals.

What will happen to the results of the research?

Results of the research will be analysed and presented in the researcher's doctoral thesis, reports, presentations and other academic outputs.

For more information contact:
Marly Muudeni Samuel (PhD researcher) at: [redacted]
Professor. Stuart Jeffrey (Supervisor) at: [redacted]
Dr. Lisa McDonald (Supervisor) at: [redacted]
Dr. Sirkka Tshiningayamwe (One Ocean Hub Researcher) at: [redacted]

Thank you for reading this information sheet and for considering taking part in this research. Please keep this sheet for future reference

Appendix 1-D: Participant Information Sheet (Second Fieldwork Session: January – February 2023)

PARTICIPANT INFORMATION SHEET

Research title: Participatory Co-production and Augmented Reality for Ocean Heritage: Promoting Ocean Culture and Knowledge in Namibia

Activity: *Efuta Letu Sida Hurib* AR Application Experience

You are invited to take part in a research research with Marly Muudeni Samuel, a Glasgow School of Art PhD student. The research research is part of One Ocean Hub, a five-year collaborative international research programme working in various countries and territories such as Ghana, Namibia, South Africa, and Pacific Islands, with the aim of encouraging equitable and inclusive ocean governance.

Before you decide to take part in the research research, you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read is not clear or if you would like more information. Please take time to decide whether or not you wish to take part.

What is the purpose of the research?

This research investigates ocean connections expressed through heritage, knowledge, and relationships with the ocean, including ocean knowledge and sustainability aspirations shared by participants from Namibia's selected coastal communities. The goal is to understand how digitalisation can support ocean heritage, promote ocean knowledge sharing, and improve ocean conservation. This research investigates the intersections of augmented reality (AR) and ocean heritage to discover the benefits and drawbacks of co-creating AR content that represents and symbolises relationships between ocean culture and coastal communities.

The research expands on ocean connections and knowledge provided by coastal co-researchers through an immersive Augmented Reality application to better understand the ocean's significance for coastal communities and how it impacts them physically, spiritually, mentally, emotionally, culturally, economically, and through nourishment. Through the AR application, which houses various objects representing ocean connections, the AR application aims to communicate the ocean's significance and the connections between the ocean and coastal community members.

Why have I been invited to take part?

You have been invited to participate because a) you currently live in a coastal town and are knowledgeable about the ocean, fishing, your heritage, the activities that take place within coastal communities, and the importance of the ocean as a source of livelihood for your community, and b) you expressed interest and responded to a call to action to participate and

attend a demonstration of the AR application. Participating in the research and providing feedback on your AR interaction and experience will make a significant contribution to the efficacy of the research and the performance of the application.

Do I have to take part?

It is entirely up to you whether or not to participate. If you decide to participate, you will be presented with a copy of this information sheet and asked to sign a consent form. You have the right to withdraw from the research at any time without having to give any reasons for withdrawing. If you decide to withdraw from the research, the research will continue to use the data that you have already contributed, with your permission. If you do not agree with the inclusion of your data after you withdraw from the research, the information you provided will be excluded from the research research.

What project activities will I be involved in if I take part?

You will take part in workshops where you will interact with the co-produced AR application. The objective of the augmented reality interaction sessions is to allow the research to gain feedback for

the refinement of the AR application (including evaluation) that captures knowledge regarding your connection to the ocean. This will involve group discussions around your ocean knowledge and how you would like to see it presented as well as demonstrations of the AR application. The data collected during the workshops will provide valuable inputs to the effectiveness of the research and the performance of the application.

The workshops will include a variety of activities. The first workshops will concentrate on AR interaction experience, and you will be given mobile phones to navigate through the co-produced AR application (you can be seated or standing). Following that, we will have a focus group discussion about your experience with the application and whether any changes need to be made. These workshops will take place on the 28th of November 2022 with the Walvis-Bay community and on the 29th of November 2022 with the Swakopmund community.

The second workshops will concentrate on the demonstration application where you will give feedback on whether it can support coastal communities in capturing ocean knowledge and connections. These workshops will take place on the 02nd of December 2022 with the Walvis-Bay community and on the 07th of December 2022 with the Swakopmund community and on the 10th of December 2022 with the Swakopmund community. At the end of the application demonstration experience, you will fill out an anonymous survey questionnaire on paper for feedback.

The third workshops will be a reflective session in which we will discuss ocean culture, heritage, identity, connections, knowledge and the research journey, and you will be provided with the AR application either by being installed on your mobile device or the application APK will be emailed to you. By installing the application, you will not be required to grant any permissions, and the app will not collect or access any of the data contained on your device. After the conclusion of workshop, you can keep and continue to use the application on your

device at your discretion. These workshops will take place on the 10th of January 2023 with the Walvis-Bay community and on the 11th of January 2023 with the Swakopmund community.

Workshops sessions will have less than 15 participants (see 'risks' section below), will be a maximum of 3 hours and will be held in the morning from 9am-12pm. These will be held at the Walvis-Bay Kuisebmund Community Centre and for Swakopmund, at the Bangelouws Conference Centre and the Mondesa Community Centre. While it is preferable that participants attend all the workshops in their area, you may withdraw your participation at any time.

Will it cost me anything?

No, you will be provided with a transportation allowance to assist you with commuting from your house to the community centre where the workshop sessions will be held. Refreshments will be provided.

What will happen if I take part?

If you agree to participate, please read this information sheet and sign and return the consent form provided by the researcher. The researcher will then provide instructions on how to interact with the AR application, and you will have the opportunity to explore it. To explore the AR application, you will use the provided mobile phones, which will already have the application installed. The researcher will then instruct you on which application to launch and how to navigate through it. After the AR experience, you will be asked to complete a brief survey about your experience with the application, and the process will be completed.

What are the possible benefits and risks of taking part?

While your participation in the research research may not provide any personal benefits, it is expected that you will enjoy the AR experience and gain new knowledge about the ocean. During the workshops and AR interaction session, you will be able to express your views and opinions regarding

the AR application and the ocean information presented which will provide valuable inputs on the effectiveness of the application, which could be useful in raising awareness of the ocean's significance.

The workshops will take place in person, and there is a known risk of Covid-19 transmission. Thus, all workshop sessions will adhere to local and national guidelines to prevent the spread of COVID-19, including hand hygiene, and enhanced ventilation. The workshop sessions will make use of mobile devices to demonstrate, evaluate and test the co-produced augmented reality application. Any equipment (for example, pens, and mobile phones) used in the workshops will be thoroughly sanitised before being shared among participants. While all rules and best practices will be followed, any meeting between people incurs some risk of transmission.

Will my participation be kept confidential?

Your personal information will not be included in any reports or publications without your permission. Any data collected about you during the workshops will be stored on a secure GSA

network and protected by passwords and other relevant security processes. The workshops will be recorded to assist with analysis. As a participant, you can choose whether you want to be credited for the information you share or whether you want to remain anonymous. If you give permission, you will be duly credited for your contributions. Permission will be sought via a consent form which participants will be asked to complete. With your consent, your interaction with the AR application will be videoed, recorded and photographed to provide information on the design, performance and effectiveness of the experience. You have a choice for you (your face) to be identifiable or not in the photographs and videos. If you are not comfortable with your face being visible in the photographs and videos, the researcher will ensure that your face is not visible and will be blurred out.

With your permission, data collected during the research including individual quotes, information contributed, photographs, videos and the co-designed augmented reality interface (with the exception of your personal information) may be shared anonymously with other One Ocean Hub researchers and made publicly available in publications, presentations, reports or examinable format (dissertation or thesis) for the purposes of research and teaching. Permission will be sought via a consent form which participants will be asked to complete.

How is the project being funded?

The research research is organised by the Glasgow School of Art (GSA) and funded by the One Ocean Hub through the Global Challenges Research Fund (GCRF). GCRF is a key component in delivering the UK aid strategy and puts UK-led research and the heart of efforts to tackle the United Nations Sustainable Development Goals.

What will happen to the results of the research?

The results of the research will be analysed, evaluated and presented in the researcher's doctoral thesis, reports, presentations and other academic outputs.

For more information contact:
Marly Muudeni Samuel (PhD researcher) at: [redacted]
Professor. Stuart Jeffrey (Supervisor) at: [redacted]
Dr. Lisa McDonald (Supervisor) at: [redacted]
Dr. Sirkka Tshiningayamwe (One Ocean Hub Researcher) at: [redacted]

Thank you for reading this information sheet and for considering taking part in this research. Please keep this sheet for future reference

Marly Muudeni Samuel, PhD Student Researcher

School of Simulation and Visualisation, The Glasgow School of Art

Appendix 1-E: Consent Form (First Fieldwork Session: January – March 2022)

Research Consent Form

Research Project Title: **Community Co-Design and Augmented Reality for Ocean Heritage: Promoting Sustainable Livelihoods in Namibia**

Lead Researcher: **Marly Muudeni Samuel**

Email address: [redacted]

Contact number: [redacted]

Please initial boxes

1. I confirm that I have read and understand the participant information sheet for the above research; ☐
2. I have had an opportunity to consider the information, ask questions and have had these answered satisfactorily; ☐
3. I agree to being photographed / audio recorded / video recorded as part of the research. (Delete as appropriate) ☐
4. I agree to photographs/ audio recordings/ video recordings being made available in publications, presentations, reports or examinable format (dissertation or thesis) for the purposes of research and teaching. (Delete as appropriate) ☐
5. I agree / do not agree to being acknowledged and credited for my contributions in the above research. (Delete as appropriate) ☐
6. I agree to the content collected, individual quotes and information contributed and the co-designed augmented reality interface to being used and made publicly available in publications, presentations, reports or examinable format (dissertation or thesis) for the purposes of research and teaching, excluding my personal information and images, unless I have given permission for these to be used; ☐
7. I agree to the results being used for *future* research or teaching purposes; ☐
8. I agree to take part in the above research. ☐
9. I am happy to be contacted about any future studies and agree that my personal contact details can be retained in accordance with the UK Data Protection Act 2018 ☐

Name of participan	Date	Signature
Researcher	Date	Signature

Appendix 1-F: Consent Form (Second Fieldwork Session: January – February 2023)

Research Consent Form

Research Project Title: **Participatory Co-production and Augmented Reality for Ocean Heritage: Promoting Ocean Knowledge in Namibia**

Lead Researcher: **Marly Muudeni Samuel**

Email address: [redacted]

Please initial boxes

Contact number: [redacted]

1. I confirm that I have read and understand the participant information sheet for the above research; ☐
2. I have had an opportunity to consider the information, ask questions and have had these answered satisfactorily; ☐
3. I agree/disagree to being photographed as part of the research and for the photographs to being made available in publications, presentations, reports or examinable format (dissertation or thesis) for the purposes of research and teaching. (Delete as appropriate); ☐
4. I agree/disagree to being video recorded as part of the research and for the videos to being made available in publications, presentations, reports or examinable format (dissertation or thesis) for the purposes of research and teaching. (Delete as appropriate). ☐
5. I agree/disagree to being audio recorded as part of the research. (Delete as appropriate); ☐
6. I agree/disagree to being identifiable in photographs and video recordings when they are made available in publications, presentations, reports or examinable format (dissertation or thesis) for the purposes of research and teaching. If you disagree to being identifiable, your face will be blurred out and your name will not be used. (Delete as appropriate); ☐
7. I agree/disagree to collected data and information being made available in publications, presentations, reports or examinable format (dissertation or thesis) for the purposes of research and teaching. (Delete as appropriate); ☐

8. I agree to the content collected, individual quotes and information contributed and the co-designed augmented reality interface to being used and made publicly available in publications, presentations, reports or examinable format (dissertation or thesis) for the purposes of research and teaching, excluding personal information, unless I have given permission for these to be used. (Delete as appropriate); ☐

9. I agree/disagree to being acknowledged and credited for my contributions (collected content, individual quotes, information contributed and the co-designed augmented reality interface) to the above research. If you disagree, your contributions will be anonymous. (Delete as appropriate); ☐

10. I agree to the results being used for *future* research or teaching purposes; ☐

11. I agree to take part in the above research; ☐

12. I am happy to be contacted about any future studies and agree that my personal contact details can be retained in accordance with the UK Data Protection Act 2018; ☐

Name of participant	Date	Signature
Researcher	Date	Signature

Appendix 1-G: Ethical Review (First Fieldwork Session: January – March 2022)

Form 2: Full ethical assessment

THE GLASGOW SCHOOL OF ART

Please complete all sections unless advised otherwise by Research and Enterprise. Questions highlighted in **bold** and *italicised* are particularly important and answers must be detailed or there will be a delay in obtaining ethical approval.

Upon completion, please email to research@gsa.ac.uk. Your application will then be sent for review by members of the GSA Research Ethics Sub Committee.

1. APPLICANT DETAILS

Name of researcher (Applicant):	Marly Muudeni Samuel
School:	Simulation and Visualisation
Project Title:	Community Co-Design and Augmented Reality for Ocean Heritage: Promoting Sustainable Livelihoods in Namibia
Funder:	GSA (GCRF)
Date work is scheduled to begin:[1]	24/1/22

2. RECRUITMENT

a)

Number of participants required:	c.20
Will recruitment be direct (led by the researcher) or indirect (led by an organisation / third party)?	DIRECT

b) If your research involves INDIRECT recruitment, please detail the recruitment plan covering: i) organisation / institution / individual in charge of identifying possible participants; ii) how they will recruit individuals (letters, phone calls etc); iii) any individual who has direct contact with participants; iv) any ethical protocols the third party has in place; v) level of permission that third party has to disseminate information on behalf of the participants (append any documents if necessary)

Participants will be recruited directly.

c) If your research involves DIRECT recruitment (i.e led by the applicant / research team):

[1] We will endeavor to return a speedy response to applicants but you are advised to send us your application as soon as possible to ensure your research timetable is not compromised

Who is in charge of recruitment:

Marly Muudeni Samuel

What is the method of identifying participants?

Participants will be identified based on a focal point that they reside in one of the Namibian coastal towns. The research will identify individuals, organisations, and communities from these coastal towns. The research will be reaching out directly to organisations and communities by looking into active groups, suggestions from the Ministries and local councils. The researcher will also reach out to chairpersons of the various fishing Associations, women groups and fishers groups.

How will participants be invited to take part: (e.g. letters, phonecalls, door to door):

The Participants will be invited through emails and phone calls.

d) Regardless of method of recruitment, what is your exclusion / inclusion criteria for this research:

The research will focus on Namibian individuals who reside in coastal towns (Swakopmund, Walvis Bay, and the Topnaar community). The research will focus on individuals between the ages of 18 and above who have connections to the ocean and do ocean-related work (Fisherman, ocean activists, community members, local authorities, civil society).

In all cases, append a copy of i) information sheet for participants; ii) consent form; iii) copies of any other documents distributed to participants

3. CONSENT

a) Give a detailed account of the steps taken by the researcher to obtain informed consent from the participants (regardless of method of recruitment):

The participants will exercise their rights to informed consent. Consent for participant to take part in the research research will obtained at the point of contact, and they will have the chance to decide whether they want or do not want to participate in the research research. • Participants will be provided with an information sheet that explains and puts the aims of the research research into perspective. • A discussion will be held with the participants to clarify all their options to participate. • The researcher ask consent for people to participate, and for the sessions to be recorded and videoed for analysis purposes. • The researcher will ask consent for photographs to taken and for them to be used in academic writings and the researcher's thesis. The researcher will enquire with the participants on the types of photographs they are comfortable with being included in academic writings and the researcher's thesis. If participants are uncomfortable with their faces being visible in photographs, their faces will be blurred. • The researcher will ensure that the participants are given adequate information research and that they understand all the details and information about the research research. • The researcher will respond to all the questions asked by the participants.

- As the research process continues, the researcher will continue providing information about the research development as required by the participants.
- The participants will have freedom of decision and they can withdraw from the research research at any time.
- With permission, participants will be credited for their contribution.

b) How will researchers ensure the participant has capacity to consent:

- Based on the discussion about the PIS and before the completing the consent process, the researcher will assess the capacity of the participants to ensure that they are independently able to freely give that consent.

c) If your work requires participants belonging to vulnerable groups (children under 16, adults unable to give consent, prisoners, individuals in dual relationships), what additional steps will be taken to gain consent:

The research will not work with vulnerable groups.

d) If your work requires the consent of a gatekeeper, please detail the steps you will take to ensure participants are not coerced by their gatekeeper. State also whether you plan to obtain additional signatures from participants and if not, why

The research work will not make use of a gatekeeper. It will, however, reach out to community group leaders for participant referrals. Every participant taking part in the research research will be asked to sign a consent form if they are willing. It will be made clear to the participants that they are under no obligation to participate in the research research and are free to withdraw at any time.

e)

How much time will be given for the participant to decide whether or not to take part:	The participants will be contacted and informed one month in advance. They will have one month to decide if they want to take part in the research project or not.
By what method will you seek to obtain consent (written, oral, video etc) and why: NB: please be aware of any Data Protection issues here	The project will seek to obtain hard copy written consent Hard copy written consent documents will be used as a guide for the verbal explanation of the research. It will be the basis of an expressive exchange between the researcher and the participants. It will include details about the research and details about what the information gathered will be used for.
Will copies of consent be given to participants:	YES
For how long will the copies of consent be retained by the researcher and where will the consent form be stored:	The hard copy consent copies will be scanned and the electronic consent forms will be retained for the duration of the research project. The hard copies will be given back to the participants. The electronic consent copies will be stored on secure GSA network drive.

4. LOCATION

a) If the research activities take place in a third party location (i.e. not on GSA premises), please explain the choice with reference to the research. Append confirmation of permission to use location given by the owner and confirm that all researchers have been made aware of any local rules and regulations (append if necessary).

The research will take place in Namibia within the local coastal towns. The research will use local community centres to conduct the workshops.

In Swakopmund, research workshops will take place at the Bangelouws Conference Centre and in Walvis-Bay at the Kuisebmund Community Centre.

Walvis-Bay: Kuisebmond Community Centre

5th Avenue ERF. 2426
P.O. Box 4253
Walvis Bay, Namibia
Phone: 064 200901
Cell: [redacted]
Fax: [redacted]
E-Mail: [redacted]

Website: https://kuisebmondcommunitycentre.wordpress.com/contact/

Swakopmund: Swakopmund Municipality Bungalows
Cnr Hendrik Witbooi & Swakop st
Swakopmund, Namibia
Phone: [redacted]
Fax: [redacted]

E-mail: [redacted] Website: https://swakopmun.com/ (This is the Municipality website)

b) If the research activities take place in the participants' home, please CLEARLY explain the choice with reference to the research and why no other location is possible. Detail all measures taken to minimise the risk to both participants and researchers entering the home.

Research workshops and activities will not take place in participants homes.

5. INCENTIVES

a) Reasonable reimbursements for time and travel compensation are acceptable as incentives to participate in a research research. An acceptable level of reimbursement would be no more than £50 (approximately).

Do you plan any of the following?

Travel reimbursement only	NO
Small incentive only (e.g. gift voucher)	NO
Travel and small incentive	YES

b) If the incentive exceeds £50, please state the reasons why (note a large financial incentive, whilst appearing generous, could be deemed unethical on the grounds of coercion. See also, the Bribery Act 2010):

The Travel and small incentive reimbursement will not exceed £50.

6. METHODOLOGY AND ACTIVITIES

a) Please state the methodology employed within the research and give references (literature or any previous work by the researcher) to support their use:

The research will employ Research through Design and Action Research as overarching methodologies coupled with community-based co-design methods (CBCD) and rapid ethnography. These methods will guide the fieldwork workshops and the design process. CBCD emphasises the engagement of communities at all stages of design processes (Kapuire et al., 2015) and empowers the community with education and skills (Van Zyl & Vannini, 2013), often engendering wellbeing through generating avenues for self-expression (Sabiescu, 2015). The research will use qualitative data gathering methods that include ethnographic mapping work through workshop focus groups, interviews, and participant observation. References • Kapuire, G. K., Winschiers-Theophilus, H., and Blake, E. 2015. An insider perspective on community gains: A subjective account of a Namibian rural

communities ′perception of a long-term participatory design project. International Journal of Human-Computer Studies, (pp. 124-143).
- Samuel, M., Taylor, J., Winschiers-Theophilus, H. and Nieminen, M., 2017, June. Improving the flow of livelihood information among unemployed youth in an informal settlement of Windhoek, Namibia. In *Proceedings of the 8th International Conference on Communities and Technologies* (pp. 256-265).
- Smith, R.C., Winschiers-Theophilus, H., Loi, D., de Paula, R.A., Kambunga, A.P., Samuel, M.M. and Zaman, T., 2021, May. Decolonizing Design Practices: Towards Pluriversality. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-5).
- Van Zyl, I. and Vannini, S., 2013. Participatory re-action: reflecting on a Design-Based Research approach in ICT4D. In *Public and private access to ICTs in developing regions. Proceedings of the 7th International Development Informatics Conference, Bangkok, Thailand*. (pp. 1-19)
- Winschiers-Theophilus, H., Virmasalo, V., Samuel, M.M., Stichel, B. and Afrikaner, H.E., 2020. Facilitating design for the unknown: An inclusive innovation design journey with a San community in the Kalahari Desert. In *Proceedings of the Sixth International Conference on Design Creativity (ICDC 2020)* (pp. 263-270).
- Winschiers-Theophilus, H., Zaman, T., and Stanley, C. 2017. A classification of cultural engagements in community technology design: introducing a transcultural approach. Ai & Society, (pp. 1-17).

b) For each activity employed please detail: i) its purpose; ii) direct correlation to the research outcomes; iii) how any analysis will be performed. **Copies of all material given to participants must be appended to this form wherever possible.**

ACTIVITY 1: (e.g. questionnaire, focus group, interview etc),

Focus Groups

i) Focus groups will be used to gather qualitative data, in-depth insight and collective views of ocean connections.
ii) The focus group sessions will be conducted with communities from Namibian coastal towns to understand ocean connections and how ocean knowledge and cultural heritage can contribute towards sustainable livelihoods and improved ocean conservation.
iii) Information gathered will be analysed through observation, comparison analysis.

ACTIVITY 2: (e.g. questionnaire, focus group, interview etc),

Interviews

i) Interviews will be used to gather qualitative data about the ocean connections and cultural heritage and gain in-depth insight into ocean knowledge.
ii) Interview sessions will be conducted with participants and individuals from local groups, local authorities, and fisheries in the Namibian coastal towns to obtain a different perspective on the ocean, its benefits, and connections.
iii) Information gathered will be analysed through observation, comparison analysis.

ACTIVITY 3: (e.g. questionnaire, focus group, interview etc),

Participant observation

i) Participant observation will be used in workshop sessions to foster an in-depth understanding of ocean connections and cultural heritage.
ii) Participant observation will be used to learn and understand the how's and whys of ocean connections, ocean knowledge, and ocean practices that contribute towards sustainable livelihoods and improved ocean conservation.
iii) Information gathered will be analysed through observation, comparison analysis.

If there are any further activities, please continue and append to this form.

c) State how harm, distress or anxiety to the participants will be minimised during the research

- The research will obtain informed consent from the participants
- Participants confidentiality will be protected.
- Shared information will not be included in any reports or publications without the participants permission.
- Participants will be provided with the right to withdraw from the research at any time.

d) Please state the time commitment of the participants and whether you plan repetitive testing as part of the research

Each workshop session will run for 2 hours. The time commitment for the participants will also be 2 hours. The research fieldwork will consist of 4 different phases that will be conducted separately.

e) What is the statistical power of the research:

This research is qualitative and not quantitative.

If you plan to leave participants with information at the close of the research (e.g. leaflets with further information, details of support groups etc), please append to this form.

7. PARTICIPANT DATA

All researchers must abide by the Data Protection Act 1998 and the GSA Data Protection Policy – it is the responsibility of the researcher to familiarise themselves with each.

Here we make the distinction between personal data (anything that identifies a participant such as name, address, phone number) and research data generated by that participant (interview, photos of etc) as each requires a different for handling and storage.

	Personal Data	**Research Data**
Who is the custodian of the data:	Researcher	Researcher
Where will the data be stored:	Data will be stored on a secure GSA network.	Data will be stored on a secure GSA network.
Who has access to the data:	Researcher	Researcher, participants, public
Will permission to identify the participants be sought as part of informed consent	YES	
What methods will be undertaken to guarantee anonymity (e.g. coding, ID numbers, use of pseudonyms)	Use of pseudonyms	
How will the link be broken between participant details and information given as part of research?	Participant details will not be included in the research without permission. If permission is granted, participants will be duly credited for their contributions	Participant details will not be included in the research without permission. If permission is granted, participants will be duly credited for their contributions. Shared information relating to the research (ocean cultural heritage and knowledge) will be used in the research also with permission from the participants.
How long will the data be stored for? (Participants must be made aware of this at point of consent).	For the duration of the PhD research research	For the duration of the OOH project plus its subsequent data retention period.
How will the security of the dataset in its entirety be secured?	The data will be secured on a GSA network.	The research data will be secured on a GSA network.
How will the data generated by analysed and used?	Participant details will not be included in the research without permission. If permission is granted, participants will be duly credited for their contributions.	For analysis, the research will use comparison analysis. The data will be used to investigate ocean connections. The data will similarly be used in academic publications and presentations for knowledge sharing and academic advancement. The output of the research

		will be embedded in an AR application that will be shared with the participants.
Who will have access to the data beyond the project (if the data is being retained, not destroyed)	The researcher will have access to the data beyond the project.	The research data generated with consent will be accessible to other One Ocean Hub researchers. The research output may be archived with the GSA data repository.
Does the research funder require the participant data generated be lodged with them upon conclusion? If yes, give details	No	No

8. SAFETY

All researchers must abide by the GSA Health and Safety Policy (_) – it is the responsibility of the researcher to familiarise themselves with this.

a) How will the safety of the participants be ensured during this research?

The safety of the participants will be ensured in conjunction with the GSA Heath and Safety Policy.

- Health and safety rule will be brought to the attention of the participants
- All the safety exits to the venue will be identified, and participants will be notified of the safety exits.
- Workshops will be conducted early (within office hours and in daylight). This will also give participants ample time to get back to their homes safely.
- If necessary and for safety, adjustments will be made to the workshop schedule.

b) If your work requires participants belonging to vulnerable groups (children under 16, adults unable to give consent, prisoners, individuals in dual relationships), what additional steps will be taken to ensure their safety:

The research will not work with vulnerable groups.

c) If the research involves work on non-GSA premises, how will the safety of researchers working off site be ensured?

The safety of the research will be ensured, and the researcher will not in any way put themselves in harm's way.

- The workshops will be held at public venues (community centres).
- The researcher will verify that the venue where the workshops will be conducted is in a safe location.
- The researcher will not work alone; she will work together with the OOH Namibia team, and in cases where they are not available, an assistant will help the researcher. In instances where the researcher will work alone, arrangements will be made with colleagues from OOH Namibia to check in with the researcher at the beginning and the end of the workshops.
- The researcher will only take necessary valuables, and they will be close and under surveillance.

d) Covid-19 safety measures?

The research will follow covid-19 security measures put in place by the Namibian government to protect the participants and curb the spread of the virus. The research will follow the measures put in place:

- Social distancing rules (1-2 metres of space between individuals).
- Wearing of masks during focus groups and interviews.
- Sanitising of hands and surfaces and off any shared equipment
- Contact tracing (register, inc. ID no./Cell to be kept for 30 days and provided to the authorities on request)
- Respect of curfew times put in place

Before travelling to Namibia, the researcher will receive the two necessary covid-19 vaccinations to protect herself and those around her.

Please see attached the statement by the Namibian President Dr. Hage G. Geingob on the Covid-19 measures to be followed released on November 2021.

Both workshop venues are run and maintained by the government. Thus, they follow the Covid-19 guidelines provided by the head of state and government. Changes to COVID mitigation measures locally and nationally will be monitored closely.

Workshop venues are run and maintained by the Namibian government. Thus, they follow the Covid-19 guidelines provided by the head of state and government.

https://moj.gov.na/general-covid-19-regulations

Current relevant restrictions.

- Use protective face masks in public spaces and public transportation.
- Keep social distance protocols at all times in public spaces like shopping centers, cultural attractions, offices, bars, restaurants, leisure places, etc.
- Indoor gatherings are limited to 50 people.

9. DECLARATION

Please ensure you have answered all the questions herein and have appended the following documents:

Consent form **YES** / NO Participant Information Sheet **YES** / NO

Follow up information YES / NO Any other relevant documentation (please state):

I certify that the information contained in this application is accurate. I understand that should I commence research work in absence of ethical approval, such behaviour may be subject to disciplinary procedures.	
Name of Principal Investigator:	Marly Muudeni Samuel
Signed:	
Date:	17 November 2022

Please email the completed form and associated documents to Research and Enterprise (research@gsa.ac.uk).

Appendix 1-H: Ethical Review (Second Fieldwork Session: January – February 2023)

Form 2: Full ethical assessment

THE GLASGOW SCHOOL OF ART

Please complete all sections unless advised otherwise by Research and Enterprise. Questions highlighted in **bold** and *italicised* are particularly important and answers must be detailed or there will be a delay in obtaining ethical approval.

Upon completion, please email to research@gsa.ac.uk. Your application will then be sent for review by members of the GSA Research Ethics Sub Committee.

1. APPLICANT DETAILS

Name of researcher (Applicant):	Marly Muudeni Samuel
School:	Simulation and Visualisation
Project Title:	Participatory Co-production and Augmented Reality for Ocean Heritage: Promoting Ocean Knowledge in Namibia
Funder:	GSA (GCRF)
Date work is scheduled to begin:[2]	09/01/23

2. RECRUITMENT

a)

Number of participants required:	c.20
Will recruitment be direct (led by the researcher) or indirect (led by an organisation / third party)?	DIRECT

b) If your research involves INDIRECT recruitment, please detail the recruitment plan covering: i) organisation / institution / individual in charge of identifying possible participants; ii) how they will recruit individuals (letters, phone calls etc); iii) any individual who has direct contact with participants; iv) any ethical protocols the third party has in place; v) level of permission that third party has to disseminate information on behalf of the participants (append any documents if necessary)

Participants were recruited directly.

[2] We will endeavor to return a speedy response to applicants but you are advised to send us your application as soon as possible to ensure your research timetable is not compromised

c) If your research involves DIRECT recruitment (i.e led by the applicant / research team):

Who is in charge of recruitment:

Marly Muudeni Samuel

What is the method of identifying participants?

Participants were identified based on a focal point that they reside in one of the Namibian coastal towns. The research identified individuals, organisations, and communities from these coastal towns. The research directly reached out to organisations and communities by looking into active groups, and suggestions from the Ministries and local councils. The researcher also reached out to chairpersons of the various fishing Associations, women groups and fishers groups.

How will participants be invited to take part: (e.g. letters, phonecalls, door to door):

The Participants will be invited to the workshops through emails and phone calls.

d) Regardless of method of recruitment, what is your exclusion / inclusion criteria for this research:

The co-research participants are Namibian individuals who reside in coastal towns (Swakopmund, Walvis Bay, and the Topnaar community), those with ocean connections and undertake ocean-related work (Fisherman, ocean activists, community members, local authorities, civil society) aged between 18 and above.

In all cases, append a copy of i) information sheet for participants; ii) consent form; iii) copies of any other documents distributed to participants

3. CONSENT

a) Give a detailed account of the steps taken by the researcher to obtain informed consent from the participants (regardless of method of recruitment):

The participants will exercise their rights to informed consent. Consent for the participant to take part in the research research will be obtained at the point of contact, and they will have the chance to decide whether they want or do not want to participate in the research research. • Participants will be provided with an information sheet that explains and puts the aims of the research research into perspective. • A discussion will be held with the participants to clarify all their options to participate. • The researcher will ask consent for people to participate, and for the sessions to be recorded and videoed for analysis purposes. • The researcher will ask consent for photographs to taken and for them to be used in academic writings and the researcher's thesis. The researcher will enquire with the participants on the types of photographs they are comfortable with being included in

academic writings and the researcher's thesis. If participants are uncomfortable with their faces being visible in photographs, their faces will be blurred.

- The researcher will ensure that the participants are given adequate information research and that they understand all the details and information about the research research.
- The researcher will respond to all the questions asked by the participants.
- As the research process continues, the researcher will continue providing information about the research development as required by the participants.
- The participants will have freedom of decision and they can withdraw from the research research at any time.
- With permission, participants will be credited for their contribution.

b) How will researchers ensure the participant has capacity to consent:

- Based on the discussion about the PIS and before completing the consent process, the researcher will assess the capacity of the participants to ensure that they are independently able to freely give that consent.

c) If your work requires participants belonging to vulnerable groups (children under 16, adults unable to give consent, prisoners, individuals in dual relationships), what additional steps will be taken to gain consent:

The research will not work with vulnerable groups.

d) If your work requires the consent of a gatekeeper, please detail the steps you will take to ensure participants are not coerced by their gatekeeper. State also whether you plan to obtain additional signatures from participants and if not, why

The research work will not make use of a gatekeeper. It will, however, reach out to community group leaders for participant referrals. Every participant taking part in the research research will be asked to sign a consent form if they are willing. It will be made clear to the participants that they are under no obligation to participate in the research research and are free to withdraw at any time.

e)

How much time will be given for the participant to decide whether or not to take part:	The participants will be contacted and informed one month in advance. They will have one month to decide if they want to take part in the research project or not.
By what method will you seek to obtain consent (written, oral, video etc) and why: NB: please be aware of any Data Protection issues here	The project will seek to obtain a hard copy written consent Hard copy written consent documents will be used as a guide for the verbal explanation of the research. It will be the basis of an expressive exchange between the researcher and the participants. It will include details about the research and details about what the information gathered will be used for.
Will copies of consent be given to participants:	YES
For how long will the copies of consent be retained by the researcher and where will the consent form be stored:	The hard copy consent copies will be scanned and the electronic consent forms will be retained for the duration of the research project. The hard copies will be given back to the participants. The electronic consent copies will be stored on secure GSA network drive.

4. LOCATION

a) If the research activities take place in a third party location (i.e. not on GSA premises), please explain the choice with reference to the research. Append confirmation of permission to use location given by the owner and confirm that all researchers have been made aware of any local rules and regulations (append if necessary).

The research will take place in Namibia within the local coastal towns. The research will use local community centres to conduct workshops and augmented reality demonstrations. In Swakopmund, research workshops will take place at the Bangelouws Conference Centre and the Mondesa Community Hall and in Walvis-Bay at the Kuisebmund Community Centre. Walvis-Bay: Kuisebmond Community Centre 5th Avenue ERF. 2426 P.O. Box 4253

Walvis Bay, Namibia
Phone: 064 200901
Cell: [redacted]
Fax: [redacted]
E-Mail: [redacted]
Website: https://kuisebmondcommunitycentre.wordpress.com/contact/

Swakopmund: Swakopmund Municipality Bungalows
Cnr Hendrik Witbooi & Swakop st
Swakopmund, Namibia
Phone: [redacted]
Fax: [redacted]
E-mail: [redacted]
Website: https://swakopmun.com/ (This is the Municipality website)

Multi-Purpose Mondesa Community Hall
8GMV+Q5J, 1st Ave, Swakopmund, Namibia
Phone: [redacted]
Email: [redacted]
Website: https://kuisebmondcommunitycentre.wordpress.com/contact/

b) If the research activities take place in the participants' home, please CLEARLY explain the choice with reference to the research and why no other location is possible. Detail all measures taken to minimise the risk to both participants and researchers entering the home.

Research workshops and activities will not take place in participant homes.

5. INCENTIVES

a) Reasonable reimbursements for time and travel compensation are acceptable as incentives to participate in a research research. An acceptable level of reimbursement would be no more than £50 (approximately).

Do you plan any of the following?

Travel reimbursement only	NO
Small incentive only (e.g. gift voucher)	NO
Travel and small incentive	YES

b) If the incentive exceeds £50, please state the reasons why (note a large financial incentive, whilst appearing generous, could be deemed unethical on the grounds of coercion. See also, the Bribery Act 2010):

The Travel and small incentive reimbursement will not exceed £50.

6. METHODOLOGY AND ACTIVITIES

a) Please state the methodology employed within the research and give references (literature or any previous work by the researcher) to support their use:

The research will employ Research through Design and Action Research as overarching methodologies coupled with community-based co-design methods (CBCD).These methods will guide the fieldwork workshops and the design process. CBCD emphasises the engagement of communities at all stages of design processes (Kapuire et al., 2015) and empowers the community with education and skills (Van Zyl & Vannini, 2013), often engendering wellbeing through generating avenues for self-expression (Sabiescu, 2015).

The research will use qualitative data gathering methods that include ethnographic mapping work through workshop focus groups, interviews, and participant observation.

References

- Kapuire, G. K., Winschiers-Theophilus, H., and Blake, E. 2015. An insider perspective on community gains: A subjective account of a Namibian rural communities ′perception of a long-term participatory design project. International Journal of Human-Computer Studies, (pp. 124-143).
- Samuel, M., Taylor, J., Winschiers-Theophilus, H. and Nieminen, M., 2017, June. Improving the flow of livelihood information among unemployed youth in an informal settlement of Windhoek, Namibia. In *Proceedings of the 8th International Conference on Communities and Technologies* (pp. 256-265).
- Smith, R.C., Winschiers-Theophilus, H., Loi, D., de Paula, R.A., Kambunga, A.P., Samuel, M.M. and Zaman, T., 2021, May. Decolonizing Design Practices: Towards Pluriversality. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-5).
- Van Zyl, I. and Vannini, S., 2013. Participatory re-action: reflecting on a Design-Based Research approach in ICT4D. In *Public and private access to ICTs in developing regions. Proceedings of the 7th International Development Informatics Conference, Bangkok, Thailand*. (pp. 1-19)
- Winschiers-Theophilus, H., Virmasalo, V., Samuel, M.M., Stichel, B. and Afrikaner, H.E., 2020. Facilitating design for the unknown: An inclusive innovation design journey with a San community in the Kalahari Desert. In *Proceedings of the Sixth International Conference on Design Creativity (ICDC 2020)* (pp. 263-270).
- Winschiers-Theophilus, H., Zaman, T., and Stanley, C. 2017. A classification of cultural engagements in community technology design: introducing a transcultural approach. Ai & Society, (pp. 1-17).

b) For each activity employed please detail: i) its purpose; ii) direct correlation to the research outcomes; iii) how any analysis will be performed. **Copies of all material given to participants must be appended to this form wherever possible.**

ACTIVITY 1: (e.g. questionnaire, focus group, interview etc),

Focus Group Workshops

iv) The workshops will consist of focus group sessions concentrating on AR interaction experience and application demonstration to test, evaluate, and refine the co-produced AR application. The focus group workshops will also include a reflection session for final views and discussions about the application and ocean connections and knowledge.

v) The focus group workshops will be conducted with communities from Namibian coastal community members to interact, evaluate and refine the co-produced AR application.

vi) Information gathered will be analysed through observation, narrative and thematic analysis.

ACTIVITY 2: (e.g. questionnaire, focus group, interview etc),

Survey Questionnaire

iv) After participants have engaged with the AR application, they will fill out an anonymous survey questionnaire on paper for feedback. The questionnaire will be used to gather qualitative data about AR application usability and their ocean connections and cultural heritage to evaluate the application and gain in-depth insight into ocean knowledge.

v) Survey questionnaires will be completed by participants and individuals who from Namibian coastal towns.

vi) Information gathered will be analysed through observation, narrative and thematic analysis.

ACTIVITY 3: (e.g. questionnaire, focus group, interview etc),

Participant observation

iv) Participant observation will be used in workshop sessions to foster an in-depth understanding of how the participants interact with the AR application.

v) Information gathered will be analysed through observation, narrative and thematic analysis.

If there are any further activities, please continue and append to this form.

c) State how harm, distress or anxiety to the participants will be minimised during the research

- The research will obtain informed consent from the participants
- Participants confidentiality will be protected.
- Shared information will not be included in any reports or publications without the participants permission.
- Participants will be provided with the right to withdraw from the research at any time.

d) Please state the time commitment of the participants and whether you plan repetitive testing as part of the research

Each workshop and application testing session will run for 3 hours. The time commitment for the participants will also be 3 hours. The research fieldwork will consist of 2 different phases that will be conducted separately. One phase will be conducted with co-research participants to test, evaluate, and refine the app. Another phase will be conducted with external stakeholders to obtain additional views and opinions about the app and to test, evaluate, and refine based on the provided feedback.

e) What is the statistical power of the research:

This research is qualitative and not quantitative.

If you plan to leave participants with information at the close of the research (e.g. leaflets with further information, details of support groups etc), please append to this form.

7. PARTICIPANT DATA

All researchers must abide by the Data Protection Act 1998 and the GSA Data Protection Policy – it is the responsibility of the researcher to familiarise themselves with each.

Here we make the distinction between personal data (anything that identifies a participant such as name, address, phone number) and research data generated by that participant (interview, photos of etc) as each requires a different for handling and storage.

	Personal Data	**Research Data**
Who is the custodian of the data:	Researcher	Researcher
Where will the data be stored:	Data will be stored on a secure GSA network.	Data will be stored on a secure GSA network.
Who has access to the data:	Researcher	Researcher, participants, public

Will permission to identify the participants be sought as part of informed consent	YES	
What methods will be undertaken to guarantee anonymity (e.g. coding, ID numbers, use of pseudonyms)	Use of alias names provided by the co-research participants.	
How will the link be broken between participant details and information given as part of research?	Participant details will not be included in the research without permission. If permission is granted, participants will be duly credited for their contributions	Participant details will not be included in the research without permission. If permission is granted, participants will be duly credited for their contributions. Shared information relating to the research (ocean cultural heritage and knowledge) will be used in the research also with permission from the participants.
How long will the data be stored for? (Participants must be made aware of this at point of consent).	For the duration of the PhD research research	For the duration of the OOH project plus its subsequent data retention period.
How will the security of the dataset in its entirety be secured?	The data will be secured on a GSA network.	The research data will be secured on a GSA network.
How will the data generated by analysed and used?	Participant details will not be included in the research without permission. If permission is granted, participants will be duly credited for their contributions.	For analysis, the research will use comparison analysis. The data will be used to investigate ocean connections. The data will similarly be used in academic publications and presentations for knowledge sharing and academic advancement. The output of the research will be embedded in an AR application that will be shared with the participants.
Who will have access to the data beyond the project (if the data is being retained, not destroyed)	The researcher will have access to the data beyond the project.	The research data generated with consent will be accessible to other One Ocean Hub researchers. The research output may be archived with the GSA data repository.
Does the research funder require the participant data generated be lodged with them upon conclusion? If yes, give details	No	No

8. SAFETY

All researchers must abide by the GSA Health and Safety Policy ( ) – it is the responsibility of the researcher to familiarise themselves with this.

a) How will the safety of the participants be ensured during this research?

The safety of the participants will be ensured in conjunction with the GSA Heath and Safety Policy.

- Health and safety rule will be brought to the attention of the participants
- All the safety exits to the venue will be identified, and participants will be notified of the safety exits.
- Workshops will be conducted early (within office hours and in daylight). This will also give participants ample time to get back to their homes safely.
- If necessary and for safety, adjustments will be made to the workshop schedule.

b) If your work requires participants belonging to vulnerable groups (children under 16, adults unable to give consent, prisoners, individuals in dual relationships), what additional steps will be taken to ensure their safety:

The research will not work with vulnerable groups.

c) If the research involves work on non-GSA premises, how will the safety of researchers working off site be ensured?

The safety of the research will be ensured, and the researcher will not in any way put themselves in harm's way.

- The workshops will be held at public venues (community centres).
- The researcher will verify that the venue where the workshops will be conducted is in a safe location.
- The researcher will not work alone; she will work together with the OOH Namibia team, and in cases where they are not available, an assistant will help the researcher. In instances where the researcher will work alone, arrangements will be made with colleagues from OOH Namibia to check in with the researcher at the beginning and the end of the workshops.
- The researcher will only take necessary valuables, and they will be close and under surveillance.

d) Covid-19 safety measures?

The research will follow covid-19 security measures put in place by the Namibian government to protect the participants and curb the spread of the virus. The research will follow the measures put in place:

- Social distancing rules (1-2 metres of space between individuals).
- Wearing masks during focus groups and interviews.
- Sanitising of hands and surfaces and off any shared equipment
- Contact tracing (register, inc. ID no./Cell to be kept for 30 days and provided to the authorities on request)

Please see attached the statement by the Namibian President Dr. Hage G. Geingob on the current Covid-19 measures released on the 15th of July 2022.

Both workshop venues are run and maintained by the government. Thus, they follow the Covid-19 guidelines provided by the head of state and government. Changes to COVID mitigation measures locally and nationally will be monitored closely.

https://moj.gov.na/general-covid-19-regulations

Current relevant restrictions.

- All Covid-19 restrictions in Namibia have been lifted as of the 15th of July 2022.

9. DECLARATION

Please ensure you have answered all the questions herein and have appended the following documents:

Consent form **YES** / NO

Participant Information Sheet **YES** / NO

Follow up information YES / **NO**

Any other relevant documentation (please state):

I certify that the information contained in this application is accurate. I understand that should I commence research work in absence of ethical approval, such behaviour may be subject to disciplinary procedures.	
Name of Principal Investigator:	Marly Muudeni Samuel
Signed:	[redacted]
Date:	15 September 2022

Please email the completed form and associated documents to Research and Enterprise (research@gsa.ac.uk).

APPENDIX 2

Appendix 2-A: January – March 2022 Fieldwork Schedule

January Workshops: Exploration Phase				
Date & Time	**Town**	**Workshop**	**What will happen**	**Preparations needed**
10-Jan-22 **09:00 – 12:30**	**Walvis-Bay**	Ocean cultural heritage, connection to place (the ocean)	Methods: Focus Group / Observation 1. Icebreaker: Participants introduce themselves. Mention your name, your favourite hobby, your favourite animal and your favourite song. 2. Introduction of PhD project. 3. Understanding culture and heritage Dialogue: Participants will engage with one another and share their views and opinions about the ocean, cultural heritage and connection to places (in this case, the ocean).	1. Audio recorder to record the session. 2. Camera to take pictures and videos. 3. Stationary, papers, pens, post it.
17-Jan-22 **09:00 – 14:30**	**Swakopmund**			
		Homework	⇒ Participants will be asked to prepare and bring anything tangible/intangible that represents their connection to the ocean on the 22nd/23rd of November 2021. ⇒ Co-researchers will be asked to write a letter to the ocean	
		After workshop	Organise and analyse collected data.	
11-Jan-22 **12:00 – 14:30**	**Walvis-Bay**	Technology Exploration	Methods: Workshop Focus group / Observation 1. Ice breaker: Two truths and one lie. 2. The participants will go through different augmented reality applications that support cultural heritage and knowledge documentation to understand how these technologies were implemented in different contexts. The workshop will focus on application functions, elements, and designs. The participants will familiarise themselves with augmented reality applications in preparation for co-designing the AR app. 3. Participants will be introduced and explore the demo AR app developed by the researcher.	4. Audio recorder to record the session. 5. Camera to take pictures and videos. 6. Stationary, papers, pens, post it. 7. Prepare the different augmented reality apps for exploration. If necessary, print them on paper.
18-Jan-22 **12:00 – 14:30**	**Swakopmund**			
		Homework	The participants will be reminded to prepare and bring anything tangible/intangible that represents ocean culture or their connection to the ocean on the 22nd/23rd of November 2021.	

		After Workshop	Organise and analyse collected data.	

February Workshops: Designing and digital production Phase				
Date & Time	**Town**	**Workshop**	**What will happen**	**Preparations needed**
31-Jan-22 **12:00 – 14:30**	**Walvis-Bay**	Co-designing 1	Methods: Workshop Focus Group / Interviews / Observation (Content Creation) 1. Ice breaker: Sweet Questions (Participants pick a sweet of a specific colour and answer a question based on the colour of the sweet they chose). 2. Participants present and explain their tangible/intangible ocean representations. 3. Participants will write down their explanations / the significance of their representations. 4. Participants will work together to write down content for the app (About app page). 5. Participants will explore examples of how to write a description/synopsis about themselves.	1. Audio recorder to record the session. 2. Camera to take pictures and videos. 3. Stationary, papers, pens, post it. 4. Example of short description/synopsis.
07-Feb-22 **12:00 – 14:30**	**Swakopmund**			
		Homework	Participants will go and think about the colours that they want to be used on the app. For the next session, participants should write down a short description/synopsis (50-100 words) about themselves.	
		After workshop	Organise and analyse data.	
01-Feb-22 **12:00 – 14:30**	**Walvis-Bay**	Digital co-production part	Methods: Workshop Focus group / Observation (Content Creation) 1. Ice breaker: Bowl of questions. 2. Participants will record their explanations / the significance of their representations from last week's session. 3. Going through the short description/synopsis written by participants.	1. Audio recorder to record the session. 2. Camera to take pictures and videos.

08-Feb-22 **12:00 – 14:30**	**Swakopmund**		4. Discussion about the colours, look and feel of the app. 5. Brainstorming a name and logo for the app. 6. Take Headshot pictures of co-researchers	3. Stationary, papers, pens, post it.
		Homework	If participants have other ideas on changes, they should contact the researcher.	
		After Workshop	Organise and analyse data.	

March Workshop: Reflection Phase				
Date & Time	**Town**	**Workshop**	**What will happen**	**Preparations needed**
16-Mar-22 **12:00 – 14:30**	**Walvis-Bay**	Overall Reflections	Methods: Workshop Focus Group / Observation 1. Ice breaker: Rock, Paper, Scissor. 2. Participants go through the application (after it has been populated with content). 3. Participants give feedback on changes to be made (if any). 4. Participants to receive/upload APK on their phones (those with smartphones). 5. Overall reflections about the workshops and app. 6. Personal views and lessons learned. 7. Explain the way forward for the participants.	1. Audio recorder to record the session. 2. Camera to take pictures and videos. 3. Stationary, papers, pens, post it. 4. Populated application
17-Mar-22 **12:00 – 14:30**	**Swakopmund**			
24-Mar-22 **12:00 – 14:30**	**Windhoek** (Walvis-Bay co-researchers)			
		Homework	If participants have other ideas on changes, they should contact the researcher.	
		After workshop	Organise and analyse data.	

Appendix 2-B: January – February 2023 Fieldwork Schedule

November Workshops: Exploration Phase				
Date & Time	**Town**	**Workshop**	**What will happen**	**Preparations needed**
09-Jan-23 **09:30 – 12:00**	**Walvis-Bay & Swakopmund** (All co-researchers)	*Efuta Letu Sida Hurib* Application navigation and testing	Methods: Focus Group discussion / Observation / Survey 4. Icebreaker Participants introduce themselves. Share something amazing or interesting that happened in the past 8 months. 5. Introduction and a brief overview of how the PhD project has expanded. 6. Navigating, Evaluating and testing the application. 7. Preparations for the outdoor application demonstration.	4. Audio recorder to record the session. 5. Camera to take pictures and videos. 6. Prepare the application for exploration. 7. Stationary, papers, pens, post it. 8. Surveys
		Homework	⇒ The co-researchers are to inform the researcher of any changes they want to be incorporated into the app.	
		After workshop	Organise and analyse data.	
12-Jan-23 **12:00 – 15:00**	**Swakopmund (**DRC Dantago Women's Group**)**	Application demonstration	Methods: Observation / Survey 8. *Efuta Letu Sida Hurib* application demonstration. Different collaborators and stakeholders will have a chance to interact with the application and provide feedback about their engagement.	1. Audio recorder to record the session. 2. Camera to take pictures and videos. 3. Stationary, papers, pens, post it. 4. Prepare the application for exploration. 5. Surveys
17-Jan-23 **10:00 – 14:00**	**Swakopmund** (Business Dome group)			

19-Jan-23 **09:00 – 16:00**	**Swakopmund** (Ministry of Fisheries and Marine Resources)			
20-Jan-23 **09:00 – 16:00**	**Walvis Bay** (Youth Choir, Accounting Society, Junior City Council)			
		Homework	N/A	
		After Workshop	1. Regroup with Co-researchers to discuss the results obtained from the demonstration session. 2. Additions or changes they want to incorporate into the app based on the results from the collaborators will also be discussed. 3. Organise and analyse collected data.	

January Workshops: Designing and digital production Phase				
Date & Time	**Town**	**Workshop**	**What will happen**	**Preparations needed**
08-Feb-23 **09:30 – 12:00**	**Walvis-Bay & Swakopmund** (All co-researchers)	Disseminate the app apk to the co-researchers. Feedback and reflections	Methods: Workshop Focus Group discussion / Observation / Survey. 6. Ice breaker: face the person next to you and try to draw them without looking at your paper. 7. Co-researchers will experience the application again. 8. Co-researchers will give feedback regarding the app demonstration sessions. 9. Co-researchers will receive/upload APK on their phones (those with smartphones and on memory sticks for those who do not have one). 10. Overall reflections about the research project, the ocean, the workshops and the co-produced application. 11. Personal views and lessons learned.	5. Audio recorder to record the session. 6. Camera to take pictures and videos. 7. Stationary, papers, pens, post it. 8. Prepare the application for exploration. 9. Surveys

			12. Discuss the way forward for the research project and how the co-researchers can participate. 13. Overall Wrap-up.	
		Homework	N/A	
		After workshop	Organise and analyse data.	

Appendix 2-C: Questionnaire

Research Research Title

Participatory Co-production and Augmented Reality for Ocean Heritage: Promoting Ocean Knowledge and Culture in Namibia

Application Name: *Efuta Letu Sida Hurib* AR Application Experience

Town: _____

Age: _____

Gender: _____

APPLICATION USABILITY and OCEAN CULTURE QUESTIONS:

Please answer the following questions based on a scale from Strongly agree to Strongly disagree by ticking in one of the boxes:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I enjoyed using this application.					
The application was easy to navigate.					
The text is clearly written and easy to read.					
The photographs and ocean representations helped me appreciate Ocean Knowledge.					
I would recommend or tell someone about this application.					
I would like to have access to this application on my phone.					
I found the application difficult to use.					
I thought the applications design was consistent throughout.					
I felt very confident using the application.					
In the future, I see myself contributing knowledge to be shared through a similar application.					

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
This application/technology is a good way of capturing and sharing ocean knowledge and culture.					
The ocean is important to me.					
I want to learn more about augmented reality and immersive technologies.					

This is the first time I am using an immersive technology or augmented reality application?

YES	NO

Any suggestions on how the application can be improved?

Is there one or more ocean culture and knowledge representations on the application that you particularly like? Please select your choice/choices below:

- ☐ !Nara Seeds representation
- ☐ Fish Tank representation
- ☐ The Ocean and I representation
- ☐ Seashell representation
- ☐ Aawambo Heritage representation
- ☐ Genesis: !Nara Roots representation
- ☐ Driftwood Art representation
- ☐ Seaweed Representation
- ☐ Oyster representation
- ☐ Venturesome Radicle Driftwood representation
- ☐ Onyoka necklace representation
- ☐ Sea sand representation
- ☐ Seagull Feather representation
- ☐ Ocean Waves representation

Why do you like it/them?

Is there one or more ocean culture and knowledge representations on the application that you particularly dislike? Please select your choice/choices below:

- ☐ !Nara Seeds representation
- ☐ Fish Tank representation
- ☐ The Ocean and I representation
- ☐ Seashell representation
- ☐ Aawambo Heritage representation
- ☐ Genesis: !Nara Roots representation
- ☐ Driftwood Art representation
- ☐ Seaweed Representation
- ☐ Oyster representation
- ☐ Venturesome Radicle Driftwood representation
- ☐ Onyoka necklace representation
- ☐ Sea sand representation
- ☐ Seagull Feather representation
- ☐ Ocean Waves representation

Why do you not like it/them?

Why do you think it is important to capture and record ocean culture and knowledge?

Do you know of any other application or medium used to capture or share information or knowledge (Information about the ocean, knowledge, culture, education, health, and more.)?

Do you think there is some types of ocean knowledge and culture that should not be shared using this technology?

YES	NO

Please elaborate.

How would you describe your relationship with the ocean?

Does the ocean contribute to your livelihood? If yes, explain how?

Do you own or have access to a smart mobile phone?

YES	NO

Do you have any other comments?

……..END……

Appendix 2-E: Letters and Poems for the Ocean

My Love Letter to the Ocean

It has been a long time since we have been together. As I can remember, the last time we were together, was in December 2020 on Christmas Day when my kids and I came to braai along the beach.

My dear ocean, I missed you so much! I missed your unique beauty; I missed your serenity, your untouched virginity, your countless endlessness, your beauty and the wonder of your deep under forever lifestyle (ecosystem).

Oh, how I missed you!

Thank you for being there for me whenever I need you...

You and I are one. I love you.

Stay the same as you are, with the same marine resources, unpolluted and sustainable. Do not change.

Until next time we meet again.

Au revoir, my love, serendipity.

By: Jota

Dear ocean,

Your uniqueness often makes me fall in love with you. I always come to you to perform the meditations or either to talk to you in silence. You always provide a friendly weather for us that are around you, let me say you are my super nature air conditioner.

You are created to hold our lives through getting food sources, tourism, leisure, power generation, extractive industries and production via desalination. Big vessels are being used on your waters for import and export transportation purposes. Jobs are being created and our GDP flourishes because of you.

Your waves offer a lot of energy that is needed for human consumption; this includes marine energy, ocean thermal energy, and wave power.

I cannot stop to call upon your name, you are natural, you are a gift from God, and you carry a beautiful natural attraction. People travel extra miles to come speak to you and for exploration. Nations are being fed through your helping hands.

I love you so much, you are our great investment, you were created to invest into our lives. Lastly, let me say that you are wonderful and lovely.

Yours sincerely, Letisia

Dear Ocean
I love the tender embrace of your breeze
I love how your soft white sand tickles my feet
Thank you for giving me life

By: Edwin

Poem for the Sea by the ≠Aoni Topnaar
Praise of the sea
Sea, of sea, you great water
Water of our ≠Aoni people
Praise the sea you ≠Aoni, children
Through him we have raised
Stingrays and steenbras and galjoen
From him we have eaten
You great sea, oh great water
Water of our ≠Aoni children
Flow, you black precipice
Feeder of our children
Please give me the stingray
Give me the barbel
Give me the whale
Give me the sand shark
Give me the Steenbras
Give me the stockfish
Flow, oh fat
Flow, you flesh-rich water

By: Shared by Morangie

A love Poem to the Sea
My love, I walk to talk you.
Your blue gives me peace,
Your white waves gives me inspiration,
Feed your children in the world my love,
Your beach can heal the sick and gives hope to the hopeless,
My love, feed your children with your big brother Sun.
Your Unity, draws all to you.
Be quite my love, I hear the screams of our future, our children.
I love you

By: Ousitjie

Dear Ocean,
You are the calmness to my spirit,
I love how you show me your waves
Whenever I visit you, because whenever
I see them, I am connected to you

By: Lucio

The Ocean
You are a beautiful living creature
You are deep but yet you are therapy to my heart

You give, and you can also take from us
Leaving us with sorrowful hearts

You are the beloved bluely
Your in and out amazes us
Wondering one day you might cross your borders

How unique you are
You feed and you give shelter
But yet, you are salty
You surround us with you tenderising coldness
And yet, brings us a cool air for oxygen

Till infinity, we still wonder where you
started and where you will end

By: Anna

My Love Letter to the Ocean
Dear ocean,
It has been a while since we last saw each other. I remember the last time we were together; it was just awesome being around you.

I love the atmosphere around you, the cold breeze that blows in my face, the cool and calming effect I experienced around you; you really know how to enhance my mood. I already saw how vexed you can get at times, and there is nothing worse than an ocean's fury.

I become like a jealous lover when people pollute you and throw all kinds of dirt and chemicals in you, but fortunate enough, you have the ability to purify yourself, but as for me, I vow to do my best to preserve the marine resources that you carry like a mother carrying her unborn child.

My dearest, I can go on forever talking to you and about you until we meet again, my dearest ocean.

Yours sincerely, TheOne

Dear Ocean
I would rather swim in
Stormy seas with you,
Than sail calm waters
With anyone else

By: Rejoice

Standwa'sam, My Dear Ocean
You, Standwa'sam, are capable of anything.

This, you have proven time to time.
Therefore, stand up, hold your head high above everything,
Don't let anyone's opinion scatter you.

Your creatures make you special, unique and extravagant.
Embrace every imperfection because it makes you perfect.
You are priceless and one-of-a-kind.

For the longest time, I didn't feel anything.
But you, Standwa'sam, you break my heart, let it beat
And share love. You open my heart.

Ondikuhole

By: Sara-Leigh

APPENDIX 3

Appendix 3-A: 3D Model Vertices

Eight ocean objects shared by co-researchers were converted into 3d models. The table below illustrates the object name and picture and the number of triangles and vertices.

Object	Number of Triangles	Number of Vertices
Radicle Venturesome Driftwood 	419,225	1,257,675
!Nara seeds 	378,330	1,134,990
Seashells 	713,338	2,140,014
Omuthigululwakalo Cultural Heritage Olukula Holder 	4,142,682	6,428,046
Seaweed 	2,112,528	6,337,584
Driftwood Art	628,444	1,885,332

		
Sea Sand, Rocks and Seashells 	1,102,842	3,308,526
Eepaya LyoOEkosa – Seashell belt 	11,328,507	33,985,521