UNIVERSITY OF CAPE TOWN

DOCTORAL THESIS

Community-Based Co-Design of a Crowdsourcing Task Management Application for Safeguarding Indigenous Knowledge

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Declaration of Authorship

I, Colin STANLEY, declare that this thesis titled, "Community-Based Co-Design of a Crowdsourcing Task Management Application for Safeguarding Indigenous Knowledge" and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all primary sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed: Signed by candidate

Date: **19 October 2020**

"There is a famous saying in Otjiherero 'Okuhena okutjiua kuanjaa esena' *translate as: 'not knowing has scratched a certain pimple (esena) that should not be scratched, when scratched its poison escalate in your body and might easily kill you.' In simple terms, this means that without proper prior knowledge before doing something you will do something that might cause you many problems."*

Otjiherero proverb

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Abstract

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Community-Based Co-Design of a Crowdsourcing Task Management Application for Safeguarding Indigenous Knowledge

by Colin STANLEY

Teaching indigenous knowledge (IK) to African youth has become more complicated due to a variety of reasons such as urban migration, loss of interest in it, the dominance of scientific knowledge and the technological revolution. Therefore, there is a considerable movement towards using technologies to safeguard IK before it becomes obsolete.

It is noteworthy that research conducted and software development perspectives being used are mainly based on Western worldviews that are inappropriate for African socio-cultural contexts. IK holders are often not in charge of the digitisation process and merely treated as subjects. In this study, we explored a suitable development approach of a crowdsourcing task management application (TMA) as an auxiliary tool for safeguarding IK. Moreover, the study sought to provide an opportunity for the indigenous communities to make requests of three-dimensional (3D) models of their traditional objects independently. The delivered traditional 3D models are imported into the communities' IK visualisation tools used by the IK holders to teach the youth about their cultural heritage.

The main objective of this study was to ascertain how the indigenous rural communities could appropriate a foreign technological concept such as crowdsourcing. This brought about our first research theme: investigating the necessary conditions to establish and maintain beneficial embedded community engagement. The second theme was to determine the suitable methods for technology co-design. Thirdly, to discover what does the communities' appropriated crowdsourcing concept entail.

We applied a consolidated research method based on Community-based Co-Design (CBCD) extended with Afrocentric research insights and operationalised with Action Research cycle principles of planning, action and reflection. CBCD was conducted in three cycles with Otjiherero speaking indigenous rural communities from Namibia. Reflections from the first cycle revealed that the rural communities would require unique features in their crowdsourcing application. During the second cycle of co-designing with the ovaHimba community, we learnt that CBCD is matured through mutual trust, reciprocity and skills transfer and deconstructing mainstream technologies to spark co-design ideas. Lastly, in our third cycle of CBCD, we showcased that communities of similar cultures and knowledge construction had common ideas of co-designing the TMA. We also simulated that the construction of traditional 3D models requires indigenous communities to provide insight details of the traditional object to minimise unsatisfactory deliverables.

The findings of this study are contributing in two areas (1) research approach and (2) appropriation of technology. We provide a synthesis of Oundu moral values and Afrocentricity as a foundation for conducting Afrocentric research to establish and maintain humanness before CBCD can take place. With those taken as inherent moral values, Afrocentricity should then solely be focused on knowledge construction within an African epistemology. For the appropriation of technology, we share co-design techniques on how the indigenous rural communities appropriated the mainstream crowdsourcing concept through local meaning-making. CBCD researchers should incorporate Afrocentricity for mutual learning, knowledge construction, and sharing for the benefit of all.

Acknowledgements

First of all, I would like to give thanks to the Almighty God for his everlasting sacred kindness, love and wisdom granted unto me. I owe my deepest gratitude to my supervisors, Prof Edwin Blake and Prof Heike Winschiers-Theophilus for being so patient, believing in me and above all, seeing that this dissertation was a success. I am grateful for their wisdom and time, especially for Skype calls.

I am indebted to my colleagues at the Namibia University of Science and Technology who gave me moral and technical support. Prof Anicia Peters for her persistent motivation, Prof Jose Quenum, for hints on the usage of some latex commands, Mr Gereon Koch-Kapuire, Mr Eliaser Mbaeva, Prof Fungai Bhunu Shava, Mr Munyaradzi Maravanyika, Mr Steven Tjiraso and Ms Albertina Shilongo for their guidance and friendship support. Ms Shilumbe and not forgetting Dr Shawulu Nggada, he has made available his help in many ways. Mr Katongo Lukwesa, Dr Nabil El Ioini and Ms Joy Anurioha for reviewing my work your assistance is highly appreciated.

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Finally, I would like to thank my wonderful parents and family for their support even though they are still wondering what I was doing for so long. Lilian Mbaeva thank you so much for being there for me, thank you very much for your love and expertise.

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Glossary

holy-fire Known as *okuruo* in Otjiherero is a sacred place where the Otjiherero speaking elders pray to God through their ancestors. 58, 75, 76, 78, 89, 165

IK holder Seniors from 30 years old or lower who have mastered the indigenous knowledge of their communities. 2–4, 10, 11, 71, 73–77, 79–81, 83, 84, 86–91, 95, 96, 105, 108, 112, 155, 158

kraal Kraal is an Afrikaans and Dutch word for a fenced area for keeping livestock for proper management. 63, 74, 76–79, 83, 165

Otjiherero Otjiherero is one of the indigenous languages of Namibia spoken mainly by the (1) ovaHerero, (2) ovaMbanderu, (3) ovaHimba, (4) ovaTjimba, and (5) ovaZemba sub-clans. Otjiherero is part of the Bantu languages that use a similar word (Omundu) for a person. The 'ova' in front of the ovaHerero indicate plurality; thus, it is written in lower case in between sentences and 'Omu' (Omuherero) prefix is for singular used when referring to an individual. v, 7, 56, 58, 62–64, 71, 73–75, 87, 88, 99, 100, 102, 103, 110, 115, 121, 123, 131, 132, 137–140, 148, 149, 151, 156, 162, 164, 165, 168, 177–179, 181, 199

oundu Oundu is the Otjiherero translation of Ubuntu. 2, 6, 8, 12, 13

Acronyms

3D three-dimensional. 4, 5, 9, 10, 33, 43, 67, 71, 135, 136, 167

AR Action research. 2, 6, 8, 9, 12, 45, 50–55, 65, 69, 70, 143, 153, 156, 171, 174, 175, 182

CBCD Community-Based Co-Design. 8, 9, 45, 48, 49, 69, 72, 95–97, 109, 111, 123, 127–129, 133, 137, 138, 140–143, 145, 147, 151, 153–157, 161, 162, 165, 167, 168, 171, 173–178, 182

CCS Community Crowdsourcing website. 112, 113

CCSP Community Crowdsourcing Platform. 5, 116, 117, 123, 144

CCSW Community Crowdsourcing Website. 5

HCI Human-Computer Interaction. 6, 21, 30, 46, 53, 158

HSC Homestead Creator. 3–5, 59, 73, 75, 76, 78–84, 89, 90, 95, 173, 178

ICH Intangible Cultural Heritage. 41, 42, 44

ICT Information Communication Technology. 17, 18, 29, 33, 34, 42, 49, 92, 183

ICT4D Information and Communication Technology for Development. 2, 53, 158, 183

IK Indigenous Knowledge. 1–6, 8, 9, 12, 13, 15, 24–34, 41, 44, 45, 48, 49, 51, 52, 56, 59, 62–64, 66, 67, 71–75, 77, 87, 90, 93, 95, 96, 110, 129, 130, 135, 142–144, 148–150, 154–156, 159, 163, 166, 173–175, 177, 178, 182, 183, 187

IP intellectual property. 30–32, 34, 158, 160, 170

IT Information Technology. 32, 48, 68, 165, 176, 177

MCT Multimedia Collection Tool. 95–100, 102, 103, 105, 106, 108, 111, 112, 118, 123, 124, 127, 130, 131, 139, 154, 166

MOU Memorandum of Understanding. 157, 158, 160, 161, 170

MTurk Amazon Mechanical Turk. 37, 40

NCRST National Commission on Research Science and Technology. 96, 101

NIKSO National Indigenous Knowledge Systems Office. 31

NUST Namibia University of Science and Technology. 7, 66, 181, 187, 188

PD Participatory Design. 21, 68

PDC Participatory Design Conference. 62, 129, 131, 135, 136, 139, 143, 144

RTQ Research Theme Question. 9, 10

RTQs Research Theme Questions. 9, 71, 147

TK Traditional Knowledge. 25, 26

TMA Task Management Application. 6, 11–13, 92, 93, 95, 96, 103, 105–108, 110–113, 115, 116, 118–120, 122–125, 127–131, 134, 137, 138, 140, 154, 161, 165, 166, 173, 177, 178

UNAM University of Namibia. 101, 105

VE Virtual Environment. 33

I dedicate this work to my beautiful family, my Love Lilian Mbaeva, my cheerful sons Kevako, Muzire and Ndino and to my loving father, Mr Kakune Kandjavera and my mother Mrs Elizabeth Kandjavera-Stanley, my grandmother Ms Kosbi Kumeeja, to my late grandfather Mr Ludwig Stanley (R.I.P.), all my siblings and still close to my heart my late uncle, Mr Gerhard Tehaa Kaumunika (R.I.P.).

To my sons, just the thought of you, longing for exceptional fatherhood support made me work with all my might during this dissertation. To my loving mother and father, this work is to rejoice your excellent parental guidance towards me through my entire life. To my goodhearted grandmother, I dedicate this work to you also to make you proud and reap the good fruits that you have sown. To my diligent late grandfather, you taught me many great things about life that I would never forget and above all, to work hard every day.

To my siblings, this is an encouragement to work wholeheartedly to whatever you want to achieve in life, no matter how long it takes you to complete.

To my late uncle, your legacy still lives on, thank you for grooming me as a child of God, now I appreciate God's miracles. Finally, I dedicate this work to all Africans as an eye opener that it is about time for us to invest in Afrocentric scientific research, I dream that we soon become more innovative rather than mere I.T. consumers.

Chapter 1

Introduction

A famous quote by Bacon "knowledge is power" (Vickers, 1992) has a direct correlation with a knowledgeable individual and the ability for that individual to regulate events. This association directly means the more one knows; the more one will be able to control activities. With that premise, we have experienced that understanding a bit or more of some information about something even if it is trivial such as directions to your destination, leaving time, whom you are going to meet, the reason for the meeting, and many others bring comfort and allows you to live in the moment of life.

Furthermore, survival tactics or knowledge becomes essential in our daily lives, especially for the rural communities who survive by fully utilising their indigenous mastery. African Indigenous Knowledge (IK) has been orally shared by elders to the youth and has not been recorded in any long-lasting format (Chisenga, 2013; Mwebesa, Baryamureeba, and Williams, 2007; Vansina, 1971). African proverbs such as *"Our books are in our heads"* by Mbope Louis (Congo, 1953) and *"When an old man dies, a library burns to the ground"* reaffirm the notion that African IK is not separated from the knowledge holder.

Knowledge in ones' mind is temporary while that individual is alive and it is quite difficult to access it instantly to a broader audience unless it is digitised and shared within the indigenous communities or shared worldwide as it is the case with scientific published articles on the World Wide Web. Construction of knowledge is dominated by Western epistemologies, and less attention has been given on how to apply an African epistemology for safeguarding African oral indigenous knowledge (Hoppers, 2002; Wane, 2005, p, 28). We prefer using the term safeguarding IK instead of preserving IK to emphasis the fact that we with the indigenous communities do not entirely keep the traditional knowledge in its original form but adapt and expand it to meet new occurring conditions. Imbalance in knowledge construction is also carried on developing Information Communication Technologies (ICTs). Thus, creating technologies that facilitate safeguarding African IK would require a pragmatic Afrocentric research approach.

On the premise mentioned above to safeguard African IK, we embarked on designing IK visualisation technologies with rural communities in Namibia. To transfer software applications to a different cultural community, we had to replace the graphical components to be suitable for that specific community. To achieve this transferability, we introduced crowdsourcing, a foreign technological concept to the rural communities. This introduction ignited a new appropriation of crowdsourcing by the rural communities. For the African indigenous

rural communities to successfully appropriate this foreign crowdsourcing technological concept, we incorporated an Afrocentric epistemology (Asante, 1987) and Oundu[1] values in our Community-Based Co-Design interactions for mutual knowledge creation and sharing. Mutual learning was achieved beyond the ordinary Information and Communication Technology for Development (ICT4D) Action research (AR) projects.

1.1 Chapter Structure

In the subsequent Section 1.2, more information on the background of this study is provided. Then the author's autobiography concerning this study is discussed in Section 1.3. The research problem is defined in Section 1.4. A brief introduction of the research methodology is provided in Section 1.5. Research themes (questions) are introduced in Section 1.6 and steps taken to find answers to the research themes are described in Section 1.7. The thesis contribution to the body of knowledge is outlined in Section 1.8. Finally, an outline of this thesis is in Section 1.9.

1.2 Background Information

In this subsection, we provide the research background starting with reasons for safeguarding IK. Then an introduction of prior technologies co-designed with the communities that sparked the crowdsourcing idea is also discussed.

1.2.1 Need for Safeguarding Indigenous Knowledge

Namibia is not immune to the extinction of IK. There is not a lot of comprehensive Namibian IK in digital format besides the sparse and scattered articles that are usually not written by the indigenous communities themselves (Gallert and van der Velden, 2015). IK holders, who are well equipped with invaluable IK, when they pass on, unavoidably depart with this irreplaceable IK wealth to their burial place. Hence IK in Namibian and other oral-based knowledge countries are currently vanishing at a rather rapid pace.

IK holders in Namibia have recognised that there is a national problem when it comes to the safeguarding of IK. The youth are forgetting about their IK and find it hard to adapt to village life due to urban migration. Urban migration has resulted in the youth ignoring and forgetting natural survival tactics, husbandry, rituals or any other IK taught by the elders. Most youths have migrated to cities for schooling and employment and are exposed to Western knowledge that they often prefer as the superior over their IK. Urban migration is, however, not permanent. Most people return to their villages either for part-time farming or visiting their families, thus investing in their rural areas (Niikondo, 2010).

[1]Oundu is the Otjiherero language translation of Ubuntu which is an African way of living among each other in kindness, harmony, consideration, respect, peace, love, caring, sharing, altruism, socially mature and socially sensitive, virtuous and blessed striving for conciliation (Cilliers, 2008; Mabovula, 2011; Mbigi and Maree, 1995, pp. vi-vii; Tutu, 2000, pp. 34-35).

The youth are growing up in this digital revolution towards an era populated with technologies without comprehensive IK or traditional games to stir interest in knowing IK. Moreover, teenagers are losing their pride of origin or sense of belonging. Many IK holders in Namibia raised their concern that the youth are paying less attention to IK while they should master it to pass it on to the next generations (Embashu, Cheikhyoussef, and Kahaka, 2012; Hilukilwa, 2019). One of our prominent IK holders, Uariaike Mbinge from the ovaHimba community that we have been co-designing software applications with to safeguard IK since 2013 also pointed out this concern several times.

IK is an essential part of the indigenous communities, it has been used for centuries and still being used by indigenous communities in support of their decision making in farming activities, social problems, natural resource management and many others (World Bank, 1998). When developing software tools to safeguard African IK, computer scientists should first understand or be aware of the ways of how African IK is constructed because those ways need to be equally used in the co-design of the software application. Incorporating African ways of knowledge construction in the co-design process also contributes to safeguarding it.

Much can be learnt from IK. For example, a stochastic strategic grassland management model has been derived from the semi-nomadic ovaHimba farmers from Namibia (Müller *et al.*, 2007). The cattle grazing system used by the ovaHimba encompasses of resting the dry land pastures during the rainy season and incremental extension of grazing land in drought season. According to Müller *et. al*, the grazing system (rotational and spatially heterogeneous use of grazing land) used by the ovaHimba return higher productivity and quality of a pasture area than homogeneous permanent grazing. The San tribe from southern Africa have used Hoodia plant stems for surpassing hunger and thirst when travelling for long distances. The San tactic of using Hoodia has resulted in the Hoodia ingredients being used in slimming products (Lee and Balick, 2007).

Since IK has proven its validity, the two bodies of knowledge, scientific and indigenous knowledge, can learn from each other (Nikolas, 2000). The fact that IK is tacitly kept in people's mind, it must be appropriately safeguarded before its extinction. IK is subjective and therefore making it hard to be expressed in formal languages and to be recorded and disseminated. Consequently, we incorporated Afrocentric epistemology in designing and developing IK safeguarding technologies.

1.2.2 Towards the Crowdsourcing System

Winschiers-Theophilus *et al.* (2010b) have co-designed software applications with the rural ovaHerero indigenous communities to safeguard IK since 2008. They co-designed a homestead visualisation tool called the Homestead Creator (HSC) with the ovaHerero community from Erindi-Roukambe, a village that is in the Omaheke region on the east side of Namibia, see Chapter 3, Section 3.2.1 for more details about the ovaHerero community.

The HSC developed by Rodil *et al.* (2012a) is a tablet-based application created in Unity[2]. The HSC allows users to build their homesteads in a virtual environment and create scenarios by dragging and dropping three-dimensional (3D) objects representing real elements in the rural surroundings of their home to be placed on a ground soil look-alike surface as shown in Figure 1.1 bottom image. Drawings and photos of the ovaHerero homesteads (see the Top in Figure 1.1)

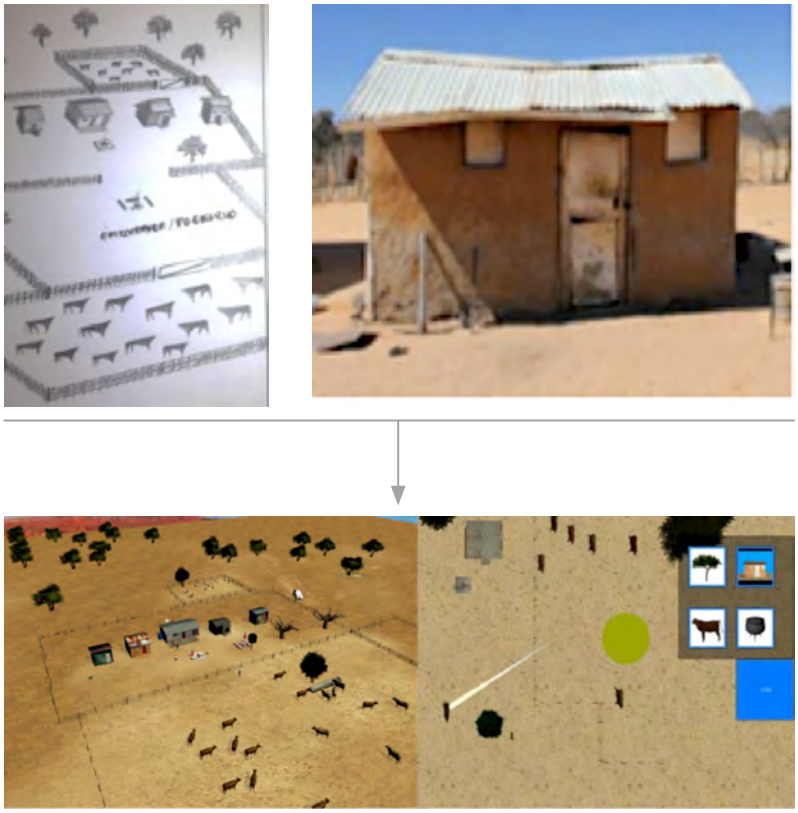


Figure 1.1. Top left corner shows a tilt and top view drawing of the ovaHerero homestead, top right is a photo of one of the ovaHerero houses made of cow dung. Bottom image pointed by the down arrow is a snapshot of the HSC application from a top view. Pictures adapted from Jensen *et al.* (2012).

were used as specifications for creating the traditional objects for the HSC.

The HSC is used by IK holders to teach the youth about IK. By dragging 3D models, the IK holders can demonstrate to the youth how their homesteads are constructed. We have witnessed that the elders share much IK while using the HSC, for example, when they are busy dragging a tree to a specific location they will share what that tree is used for such as for healing, crafting, and how to conserve it. The good feature of the HSC is that it can be used as storytelling with more visual demonstrations keeping the old traditional custom of storytelling alive. The demonstration of how the homestead was constructed can be video recorded, archived and played back at any given time. The youth can use the

[2]Unity is a development environment created by Unity Technologies for developing Three-Dimensional (3D) and Two-Dimensional (2D) video games and simulations for a variety of platforms, see https://unity3d.com for more information.

HSC as a game to teach others within the indigenous communities and other communities. We see HSC as an interesting and fun way of transferring IK to youth.

The HSC 3D models needed to be replaced when the HSC was transferred to other rural communities with different cultures. Transferring the HSC to other communities might not work at all due to the language barrier, unacceptable visual representation of the community surroundings and others. To test this technology transfer, we gave the ovaHimba communities the ovaHerero HSC to construct their homesteads. They could not relate to it because the 3D models were from the ovaHerero community that are visually quite different from the ovaHimba homesteads (Stanley *et al.*, 2015). The ovaHerero and ovaHimba traditional attire differences are outlined in Chapter 3, Section 3.2.1. For the ovaHimba finding it difficult to relate to the ovaHerero HSC proved that straightforward transferability of the co-designed artefact without proper cross-contextual validation is intractable as cautioned by Winschiers-Theophilus *et al.* (2013).

Noting the importance of replacing most of 3D models in the HSC we started looking at how we could fast track the replacement of those 3D models for other rural communities. We, therefore, opted to tap into using a crowdsourcing tool that would allow the rural communities to crowdsource the 3D models of their traditional objects that are missing in HSC to graphic designers on the Internet. Crowdsourcing is when someone asks a large group of unknown people on the Internet to do something for him or her. Crowdsourcing is fully defined in Chapter 3. Crowdsourcing was chosen due to its cost-effective benefit (Kaufmann, Schulze, and Veit, 2011), for creativity and open innovation (Bonabeau, 2009) and quality of work (Schenk and Guittard, 2009) delivered by the contributors. It was on this background that the author of this thesis proposed a Community Crowdsourcing Platform (CCSP) as depicted in Figure 1.2.

Figure 1.2 shows that a IK holder (elder) can make use of a tablet to create a request for 3D models which are uploaded to the Community Crowdsourcing Website (CCSW). The graphic designers can then download the request from the website to work on it and upload once done. Any web server can be used to host the web application. The completed requests each with a request identifier, that is, the tablet International Mobile Equipment Identity number is then pushed back to Indigenous Knowledge (IK) holder for evaluation. The Google Cloud Messaging server or the Firebase Cloud Messaging (indicated as FCM server in Figure 1.2) can be used to handle message processing from the web server to the IK holder's tablet, a more detailed technical description of this architecture can be read in (Stanley *et al.*, 2013). If the IK holder is not satisfied with the completed 3D models, the IK can then provide a more detailed description of what is missing and send back the request to the website. Once the IK holder is satisfied with the completed 3D models those three models are to be imported into their HSC.

Initially, we thought this process was straightforward until we started with the rural communities simulating the activities for creating the request. The rural communities had to contextualise the crowdsourcing from their perspective. Moreover, they started asking the meanings or clarification of the standard icons depicted on the classical multimedia capturing operations, for example, a video icon (picture of a video recorder) for video recording that did not make much

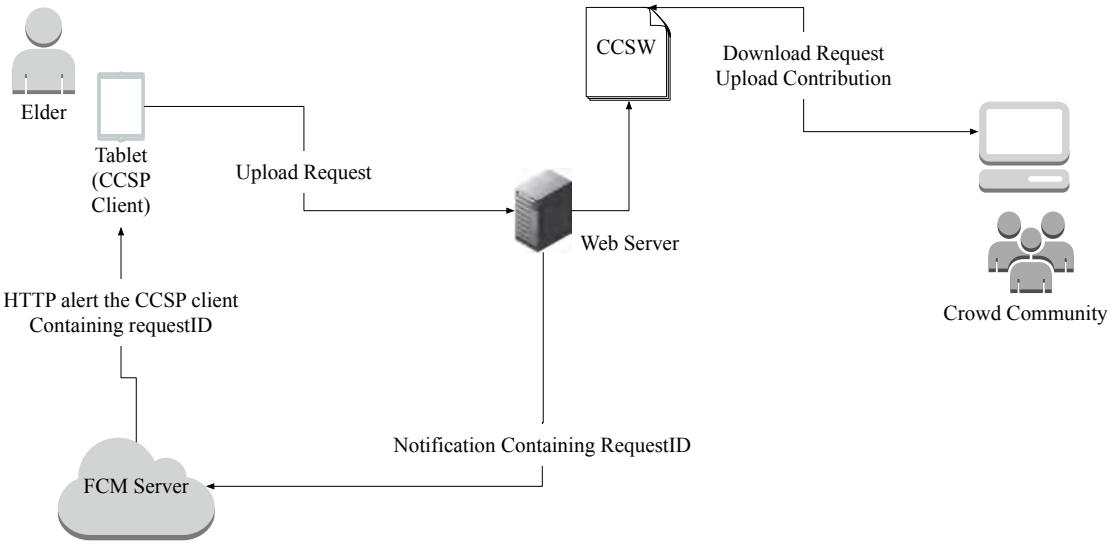


Figure 1.2. The diagram depicts the Community Crowdsourcing Platform interaction. The diagram shows that the IK holder (Elder) using a tablet can create a request for 3D models to the Community Crowdsourcing Website (CCSW), see Appendix D for the CCSW flow chart. The graphic designers (Crowd Community) then work on the request and send it back to the IK holder for acceptance. Diagram adapted from Stanley *et al.* (2013).

sense to them. It was at this point that we realised that a community crowdsourcing Task Management Application (TMA) needed to be co-designed with the rural communities. This study reports on the unique challenges and achievements encountered in performing this process. The findings provide new directions for safeguarding African IK by integrating Afrocentric epistemology, Oundu values, community-co-design methods perspective for AR researchers and for Human-Computer Interaction (HCI) practitioners.

1.3 Author's Introspection

Keane, Khupe, and Muza (2016) stated that it matters whom we are when researching IK. They cautioned that researchers who often have scientific education tend to bring along their view of objectivity in research which is not appropriate for IK research. Although most researchers carry out qualitative IK research they still conduct it from a scientific perspective of validating knowledge, setting up contractual ethics, treat the indigenous people as 'research subjects' and the researcher separating him or herself from the community. Keane, Khupe, and Muza illustrated that the researcher's life experiences shape the research purpose, design, and reliability. They suggested that the researchers should start by stating their own story or statement before trying to understand other people's story. Thus an introspection of the author of this thesis is given here.

I am a Otjiherero speaker, the language spoken by both the ovaHerero and ovaHimba communities with whom we have piloted this study. There is a standard greeting etiquette for us the Otjiherero speaking communities, and that is to state our matrilineal *(eanda)* family relation. This greeting is structured by stating your mother's eanda, father's eanda and grandfather's eanda. For example, if I had to introduce myself to another Otjiherero speaker I would say: *Ouami Omukuatjivi ngumbi janenua mo Vakueyuva omunaa Kueyuva* roughly translating as My mother is *Omukuatjivi*, my father's mother is *Omkueyuva*, and my grandfather's mother was also *Omkueyuva*. The matrilineal system should be well known by every Otjiherero speaker so that upon greeting family relationship can be established. For example, if I meet a lady for the first time, and she introduced herself as an Omukuatjivi that implies that she is my sister since we are a descended of the same mother.

I grew up with my sister, grandmother and uncle in a communal village called Aminuis on the eastern side of Namibia. Aminuis is in the semi-Kalahari desert close to the Botswana and Namibian border. My uncle was of mixed cultural background; his late father is of European descent and his mother, Omuherero. I spent most of my teenage life with my late grandfather, who lived on a farm in Botswana. My late grandfather (Stanley) is also of European descent and his mother, Omuherero.

In my primary education from grade four, I was taught in Afrikaans[3] and high school and university in English. I did my postgraduate masters degree specialising in Software Engineering in Italy.

I initially started this research with a form of scientific reasoning that I later came to realise that I should unlearn and learn a new African perspective of constructing knowledge. My assumption about the rural IK communities was that they would not easily understand the technical terms and how computers operate, therefore making this study complex.

Being raised by parents with mixed-cultural background, who hardly practised any of the ovaHerero traditional practices and a lack of proper Otjiherero language foundation, common knowledge about the culture of my community sparked my curiosity to know more about my culture while I was young. I have received several criticisms for the lack of sufficient IK of my community. I also have received several questions from the Otjiherero speaking people in Namibia doubting whether I was an Omuherero because of my Stanley surname.

I am employed as a lecturer at Namibia University of Science and Technology (NUST) since 2006. At NUST I am part of the IK in Digital World research cluster. The NUST main campus is in Windhoek, the capital city of Namibia where we were travelling from to go to the research sites.

The author conducted all the workshops of this study as the leading facilitator. When the workshop facilitator is used in this study, it refers to the author of this thesis. The author is also regarded as one of the Otjiherero speaking researchers in this thesis. Providing this background will make the reading easy to understand when the above conventions are mentioned.

[3] Afrikaans is a southern African language formed by the European (from South Netherlands) settlers, the indigenous Khoekhoe and enslaved African and Asian people in the 17th century (Roberge, 2002).

1.4 Problem Definition

It is noteworthy that research conducted, and software development approaches being used to safeguard IK are mainly based on Western worldviews that are inappropriate for African socio-cultural contexts. IK holders are often not in charge of the digitisation process and merely treated as subjects. The problem is how to fuse African indigenous communities ways of constructing knowledge and moral values in the co-design of IK safeguarding software applications. Moreover, how can the indigenous communities independently continue to request software artefacts that facilitate with safeguarding their cultural heritage?

Developing technologies for safeguarding IK should not be treated as creating software tools for general purpose. IK is a complex in itself as it is practical embodied knowledge that is interrelated with the ecosystem encompassing African cultural or moral value systems that should be first understood by researchers before initial research conducts. Co-creating tools with the African indigenous communities is a process of knowledge co-creation with mutual respect, mutual learning, and sharing in itself.

We have to look at the practical ground of implementing African principles such as Oundu with our co-design interactions, especially when we are taking a foreign technological concept to the rural communities to adapt. Researchers have to appropriately engage with communities allowing transformation (communities becoming co-design experts), respecting community ethics and protocols and cross-culture validity checks when transferring concepts, methods and tools within the communities (Winschiers-Theophilus and Bidwell, 2013).

1.5 Research Methodology

This section briefly introduces the research methodology used in this study. A more detailed report of this is provided in Chapter 3. This study used a consolidated research method based on Community-Based Co-Design (CBCD) extended with Afrocentric research insights and operationalised with implicit Action Research cycle principles of planning, action and reflection.

In an African village *community*, the focus is not given to an individual but rather to a demographic population composed of elders, the youth and neighbours from other villages whose voice must be accounted for in the design artefact. Every individual's view or design idea is not guaranteed in the design artefact, but a satisfactory agreement must be met to harness Oundu values. Merging Afrocentric epistemology on safeguarding IK of the African indigenous communities, contextualising co-design techniques with Oundu values and the whole research approach being guided by Action Research (AR) principles, we call this research methodology CBCD pioneered by Winschiers-Theophilus, Bidwell, and Blake (2012b). In this context we go with Tripp (2005) definition of Action Research, that "Action Research is a form of action inquiry that employs recognised research techniques to inform the action taken to improve practice."

The core objective of AR is to create new knowledge by searching solutions or improvements to "real-life" practical problem situations (Elden and Chisholm,

1993; Shanks, Arnott, and Rouse, 1993). The nature of this study was unpredictable and involved complex human social aspects that cannot be studied based on a predefined hypothesis testing as in most natural science, and it is, therefore, selecting AR as a guiding action of inquiry for CBCD was the right choice. The research was conducted with rural communities, whereby human social challenges and achievements surfaced.

Any AR research is composed of the following three elements (1) *framework of ideas and concepts*, (2) *a way of applying the ideas*, and (3) *an area of interest to use the ideas* (Holwell, 2004). AR elements were incorporated into this study as follows:

1. Crowdsourcing, rural communities formulating task request for 3D models from their photos of traditional objects, and them evaluating the 3D models designed by graphic designers from the Internet as a *framework of ideas and concepts*.

2. Afrocentric epistemology integrating with AR and Ubuntu values for CBCD interactions as *ways of applying the ideas*.

3. Safeguarding IK of the African rural communities as *the area of interest*.

1.6 Research Themes

In AR, research interests are defined in *themes* after the researcher has declared the ideas and ways on how to apply them. AR being an iterative cyclic continuous process (Susman and Evered, 1978) means that the researcher with a set of themes takes action into a situation and studies it using the declared framework of ideas and concepts and methodology (the way of applying the ideas) until acceptable criteria of findings have been reached.

Since a concrete idea on how to solve a problem is not known from the beginning, hypothesis definition is not required from the start in AR. The researcher takes some action to encounter the challenges and learn how to solve them. In each cycle, a reflection of the AR elements are assessed for improvements and to keep a record of experience encountered, and new themes can be added. The themes are not created from a specific context; thus, they can change as discoveries are exposed. Themes are a broader set of questions or topics that motivate the researcher (Holwell, 2004). This research was initiated with the following research theme:

How can the Indigenous rural communities appropriate a foreign technological crowdsourcing concept?

Two sub research themes were defined to get more insight into the first research theme mentioned above. The themes are treated as *research questions* therefore named Research Theme Questions (RTQs). The three RTQs are briefly explained below:

Research Theme Question $(RTQ)_1$: *What are the necessary conditions to establish and maintain a beneficial embedded community engagement?* This theme looked at establishing a suitable CBCD approach that incorporates Afrocentric epistemology and Action Research for mutual knowledge creation and sharing for the well-being of the community.

RTQ_2: *What are the suitable methods for technology co-design?* This theme focused on finding out how to appropriate a community crowdsourcing technology with rural communities. Precisely to find out the appropriate co-design techniques that ensured that the communities could appropriate the crowdsourcing a foreign technological concept.

RTQ_3: *What does the communities' appropriated crowdsourcing concept entail?* Involves identifying the key features of the appropriated crowdsourcing concept. To investigate whether any specific unique attributes were brought in by the rural communities. Moreover, to report on the challenges and achievements of implementing the appropriated crowdsourcing system.

1.7 Research Steps Taken

Action Research follows a cyclic process rather than a linear approach. AR cycle can be divided into four main stages, that is, (1) plan, (2) action, (3) evaluate, and (4) reflect (Susman and Evered, 1978). The planning briefly entails problem identification and developing the research plan, which can be revised in the next cycle. Action stage involves executing the outlined plan to examine the research problem. Evaluating or observing involves a careful analysis of the actions taken to be used for later refinements and reflections (Crane and Richardson, 2000). Reflection phase is about sharing and communicating the results and reflecting on the overall action (process) taken.

Although the AR stages are described sequentially, in reality, they might overlap, the initial phase might quickly become inadequate in the next cycles when the problem is clearly defined from previous reflections (Kemmis and McTaggart, 2005). According to Kemmis and McTaggart, the success criteria is not about whether the stages have been followed thoroughly but ultimately that the participants are progressively mastering their practises and knowledge discovery is within context.

Based on the background outlined above, the phases adapted for each AR cycle in this study are (1) planning, (2) action, and (3) reflection phase as shown in Figure 1.3. The action phase subsumed the evaluation activities. To find solutions to the two research *themes* (questions) mentioned in the previous Section 1.6, three AR cycles were carried out as shown in Figure 1.3. Figure 1.3 depicts dotted arrow lines showing the planning of interlink from reflection phase of a specific AR cycle to the next. This setup whereby each cycle builds upon the understanding of the previous cycle is referred to as the "hermeneutic spiral" by Gummesson (2000). What each of the three cycles consisted of is outlined below:

1. AR Cycle one: Crowdsourcing Conceptualisation

   The *first AR cycle* was carried out approximately over a year from September 2013 until October 2014. IK holders were introduced to the broad idea of crowdsourcing asking others to help them with their problems. The overall crowdsourcing process for the rural communities to formulate a crowdsourcing task request for to create a 3D model of traditional object was conceptualised. To create a request, the IK holder uses a tablet to record multimedia, that is, to take pictures, videos, audios, and text or drawings about

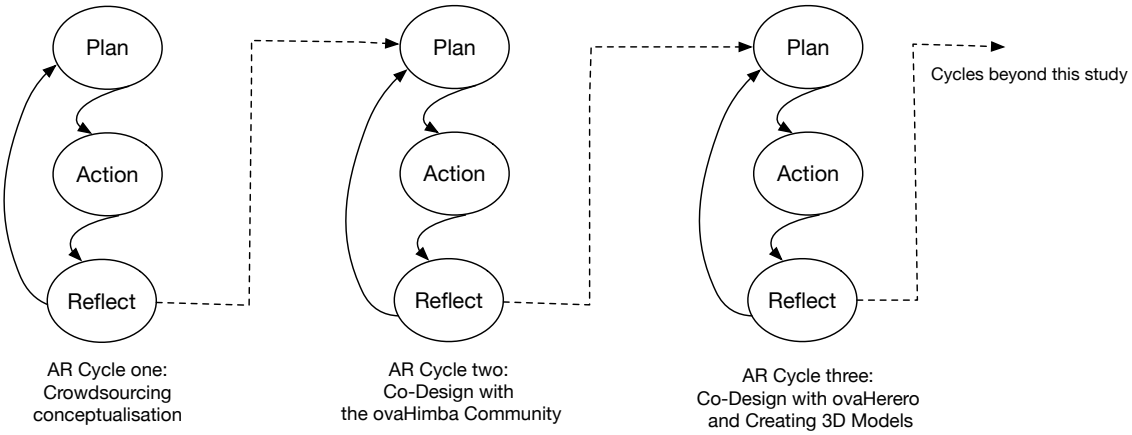


Figure 1.3. This diagram depicts the three AR cycles with the adapted stages (plan, action, and reflection) carried out in this study. The action phase included evaluations. The phase name is in the cycles of each iteration of the AR cycle. The dotted arrow line shows the interlink from reflection phase of a specific AR cycle to the next.

that traditional object to be modelled in 3D. The crowdsourcing familiarisation went further on looking at how the IK holders would like to evaluate the completed 3D models, and a simulation thereof was done.

2. AR Cycle two: Co-Design with the ovaHimba Community

   The *second AR cycle* activities were carried out from early 2015 to mid-2016. This cycle included the TMA interface and its process co-design activities carried out mainly with Uariaike and his wife Mukamberenge from the OvaHimba community. Although Uariaike and Mukamberenge were the main co-designers, other community members took part in some workshops but were not always present in all co-design workshops.

3. AR Cycle three: Co-Design with ovaHerero and Creating 3D Models

   The TMA was mainly co-designed with the ovaHimba community, and therefore, we needed to validate the co-designed ideas with the ovaHerero communities in this cycle. The *third AR cycle* was also to get the graphic designers perspective while creating the requested 3D models thus this was done at Aarhus in Denmark at the fourteenth PDC from fifteen to nineteenth of August 2016. The idea was to get details on what should be included in the crowdsourcing task requests so that the rural communities' specifications could be complete for the graphic designers to understand. It should be noted that the literature review was done all along with the duration of the research project.

Much emphasis has been put on AR concerning the research steps taken to clarify that CBCD inherently has AR principles. CBCD bring in the *community* and *co-design* aspects in the research cycles as discussed in Chapter 3. How each

of the three cycles was carried out in this study are described in separate chapters from Chapter 4 to Chapter 6, as outlined in Section 1.9 of this chapter.

1.8 Thesis Contribution

This study provides a novel integration of Afrocentric epistemology and CBCD that blend well with each other based on mutual knowledge creation among researchers and African indigenous communities. This contribution is unique since the two domains have not yet been integrated to take full advantage of their pragmatic approaches of constructing and sharing knowledge while co-designing technologies. We have shown that rural indigenous communities can co-create technologies with researchers if the appropriate research approach is being applied. We begin to see that rural communities are taking the co-design further by training other rural communities on the concept of co-creating technologies with computer scientists and the usage of the deployed technologies. Achieving that contributes to supporting sustainable safeguarding of IK for future generations.

The study also shows how to blend Oundu values in the community-based co-design interactions to develop IK safeguarding technologies. The researchers have to immerse into the indigenous rural communities and become one family; embracing Oundu values of living in kindness, harmony, respect, peace, love, caring, and sharing.

The study demonstrated an intriguing result on how the rural indigenous communities appropriated the mainstream multimedia collection tool and contextualised a foreign technological crowdsourcing concept for best use. An alternative approach to crowdsourcing was taken in this study. Requesters are from a developing country (Namibia) compared to the current trend where developed nations make requests to target contributors from any developing country such as India for micro-tasks completion. The software product, the crowdsourcing TMA co-designed with the Namibian rural communities, allows different people to learn from each other's cultures and knowledge.

This study introduces a different angle of research ethics and digital intellectual property rights for indigenous people that have to be carefully looked into considering the communities' views and values. This research share insights on how to deal with the variable research conditions of indigenous rural communities among uncertainties of trans-cultural interactions, mutual benefits, response and availability of the indigenous people. This work has established a concrete foundation for Afrocentric computer science research.

1.9 Thesis Outline

This thesis report is organised into eight chapters to account for a clear description of the work done. The chapters do not follow the conventional dissertation structure, especially from Chapter 4 onwards. Dick (1993) have stated that studies that are based on AR research requires a different approach of writing to report on their findings effectively. Dick suggests that the AR thesis writing should be

rather organised around themes or specific contributions that the thesis makes to the body of knowledge. It is on this background that Chapter 4 to Chapter 6 are organised around the three cycles that were introduced in Section 1.7 of this chapter. Chapters 4, 5 and 6 serve as twofold: they provide elaborated descriptions of the research. Also, they offer a contribution to knowledge as narratives of the fieldwork which hold scientific value as exemplars of co-design with communities.

The following paragraphs provide an overview of each chapter.

Chapter 1, *Introduction*, introduces and provides an overview of the research problem and contribution of this study to the body of knowledge. The author's introspection concerning this study is also highlighted. A summary of the research methodology is given in this chapter; detailed information about this is discussed in Chapter 3.

Chapter 2, *Theoretical context and Related Work*, provides the philosophical theories that were built upon to devise the Afrocentric epistemology integration with Community-based Co-design and Oundu values. The chapter also looked into different pathways of preserving IK highlighting on the complexities that come with it. Chapter 2 also discusses crowdsourcing and related projects. Each chapter from Chapter 2 to Chapter 7 have a conclusion section at the end.

Chapter 3, *Overview of Research Methodology and Design*, this chapter describes the research methodology and design. This chapter also highlights how the different types of analysis were performed to find answers to the research themes. Background information about the Namibian indigenous rural communities that this study was piloted with are discussed.

Chapter 4 presents the first CBCD cycle *Crowdsourcing Conceptualisation*. The chapter discusses how the crowdsourcing concept was introduced to the ovaHerero and ovaHimba communities and how they adapted it to their context.

Chapter 5, *Co-Design with ovaHimba Communities*, reports the second CBCD cycle on how the crowdsourcing TMA was co-designed with the ovaHimba community.

Chapter 6, *Co-Design with ovaHerero Communities*, presents how the third cycle was carried out replicating the TMA co-design ideas with the ovaHerero communities and simulating the creation and evaluation of 3D Models.

Chapter 7, *Reflection*, this chapter looks back at the interpretation of the detailed findings from all three CBCD cycles. Following an Afrocentrism research approach, this chapter is not a general discussion that justifies the implication of the results; it instead makes peace with work done by reflecting on it.

Chapter 8, *Conclusion and Future Work*, reports on how the whole study answered the research questions, also pointing out the limitations of the study and future works and recommendations. The author also provides his epilogue. This chapter ends with concluding remarks.

Chapter 2

Theoretical Context and Related Work

This chapter starts with the theoretical framing of Afrocentricity and Ubuntu for this research. An overview of safeguarding Indigenous Knowledge (IK) is given starting with its various terms and definitions to establish our reference point. Safeguarding IK through digitisation from the IK holder's perspective is given. Particular consideration is highlighted on the fact that an IK holder is inseparable from his or her embodied knowledge such as spiritual healing, rituals and emotions. Safeguarding IK is also discussed from its disseminating frame of reference.

Furthermore, crowdsourcing as the chosen technological solution facilitating safeguarding IK is explained. Finally, related work on crowdsourcing projects and their challenges are outlined.

2.1 Theoretical Framework

Afrocentrism theory although initiated by Afro-Americans resonates well as an African research paradigm. Africans operate on their space within their practices, worldview and value system and therefore researching within such environment requires theories that best fit it. *Ubuntu*, which embraces African principles of living, can be used to direct researchers' interaction with the indigenous communities and within indigenous communities themselves. The following sub-sections elaborate on Afrocentrism and Ubuntu practices.

2.1.1 Afrocentrism

Afrocentrism is also known as *Afrocentricity* (Asante, 1991). According to Asante Afrocentricity is about placing African understanding of the world at the centre of analysis and interpretation of African concepts, interests, issues and behaviour. Afrocentricity aspiration is to prevent African concepts to be purely studied based on the Eurocentric ideologies (Asante, 1987). To fully grasp the term Afrocentricity, *centricity* must first be defined. According to Asante (1987), centricity in education refers to the perspective of locating students within the context of their own cultural references so that they can relate well socially and psychologically to other cultures. Afro for an African combined with centricity,

thus Afrocentricity, putting the focus on African concepts within African perspective.

Early *et al.* (1994) defined Afrocentrism as an intellectual trend, togetherness and psychological and emotional well-being through the righteous living and African believes. Chukwuokolo (2009) described it as an African centredness, a quest for Africans to own their intellectual pride as the originators of civilisation. Walker (2001) defined Afrocentrism as an African cultural nationalism that strives to restore Africans' self-esteem for their generation of knowledge and the world of understanding. There are also other numerous authors such as Keto (1989), Nobles (1972), Karenga (1993), and Goggins (1996) who defined Afrocentrism. Careful analysis of their nuance definitions shows that they all are boiling down to the same underlying ideology of an African view of knowledge that is interrelated to the universe (Bangura, 2012; Chawane, 2016).

Afrocentric general rules (canons)

Reviere (2001) argued that the Eurocentric research criteria of objectivity, reliability and validity cannot be applied in context for a research that involves human experiences. Reviere suggested five general rules (canons) for Afrocentric research to be used primarily for research that involves human behaviour. Inspired by Afrocentric principles of *Máat*[1] which is about the quest for justice, truth, and harmony (Asante, 1990) and *Nommo*[2] which concentrates on knowledge creation for improvement of human relation (Asante, 1987). Máat principles of living in truth, harmony, morality, and justice are similar to those of Ubuntu. For detailed explanation of Ubuntu see Section 2.1.2. Reviere defined five canons in Swahili as:

(1) *Ukweli* meaning *truth*, emphasise that the communities' input is crucial for validating the accuracy of the research process and output. The truth or facts of the research findings are lived community experiences.

(2) *Utulivu* means *justice* loosely translated from Swahili. The utulivu canon requires that an authentic Afrocentric researcher actively avoid creating divisions between or within the communities.

(3) *Uhaki* is about *harmony* which requires an Afrocentric researcher fairness in his or her research procedures to all the community members even to those that are not part of the research.

(4) *Ujamaa family-hood* canon, put recognition and maintenance of the community as a mandatory requirement. The researcher should avoid the separation of researchers and participants (community members), but instead sees the whole research team as a family. The aspired interest of the community should guide the theory and practices of the researchers. Ujamaa carries the same principle of *Ubuntu* that a person becomes a person through other people (see the following Section 2.1.2). The communities' values and perspective of togetherness should be reflected throughout the research process.

(5) *Kujitoa* means *commitment*, it is about knowledge construction emphasising that researcher should accept subjectivity. Afrocentric research approach that involves communities is a constructive pragmatic research paradigm that embraces

[1] Is an Egyptian term used for one to live life in harmony with all related laws of the community (Assmann, 2003, p,133).

[2] Is an African mastery of the world through expressive use of spoken words (Hamlet, 2011).

subjectivity (Mkabela, 2005).

True lived experiences of the native people (1 Ukweli) are regarded as input into the research process. Researchers are immersed and become part of the community while striving for justice (2 Utulivu) and harmony (3 Uhaki), to achieve togetherness (4 Ujamaa). Justice, truth, and unity are derived from the *Máat* principle as mentioned earlier (Asante, 1990).

Knowledge creation is the final output of Afrocentric research. The knowledge created is for the improvement of human relations and therefore, the communities should validate it. Researchers should appreciate the subjectivity of feelings, ideas and opinions (5 Kujitoa) of the communities. In other words, researchers are to overcome the idea that they (academics) are the sole knowledge creators but that the community is part and parcel of that creation. Knowledge conception originates from the *Nommo* principle from which the Afrocentric canons were derived from (Asante, 1987). For researchers to successfully conduct an Afrocentric research paradigm, all research activities from setting up research questions to data gathering techniques and interpretative analysis should integrate those five Afrocentric canons (Reviere, 2001).

The general rules for Afrocentric research by Reviere (2001) are different from the African principles stated by Kochalumchuvattil (2010). Reviere's canons do not necessarily extract personhood from brotherhood for successful implementation of an Afrocentric research approach. From Reviere's standpoint, the principles implicitly implied to the individual members of the community or the one working with the community. The African tenets taught to community members from childhood instil justice, truth and harmony and do not necessarily oppress one to the evil deeds of African communalism as Kochalumchuvattil argued.

The general canons assume a peaceful environment, but in reality, there are communities with conflicts. There can be misunderstanding or misinterpretation, assumption or incorrect translation within communities. When values, interests or resources of people are deprived, conflicts are likely to happen (Rugumamu, 2002). Rugumamu recommended that researchers should first thoroughly investigate the background of the conflict as disagreement does not occur in a vacuum. Secondly, to investigate the roles of the groups of people involved in the conflict whether direct groups (those opposing one another), those who have indirect share in the outcome and those that act as arbitrators. He further mentioned evident causes of conflict such as assumed goals, interest mismatch, imbalance distribution of wealth, stereotyping, cultural differences and others.

Those involved in Information Communication Technology (ICT) research especially interacting with humans are not immune to conflicts. People tend to think that the ICT focus is on the technological aspects and research approaches only. Morrison (2016) pointed out that conflicts are not merely solved by finding the right technical solution, as conflict is an intricate, inevitable social phenomenon within communities. Morrison provided two recommendations on how ICT researchers can minimise conflicts in their enquiries.

1. Researchers should try to build upon what the community is already using, rather than introducing something completely different.

2. To use well settled trusted and respected community partners for building long-term relationships instead of focusing on introducing short-term innovative ICT solutions.

Peters *et al.* (2014) based on their experience in community-based research in Africa discussed three essential themes that researchers should strive to resolve, that is, (1) Conflicting protocols, (2) building and maintaining trust, and (3) investing more time to know the community before technological designs. On conflicting protocols, for instance, they highlighted the issue of remuneration for community members who took part in the research activities. In some communities it is a norm for elders to get more than the youth even regarding payment. Peters *et al.* suggested that in this regard researchers should allow the community members themselves to decide on the payment strategy and this should be discussed before research activities commence.

2.1.2 Ubuntu

Ubuntu is a word derived from the Nguni languages and it means "humanness". Nguni languages are as follows: isiZulu spoken by the amaZulu, isiXhosa by amaXhosa, and isiNdebele seSewula (Southern Ndebele) by Ndebele people of South Africa, siSwati spoken by emaSwati of eSwatini (formerly known as Swaziland), Síphùthì spoken in Southern Lesotho, and siNdebele saseNyakatho (Northern Ndebele) spoken by Matabele people of Zimbabwe (Doke, 2017).

The ubuntu word and its underlying concept is not only found in Nguni languages, but it is indeed part of many African Bantu languages (Asike, 2016; Broodryk, 2005, pp. 235-236; Oppenheim, 2012; Wa Mberia, 2015). Bantu languages are spoken by communities living from the Southern line of Nigeria towards central Africa to Southern Somalia in the East until Southern Africa including the Nguni languages (Nurse and Philippson, 2006). The Nilotic languages spoken by the indigenous people to the Nile valley in South Sudan, Uganda, Kenya and northern Tanzania may have a similar ubuntu term with a different distinction (Heine and Nurse, 2000, p. 47).

Ubuntu is known as Botho in Setswana language of Botswana and it is part of their economic and social development agenda principles (Victor Mofuoa1, 2010) and was part of their 2016 vision plan (Osei-Hwedie, 2004). It is also known as Ujamaa (see Reviere's second Afrocentric canon mentioned earlier in Section 2.1.1) in Kiswahili language of Tanzania, Utu in Swahili of Kenya and Obuntu in Runyakitara dialect languages of Uganda.

Ubuntu is well-known for this Nguni languages short phrase: *Umuntu ngumuntu ngabantu* which translate as "A person is not a person without other people" (Broodryk, 2002; Makgoro, 1998; Mbiti, 1990; Ramose, 1999). Several authors have explained this phrase with similar terms; for example, Mbigi and Maree (1995) said it stands for "personhood and morality", Mugumbate and Nyanguru (2013) pronounced it as "being self through others", Battle (1995) said it means each's humanity is ideally expressed in relationships with others. Noble peace prize winner in 1984, Archbishop Desmond Tutu (Tutu, 2000, p. 34) once said

that ubuntu is: "human uniqueness, the profound truth is that you cannot be human on your own, it is inter-dependency, I need you in your fullest to be me, we are made for complementary".

Ubuntu Definition

Ngubane made the first attempt to define the ubuntu philosophy in the 1960's and 1970's. Cited by Wa Mberia (2015) that Mapadimeng observed Ngubane's definition of ubuntu as: "a philosophy of life and practice of being humane, which gave content to live for African people long before the arrival of white settlers, and that it rests on the supreme ethical code which attaches primacy to human personality as a sacred being". However, Gade (2011) pointed out that the term ubuntu has frequently been used since 1846.

Makgoro (1998) and Tutu (2000, p. 34) are in agreement that it is not easy to define ubuntu in an abstract way and especially in foreign languages. Ubuntu philosophers such as Shutte (2001, pp. 16-20) and Broodryk (2006, pp. 20-21) often use real-life anecdotes to explain ubuntu. Broodryk made an analogy of blind people touching an elephant and everyone having a different interpretation of what an elephant is depending on where they have touched it to relate to how different people perceive the concept of ubuntu depending on their experience with it.

Beside the various definitions and interpretation of the ubuntu concept, what appears is that ubuntu is more than a word, it is an African way of living among each other in kindness, harmony, consideration, respect, peace, love, caring, sharing, altruism, socially mature and socially sensitive, virtuous and blessed striving for conciliation (Cilliers, 2008; Mabovula, 2011; Mbigi and Maree, 1995, pp. vi-vii; Tutu, 2000, pp. 34-35). According to Tutu (2000, p. 34), ubuntu is indeed the essence of being human. Moreover, there is a religious significance to ubuntu (Khoza, 2005, p. 269; Louw, 1998). Mbiti (1990) explained that a person is linked to the dead (ancestors) and children yet to be born. There is a high respect for the ancestors that are believed to provide protection and guidance in life. Everything that exists in the ubuntu world is seen as religious forces interacting with each other, rather than isolated physical artefacts (Shutte, 2001, pp. 21-22).

Ubuntu related to Western Tradition

In the following paragraphs, we distinguish and relate the ubuntu philosophy with similar Western humanistic theories. René Descartes (Descartes, 1969) a French philosopher, wrote about radical doubt. That for him to be genuinely convinced to accept anything to be true, it must be right and that it is right in itself. In simple terms, according to Descartes, this means nothing that seems to be understood or sensed is necessarily true, the only truth is the questioning of the doubt and believing its understanding. His theory brought about this statement: "I think therefore I am", and in Latin, known as the *cogito*, "Cogito ergo sum". Descartes' theory relates to what Pietersen (2005) said that Western approaches emphasise logic, individual personal growth, independence, innovation, performance, responsibility, and achievement and pay less attention to the daily social and communal aspects of life.

In Ubuntu principles, an agreement is highly regarded in decision-making even if the process takes longer (Blunt and Jones, 1997). Nzelibe (1986) and Pietersen (2005) pointed out that the differences between African and Western

theories are present in teamwork. Western team members support Eurocentrism, individualism and modernity, whereas African team members pay more attention to ethnocentrism, traditionalism, communalism and collaborative cooperation. Shutte (2001) mentioned that African socialism rejects both European socialism and Western capitalism. The European theories can establish a society which is not in line with ubuntu principles.

Charles Darwin wrote about the evolution of sympathy (empathy) theory (Darwin, 1888). He pointed out that the most significant moral achievement is to be concerned with the welfare of all living beings, that is, human and nonhuman. He explained the origin of compassion was initiated by witnessing pain or distress of another person, that makes the witness to experience the same feelings and to reduce these feelings, the witness voluntarily help the other in pain. There are similarities between Darwin's empathy theory and ubuntu, in people caring for each other. However, what stands out in ubuntu is the fact of voluntarily helping without noticing sorrow of the other person. Mandela (Experience Ubuntu Interview, 2012) and Munyaka and Motlhabi (2009) explained that a stranger does not have to ask for help in ubuntu philosophy (proactive empathy).

Friction between ubuntu collective worldview on privacy and Western individualistic values has started to prevail. Olinger, Britz, and Olivier (2007) reported on the influences of adopting European Union individualistic approach might have on data privacy bill in South Africa. Olinger, Britz and Olivier pointed out that thorough analysis of the ubuntu concepts and values is contradicting with the ones of the western cultures. They highlighted that in ubuntu worldview, the well-being of the community is seen more important than of the individual and therefore personal privacy might not be regarded as beneficial for the good of the community. While in western culture personal privacy is mandatory for true individuality.

On the contrary, Makulilo (2016) and Scorgie (2004) had different views from Olinger, Britz, and Olivier (2007) and others that Africans do not value privacy. Makulilo argued that there is not sufficient empirical evidence to support that claim and it is based on a misconception that the understanding of privacy concept in Africa does not evolve. According to Makulilo, globalisation, social cohesion and technological advancement in Africa have inherently caused the adoption of Western individualistic use of privacy for the benefit of ensuring and individual's right to privacy. We argue for a fresh re-look into adopting Western individualistic values within Ubuntu interpretation for an appropriate contextualisation.

Humanistic Application of Ubuntu

The African communities support each other in a communal manner, caring for each other and progression in life is achieved by working together rather than concentrating on individual self-reliance. Matshe (2006, p. 17) in her book titled "Born on the continent: Ubuntu" mentioned that in the ubuntu world "there is no you or me, there is only we".

Mbigi and Maree (1995, pp. vi-vii), mentioned that ubuntu plays a pivotal role especially for the poor African communities in helping each other for survival.

They argue that for the Africans to transform their management, the ubuntu concept including African religious experience combined with some adopted Western theories could be the solution.

The first president of South Africa after the apartheid era, Nelson Mandela, showed the world that embracing ubuntu philosophy, peace and racial reconciliation can be achieved. When he was asked by Tim Modise in an Ubuntu Linux distribution promotional interview (Experience Ubuntu Interview, 2012), what ubuntu meant for him, he explained as follows: "In the old days when we were young, a traveller through a country would stop at a village, and he did not have to ask for food or water. Once he stops, the people give him food, entertain him. That is one aspect of ubuntu, but it will have various aspects. Ubuntu does not mean that people should not enrich themselves. The question therefore is: Are you going to do so to enable the community around you to be able to improve?"

Application of Ubuntu to Computer Science

After having set the theoretical background of the ubuntu philosophy, we now look at how the Computer Science profession has employed ubuntu. One of the famous, successful Linux operating systems named Ubuntu has adopted the principles of free sharing of its source code and usage thus caring for others (Gianan, 2010). Linux code of conduct has been adopted widely by other open source projects (Tourani, Adams, and Serebrenik, 2017).

Winschiers-Theophilus *et al.* (2010a) proposed that we integrate the ubuntu philosophy in HCI, mainstream Participatory Design (PD) techniques should be rooted in core values of the African communities. They cautioned researchers to be aware that the interactions with the communities can alter their ways of participation and this brings in the concept of "*being participated*". Being participated by the communities means that computer scientists should still focus on their conceptualisation of the final software product while incorporating the community participatory practises. This *participation* points us to Setiloane (1986, p. 14), when he stated that the essence of being in the ubuntu view is "participation", in which people are always intertwined with one another. Moreover, he mentioned that people are not only the "essential force" but rather the "essential force in participation".

Blake (2010) mentioned that real essential values of the community could only be put in the Software Engineering method if ubuntu values are incorporated. To achieve that, he suggested that it requires paradigm shift by the computer experts to support the unintended use of the software so that the communities can adjust the technology for their use. On a similar school of thoughts, Bidwell (2010) argued that an increase of social networking sites usage in Africa does not necessarily narrow the digital divide. She proposed to solve the problem, Africa electronic-inclusion (e-inclusion) strategies should consider situated humanness interactions of Africans instead of relying on generalised HCI emotional support analysis.

Kapuire *et al.* (2015) found that ubuntu values, for example, togetherness and moral support are implicitly practised by the communities even if they do not call it ubuntu. They proposed that the software designers should incorporate ubuntu values into their design process and community design ideas should be respected.

There is ongoing research to include the ubuntu philosophy in universities curricula. For example, Chmela-Jones (2015) from Vaal University of Technology, South Africa, have incorporated ethics of ubuntu and community participation in a graphic design programme. The students worked with their community to put in practice what they have learnt from the Ubuntu seminars. Combining technical skills of graphic design, human centred design theories, and ubuntu ethics allowed the students to develop that promised *good design*. Bennett (2012) defined a good model as a design that "improves humanity or the environment; resonates with the culture(s) of users; includes the user and other stakeholders in the design process; stimulates and facilitates ease of use in a public context and establishes credibility with its user".

Lack of Ubuntu

In this subsection, we highlight on the lack of ubuntu and thoughts of its revival and continuity. A survey was conducted by Mabovula (2011) in South Africa to find out people's understanding about ubuntu values and whether they are interested in embracing it. Her finding shows that the majority of the participants had an excellent knowledge of ubuntu. Many communities still practise ubuntu but not as it used to be. It is now on a small scale, and more profoundly, they are always willing to embrace the ubuntu values. Mabovula highlighted several challenges in fulfilling the ubuntu values such as xenophobia, moral degradation, urbanisation, crime, religion and individualism. To revitalise ubuntu values, she proposed that the communities re-adjust and restore ubuntu to cope with the new modern challenges.

Several authors such as Konyana (2013), Metz (2007), Pietersen (2005), and van Binsbergen (2001) have questioned the practical application of ubuntu principles. Kumalo (2017, p. 24) mentioned that at times we see the absence of ubuntu, that is, jealousy, greed, hate, anti-communal practices, xenophobia and many more within the same communities that claim the origin of ubuntu values. In this regard, Kumalo said ubuntu becomes "already-not-yet" lived experience in the community.

In a similar vein, Hailey (2008) mentioned that ubuntu noteworthiness is often reduced to what he termed "flavour of the month status" in short-lived management practices. Karsten and Illa (2005) said that this practice diminishes ubuntu's true worthiness as a process for economic and productivity benefits rather than its core reality of more profound personal and community development. On similar arguments, Hailey made it clear that ubuntu cannot be imposed but instead fostered through a suitable progressive process.

In the absence of ubuntu aspects there could be catastrophic events, for example, the Belgian Congo crisis in the early 1960s and the Rwandans genocide of 1994 as questioned by Tutu (2000, p. 36). Tutu warned that honouring ubuntu is not a routine, pre-programmed and assured process; it takes terrific people of all races to embrace it.

Louw (1998) talked about the negative aspects of ubuntu by relating it to "totalitarian communalism" in this sense, change in ubuntu is feared, and differences rejected. According to van Binsbergen (2001) ubuntu denies humanity to the colonists or migrants. On the contrary, Kumalo (2017, p. 24) reminded us that ubuntu is racially diverse, it alludes to all humanity, not only for the black

or African descent. Furthermore, if you look at the Rainbow African Spirits Theory (Afrocentric religion), mentioned earlier in 'application of ubuntu' Subsection 2.1.2, that ubuntu does accept differences (Mbigi and Maree, 1995, pp. vi-vii). Mandela also clarified this, that ubuntu does allow personal growth but it is a question of how the individual do so to bring about improvement in the community (Experience Ubuntu Interview, 2012).

Kochalumchuvattil (2010) argued that personal development should enhance African of collective identity (Ubuntu) to solve humanitarian problems such as ethnic violence, poverty, corruption, dictatorship and many others. He stated that Africans are dominated by communalism which blocks or lacks the process of individual actualisation. Kochalumchuvattil argued that ubuntu on its own is not sufficient to bring out true personhood. He claims that true personhood has to be established first for someone to positively contribute to Ubuntu. For one to foster individuality and still have respect for others, Kochalumchuvattil proposed five principles (*Nguzo Tano* in Kiswahili) to be followed. A summary of the five principles titled in Kiswahili is provided below:

(1) *Kujichagulia* is self-determination and liberty for an individual African to make own responsible choices instead of abiding by collective judgements made on one's behalf.

(2) *Ujimaa* is the same as the fourth canon of Reviere (2001) dealing with collective work and responsibility. It is about working together helping those that need assistance to achieve a common goal.

(3) *Nia* is concerned with the individual determining and pursuing his or her personal goals. The achievement of the personal ends is not only self-centred but should also contribute to the communities' goals.

(4) *Kuumba* is the output of Nia whereby the person's well-being of mental, physical, and spiritual energies are synergies for creativity. One can realise Kuumba by stimulating creative thinking and learning by taking essential elements from the African cultures and traditions.

(5) *Imani* is concerned with Africans believing in themselves. Africans should empower themselves with opportunities to take responsibility for themselves and their community. One can achieve Imani by having an attitude of confidence, self-belief, optimism and hope that it eliminates the identity crisis of self-doubt.

Matolino and Kwindingwi (2013) made a different criticism about ubuntu. They highlighted two shortcomings of ubuntu, that is, firstly, they believed that there could have been other African humanistic philosophies that did not receive the same popularity as ubuntu or were sidelined. Matolino and Kwindingwi argued that different African interpretations that existed could have been suppressed and should not be seen as insignificant or less African authentic. They further mentioned that denying the existence of other theories undermines African's intellectual freedom. Finally, they stated that those who want to revive ubuntu values tend to make people believe that everything authentic about Africa is from the time before slavery and colonialism. Matolino and Kwindingwi pointed out that this argument is at times used in a politically driven way; this in return avoid other approaches that are inclusive.

Metz (2014) responded to Matolino and Kwindingwi stating that their arguments that ubuntu should be put to an end are *prima facie*. He questioned that if

there was no philosophical value in ubuntu, why then was it not left out as an invalid ethical theory. Metz instead argued that ubuntu is yet to be tested on contemporary societies, scholars and politicians should preferably embrace ubuntu and put it in action on projects before concluding its irrelevance.

Verharen (1997) reported on how Lefkowitz (1997) and Hegel (1956) misread Afrocentrism and how researchers such as Diop (1989) are putting in all effort to reverse the misjudgement of Afrocentric or Ubuntu. Opposing Afrocentric philosophies on certain aspects and similarity on some shows that an Afrocentric research approach is yet to be exhaustively conducted especially in computer science where it has not been tried out comprehensively to devise achievable guidelines. Without application of ubuntu segregation, inequality, prejudice, conflicts, and others among and within communities will continue to take place. Researchers that are involved in African community-based research should be aware of the repercussions of lack of ubuntu and take effort to incorporate the ubuntu values in their practices.

2.2 Indigenous Knowledge

African Indigenous Knowledge (IK) or cultures are at times studied with an external view instead of using an African perspective. The fact that the majority of published work is based on Western Knowledge and not on the African understanding have reasonably attributed to the use of this external viewpoint (Hountondji, 1997). According to Mkabela (2005), most researchers working with the indigenous communities in South Africa have not been of the satisfactory standard. Mkabela mentioned that the researchers do not consult the indigenous communities about the research priorities, design and evaluation of the results. Researchers have been considering the native populations as *informants* rather than equal partners. Excluding the Africans has often caused misconception of African cultures and their IK.

2.2.1 Indigenous Knowledge Definition

In simple terms, IK is the knowledge that is native to a specific community formerly learnt outside the conventional education systems. However, provisions are now made to include IK in school curricula, several countries such as South Africa (Le Grange, 2007), Kenya (Owuor, 2008), Australia (Nakata, 2011) and many others have started with this process. There are various definitions and terms for IK cited in literature depending on the focus (Grenier, 1998). There are also different views on whether IK in the description should be separated from scientific knowledge or not. In these subsections, we highlight the challenges of defining IK.

Before looking at the detailed definition of IK, it is worthwhile to start with the description of 'indigenous people' and 'knowledge'. The International Labour Organisation under the revised Convention 169 (Swepston, 1990) for instance, refers to indigenous people interchangeably with tribal populations as: "people in independent countries who are regarded as indigenous on account of their

descent from the populations which inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonisation or the establishment of present state boundaries and who, irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions". Another good example is Purcell's definition (Purcell, 1998) of indigenous people that: "it is a term used to refer to a particular group of people who maintain their complex culture and continue to occupy their ancestral land or relocated due to colonisation".

We disagree with these types of defining indigenous people because it brings in sensitive contentious issues such as colonisation, racism, those in need or poor and others as pointed out by other authors (Beteille, 1998; Sanders, 1999; Smith, 2013 ; Weaver, 2001). In this thesis, we, therefore, use a neutral abstract definition for indigenous people as *any community that has mastered survival tactics in their ecosystem*. The focus on indigenous on the above description is rather on the knowledge originating from the mastery of the ecosystem than on the people.

Knowledge has been popularly defined as "justified true belief" by Plato (Chappell, 2005). Indigenous people themselves have their name in their languages; it has not been a problem trying to define it for themselves. It is more of their integral custom of survival (Boven and Morohashi, 2002a; Nakata, 2002). However, the problem arises when others try to define the knowledge of the indigenous people.

Lodhi and Mikulecky (2010) defined *indigenous knowledge* as follows: "Indigenous knowledge is the comprehensive knowledge and practices sustained and developed by generally rural communities from generation to generation." While Dei (1993) defined IK with the following statements: "That it includes the cultural traditions, values, and worldviews of local people as distinguished from Western scientific knowledge. IK is the product of indigenous people's direct experience of the workings of nature and its relationship with the social world. It is also a holistic and inclusive form of knowledge".

There are several phrases used to refer to IK namely; tacit knowledge, community knowledge, rural people's knowledge, people's science, local knowledge, traditional knowledge, cultural understanding, traditional ecological knowledge, indigenous technical skill, folklore and others (Chisenga, 2013; Nakata, 2002).

The problem in dealing with IK is already reflected in the struggle to describe it (Mazzocchi, 2006). On the other hand, Hiebert (1998) pointed out that although there are different IK terms and definitions, they all refer to the same theme, that is, knowledge passed from one generation to the next for survival while still living in harmony with the ecosystem. IK can be defined differently depending on the focus; some focus on the environmental or biodiversity, some on political agendas, some on the culture.

Literature supports the view that IK and Traditional Knowledge (TK) may be used interchangeably. It is argued by Payyappallimana and Fadeeva (2013), that indigenous and traditional knowledge support for biodiversity is fundamental to clarify their situations for developing creditable context based on community participation. Another analyst Bruchac (2014) emphasised that indigenous people around the world have conserved distinctive understanding rooted in (*their*) cultural experience that guide relations among human and non-human beings in

specific ecosystems. It is precisely these understandings and relations that constitute a system broadly identified as indigenous knowledge, also called traditional knowledge. It is against that background that it is argued that safeguarding IK may as well be done with regard to TK.

The emphasis in this study is not much on the IK or TK itself but rather on the process of safeguarding it using software applications co-designed (see the next Chapter 3) with the rural communities. A broad general definition of IK interchangeable with TK is referred to in this thesis excluding the focus on contentious issues such as land attachment and colonisation.

2.2.2 African Indigenous versus Western Knowledge

There are different school of thoughts whether there should be a distinction between African IK and Western scientific knowledge or not. Numerous researchers such as (Agrawal, 1995; Duncker, 2002; El-Hani and Ferreira Bandeira, 2008; Velden, 2013) argued that IK should be defined and valued particularly from the indigenous people's perspective on its merit, validity, and legitimacy. The International Institute of Rural Reconstruction (1996) identified IK to have the following attributes:

- it is mostly not in written format,
- transferred through stories, traditions, dances, and artefacts,
- derived from lived experiences tested over centuries of use,
- it is context and culturally specific,
- it is dynamic and changing, and
- more practical rather than abstract.

Nakata (2002) talks about *Cultural Interface* as an intersection between Western and Indigenous Knowledge. He explained cultural interface as a place where we live and learn. Cultural interfaces condition and shape our future. It is the interaction relation of an individual from home to work or school environment. He further stated that it is a complicated place with a lot of tension, a source of confusion for many thus it requires constant negotiation. The negotiations are about different interests and systems of knowledge to be reflected on and cross-questioned. Jegede (1999, p. 125) made a comparison between African and Western systems of thought as displayed in Table 2.1. From the tabulated comparison, the points that might not be clear are elaborated here. *Anthropomorphic* means that African knowledge system considers human characteristics and relations while the Western knowledge is *mechanistic* that relies on theories or in deterministic terms. African knowledge system is *monistic-metaphysical* meaning there is a belief in oneness uniformity. African knowledge is *sagely practised* meaning there is usually mastery of wisdom by intelligent people that teach others and therefore subjectivity should be accepted as mentioned early in Section 2.1.1 on the fifth Afrocentric canon proposed by Reviere (2001).

TABLE 2.1

A Summary of African and Western Systems of Thought, adapted from (Jegede, 1999, p. 125)

African	Western
Anthropomorphic	Mechanistic
Monistic-Metaphysical	Seeks empirical laws and principles
Cosmology with religion as an important focus	Public property minus religion
Orality predominates	Documented
Sage practice	Truth can be challenged
Learning is communal	Learning is an individual enterprise

Le Grange (2007) cautioned about blind romanticism of IK existence in isolation. Mazzocchi (2006) in support mentioned that the differences between the IK and Western knowledge should be used to learn from each other. In support of this argument, Stevens (2008) encouraged non-indigenous researchers to continually adapt their knowledge management tools and strategies and moreover entirely understanding of knowledge.

Keita (2014) argued that the technological knowledge[3] advantage by the European attributed to cultural diffusion and modes of knowing in Africa. Keita is of the opinion that the inflicted Eurocentric knowledge system on Africans orchestrated Africans to devalue their knowledge systems. This imbalance made people believe that superior humans (Western) produced more advanced technologies than the less-superior people (African). Keita also stated that the Western knowledge superiority conflicted with African modes of knowing on different dimensions whether on the language, metaphysical (religious) or the traditional technological knowledge (empirical). We agree with Keita that European knowledge superiority could be overcome by rejecting European universal application of studying African knowledge, that means unpacking Eurocentric knowledge and replacing where necessary.

2.2.3 Digitising Indigenous Knowledge for Safeguarding

In this section, we highlight the issues surrounding the digitisation of indigenous knowledge (IK) for safeguarding. As illustrated in Figure 2.1, while researchers or computer scientists are working with IK holders to digitise IK for safeguarding, several issues need to be addressed. For example, challenges in collecting IK in its complexity, whether the existing technologies are suitable or not; thus, *technology appropriation* might be required. IK holders and researchers must adequately address access rights issues and how to disseminate IK to the audience, and above all, what research processes are used in solving all these issues.

Identifying and Collecting IK for Digitisation

[3]Keita (2014) referred to technological knowledge as knowledge that we humans use to enhance our understanding of the natural structures of the world and its functional representation in forms of tool-making.

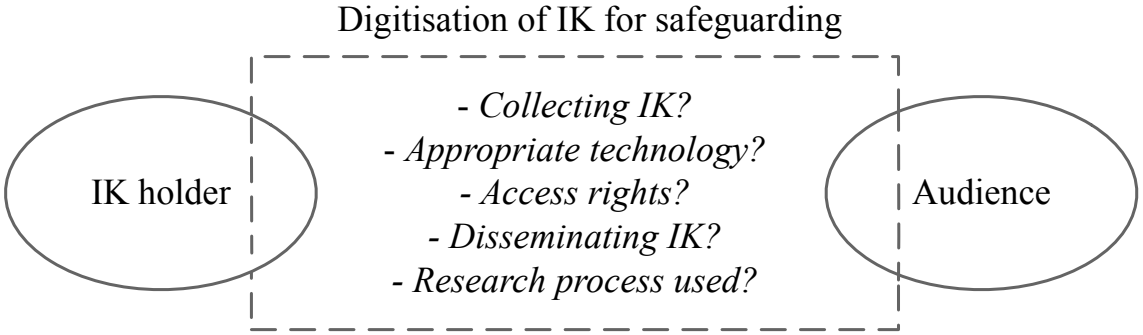


Figure 2.1. IK perspective for digitisation as discussed in this section. (Diagram constructed by the author.)

Chisenga (2002) recommended that IK of the African people must also be codified in print and in electronic formats (website, audio, and video) to be accessible on the global infrastructure. IK should be safeguarded and integrated into existing knowledge systems were necessary for the well-being of the entire society (Ngulube, 2002). The first activity for digitising IK is to establish what has to be captured. This might seem like a trivial process, but one should consider that not all dimensions of the IK would be captured depending on the recording option selected (Hunter, 2005).

Rodil *et al.* (2014) pointed out the following predicament that could occur for capturing the ovaHerero traditional wedding as an example. Pictures alone do not portray precise movement or the important voice etiquette, videos might not be allowed during private meetings, for example, in bridal payments, and audio recording might miss the physical action of activities before, during, and after the wedding. The above mentioned scenario tells us that appropriate method or a combination of recording features should be investigated for capturing IK as Hunter (2005) pointed out.

The work of Gallert and van der Velden (2015) showed that Wikipedia's established rules makes it difficult for oral shared traditional knowledge to be accepted as authentic referenced work thus blocking it from the international encyclopedia. Furthermore, what about embodied IK such as spiritual healing or trade knowledge that the IK holder would not like to share with the audience (Ngulube, 2002; Stevenson, 1999). What about verification or reflection for enhancement before broadcasting to the public (Hunter, 2005). What about incentives for the IK holders that partake in the innovation and sustainable development of IK. For example, in Canada IK teachers are financially rewarded for their creative and innovative contribution (Battiste, 2002, p. 34). These are some of the issues to be considered when identifying and collecting IK for digitisation. Adam (2007) stated it well that successful IK initiatives so far are the ones that comprehend the difficulty of access to indigenous communities, how everything in their environment relates to the ecosystem, and value of the indigenous people's knowledge.

Noting the importance of IK and that it is not well documented has initiated several research projects focusing on capturing and recording or archiving it. Documenting IK refers to the process of identifying, collecting, organising, and recording IK to be retrieved efficiently. One of the drivers for documenting IK is

for the indigenous people to share what they know with the youth of the same indigenous community and with the rest of the world. IK should be documented in languages that are understood by owners of the IK and other communities for sharing it. Documenting IK can provide evidence that the indigenous communities are the source of such knowledge (Sithole, 2007). For example, documentation of ethnoveterinary medicine has gained international recognition (Wanzala *et al.*, 2005). Ethnoveterinary refers to how the indigenous communities have been healing their livestock without veterinary prescriptions (McCorkle and Mathias-Mundy, 1992).

Sithole (2007) pointed out that although the process of documenting IK can be viewed as easy, it can also be tedious, costly, and sometimes disappointing. There is a fear that documenting IK may lead to IK being misused or loss of secrecy or confidentiality. In this regard the World Intellectual Property Organisation (2016) proposed that government authorities should provide a defensive mechanism for protecting misappropriation of IK.

Adam (2007) cautioned computer scientists to consider the characteristics of IK when developing ICT tools aimed at facilitating documenting IK. For example, the fact that IK is verbally transferred to the next generations, the focus should be on devices that have appropriate functionalities such as audio-visual and text to speech for those that cannot read. On the other hand, there is a different opposing school of thought researchers such as Bidwell (2014, p. 24) argue that since IK is orally shared it should be treated that way in line with the communities' knowledge without any interruption. However, even that does not guarantee no interference. Observing, training, writing research papers about IK and others may transpire what currently might not be visible.

To assist with challenges that come along with recording and working with IK, researchers such as Boven and Morohashi (2002b) and Grenier (1998) published best practices on how to effectively document IK. They additionally provided several IK case studies with what inspired people to work on them and their success and challenges encountered. However, neither the guidelines or best practices provided by Boven and Morohashi nor by Grenier provide a detailed methodology of conducting IK research, what they provide is instead a checklist of items recommended for a project to be bench-marked for adhering to best practices.

Technology Appropriation

Technology appropriation refers to the process of collaboratively changing technology from its original designed purpose to a new way that is more suitable for that specific individual, group or community (Salovaara *et al.*, 2011; Stevens, Pipek, and Wulf, 2010). Based on the above definition, it means to appropriate something; one has first to try it out. In IK digitisation context, it is during the process of digitising IK that we often find that the mainstream technologies are not best suited to how the communities want to use it. It does not mean that technologies are only appropriated when we encounter challenges in using it, at times; it can be adapted for fun (Carroll *et al.*, 2002) or when unprecedented innovation opportunities raise (Arbussà and Coenders, 2007).

In this study, since we co-design technologies with the *communities*, we have

moved towards inclusive community technology appropriation for culturally diverse indigenous communities. We agree with Overdijk and Van Diggelen (2006) that during the process of appropriating technology, users and technology are transformed at the same time. We strive for a more prominent representation of community appropriation in HCI (Kapuire *et al.*, 2010), which allows communities to first interpret technologies (Dix, 2007) from their context for authentic meaning-making (Muller *et al.*, 2016) and to resonate with their culture (Lindtner, Anderson, and Dourish, 2012). We appropriate technologies based on the communities' technology adoption model proposed by Kambunga, Winschiers-Theophilus, and Goagoses (2018) that is applicable within an African context, no longer based on intention-behaviour theories.

Access Rights

The fact that the management of IK involves rules of secrecy and sacredness and communal ownership makes it different to handle its ownership and protection as compared with the Western concepts of intellectual property (Darch, 2014; Smallacombe *et al.*, 2007). It is perhaps the reason that most research about IK missed collective ownership and interest of the indigenous people in their knowledge as stated by Davis (1998) and Janke (1997) and many other authors. The difficulty in determining what precisely IK is and what it is not and moreover how it relates to intellectual property (IP) concepts have been termed by Hughes (2012) as "definitional instabilities" of the field of traditional knowledge.

The Business and Intellectual Property Authority in Namibia classifies IP into two different categories, namely (1) Industrial Property and (2) Copyright (BIPA, 2018). The latter denotes literary and artistic works, which includes *inter alia* poems, paintings, musical work and agricultural designs. Industrial Property rights, on the other hand, includes work such as inventions, trademarks and industrial designs. The problem with the categories mentioned above is that both relate to individual activities or well defined groups such as music groups or organisations that are easily identifiable and owned and therefore can be patented. However so far as it relates to IK most legendary creations are as a result of an information sharing process influenced by cultural practices collectively owned by that particular community. As described by MacQueen *et al.* (2001), a community is a "group of people with diverse characteristics who are linked by social ties, share common perspectives, and engage in joint action in geographical locations or settings." Patenting something belonging to a community makes it then difficult.

The drive for the protection of IK has been augmented by the financial gain that accrues to users of IK at the expense of the indigenous knowledge holders (Masango, 2010). According to Darch (2014), South Africa's IK has been and still is appropriated and absorbed into the knowledge systems of the former colonial powers. Darch mentioned that when it comes to IP rights for traditional knowledge, the most raised concern is whether Western IP is suitable for protecting non-Western knowledge (IK) that is not mostly in written form and not commercially used for trading. In this regard Anderson (2010) makes the following statements:

"*The most significant problem with using IP to protect traditional knowledge is that*

IP has a unique European derivation that drives its classification, identification and operation. Intellectual property law promotes particular cultural interpretations of knowledge, ownership, authorship and property. These do not necessarily correspond to or complement indigenous people's understandings about the role and function of knowledge and knowledge practices."

In an attempt to address this problem countries such as Australia, India, Fiji, Costa Rica and others have come up with policies aimed to regulate access to IK (Shikongo, 2007). Those countries opted for access and benefit-sharing framework. The Organisation of African Unity has adopted the *African Model Law* (Zerbe, 2005) to assist in the process of formulating and developing national access and benefit sharing legislation. Namibia is a State Party to international instruments such as the United Nation Convention on Biodiversity, the Cartagena Protocol (Schweizer, 1999-2000) on Biodiversity to the Convention on Biodiversity and, the Nagoya Protocol (Chennells, 2013) on Biosafety to the Convention on Biodiversity and the Nagoya Protocol on Access to Genetic Resources and the fair and equitable sharing of benefits arising from their utilisation – a supplementary agreement to the Convention on Biodiversity.

Several governments are busy establishing laws to protect indigenous people's knowledge from further exploitation. The question remains whether these laws are still based on a Western concept of IP or adequately consulted with the indigenous communities or whether the indigenous communities even want them in the first place. The laws might over-protect the indigenous communities and in return disadvantage the very same communities in question.

A good example would be the registration of the batik designs in Indonesia. The batik designs have been recognised as traditional arts of the batik artistic community by the Indonesian government (Jaszi, 2010). The designs are considered as a conventional practice of the batik community because it has been learnt from their older generations and denotes significant meaning and traditional stories for specific families. To protect the classic trademark of the batik designs from misuse and misappropriation the local government has developed a patent program for the conventional models. The traditional designers are now required to register their designs by paying a registration fee, although not all batik artists can afford this registration fee thus excluding them from participation. For those that want to use the registered designs, permission has to be obtained at the government office.

In South Africa, for example, the government is currently working on the "Protection, Promotion, Development and Management of Indigenous Knowledge Systems" bill (B6-2017) that seeks to protect IK in the development of socially and economically suitable products and services (Parliamentary Monitoring Group, 2018). The law places an obligation on any person who wishes to practice as an indigenous knowledge practitioner to apply in the prescribed manner to the National Indigenous Knowledge Systems Office (NIKSO) in order to be accredited, certified and also registered as such. Upon certification, a practitioner may commence practising as an authorised indigenous knowledge practitioner. The Chief Director of NIKSO Yonah Seneti in his interview with Saez (2018) stated that it was a challenge to convince the traditional healers to share their knowledge as it is their means of survival.

The discourse on to what extent IP law could or should not be used to protect indigenous people's knowledge has been debated widely on an international level. The World Intellectual Property Organisation held several meetings since 2001 to discuss this issue. Despite various efforts to protect IK, there is not yet an agreed international consensus on how to protect indigenous people's knowledge. Anderson (2010) reminds us that there is an urgent need to develop local strategies that are appropriate for the indigenous communities' context and that are immediately accessible.

Disseminating Indigenous Knowledge

The Internet is being explored to its full potential for safeguarding IK. As a starting point telecentres in rural areas are being set up in some African countries (Chisenga, 2013; Ulluwishewa, 1994). The indigenous communities can use the Internet at telecentres to upload their IK. Owiny, Mehta, and Maretzki (2014) proposed usage of social media technologies to create, safeguard, and disseminate IK. Social media such as YouTube that do not require specialised Information Technology (IT) skills can easily be used by the indigenous communities to upload and share the knowledge they can. The African Culinary Network is one of the successful websites that allow scholars to share information via Twitter, Instagram or Facebook about the culinary heritage of Africa (Osseo-Asare, 2012).

Christie (2001) has been working on safeguarding the IK of the Yolngu people from northern Australia. The knowledge of the Yolngu is often shared through performance and representation of artwork. Making use of the Internet the Yolngu people can represent their embodied knowledge through sharing multimedia recordings of video and audio and taking photos. This approach does not deviate much from their classical oral transfer of knowledge contrarily to the unfamiliar Eurocentric method of reading and writing. Performance of traditional events such as Garma can be shared online, providing functionality for grouping related events for viewing and discussion. Garma is a designated sacred area for a formal public event whereby the Yolngu people from different locations come together to perform old stories in songs, dance and art. According to Christie, the challenge would be to incorporate remote presence of performed protocols followed at the physical Garma onto the online virtual Garma space. From the above-given scenario, the actual physical experiences cannot be obtained from the online visualisation and demonstration. Christie (2004) stated this very well that the digital object or recorded performance is merely a representation or act of prior knowledge, it is not knowledge but rather information. She suggested that the IK digital objects should not be seen as replacing the conventional wisdom but instead as something that will enhance future production of knowledge.

Chisenga (2002) mentioned that for the web to apply to Africa's information needs, culture and environment, it must contain the correct African content. Africans themselves must substantially update the web with the appropriate content about Africa. Although theoretically, it is possible for the IK holders to update the web with their content, practically it has proven to be a daunting task to be achieved. The experts of the IK are elders who find it difficult to use the standard content management web applications. It is therefore that researchers such as Zaman, Kulathuramaiyer, and Yeo (2015) are co-designing the web forms with the IK holders. They co-designed an original content management system with

the Penan community after realising the weakness of the Open Data Kit (2015) form-based entry for capturing multimedia of the Penans' indigenous botanical knowledge. They found out that besides the usability issues of web applications for the indigenous communities, established standards on how to publish knowledge makes it very difficult for IK.

To support the process of recording, organising, and retrieving IK, computer scientists have started designing software applications. The trend for developing IK safeguarding software applications is moving from the classical text or graphical user interfaces to more 3D, Virtual Environment (VE), and Augmented Reality (AR) applications (Biyela, Oyelude, and Haumba, 2016; Kapuire and Blake, 2011; Rodil *et al.*, 2012b). To make this success computer scientists have to be more creative working hand in hand with the indigenous knowledge holders to design software applications that are still in context and of use to the indigenous communities.

Jensen *et al.* (2012) used graphical representations to organise IK knowledge repository logically after recording a substantial amount of videos representing IK of the ovaHerero community. Jensen *et al.* used ethnographic observations, discussion with the community members, and including analysis of narrations and found out that there was a dominance of spatial and social structures within the ovaHerero community as also stated by Bidwell *et al.* (2011a).

In the same line Ladeira, Marsden, and Green (2011) have been working on safeguarding historical oral stories told by tour guides at District Six Museum in Cape Town. Past events are often well said by those that experience those events. Unfortunately, those that lived in that time are becoming too old, and their stories are not recorded. According to Marsden *et al.* (2010) to playback oral taped stories poses the following issues to be considered:

1. The listener is most likely to be in a completely different physical environment from which the story was recorded.

2. The listener might not have the full understanding of the cultural experience to interpret the story.

3. The listener will not have the possibility to interact with the storyteller.

To overcome some of those issues Ladeira, Marsden, and Green have designed an interactive VE. Guided by an ethnographic study of real-life storytelling their VE was developed to visualise the actual dynamics and qualities of a storyteller and listener. The VE allows the museum visitor (user) to be part of the virtual audience to listen to the storyteller (agent) and interact with the agent by raising a hand to ask questions. The agent also hints the users to ask questions while telling the story and for the users to provide their feedback at the end of the story. The results of this study shows that the users were happy about the VE interaction and were not satisfied if the agent could not answer specific questions.

Challenges in Digitisation of IK

Although there is a great effort to make use of ICT to safeguard IK for future generations, there are also challenges that come with this process. According to Ngulube (2002), the main difficulties faced with management and safeguarding of IK are the methodology, that is, whether to use the Western paradigm or

not, access, IP rights, and media and format in which to safeguard it. Lawas and Luning (1996) cautioned that the IK collection process alone is tedious, time-consuming, and costly and therefore, proper storage and management should be satisfied with the ease of access and use. Hunter (2005) further mentioned that the challenge of finding an optimal and most culturally appropriate approach to recording and disseminating IK without intrusion, constraints, misrepresentation of the content is often underestimated. Therefore, a suitable consultative process needs to be established to identify and prioritise on what materials are to be recorded and to understand the underlying African IK.

On the perception that technology affects the *authentic* and *traditional* aspects of the indigenous people's customs and culture. Brown (2007) argued that such a proposition does not take into account that there has been centuries of technology appropriation as an output of imperial expansion and globalisation. She stated that it should be better argued that the indigenous people have always been interested in new technology and have never intentionally appropriated it without considering its effect on their traditions. Brown mentioned that it is worthwhile for the indigenous people themselves to appropriate new technologies for their purpose before the techniques are applied to them by others. Similarly, Winschiers-Theophilus *et al.* (2010b) mentioned that eliciting software requirement from African rural communities requires different approaches besides the current ICT supported methods. They recommended person-bound, audience, purpose-driven, and narrator and listener user roles approach.

2.3 Crowdsourcing

In the following subsections, we firstly look at the various crowdsourcing definitions from literature and point out the meaning we used. Secondly, to better understand crowdsourcing, a detailed description of the four core elements or pillars, that are, (1) the crowdsourcer making a request, (2) the crowdsourced task, (3) the crowd working on the crowdsourced task, and (4) the platform as a medium of interaction for the crowdsourcers and the crowd will be explained. Thirdly, an overview of motivations that drive the contributors to contribute on crowdsourcing platforms will also be discussed. Fourthly, touch on crowdsourcing projects related to this study to point out our direction. Finally, we provide an overview of the challenges faced by those related crowdsourcing projects.

2.3.1 Crowdsourcing Definition

There are numerous definitions of what crowdsourcing is. However, it is well cited (Nag *et al.*, 2012; Pedersen *et al.*, 2013; Simula, 2013; Stol and Fitzgerald, 2014) that *crowdsourcing* was first coined in 2006 by Wired magazine editors Jeff Howe and Mark Robinson to explain the business model of organisations that were using the Internet to outsource their work to the crowd (Howe, 2006b). Therefore, in basic terms crowdsourcing implies outsourcing to a public. It is a made-up word from a combination of crowd and outsourcing (Schenk and Guittard, 2011). Howe (2006a) defined crowdsourcing as follows:

"*The act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in an open call.*"

Howe (2008) himself also pointed out that the term crowdsourcing is used for a set of different activities that are not well fitting to its definition. Several researchers (Brabham, 2009; Faridani, Hartmann, and Ipeirotis, 2011; Surowiecki, 2005; Vukovic and Bartolini, 2010; Wexler, 2011) defined it differently depending on their point of focus. For example, Brabham (2009) defined crowdsourcing as:
"*Legitimate, complex problem-solving model, more than merely a new format for holding contests and awarding prizes.*"

While Wexler (2011) defined it as a " *focal entity's use of an enthusiastic crowd or loosely bound public to provide solutions to problems.*" Pedersen *et al.* (2013) also suggested a common crowdsourcing definition to read as:
"*A collaboration model enabled by people-centric web technologies to solve individual, organisational, and societal problems using a dynamically formed crowd of interested people who respond to an open call for participation.*"

Different unconventional terms are also used such as crowd-based outsourcing, civic-sourcing, crowd wisdom, human-based collaboration, peer production, smart mobs, collective intelligence and many others (Nam and Sayogo, 2011; Doan, Ramakrishnan, and Halevy, 2011). Different use of terms for crowdsourcing led to inconsistency whereby Estellés-Arolas and Guevara (2012) evaluated 209 articles and extracted 40 original crowdsourcing definition and use those to construct an integrated definition, defined as follows:
"*Crowdsourcing is a type of participative online activity in which an individual, an institution, a non-profit organisation, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task. The undertaking of the task, variable complexity and modularity, and in which the crowd should participate in bringing their work, money, knowledge and or experience, always entails mutual benefit. The user will receive the satisfaction of a given type of need, be it economic, social recognition, self-esteem, or the development of individual skills, while the crowdsourcer will obtain and utilise to their advantage what the user has brought to the venture, whose form will depend on the type of activity undertaken.*"

Having considered all the well-researched articles on defining crowdsourcing especially by Estellés-Arolas and Guevara (2012) we can see that the rural communities were not identified as requesters or as crowdsourcers. Estellés-Arolas and Guevara listed four crowdsourcers as (1) an individual, (2) an institution, (3) a non-profit organisation, or (4) as a company. However, Stanley *et al.* (2013) have shown that the crowdsourcing requesters can also include rural communities. In this study, when we are mentioning crowdsourcing, we are referring to the integrated crowdsourcing definition by Estellés-Arolas and Guevara with the addition that rural communities can also be crowdsourcing requesters.

2.3.2 Crowdsourcing Taxonomy

Initial research work on crowdsourcing has been on how it has been used and its benefits. More of the recent studies have started focusing on coherent comprehension of this concept. One of the clear crowdsourcing taxonomies was made

by Hosseini *et al.* (2014). They classified crowdsourcing into four pillars based on what they found familiar in the crowdsourcing process. The four components were identified namely as: (1) the crowdsourcer or requester, (2) the crowdsourcing platform, (3) the task, and (4) the crowd or contributor are now used as a crowdsourcing reference model (see Figure 2.2). Each pillar characteristics as described by Hosseini *et al.* are summarised in the following paragraphs.

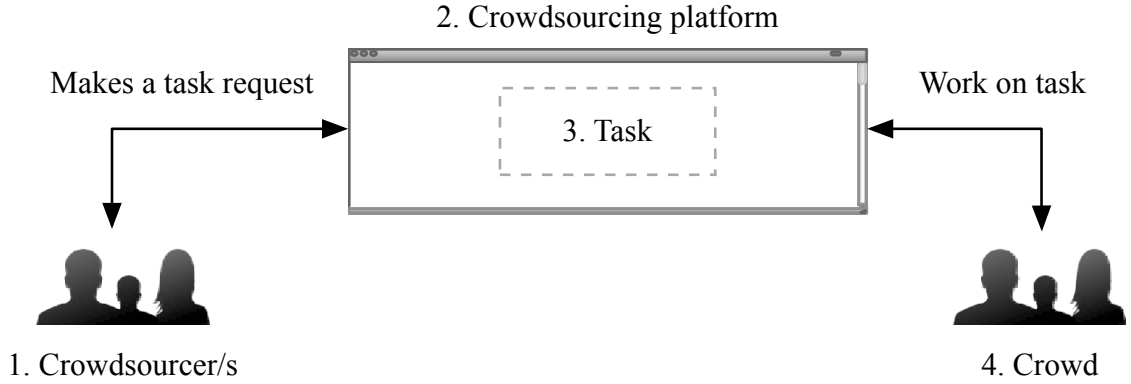


Figure 2.2. Pillars of Crowdsourcing: the *crowdsourcer* that makes a request, the crowdsourced *task*, crowdsourcing *platform*, and the *crowd* (contributors) working on the task as proposed by Hosseini *et al.* (2014). (Diagram constructed by the author.)

Pillar one, the **crowdsourcer** or **requester** both terms are used interchangeably, is an individual or a group of people (institution, company, a non-profit organisation, or rural communities) that initiates a request seeking for a solution from the contributors (the crowd). Hosseini *et al.* (2014) identified four critical features of the crowdsourcer as incentive provision, open call, ethicality provision, and private provision.

However, we argue that in a practical sense when the crowdsourcer is using a crowdsourcing platform, what is required by the crowdsourcer is to create an account by specifying the required information, publish the task with the budgeted amount if any, and get and evaluate the results unless the crowdsourcer is the implementer of the crowdsourcing platform. The crowdsourcer as an ordinary requester does not have to think about all possible incentive strategies, ethicality provision, and private provision. Based on this rationale the three features of the crowdsourcer, that is, open call, ethicality provision, and privacy provision placed by Hosseini *et al.* (2014) are instead discussed with the crowdsourcing platform. Those three features can easily be implemented as part of the crowdsourcing functionalities. The incentive provision is examined on its own in Subsection 2.3.3.

Pillar two, the **platform**, is a web application that the crowdsourcer and the crowd use to perform their functionalities. The crowdsourcing platform features are outlined below:

1. *Crowdsourcer-related interactions*, these are functionalities provided by the crowdsourcing platform to allow the crowdsourcer to use the platform.

These functionalities can be for creating an account, authentication, broadcast tasks, assistance for all the features, time and price negotiation, verification, feedback loop facilities and others.

2. *Crowd-related interactions*, these functionalities are made available on the crowdsourcing platform to allow the crowd to use the platform. These functionalities might be to provide: enrolment, authentication, skill declaration, task allocation, assistance for all the features, coordinate and supervise the crowd negotiation, feedback loop facilities and many others not listed.

3. *Task-related facilities*, these are facilities available on the crowdsourcing platform so that the task can be done efficiently. These facilities might include broadcasting the crowdsourced task (open call), aggregate results of the crowdsourced task, to hide the work of individuals from others, archive completed tasks, and to provide quality and quantity threshold of results.

   Provide *ethical provision*; this involves complying with moral standards or ethics from specific professions or groups. In crowdsourcing three ethical behaviours have been identified. One, the crowdsourcing platform should provide an opt-out procedure that does not affect the crowd and the crowdsourcer. Two, the platform should offer functionalities that allow the crowdsourcer to give feedback about the completed task especially if the crowd ask for it. Three, the crowdsourcer should ensure that the requested task does not put the crowd in any situation that might harm them especially if the job has to be carried out offline in a real set-up.

4. *Platform-related facilities*, these are facilities provided by the crowdsourcing platform itself to render an excellent service such as to provide payment mechanism, manage platform misuse, ease of use, to provide an attractive interface to attract crowdsourcers and contributors and others. Provide privacy provisions that ensure that the participating crowd's solutions are not shared with others. To make this efficient researchers have started to look at ways on how to automate this process. For example, Amor *et al.* (2016) developed a system (*SocialCrowd*) to ensure that solutions shared within crowdsourcing teams are kept secret preventing data leakage to the other groups. Their system can be used as an extension plug into existing crowdsourcing platforms, for example, on MTurk.

Pillar three, the **task**, it is the job prepared by the requester or crowdsourcer to be completed by the crowd. The work does not always have to be a problem, but it can be a competition or a fundraising activity (crowdfunding). The task features are outlined below:

1. *Modularity*, the crowdsourced task can be a single unit (atomic) work that cannot be broken down into micro-tasks.

2. *Complexity*, some crowdsourced task can be difficult and has to be split to be solved.

3. *Solvability*, the crowdsourced task is merely solved by humans but difficult for computers, for example, tagging images.

4. *Automation*, a crowdsourcing task is usually difficult or expensive to automate thus it is crowdsourced.

5. *User-driven*, users powered activity meaning the crowd is the driving force for solving that problem, for example, when the group is tasked to innovate (generate ideas) or create designs.

6. *Contribution type*, whether the contribution is from a single individual or a team of collaborators.

Pillar four, the **crowd** or **contributors** both are used interchangeably, and are those that intrinsically or extrinsically (see next section for full details) work on the task request. Five distinct features of the crowd are outlined as follows:

1. *Diversity*, the crowdsourcing crowd is usually composed of members of different cultures, expertise, age group, gender, time zone, and work ethics.

2. *Anonymity*, when the crowd is taking part of the crowdsourcing activity individuals do not know the other members. Teams can be formed, and members might be able to identify each other by the group name or by their participating name, but this might be fictitious. Although anonymity is advised, Marlow and Dabbish (2014) found contrary to this that when the requesters' information is provided, it led to an increased effort by the contributors because it reduces the social psychological distance.

3. *Largeness*, whether there is enough crowd to complete the crowdsourced task. Crowd largeness should be considered with care in certain circumstances when the group is too large to be controlled.

4. *Undefined-ness*, the crowd is not selected with pre-defined criteria that filter out other volunteers.

5. *Suitability*, whether the crowd can complete the given task. Relevance is determined by some factors such as whether the group has the required skills, are motivated enough to perform the job, or able to collaborate with others.

Another crowdsourcing classification was done by Geiger *et al.* (2011), and it is one of the early and most cited work on crowdsourcing classification. They identified four characteristics by dividing the crowdsourcing process as follows: pre-selection of contributors, accessibility of peer contributions, aggregation of contributions, and remuneration of contributions. Recently, Aris (2017) looked at the current status of crowdsourcing taxonomies and classified crowdsourcing into processes, tasks, and crowd. Her findings further grouped the crowdsourcing characteristics into seven themes namely: crowdsourcer, crowd, work, process, platform, content, and reward. In this study, we preferred the crowdsourcing classification of Hosseini *et al.* (2014) because it incorporates more or less all previous and recent crowdsourcing taxonomies.

2.3.3 Why does the Crowd Contribute?

There is evidence from studies that not all users that visit user-generated content systems contribute and in fact that minority do the majority of contributions. The skewed input is illustrated by the power-law distribution of participation whereby a high engagement level is achieved when the user starts to create and maintain content contributing to collaborative intelligence instead of collective intelligence as stated by Mayfield (2006). A lot of users on the Internet participate on the low-level threshold of collective intelligence, that is, reading, tagging, and commenting. Few users on the Internet reach at the high engagement level. Studies such as by Kittur *et al.* (2007), Varshney (2012), and Voss (2005) showed that participation in crowdsourced software development tasks and content creation in numerous socio-technical systems follows this power-law distribution of participation. The question that ponders many is what motivates those few users to participate at that high level of engagement.

Dholakia, Bagozzi, and Pearo (2004) derived five motivational factors for online contributors. One is purpose value, which is the usefulness attained by completing some influential commitment such as giving and receiving information. Two, self-discovery, finding one's worth and understanding through social interactions. Three, maintaining interpersonal connectivity, happiness achieved by establishing and maintaining a relationship for a longer time. Four, social enhancement, the status gained by recognition from others for one's contribution. Five, entertainment, having fun and relaxation by playing games or interaction with others. On the other hand, Puah, Bakar, and Ching (2011) identified eight strategies needed to attract new contributors to community-based crowdsourcing platforms. The eight procedures are:

1. rewards either as monetary or non monetary
2. user-friendliness of the platform
3. community awareness or advertising of the platform
4. good infrastructure in terms of accessibility, quality, and reliability to ensure crowd participation
5. allow contributors to evaluate themselves for reputation
6. ranking of contributors based on their number of contributions
7. allow competition, for example, for a logo design
8. provide merit badges for contributors for completing a task

Among all those eight strategies only the human factors and platform itself is correlated to the willingness to share or contribute knowledge. Puah, Bakar, and Ching recommended that different kind of motivations have to be used as users have different preferences and their motivation evolves overtime.

Keating and Furberg (2013) proposed that incentives should be used to active motives, for example, for someone taking time to assist with the crowdsourced task. On that premise they suggested the motive-incentive-activation-behavior

(MIAB) model for crowdsourcing. Motivation is mainly divided into two classes: *extrinsic* and *intrinsic*. Extrinsic motivation is when someone performs a task because of the reward attached to accomplishing that task. While intrinsic motivation is when someone completes the work irrespective of the award for achieving that task.

Extrinsic Motivation

Hossain (2012) categorise users' extrinsic motivations to participate on online crowdsourcing sites into three groups of (1) financial, (2) social, and (3) organisational motivators. Under financial motivators, the following: cash, job opportunities, personal needs, and others were listed. On the social motivators group, the following: obligation, peer recognition, status, reputation, power, skill development, experience, knowledge gathering, social bonds social interaction, and others were listed. Finally, on the organisational group, the following: career development marketing oneself, professional prestige, and recruitment responsibilities were listed.

There are crowdsourcing platforms that use monetary payment as a reward. A good example is Amazon Mechanical Turk (MTurk) where payment varies from little as USD 0.01 (micro-payment) to about USD 80.00 depending on the complexity and given the duration of the task to be completed. On Upwork Freelance Crowdsourcing Jobs online website (Upwork Global In., 2017), for example, a user interface design job was budgeted for USD $5,000$. Although there is monetary payment to work for MTurk, Kaufmann, Schulze, and Veit (2011) found out that intrinsic motivation factors were more dominant over the external ones. An interesting point mentioned by them is that an inherent element such as the ability for the contributor to decide on their own on how to solve a problem is linked to an extrinsic reward of gaining new skills.

Intrinsic Motivation

In many open source software development projects intrinsic motivation is the dominant motivator (Ghosh, 2005; Hertel, Niedner, and Herrmann, 2003; West and Gallagher, 2006). According to Wasko and Faraj (2000) the most common reason for people to participate in online platforms is to give back to the community. Brabham (2008) found out that users can also join in online platforms due to addiction. Hossain (2012) provided a range of intrinsic motivators as charity, enjoyment, pleasure, self satisfaction, altruism (desire to increase the welfare of others even at own cost), and many more others.

To give as an example, Lampe *et al.* (2010) examined why users participate on Everthing2.com[4] from a theoretical viewpoint of *uses* and *gratification*. They found out that users continue to participate for different reasons than those that brought them to the site. Users visited the site seeking for information. However, the most predominant reason why users participated and were willing to continue on Everything2.com was for the entertainment value they got from the site. The importance of providing information showed to be the highest determinant for the intention to contribute in the future. Users who had a strong sense of belonging to the site believed that they are more likely to use the site in the future.

[4]Everything2.com also known as E2 is a platform that allows writers to write and share their creative original write-ups for others to read and talk about.

Interestingly, the ease of use of the site among these users was not a universal predictor for future contribution, rather factors of social or cognitive were.

Numerous researchers such as Amabile (1983), Calder and Staw (1975), Deci (1972), and Puah, Bakar, and Ching (2011) agree that to enhance intrinsic motivation one should not focus on the external factors such as money because that can influence the performance. A better approach is to concentrate on organising the situations that are interesting and supportive for that person in that situation.

2.3.4 Crowdsourcing Projects in Intangible Cultural Heritage

In this section, we discuss crowdsourcing projects that are similar to this study in safeguarding Intangible Cultural Heritage (ICH). The similarities are regarding the following: users of the crowdsourcing platform have input in the design process (see next Chapter 3 for details) of the crowdsourcing platform itself, the crowdsourcing platform allows the requesters to upload multimedia items as part of their crowdsourcing task request for safeguarding Intangible Cultural Heritage (ICH). We also touch on the challenges involved in projects crowdsourcing ICH for safeguarding.

There is no single agreed universal definition for ICH as pointed by Ahmad (2006). Nonetheless, the UNESCO (2003) convention for the safeguarding of ICH defined ICH as: "*The practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognise as part of their cultural heritage transmitted from generations to generation.*" From the above definition, it can be noted that IK is a subset of ICH, it is therefore that at times we will use IK interchangeable with ICH in our context.

Preece *et al.* (2016) have been working on a crowdsourcing system called NatureNet. NatureNet allows individuals that are interested in nature to input multimedia information about the environment and their preferred topics to be investigated by the scientists. The system also allows the users to suggest design ideas on how the NatureNet system could be improved. According to Preece *et al.* including the users in the design and development of the system allows users to take ownership of the system for its successful completion and maintenance.

On similar grounds Jennings, Dobreva, and Devreni-Koutsouki (2017) have started using citizen science in the ICH domain. Their research work is about safeguarding family names (surnames) in rural Ireland. The family names also known as "micro names" have rich information about local fields and other interesting features of the rural landscape. Jennings, Dobreva, and Devreni-Koutsouki mentioned that an added value to the citizen-led approach for recording and digitisation of ICH allowed inter-generational exchanges to take place which provides valuable memorable personal participation beyond just collecting ICH for storage. The authors admitted that ownership of materials collected in the citizen projects, authorship and copyright are all issues yet to be clarified further.

The UNESCO (2003) convention for safeguarding ICH in Southern African countries is promoting the importance of safeguarding ICH on a national level. Besides the research, one of the tangible outcomes of this project is to implement

national ICH web-based database that respect access rights of the agreed communities.

Looking at the projects mentioned above and others, for example, the landmark sound (*Soundsslike*) project by Yelmi, Kuşcu, and Yantaç (2016) although there are similarities to this study in terms of capturing multimedia items for safeguarding ICH and allowing users to be part of the design process, there is one distinct difference. Most projects crowdsourcing ICH did not investigate how to incorporate the theoretical epistemology of requesters in their research process and design of the crowdsourcing platform. Most cited (at the time of writing this) book on Google Scholar related to crowdsourcing ICH is a book by Ridge (2014) titled "Crowdsourcing our cultural heritage". In this book, the case studies discussed are from the United Kingdom (UK) and the United States of America nothing from Africa. The most cited article was by Kidd (2011) also from the UK. This rare occurrence gives a signal that not much has been researched about crowdsourcing ICH especially using underlying African philosophies. Ubuntu principles have been included on the co-design level with rural communities by researchers such as Winschiers-Theophilus, Bidwell, and Blake (2012b) yet not Afrocentric as a theoretical framework.

Challenges

Developing an application that would be used by different people globally and especially by indigenous communities comes with certain complications. Most crowdsourcing platform implementations assume that most users are ICT literate, for example, using websites to tag pictures and text input descriptions. For instance, Noordegraaf, Bartholomew, and Eveleigh (2014) identified conditions in which crowdsourcing ICH projects can be implemented. They provided design properties that are influential to the success or failure based on a case study of two projects the *Red een Portret* (Save a Portrait) and a photo-tagging the *Vele Handen* (Many Hands) and based on literature review. They proposed a responsive questionnaire model that provides suggestions for effective design, and this is more suited for well established cultural heritage institutions. The targeted crowd is assumed to be ICT literate.

On a general approach Doan, Ramakrishnan, and Halevy (2011) identified four fundamental challenges that should be handled by crowdsourcing applications. However, their solutions to those challenges focused more on an implemented crowdsourcing system instead of its development. Those challenges are namely:

1. How to recruit and evaluate users?
2. What contributions can users make?
3. How to merge user contributions to solve the targeted problem?
4. How to assess users and their contributions?

More specific to development, Stol and Fitzgerald (2014) pointed out six key concerns in crowdsourcing software development. The key concerns are namely:

1. task decomposition,

2. coordination and communication,
3. planning and scheduling,
4. quality assurance,
5. knowledge and intellectual property, and
6. motivation and remuneration

Their findings are significant for a well-established organisation or individuals with software development skills. There is no agreed framework on how to handle these issues (Erickson, Petrick, and Trauth, 2012; Schwarz *et al.*, 2007; Simula, 2013). However, Keating and Furberg (2013) proposed a general methodological framework for crowdsourcing in research. Researchers should start by stating their research goals to determine who can assist in achieving the set goals. Establish incentive engagement mechanism guided by the MIAB model mentioned earlier in Section 2.3.3 and the appropriate crowdsourcing platform for sensemaking of the generated content.

Baillot *et al.* (2017) highlighted that there is a lack of connection between local galleries, libraries, archives and museum institutions, infrastructures and researchers thus making it difficult to access cultural heritage data. To resolve this issue a shared online environment (Cultural Heritage Data Reuse Charter) is being developed. On another angle, Blanke, Kristel, and Romary (2015) pointed out that working with different cultural heritage data formats is a challenge, and this has complex semantic relationships and cannot be generally solved by algorithms. In addition to that, Champion (2017) said that the current 3D models used in virtual heritage infrastructures lacks meaningful context, audience feedback, and well managed up-to-date content. There is no linkage to provide input to the scholarly resources that created the 3D models. Therefore, there is a need to develop a dynamic way of linking text, 3D models, other media and community feedback. Champion further stated that all shareholder issues such as cultural knowledge issues of privacy and ownership should be handled.

2.4 Chapter Conclusion

This chapter provided insight on how Afrocentricity and Ubuntu philosophies can be guiding lenses in conducting African community-based research. Afrocentrism provides guidelines on how African epistemologies can be incorporated into the research practices; while Ubuntu delivers cultural, moral values for the well-being of the African communities.

Application of Afrocentrism means that the communities culturally accept our research contact, and we accept the communities' ways of constructing and sharing of knowledge. Afrocentric canons can be used as guidelines allowing the rural communities' lived experiences and subjectivity to be incorporated in the research. The communities should validate the research process and the truth of the research findings.

The Afrocentric canons state that to research respectfully is to maintain justice, harmony and togetherness. To embrace that created knowledge can be influenced by subjectivity. The constructed artefact should empathise with the cultural values of the community. We note that Afrocentric and Ubuntu can be misunderstood and wrongly practised resulting in misinterpretations of indigenous knowledge (IK), conflicts, and oppression.

This chapter also shared different definitions of IK and the debate of distinguishing indigenous knowledge from western scientific knowledge. From the description of IK, we do not attach contentious issues such as colonisation and land relocation. We consider IK as the knowledge that is mastered by people for survival from their ecosystem. On the argument of IK versus western knowledge, we are of the point that even if there was no distinction, the African knowledge bearers are undoubtedly distinct with different ways of acquiring knowledge that is culturally-driven. Taking that premise it makes sense to use the appropriate African epistemology, that is, Afrocentric research about African IK.

We also touched on different approaches of digitising IK for safeguarding. We highlighted issues that should be considered by computer scientists such as co-designing the appropriate recording feature that is in context with the community. Computer scientists need to be aware and accept that technology cannot fully capture all aspects of IK, for example, beneficial personal knowledge such as traditional healing. There are issues of intellectual property rights that should be taken sensitively concerning indigenous communities.

We have looked at related crowdsourcing projects for safeguarding intangible cultural heritage (ICH), and we have found that not much has been done on the implementation of specific African indigenous communities crowdsourcing applications for safeguarding their ICH within African philosophies. Achieving this will grant the African indigenous communities an opportunity to be at the same level of participation as global crowdsourcing requesters instead of as merely contributors.

The next chapter provides an overview of the research methodology and design required to be followed to co-design the crowdsourcing task management application with the rural communities. The following parts of the thesis after Chapter 3 will unfold Afrocentricity and Ubuntu in our research conduct.

Chapter 3

Overview of Research Methodology and Design

Chapter 3 provides an overview of how the three Action Research Cycles were conducted. Detailed information about the fieldwork is discussed in Chapter 4 to 6. The elaborated information in Chapter 4 to 6 is part of this research findings, therefore, cannot be addressed early in this Chapter 3 based on the Action Research methodology applied. This chapter is arranged in five sections as follows: Section 3.1 discusses the Afrocentric research as a theoretical perspective for this study. The research paradigm that this study abides by is also outlined. CBCD was operationalised based on the AR research process; thus, AR is introduced detailing its cyclic phases.

In Section 3.2, we discuss the research design as a blueprint for carrying out the research. The selected indigenous rural communities that co-designed the Crowdsourcing Task Management Application (TMA) are introduced. A process overview of the entire fieldwork with a timeline is provided. Co-design techniques and methods for data collection and analysis for this qualitative type of research are also discussed. Section 3.3 outlines ethical research considerations. The research evaluation is described in Section 3.4, looking at credibility, transferability, conformability, and dependability. Finally, the chapter's conclusion is provided in Section 3.5.

3.1 Applied Methodology

The research methodology applied in this study is Afrocentric CBCD executed within AR principles. The intervention (*action*) was the *co-design* process itself and the *research* was about mutual learning on the community engagement and Afrocentrism epistemology, and the produced technology as a proof of concept for safeguarding IK. The following subsections provide more details about Afrocentric research, CBCD and AR applicability to this study.

3.1.1 Application of Afrocentric Research

Asante (1990) recommends two methodological tactics, that is, *introspection* and *retrospection* for conducting Afrocentric research. Introspection ensures that the researcher voices any assumptions that she or he might have before starting with

the investigation. The researcher should begin by asking "Who am I", considering his or her historical, social, cultural, and political background. Moreover, researchers should state their beliefs about the research participants and how their views will affect the research. In the introspection process, researchers define their views which they bring to the research.

Retrospection is concerned with the interpretation of the research findings. In completion of data inquiry, researchers must question themselves if any of their obstacles do exist in the analysis of the data. The researchers must decide how their life experiences facilitated or hindered the data interpretation. At the end of the study, researchers should state whether initial positions were changed or not. According to Asante (1990), the retrospection process is essential for a fair and accurate conclusion of the study. It is on this background that there is a section of the author's introspection of this dissertation in Chapter 1 and retrospection in the conclusion Chapter 8, Section 8.5.

Mkabela (2005) and Reviere (2001) remind researchers to be on equal negotiation and consensus with the indigenous African communities. The agreement should allow the communities to have control of the research process so that everyone can monitor the progression to be aware of what the research is all about and its expected outcome. Mkabela further stated that mere having equal participation with the indigenous African communities is not enough to equate to be an Afrocentric research approach.

Mkabela (2005) emphasised that Afrocentric research is only possible when the research is conducted from an African outlook of the world and allowing researchers to learn with and from the communities. According to Mkabela, Afrocentric aims for establishing a working environment whereby all stakeholders priorities, cultures, and values are fully expressed and respected in the research process. Afrocentric researchers should immerse themselves into the community and be familiar with the history, language, philosophy, and myths of their research partners (Asante, 1983; Ladson-Billings, 1995; Willoughby, 1928). To achieve Afrocentric research that creates a dynamic multicultural approach and considers communities' cultural experiences, Mkabela suggested the following:

1. that ethics are culturally defined, and have an indigenous African code,
2. to create guidelines and ensure solid inclusion of native African views, and
3. research methods and styles are culturally acceptable.

Winschiers-Theophilus and Bidwell (2013) advocate embracing an Afrocentric interaction paradigm. They proposed that researchers should consider principles of the interconnectedness of all, a holistic view of spirituality, oral and performed or embodied communication of African indigenous communities. Winschiers-Theophilus and Bidwell proposed that researchers should integrate interconnectedness over time in the research approach, design goals, and in the artefact itself to achieve an African HCI paradigm. They further encourage researchers to immerse into the community instead of being distant observers. Blending with the communities provides a new design interaction style, for example, walking in the field, sitting and cooking at the fire (Bidwell *et al.*, 2011b).

3.1.2 Research Paradigm

The synthesis of the research process and epistemology is one of the core contributions of this study; thus, here only a summary of the research paradigm is provided. A research paradigm is a commonly accepted pattern of solving a problem that has the following concepts; ontology, epistemology, theoretical perspective, methodology, and methods (Guba, 1990, p. 17; Kuhn, 1962, p. 23). The research paradigm provides justification and direction on how and why the research is conducted in a certain way (Yvonne Feilzer, 2010).

Paradigm	Ontology What is reality?	Epistemology How can I know reality?	Theoretical Perspective Which approach do you use to know something?	Methodology How do you go about finding out?	Method What techniques do you use to find out?
Pragmatism	Reality is constantly renegotiated, debated, interpreted in light of its usefulness in new unpredictable situations.	The best method is the one that solves problems. Finding out is the means, change is the underlying aim.	Deweyan pragmatism Research through Design (RtD)	Mixed Methods Design-based research Action Research	Combination of any qualitative methods, data mining, expert interviews, usability testing, prototyping, etc.
Pragmatism	Reality is from the Community lived experiences	**Afrocentrism** The truth (Owatjiri) determines the research findings and the research process validated by the communities' lived experiences (Ounongo).	**Afrocentric Research** Grounded on Oundu axiological principles: Sharing, Peace, Harmony, Togetherness, Respect, Altruism & Love	**Action Research** (AR) Actions taken in cycles with reflections. Take action to find what the problem is.	**Community-based Co-Design** (CBCD) - Impromptu *in situ* - Story telling/role-play - Walking in Design - Affinity Diagraming - Paper prototyping - Technology probe - Usability Testing, etc.

Figure 3.1. Comparison of the adopted research paradigm (second row highlighted) with the standard Pragmatism. Diagram and content for the Pragmatism paradigm are adapted from Patel (2015).

It can be noted in the table displayed in Figure 3.1 that the paradigm that we have adopted is pragmatism. Pragmatism on the ontological concept constitutes that "the reality is constantly renegotiated, debated, interpreted in light of its usefulness in new unpredictable situations". In our context of co-designing technologies with indigenous communities to safeguard IK, the reality is from the lived experiences of the communities.

Our epistemology is Afrocentrism that postulates that to know the reality we must find the knowledge (Ounongo) from the community lived experiences, and that should validate our research process and findings. We use Afrocentric research rooted with Oundo axiological principles (sharing, peace, harmony, togetherness, respect, altruism and love) as an approach to know something. The chosen methodology is Action Research discussed in detail in the following section. We use community-based co-design as a method to find solutions to our research problems. Community-based co-design is also discussed in detail in the following sections.

3.1.3 Community-Based

Working with communities has its own dynamics as compared to individuals. Community diversity has to be considered ensuring that the agreed consensus is taken into account in the whole research process. CBCD was coined by Blake *et al.* (2011) and Winschiers-Theophilus, Bidwell, and Blake (2012b) after close engagement with communities since 2008 endeavouring on developing software applications that is in context and acceptable to the African indigenous communities. The following paragraphs elaborate on CBCD by separating the community from the co-design process.

Our departing ideology on community definition is based on the Ubuntu concept of a community, that *people depend on other people to be people* (Shutte, 2001, p. 25). There is an African proverb that says: It takes the whole village to raise a child and therefore an African community should never have orphans (Mugumbate and Nyanguru, 2013). This proverb reminds us of the importance of working together in African societies. In CBCD we have to acknowledge that the communities are diverse and yet share common interests. The community including the researchers have its dynamics of cultural differences and technical skills. Being mindful on the rural community dynamics has taught us to be conscious on approaches of entering into design conversations with people who do not have IT technical skills but who are knowledgeable on their needs and especially how their own communities operate. We value and appreciate the community's cultural values and ensure that those values are not oppressed in the research process. Moreover, those values are embedded in the artefact that we co-design with the communities.

According to DiSalvo, Clement, and Pipek (2013) community groups can be separated into age, gender, ethnicity and physical abilities. We primarily worked with the elders who are knowledgeable in indigenous knowledge (IK) practises, and we often referred to them as IK holders in this study. Dewey and Rogers (2012, p. 60) defines a community as a group of individuals with shared affected social issues rather than the common mass of people. This community definition by Dewey and Rogers can provide an entry point into producing contextual technology solutions. Developing contextualised technology solutions is not only about finding issues that affect the community or the public but looking at mechanisms on how to tackle those issues affecting the community.

Le Dantec (2016), reminds us that there is more to *human* and *computer* interaction. Computer scientists should also consider that the applications they develop should support *human-to-human* interaction for social justice. Le Dantec mentioned that this approach of social design requires us to design applications with a different 'mindset' so that our solutions allow those that are affected to connect and take collective action to tackle their issues of concern. He further stated that this novel design paradigm requires collective contribution, that does not see everyone as a designer but appreciate the diversity of skills.

We share the same sentiment of social design mentioned by Le Dantec (2016) to create computing solutions that promote human relations and collective action. In our CBCD methodology, the design process is done within the indigenous rural community villages to establish long-term trust relationships. The co-designed solutions allow the rural indigenous communities to interact among

themselves and at the same time also with the global crowdsourcing contributors on the Internet. Moreover, promote collective action of the communities to safeguard IK.

Some projects have used CBCD successfully, for example, one is by Ssozi-Mugarura, Blake, and Rivett (2016). They have used CBCD as a method to introduce ICT to rural communities in Uganda for water supply management. Beside successful implementation of the mobile-based Pay Me for Water application, other considerations were crucial such as to be sensitive to values, available technology resources and constraints, and long term collaboration with the communities beside initial design engagements. According to Groeneveld, Boess, and Freudenthal (2013) CBCD had delivered valuable results when they applied it in their project of developing technologies assisting home caregivers. Caregivers look after elderly or those that are chronically ill living at homes. The system was conceptualised from scratch by all participants taking into account all the difficulties encountered by the caregivers. This approach of contextualising from the early phases of the design process with all stakeholders provided more valuable system functions as compared to those available in literature (Groeneveld, Boess, and Freudenthal, 2013).

Working with African indigenous communities requires the approach to be aligned with the African humanism way of living. Mkabela (2005) mentioned that the challenges encountered by the African researchers are whether they can use their theories as a valid field of academic enquiry besides sticking to the practices provided by the colonial experts. She, therefore, proposed "*Afrocentric*" as a guiding epistemology for researchers that investigate African cultures to face the realities and dynamics that comes with it. Afrocentric as defined and discussed in the previous Chapter 2 is used as a mechanism that allows researchers to view the world from an African perspective (Asante, 1991). Mkabela further stated that even though an African researcher might have an advantage of knowing the African languages and customs of the communities mastering the research practices can only be achieved through the mutual exchange of knowledge with the indigenous communities.

In a community-based engagement, we aimed at establishing a long-lasting commitment by the community members. The co-design techniques used in this study allowed the opinions of the community members to be voiced in the software design process. To include the community decisions has been a vital element to get participation by the community members throughout our design interactions. The following section highlights the co-design process followed in this study.

3.1.4 Co-Design

Co-Design is a movement to allow users and designers to have a shared input of ideas (equal participation) in the product development process. Co-design is comparative to two other design and development approaches, namely: *Participatory Design* (PD) and *User-Centred Design* that consult users in the design process. User-Centred Design was coined by Norman (1988) as "*a philosophy based*

on the needs and interests of the user, with an emphasis on making products usable and understandable".

Dearden and Rizvi (2008) provided a historical relation of developing interactive systems and participatory approaches. They mentioned that this relation could be traced back to the work of Kristen Nygaard from Scandinavia in the early 1980s. Hi Chun, Harty, and Schweber (2015) also reported that participatory design originated from the Scandinavian Cooperative design tradition. Nygaard looked at possibilities of how people' interests could be voiced and encouraged in the design of technology. Other researchers such as Bannon (1995) outside Scandinavia also picked up on this with emphasis on how to actively engage users in the design and prototype of technologies. Dearden and Rizvi based on their literature review cautioned researchers that are developing interactive systems to critically reflect on their priorities, motivations, skills, practices and relationships to cope with the hidden complex power relations.

PD stands on two premises, that is, *moral* and *pragmatic* (Carroll and Rosson, 2007). Moral emphasis on the users of the design to have an equal say with all involved in determining the outcome of the envisaged artefact. This voice inclusion of all is justice to ensure that the users are not in any way negatively affected by using the produced artefact. Pragmatic signifies that users of the expected design expertise and knowledge are essential that should not be left out in contributing to the development of the design.

PD focuses on how to handle issues of power relations, investigating how it is shared in design (Wilson *et al.*, 2019). Co-design is the current PD with a focus on collaboration and participation, thus not different from PD if all PD ideologies are included (Simonsen and Robertson, 2012). Therefore, we adopted a PD approach (Co-design) without a focus on power relations. Our philosophy is not to try to change the community existing power structures but instead to immerse into the community. Ultimately harvest a trans-cultural Community-based Co-design that encapsulate unity of epistemologies and relevance (Winschiers-Theophilus, Zaman, and Stanley, 2017).

The equal participation of designers, researchers, and users in the design of a product inherently harness collective creativity and innovation, knowledge sharing, and to have a sustainable solution (Prahalad and Ramaswamy, 2004; Sanders and Stappers, 2008; Steen, Manschot, and De Koning, 2011). Co-design is an approach that changed the interactions of the conventional user-centred or user-driven development approach. In the classical user-centred approach, users are treated as the *subject* that are interviewed to provide their views of the product being developed and the researcher analyses and interprets the users' opinions and passes the findings to the skilled software designer to create the prototype (Sanders and Stappers, 2008). In co-design, the user is not treated as a subject but rather as a *equal partner* who provides design ideas. We are referring to all participants as co-designers; if a distinction is required, we refer to the academic researchers as the research co-designers and the rural community members as the community co-designers. Co-design is an ongoing activity carried out at all stages of software development, especially when combined with AR (Blake *et al.*, 2011).

The mixed roles in co-design come with its challenges, for example, rural communities at times lack technological skills. Winschiers-Theophilus, Bidwell, and Blake (2012a) encouraged researchers to provide technological interventions to help the rural communities to partake in the co-design activities equally. As a technological intervention with communities Molapo, Densmore, and Morie (2016) co-designed a feedback reporting tool with community health workers (CHWs). The feedback reporting tool allows the CHWs to communicate with nurses. CHWs were provided with mobile phones throughout 18 months to explore mobile technologies. Their results show that technology exploration enabled the CHWs to engage in the co-design discussions productively.

We agree with Sanders and Stappers (2008) in using the co-design term in a broader sense to refer to the collaborative contribution of all stakeholders not necessarily only of the expert designers. We referred to the community members that we co-designed with as *community co-designers* in that we value their IK input in the design process. Researchers have to put aside their technical expertise to allow rural communities to voice their ideas in the design process. The shared co-design skills among all stakeholders can be used in future co-design sessions.

3.1.5 Action Research

AR is pragmatic with emphasis on practical application of ideas to solve real-life problems and test the implemented solutions for correct functionality. AR aim is twofold, one to take *action* that bring about change in a community, company, or organisation (Dick, 1993). Two, to carry out *research* that increases the understanding from all dimensions of relations of cause and effect and consequences for both the researcher and the participant (Dewey, 1929, p. 80; Dick, 1993). Action research was coined by Kurt Lewin in 1946 when he described its cyclic approach of solving problems (Walter, 1998).

There are some AR that mainly focus on the action or on research (Dick, 1993). Kemmis and McTaggart (2005) outlined seven family of AR that emerged from the early 1930s to 1990s. The seven groups of AR are: (1) Participatory Research, (2) Critical AR, (3) Classroom AR, (4) Action Learning, (5) Action Science, (6) Soft Systems Approaches, and (7) Industrial AR. A brief description of each of those seven AR family is provided below:

1. *Participatory AR research*, is characterised by three attributes, that is, shared ownership of research projects, solving community-based social problems, and focus on community action.

2. *Critical AR* focuses on combining education and social change. Critical AR is termed as research for education rather than research about education (Wilfred and Stephen, 1986).

3. *Classroom AR* is used by teachers to practically improve their practices.

4. *Action Learning* focuses on providing an opportunity for people to learn from each other's experiences.

5. *Action Science* pioneered by Argyris (1995) focuses on fostering skills and confidence of individuals to solve complicated experienced problems systematically.

6. *Soft Systems Approaches*, researchers collaborate with participants to develop systems or models for a given problem and use those models to understand the problem better to come up with refined actions (Davies and Ledington, 1991).

7. *Industrial Action Research*, focuses on social issues in organisations to improve effectiveness and employee relations.

Claiming to follow one specific AR strictly can be difficult as attributes of different AR can be traced in the context of how the methodology is applied. The type of AR that we followed is more of the soft systems approach and safeguarding community-based IK was attributed by participatory AR and action learning. We approached the community with a theme (idea) to try the crowdsourcing technology as an opportunity to speed up the process of designing 3D models for the communities' IK visualisation tool. We, therefore, can not claim fair, equal participation from the beginning of the research idea. However, we had equal participation in all our research process and co-design sessions, and this provided an opportunity to learn from each other.

Beside the various family of AR, three widely accepted characteristics of AR have been identified (Argyris, Putnam, and Smith, 1985; Baskerville and Wood-Harper, 1996; Holwell, 2004; Walter, 1998). First, ideas on how to solve the problem are derived from local context. Accepting ideas from a local context does not mean that outside ideas are not considered, they are welcomed but should be contextualised to solve the problem effectively. Second, the researcher does not only consider his or her requirements but reflect on all scenarios. Third, the researcher and the participants work closely together to elicit theories from iterations within context. Combining the research and theories, experiences, skills with practical actions makes AR to produce applicable research discoveries. AR is aimed at working with the research participants within a reciprocal and ethical acceptable environment and at the same time generates new knowledge (Rapoport, 1970). We agree with Carson (1990) that despite the different variety of AR and generally accepted attributes, there is a common AR goal and that is to *create knowledge that brings about change to real problems*.

Kurt Lewin in his early 1930s action research showed that knowledge could be constructed in a holistic fashion *in situ*, that is, in its place of origin (Hayes, 2011). AR has become an acceptable methodology for knowledge creation and theory generation as pointed out by McNiff (2013). McNiff on the principles of AR made a good point that people are doing AR should stop searching for specific knowledge based on conditions, for example, if I do y, what would happen, expecting the answer to be x. The answer could be anything depending on the context and circumstances. To complement the argument as mentioned above Grønhaug and Olson (1999) stated that knowledge could be obtained in many different ways, and the source of knowledge can also be in many forms. We also agree with Fernie *et al.* (2003) that knowledge cannot be separated from the knowledge bearer.

What needs to be focused on is the significant role of re-contextualisation, social interactions, and contentious debate in a better understanding of knowledge sharing.

Riel and Lepori (2014) analysed AR projects to find researchers' reflections on three contextual levels (1) professional development, (2) organisational, and (3) scholarly contribution. Professional contribution in this context looked at the AR researchers improving their systematic enquiry process such as reflecting on theories that guided new cycles of enquiry. Professional level contribution scored the highest. The organisational and scholarly contribution was equally scored. Organisational contextual looked at the AR researcher paying attention to the interactions with participants based on the action taken. Results from Riel and Lepori study showed that AR does indeed contribute to researchers' skills of understanding the theories and at the same time, steps taken to solve the problem.

It is also on this background that we selected action research to understand the Afrocentric epistemology pragmatically. Levin and Greenwood (2001) made it clear that AR is not just another way of conducting research, but rather it is to carry out research that is "epistemologically sound and socially valuable". We, therefore, based on our practical epistemological, theoretical perspective of AR we do not separate our practical interventions from our theoretical knowledge, and there is no bias towards actions neither to knowledge (Blake, Tucker, and Glaser, 2014).

Application of Action Research in ICT

When AR is applied in the context of ICT4D, the enquiry is how the technology is developed and utilised effectively. Practical consequences of the technology in use towards social, economic, and political development, with a particular focus on helping the poor and marginalised communities, are considered (Sharma and Sturges, 2007). The overall aim is not only about the end product but also about the interactions while developing the software and afterwards consequences beyond deployment.

When Blake *et al.* (2011) applied AR in developing software solutions for the Deaf community, besides the technical development they tackled other issues such as engagement with the Southern African government in drafting the policy of Universal Access to Communication, and training for capacity building. In the same vein analysis done by Riel and Lepori (2014), indicated that AR as a paradigm has professional growth for researchers and reciprocal valuable knowledge transfer to and from the community.

Hayes (2011) brought about awareness that HCI and AR can supplement one another. We agree with their argument that although software development follows similar AR cyclic approach to development, the end product is different. Concerning software development, the output is essentially the required technological artefact. On the other hand, the visible result of AR is knowledge sharing and creation. In Chapter 7 we report our findings of knowledge creation and sharing.

Action Research Process

In the following paragraphs, we touch on the steps taken to carry out an action research study. AR process tend to be cyclic in nature because its end step is never known until the solution to the problem is sufficiently refined to satisfy all

stakeholders (Mertler, 2008, p. 30; Riel and Lepori, 2014; Susman and Evered, 1978). The cyclic iterative process of AR can be used as one of the assessment criteria in evaluating its scientific goodness (Susman and Evered, 1978).

Susman and Evered (1978) outlined AR process to be composed of five phases as shown in Figure 3.2. These five steps are mainly: (1) identify or diagnose, (2) plan for action, (3) implement, (4) evaluate, and (5) reflect. The researcher and the participant work together interacting with all five phases, this is depicted in Figure 3.2 on the section labelled "*Development of the client system infrastructure*". It should be noted here that AR projects differ in their application and might not follow all five phases, the AR model adopted for this study is outlined in Chapter 1, Section 1.7. The five general steps of AR are briefly discussed below.

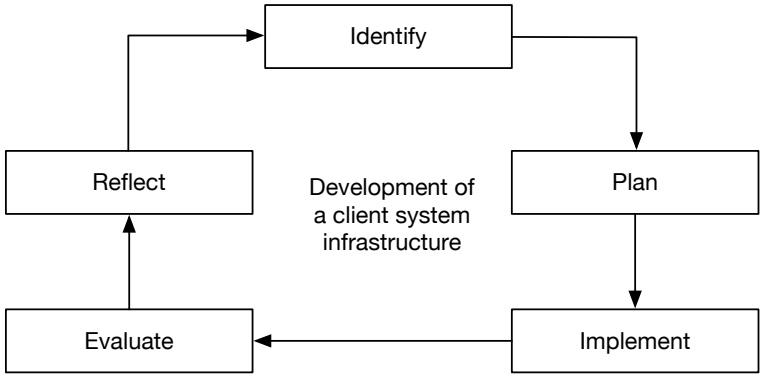


Figure 3.2. Action Research loop process steps adapted from Susman and Evered (1978). The five steps shows one cycle instance if a specific cycle is completed the process exit from the reflection step and new cycle starts again from the identification step.

Step 1 - *Identify:*

AR is initiated with a goal to solve a thematic issue of concern. The thematic concern defines the domain area of the problem to focus on improvements or change strategy, that is why questions such as "Why is the project necessary or desirable?" are asked (Hearn *et al.*, 2009). This step, is, therefore, about identifying and defining that shared concern (Susman and Evered, 1978).

Step 2 - *Plan:*

The next step after the problem has been identified is to plan for the actual action. This step also considers alternative actions to be taken to tackle the problem successfully (Susman and Evered, 1978). Coming up with the plan ensures that the research is adequately planned and remain relevant (Hearn *et al.*, 2009). The plan might be refined in the next cycle as new understanding emerged.

Step 3 - *Implement:*

Implementation is about systematically and creatively executing the planned actions and testing the research questions in practice (Crane and Richardson, 2000; Hearn *et al.*, 2009). The implementation activities may include software development or evaluating the use of the technology deployed (Hearn *et al.*). The

implementation might be modified if the need occurred and moved to another separate cycle with its and action taking (Crane and Richardson, 2000).

Step 4 - *Evaluate:*

Evaluating or observing involves careful analysis taken by documenting and preserving the observations to be used for later reflections or as evidence (Crane and Richardson, 2000). This observation or evaluation aims to precisely describe and document the consequences of the action (Hearn *et al.*, 2009).

Step 5 - *Reflection:*

Reflections involves identifying general findings (Susman and Evered, 1978). It is about establishing a common understanding of what happened. It also includes developing theories of what happened and sharing with all stakeholders to get a broad overview of the interpretations (Crane and Richardson, 2000).

Corrective Features for Action Research Criticism

Contrast to AR benefits, AR has been criticised for its scientific accuracy as a research method for solving scientific problems. One of the action research pioneers Lewin (1946) mentioned that it can be difficult to judge whether the action taken in AR led the researchers forward or backwards. Moreover, that there is nothing preventing action researchers from making wrong conclusions because of the lack of a benchmark for evaluating the effort taken and achievement.

Susman and Evered (1978) provided six ways of using AR to respond to the critics made towards it. The six corrective features are explained below.

1. AR is future-oriented, AR is aimed at creating desirable futures by solving people's real problems.

2. AR is collaborative in the nature the researchers and the participants work together to produce a research output that is composed of competencies of both parties.

3. AR is about generating an infrastructure that improves soft skills, technical skills and knowledge discovery at the same time.

4. AR is about doing the knowing, that is, to create a theory grounded in action. Actions are strategically executed based on theories and theories are evaluated and revised if necessary.

5. AR is sceptical, the researcher is aware that theories and actions are based on previous actions taken and therefore re-evaluation before entering into a new situation is required.

6. Finally, AR is situational; the researcher knows that every situation is different considering people diversity and their relation to events and the environment within they exist.

AR has also been criticised that it lacks generalisation (Baskerville and Lee, 1999; Lee and Baskerville, 2003). In this regard, Hayes (2011) argued that AR focuses on developing localised and contextualised solutions and transferability of knowledge where applicable.

3.2 Research Design

In this section, we describe the blueprint for the data collection and analysis to provide solutions to our research questions. This research is a qualitative research that engaged with the communities; thus appropriate data collection techniques have to be used. The communities that we co-designed with transfer their IK orally. IK are verbally shared through storytelling from generation to generation (Eyong, 2007). Keeping that in mind, the data collection techniques that we used are discussed in this section. The chosen indigenous Namibian communities are first introduced before the discussion of how the data collection and analysis was carried out. We also provide a short historical, cultural background, similarities, and the rationale for the selection of the Namibian rural communities.

3.2.1 Selected Communities

The identified rural communities for the pilot fieldwork for this study are three communities, two ovaHerero communities and one ovaHimba community. We worked with the ovaHimba community for the first time in this study. OvaHerero and ovaHimba migrated from the Great Lakes of Tanzania towards South West, only to be held up by the unassailable impediment of the Atlantic Ocean. They then crossed the Kunene River entering from the south of Angola into the north of Namibia (Bollig and Gewald, 2000).

According to U. Mbinge and T. Kambindja (personal communication, May 17, 2019), the Otjiherero speaking sub-clans mainly comprise of the (1) ovaHerero, (2) ovaMbanderu , (3) ovaHimba, and (4) ovaTjimba. Mbinge and Kambindja further stated that these sub-clans were initially all called ovaTjimba until a war with the Namas[1] in 18*th* century over cattle forced some of the ovaTjimba people to move into Angola from Kunene region and some further down to central Namibia. Those that moved to Angola were referred to as ovaHimba (meaning those that are begging in Otjiherero) because they flee without livestock and were asking for food in northern Angola. The ovaHerero were named due to their perseverance (stubbornness) character how they fought the Germans during the colonial war of 1904 to 1908 (Eckl, 2008). The ovaMbanderu were named due to their relocated location, meaning those that went further uphill. The ovaHerero were the majority of the ovaTjimba groups, and thus the naming of the Otjiherero language spoken by all these sub-clans was dominated by this fact. Otjiherero is part of the Bantu languages[2].

OvaHimba are semi-nomadic pastoral people, and the ovaTjimba are hunters and gatherers. ovaTjimba are identified as one of the marginalised communities by the Namibian government. They live in community camps for the government to supply food and shelter for them. Both ovaHerero and ovaHimba are semi-nomadic cattle and small livestock breeders and small-scale agriculturalists. Hahn (Bollig and Gewald, 2000) labelled them as "pastoral people rich in measureless herds of cattle and small livestock."

[1] Namas are an ethnic group of South Africa, Namibia and Botswana, see Smith (1990) for more detail.

[2] See Section 2.1.2 of the previous Chapter 2 for the Bantu language definition.

Albeit sharing commonalities, ovaHerero and ovaHimba hold differences in traditional practices and attires. The ovaHerero traditional dress is adapted from the German colonial and British Victorian era (Goldblatt, 1971). For comparing the ovaHerero dress with the Victorian see photos in Figure 3.3, on the left, is the ovaHerero dress. The colonial footprint of the ovaHerero with the Germans is

Figure 3.3. The photo on the left shows the dress of German queen Augusta Victoria (Peers, 2001) for comparison with the ovaHerero dress on the right. Photo of the ovaHerero dress was taken by the author.

still visible in Namibia, for example, the graves of the German soldiers who lost their lives due to the war between Germans and ovaHerero from 1904 to 1908 (Eckl, 2008) can be seen at the Waterberg Plateau National Park.

OvaHimba still wears clothes mainly made from animal skin, see photos in Figure 3.4 for differences and similarities of the ovaHimba and ovaHerero. The ovaHimba dress code carries an abundance of information about their indigenous knowledge. The dress attire is worn differently depending on their age group and associated events, for example, the wired thread decoration on the woman's ankles can be cut in half if her father or mother passes on. The omuHimba woman in her traditional attire wear huge adornments, mainly made of leather, iron or copper, and decorated with bone fragments, and a necklace called *ohumba* made up of a large white shell hanging down between her breasts as a sign of fertility. The hairdressing plays a vital role among the ovaHimba women in their culture as they indicate the social status of each person within the community, young girls put on their hair with two braided hair plaits lengthen forwards, in contrast after puberty, hair is worn down. The hairstyle of the ovaHimba women in their culture is a real gem with embodied knowledge; when a woman is married she dresses in a sort of headband made from antelope skin, called *omarembe* or *erembe*; widows wear this singular hat in reverse.

Figure 3.4. This photo shows on the left side, ovaHimba and on the right side ovaHerero. Differences in the traditional attire and similarity of cattle farming can be clearly seen.

The ovaHimba homesteads are constructed in a circular shape and the ones of the ovaHerero in a rectangular shape (see Figure 3.5). The homesteads arrangement have a defined set of rules on where to be built, for example, the ovaHimba fenced area for keeping the cattle is constructed in the centre of the circular homestead. The reason for this, according to Uariaike (2017), is so that the huts or dwellings where people sleep surround the cattle for protection. Both the ovaHerero and ovaHimba entrance door of their houses faces in the sunset direction.

The ovaHerero and ovaHimba stay in large family groups of uncles, grandfathers, sisters, and so on. The eldest men in the family own the main house, and its front door faces the gate of the fenced yard of the cattle (see Figure 3.5). The holy-fire (*okuruuo*) is placed between the main house and the fenced yard of the cows. The area around the holy fire is a sanctified place where the elder of the homestead talks to the ancestors and God praying for blessings (Nyathi, 2014). No stranger is allowed to cross this area. The ovaHerero and ovaHimba homestead location customs show that although the Otjiherero-speaking community is an oral tradition, there is particular significance and meaning on their surrounding and people. Digitally visualising the location-based knowledge augment this knowledge.

The Otjiherero-speaking sub-clans, that is, the ovaMbanderu, ovaHerero, ovaHimba, and ovaTjimba have a phenomenon of praising locations and people referred to as *omitandu* (Kavari and Bleckmann, 2009). The location-based praises are given based on momentous past events that happened at that specific location (if a chief was killed there during the war) or due to the place uniqueness such as its aesthetic, or on what people experienced when they first arrived at that place. Someone is given praise due to their bravery or excellent lifetime achievement. Omitandu is ubiquitous and origin of identification in the Otjiherero-speaking communities. Those that are conversant with the omitandu are very well respected in their communities. The praises are recited during ceremonial events such as funerals or remembrance of the chiefs who passed on during

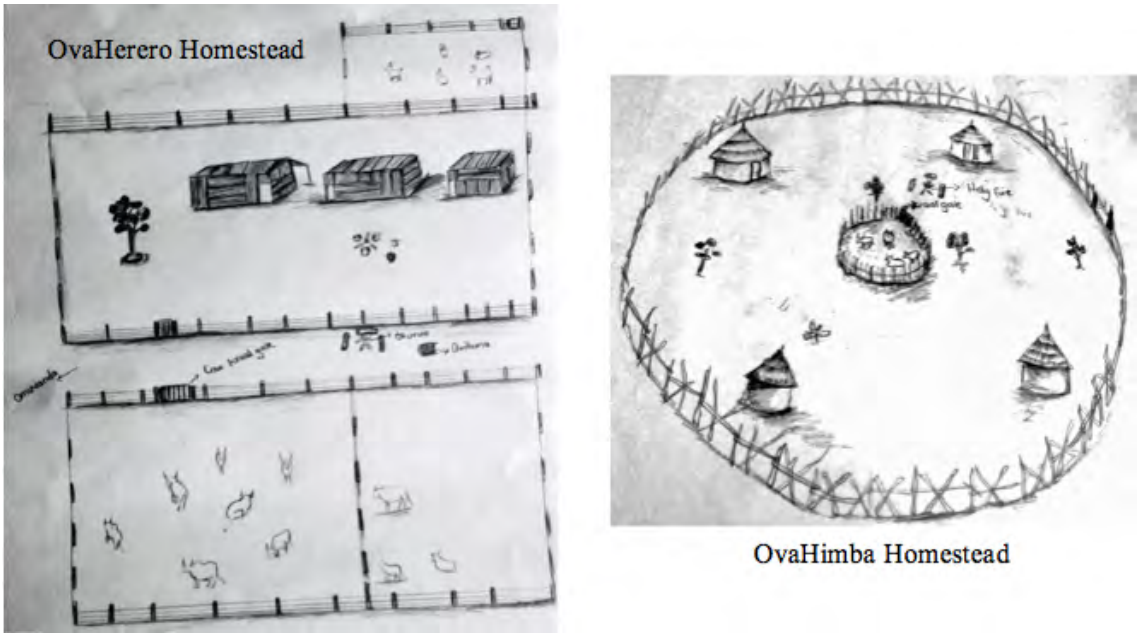


Figure 3.5. On the right, as indicated, is a drawing of the ovaHimba' homestead constructed in a circular set-up. On the left, is the ovaHerero' residence built in a rectangular set-up — credit to Eliaser (2019) for the sketches.

the wars. The omitandu are shared with pride to bring good memories during the mourning period and also during casual greetings.

The ovaHerero and ovaHimba have kept their double descended system of relating families for many years till today. The double system is composed of matrilineal (*eanda*) and patrilineal (*oruzo*). The matrilineal records the related family from the mother side called matriclan and patrilineal (patriclan) from the father's side. The matriclan is composed of seven groups namely: (1) *Omukweyuva*, (2) *Omukwendjandje*, (3) *Omukwendata*, (4) *Omukwenambura*, (5) *Omukwauti*, (6) *Omkwatjivi*, and (7) *Omukwenatja* as listed by Bollig and Gewald (2000). The matriclan system has strong social power in decision making and marital rules, for example, someone who is Omkwatjivi from ovaHerero cannot marry someone who is also Omkwatjivi even from the ovaHimba; it means they are descended from the same mother. Thus they are related as a brother and sister. The patriclan is associated with customs for a certain group from the father's side that has to be adhered to, for example, a specific colour of livestock they can only breed (Crandall, 1991). The eldest man in the patriclan group is in charge of the holy fire which is passed on by inheritance. The ovaHerero-speaking community presented a good study with rich traditions and IK to safeguard.

To include the ovaHimba community in this study was based on the following rationale. The ovaHimba and the ovaHerero share related cultural heritage. OvaHimba and the ovaHerero people still share many similar traditional practices. However, the ovaHimba traditional houses, homestead arrangements, and traditional attire are very different from the OvaHerero. These underlying similarities of tradition with a set of apparent differences presented an ideal case to investigate the transferability of the HSC application co-designed with ovaHerero by

maintaining the features yet allowing changes to the 3D models that would be crowdsourced.

One of the ovaHerero selected communities for this study is from Erindi-Roukambe (see marker number three (3) on the Namibian map in Figure 3.6) village from Otjinene in Omaheke region. Omaheke region is on the eastern side of

Figure 3.6. The map shows the selected community research sites. Marker one (1) Otjisa village for the ovaHimba community. Marker two (2) Okomakuara and marker three (3) Erindi-Roukambe village for the ovaHerero communities.

Namibia close to the Kalahari (semi-arid desert area) bordering with Botswana. The rural community from Erindi-Roukambe was part of the long-term project for preserving IK (Winschiers-Theophilus *et al.*, 2010b) where the HomeStead-Creator (Rodil *et al.*, 2012a) was co-designed as mentioned earlier in Chapter 1 (Section 1.2.2).

The other ovaHerero community identified for this study is from Okomakuara village (see marker number two (2) on the Namibian map in Figure 3.6) in Ovitoto. Ovitoto is part of the Okahandja Constituency in Otjozondjupa region. Every region in Namibia is sub-divided into smaller electoral sections called constituencies. Okahandja is about 70 kilometres north of Namibia's capital city, Windhoek. Okomakuara' community was chosen because it is close to Windhoek where the researchers were commuting from to conduct the research. The

Okomakuara community was first introduced to our research work during a participatory design workshop at the thirteenth PDC Conference that was held in Windhoek in 2014. The purpose of the workshop was to allow the workshop participants to validate their participatory design techniques by conceptualising it in-situ application against the Okomakuara community evaluations (Kapuire *et al.*, 2014). Although the ovaHerero community from Okomakuara is close to Windhoek, the capital city, they kept their traditional customs, thus satisfied as an ideal location.

The third research site chosen is from the ovaHimba community of Otjisa village (see marker number one (1) on the Namibian map in Figure 3.6). Otjisa is in Kunene region in the northwest of Namibia about 55 kilometres from Opuwo. The research team composing of the author, developers, NUST research colleagues of the author, and the author's second supervisor from NUST were travelling from Windhoek (Namibia capital city) to the research sites. These research sites were strategically chosen to have multiple information sources as triangulation that we can use their similarities and differences to increase the accuracy of our qualitative data analysis.

3.2.2 Research Process Overview

In this section, we provide a bird's view of the research steps taken, as depicted in Figure 3.7. The diagram shows each of the three AR cycles with every workshop where and when it was conducted. In total, we administered 17 workshops.

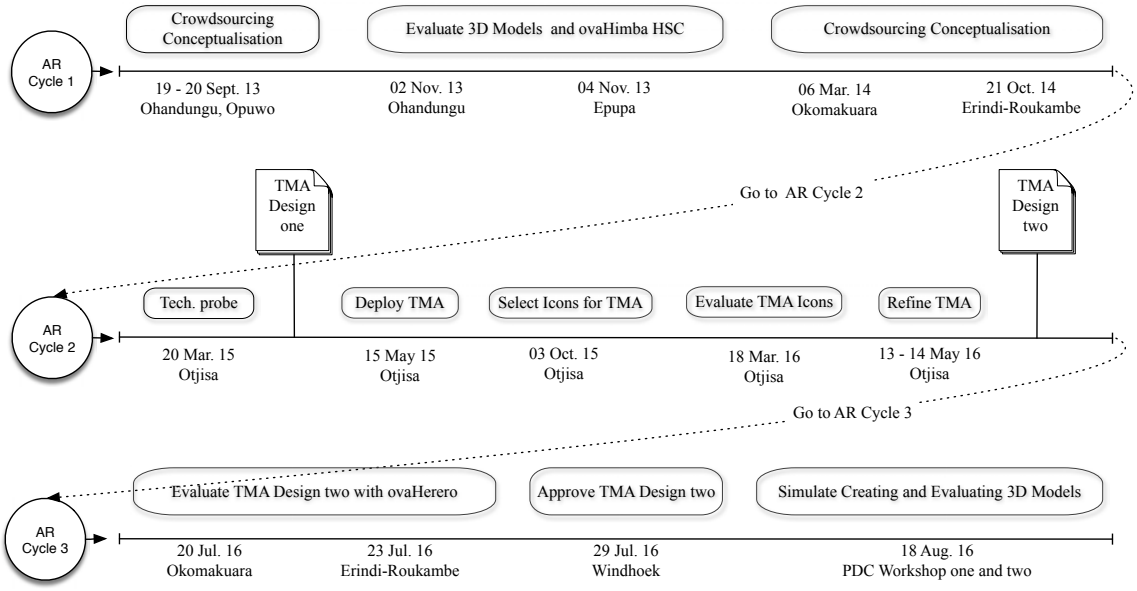


Figure 3.7. Research Process overview with each of the three AR cycle workshop dates and places where they were conducted. AR cycle two key outcome are indicated as a *page note*, for example, 'TMA Design one'.

We started our first AR Cycle, that is, crowdsourcing conceptualisation, with the ovaHimba community and then moved to the ovaHerero community to get

their crowdsourcing perspectives for requesting 3D models of traditional objects online. The second cycle took us the longest over a year of co-designing the TMA with the ovaHimba community. The TMA interface and functionality was revised several times in our AR Cycle two before proceeding to the third cycle. In the third AR Cycle, we took the ideas that were co-designed with the ovaHimba community to the ovaHerero communities for evaluation and acceptance. The TMA design two was finally approved in Windhoek by Uariaike and his wife Mukamberenge. The last activities from our final AR Cycle were closed off with two workshops we conducted at the 2016' Participatory Design Conference (PDC) to simulate creating and evaluating 3D models from graphic designers.

It is worth noting that the developers were part of every co-design session from the crowdsourcing conceptualisation, task manager refinement, and simulating the creation and evaluation of the 3D models. During the co-design sessions, the developers made notes of the communities' requests; they were equal partners in the co-design process with the research team and community co-designers.

3.2.3 Community Engagement

When entering a community for the first time, we learnt that it is the desired courtesy to inform the chief of that community first before conducting a workshop, especially for a new community. We have learnt to trust the information we get from the community. We at times went into a new community without knowing anyone, and by asking around for indigenous knowledge holders known in the community, we were usually directed to the right homestead. The project background was explained to the community. After that consent of the community to take part in the research was discussed for approval. If consent was given, then permission to take photographs and record the entire session was asked.

We learnt ice-breaking tactics, for example, extended formal greetings establishing lineages relationships and asking about the weather conditions (especially rainfall) and the well-being of the community's livestock was necessary before starting with research workshops. It was worth note taking because enquiring about family genealogy is a common practice for the Otjiherero speakers when greeting each other.

During the first workshops with a new community, we identify one or two participants from the community ideal to be our lead co-design contact persons. The lead co-design person is usually easily identified by his or her ease of sharing IK and eager to know about the technologies. At the end of the workshops we conclude by giving tokens of appreciation to the community members for their valuable time spent and knowledge shared. The tokens are mostly a parcel of staple food (cooking oil, maize meal, soup, and sugar).

3.2.4 Co-design Methods

Several situated co-design techniques such as *design probes* (Gaver, Dunne, and Pacenti, 1999) or *technology probes* were used. According to Hutchinson *et al.* (2003), technology probe is when one uses technologies that are simple, flexible,

and adaptable for the following three reasons: (1) to understand the needs and desires of users in a real-world situation, (2) testing the technology, and (3) to inspire designers and researchers to rethink about new technologies for improved usage. We also had *generative sessions* by observing our co-designers' behaviour rather than focusing only on what they said or the other way around, and also focusing on what they created (Sanders, 2000; Stappers and Sanders, 2003). *Brainstorming* sessions where appropriate were used.

It was crucial to allow elders to share their IK that they thought the youth from their community should know of before jumping into the co-design discussions of technologies, see Kankainen *et al.* (2012) for storytelling. The stories shared in the ice-breaking session are later used in the technology co-design discussions. Doing this has shown that the communities could easily relate to the co-design process before the actual software in use.

We use card sorting to demonstrate scenarios. Cards with pictures of traditional objects were handed out to the elders to place them around to demonstrate location where the object should be on their homestead or to portray a scenario. Blank cards without drawings were used for the participants to draw the missing objects that were not on the cards deck. The cards were placed on a table with removable adhesive (prestik) or the ground when there was no strong wind. Once a scenario demonstration was done, photos of the layout of the cards were taken.

Paper prototyping was used with notes placed on a board or a table using prestik. The notes were written or drawn on them and were placed on the board and moved around or replaced to demonstrate system behaviour. The paper prototyping can provide insightful for early usability evaluations (Snyder, 2003). The way we used paper prototyping is similar to affinity diagramming. Affinity diagramming is a technique that allows the researchers and the participants to visualise the problem being solved. Affinity diagramming is done by placing sticky visual notes on a board and moving them around to indicate interaction of the system being designed (Simonsen and Friberg, 2014). Affinity diagramming or paper prototyping are great tools for cognitive activities such as co-designing the application flow and functionality.

We allowed the rural communities to impromptu freely share their ideas using traditional objects for demonstration purposes if necessary. Chen and Wang (2012) also found that allowing participants to bring meaningful objects and share stories relating to those objects in the design sessions was productive and enjoyable as compared to the classical interviews.

The workshops were *focused groups* of three to five participants for closer interactions. Each workshop took us about four to five hours with 15 minutes break time. The author of this thesis was the primary facilitator of the workshops conducted for this study. All sessions at the community sites were conducted in Otjiherero. Selective translation to English was done concurrently for the those who cannot understand Otjiherero.

IK holders moved around while taking photos of the traditional objects. IK was then shared by the elders while navigating around the homestead surroundings, or the kraal, yard, holy fire or in the field. The co-designed application was re-evaluated during those walks (walking in design). We need all our senses when acquiring knowledge and walking brings the past into the present and that

walking is one of the most common regular daily activity that can stimulate creativity (Bidwell and Winschiers-Theophilus, 2012).

3.2.5 Data Collection

Photographs of the researchers and the elders from the community were taken to capture challenging and exciting moments. Photographs were also taken to capture co-design activities and in events where the elders were interacting with the application for evaluation purposes. Photographs were effectively used to refer to a specific screen that the elders were excited about or found challenging; facial expressions were also considered in the photograph to tell a story about experiences encountered. Besides using the photographs for academic purposes, pictures taken of the elders with the researchers as a team and the homestead surroundings of the indigenous communities were given to them as a sign of friendship (Kapuire, Winschiers-Theophilus, and Blake, 2015).

The communities preferred their faces not to be blurred when their images are used in publications (Kapuire, Winschiers-Theophilus, and Blake, 2015). They felt that they are part of a good community project safeguarding IK that they are very proud of and would like to be visible to the people around the world and their fellow community members.

The whole workshops sessions were video recorded. The cards that displayed scenario were also video recorded. All recorded video clips were transcribed and analysed for report writing and transcribed from Otjiherero to English so that all the researchers can understand the transcripts content. An independent consultant was hired for transcribing. See a sample of a transcript in Appendix G.

While some researchers were video recording, translating or taking photos, those that were part of the co-design session took notes. The notes were recorded in the researchers' diaries for recalling interesting aspects encountered. The notes were also used in report writing. The researchers sometimes asked the elders to draw or write in the researchers' diaries.

After every road trip from the community site, the author wrote a field report based on the handwritten notes during the workshops. The field trip reports were shared among the other researchers for comments and were corrected by the author. The field reports were used as a starting point for published articles of this study. The field report contains full descriptions of the indigenous rural community members that took part in the workshop and activities carried out.

The observed behaviour of the co-researchers and the rural community members were also reported. The report also contains reflections from the overall community engagement and about the tools and techniques used during the co-design sessions. This approach of having descriptive and reflective content in the field report is practical, useful research reporting technique as suggested by Bogdan and Biklen (1992). See Appendix B for a sample field report.

3.2.6 Data Analysis

Miles and Huberman (1994) mentioned that creating, testing, and revision of simple, practical, and compelling analysis methods remains the highest priority for qualitative researchers. Miles and Huberman outlined three ways to analyse qualitative data. One is the *interpretative* approach which provides a broad view of the data instead of a detailed one. Second, is *collaborative* that is often used by action researchers (used in this study). Collaborative approach tries to represent views from all stakeholders involved in the project. Third, is *ethnographic* approach whereby the researchers provide detailed descriptions from different sources to discover human behaviour patterns.

Data analysis was done progressively from the conceptualisation phase of this study till deployment of the produced artefact. Video recordings from all the 17 workshops were transcribed, and the transcripts were coded using `NVivo`[3]. Coding, often called open coding referring to the process of coming up with the recurring categories or nodes from the transcript text (Strauss and Corbin, 1990). The nodes represent the *themes* which is the things that were mentioned most from the workshops.

The author used a hybrid of deductive and inductive thematic data analysis, see Alhojailan (2012) for more insights on these methods. The deductive thematic analysis to extract codes from literature was guided by Crabtree and Miller (1992) and inductive to extract codes from fieldwork dataset was directed by Boyatzis (1998). The extracted codes from literature, for example, were from Afrocentric canons and Ubuntu values (respect, caring, togetherness, truth, knowledge, sharing). Nodes were first defined in Nvivo based on recurring topics from the literature related to this study and mainly from what frequently appeared from the workshop transcripts.

All 17 workshops transcripts were imported into Nvivo, and each transcript was analysed to select phrases or sentences that contained content related to the defined nodes. The selected phrases from each transcript were assigned to the appropriate node(s). After this process of coding (assigning phrases to the nodes), visualisations such as word clouds were generated from the nodes, see Appendix C for a sample of the nodes created, transcripts, and generated graphs. The themes coded from all AR cycles are discussed in details in Chapter 7. The themes created in NVivo are different from the AR themes. AR themes were our initial research interests or the research questions as discussed in Chapter 1, Section 1.6.

3.3 Ethical Considerations

This research being a qualitative study, the researcher has to work closely with the IK holders as participants. Those interactions required that the researcher had to take critical ethical precautions. The research was conducted based on the

[3]NVivo is a qualitative or unstructured data analysis software developed by qualitative research software (QSR) international company (QSR, 1995). It helps researchers that do qualitative research to quickly discover patterns from their large volume of text data.

community ethical understanding, see Chapter 7 for results concerning ethical issues.

The ethical clearance considerations section that follows discusses how the ethical issues were handled in this study. Some ethical considerations in this study were handled differently. From the conventional approaches, that is, the participants were not forced to sign consent forms, the elders themselves did not prefer consent forms and anonymity.

Our prominent co-designers from the rural communities preferred not to be mentioned as participants or as subjects but rather by their first names or as community co-designers. Once an IK holder is listed as an author of an article, we translate it to Otjiherero and let the elder read and contribute to the paper discussion. We treated this paper by Kapuire *et al.* (2016) in this manner.

3.3.1 Ethical Clearance

All the community engagement activities were carried out in Namibia. Thus the ethical clearance to conduct this research was granted by NUST where the author was employed instead of at the University of Cape Town. It was at this point that author proposed that the community crowdsourcing website that would allow the graphic designers to contribute to the rural indigenous community request to be open source. The Ethical Clearance Certificate is attached to Appendix A.

Researchers are cautioned by Silverman (2016) to take note that when they move into the participants' environment to conduct their research, they are entering into the participants' private space. Entering into the communities space brings about several ethical issues that should be considered such as getting consent from the participants or agreeing on the terms of the communities, how to handle the potential risks of harm, honesty and trust, privacy, confidentiality and anonymity, and voluntary participation (Miles and Huberman, 1994). Below is a summary of those ethical issues.

3.3.2 Informed Consent

The author informed the participants who are the IK holders from the selected rural communities of the research purpose, data collection methods, and scope of the research before commencement. Besides, the author explained the co-design phenomenon to the IK holders working with for the first time. Explaining the co-design concept was done so that IK holders could be on equal terms with the concept of designing software applications in perspective of the rural communities' context. From our long-term engagement with rural communities, community members have informed us that they prefer verbal agreement. Signed forms are seen as a threat or as a sign of being sidestep. We, therefore, did not ask the IK holders to sign any consent agreement.

3.3.3 Risk of Harm

The participants were not involved in any harmful activities. Harm refers to either physical or psychological (mental distress) as Trochim (2006) pointed out.

The typical activities were to take pictures, video or audio recording, scenario demonstration by using card sorting, sorting sticky notes (paper prototyping) during co-design sessions, and make drawings of the traditional objects to be modelled into 3D. The researchers tried to the best of their abilities to ensure that no participants were put in situations that might have been harmful as a result of their participation.

3.3.4 Honesty and Trust

We followed the Oundu principles of living in harmony and caring for each other let us foster honesty and trust at all times. On the software development aspect the "Software engineering code of ethics and professional practice[4]" were followed.

3.3.5 Privacy, Confidentiality, and Anonymity

The researcher ensured that privacy, confidentiality and anonymity were done according to the rural communities preferences. The IK holders preferred their names to be revealed in our publications and discussions.

3.3.6 Voluntary Participation

The IK holders and the students that took part in this research were not forced to join the project. It was made clear that their participation was voluntary and that they could leave the research at any given time.

3.4 Evaluation of the Research

Standard criteria for evaluating quantitative research are well-known. However, assessing accuracy in qualitative research is not easy. Some strategies and approaches can be used to enhance the truthfulness of qualitative research findings (Lincoln and Guba, 1985). This research is of the pragmatism research paradigm, and thus, specific quality criteria have to be set for the study to be benchmarked. Those quality criteria are highlighted below:

3.4.1 Credibility

Credibility is about establishing confidence in the truth of the research findings. To achieve credibility research findings should relate to the actual reality on the ground (Pandey and Patnaik, 2014). Several techniques such as prolonged engagement and persistent observation, have been identified to ensure credibility in qualitative research Erlandson *et al.*, 1993, p. 136.

[4]This is the International Standard for Professional Software Development and Ethical Responsibility as recommended by the IEEE-CS/ACM Joint Task Force on Software Engineering Ethics and Professional Practises and jointly approved by the ACM and the IEEE-CS as the standard for teaching and practising software engineering.

The three selected communities enabled further exploration and validation of the findings. Different co-design tools or techniques were used in the co-design sessions. Focus group discussions with the communities were also used for them to validate the research process, prototypes and deployed products.

3.4.2 Transferability

Research findings can be transferable or generalised only when they are applicable in a different context from where the study was conducted. Qualitative research can enhance transferability by providing a clear, detailed description defined by Lincoln and Guba (1985) as clear thinking of the research setting studied. By doing these, other researchers can decide whether the findings can be applied in different contexts they are familiar with. In this section, we do not only discuss transferability from research findings but transferability within the research process, specifically focusing on the co-design of technologies.

Since we use Community-based Co-design as a research methodology, we aimed for achieving transferability to a certain extent of our community engagement approach, research process and co-design techniques than generalisation. In support, Boex and Boex (2012) also mentioned that several design concepts and methods can be widely applied. We are in agreement with Hansson *et al.* (2018) that motivation in design is often more about finding a throughway for connection and participation than designing the object. With this design approach, the design becomes more process oriented and less tangible requiring designers to establish a long-lasting commitment and to have a more in-depth look on how to 'appropriate' and 'reformulate' design and participation (Hansson *et al.*, 2018).

Transferability in co-design can be accomplished from different angles, such as through knowledge transfer and shared control in the research process among researchers and community members. Winschiers-Theophilus *et al.* (2013) cautioned researchers to be careful before concluding transferability without a comprehensive understanding of community engagement, transformation, contextual similarities, and cross-contextual validation.

Carroll and Rosson (2007) highlighted the necessity to create platforms, for example, IT workshops whereby different community members share their technology requirements, development or user experiences. The technology ideas can be discussed, refined and shared between communities and researchers as a basis of shared work for future endeavours. Vines *et al.* (2013) support conducting co-design workshops as an essential element in the PD process for knowledge to be shared and integrated into the design of the technology.

When it comes to sharing decisions in the research process, Vines *et al.* (2013) pointed out that it is essential to ask what decisions are made and by whom. They further cautioned that researchers tend to claim to have shared control; however, the community members or participants are consulted only during the design sessions.

3.4.3 Conformability

Conformability refers to whether the research findings can be confirmed by others especially the research participants. Conformability can be achieved by auditing as proposed by Seale (1999). In order to make the auditing process straightforward, all collected pictures and video recordings plus their transcripts of this study were stored in a database for quick retrieval and backup by other members of the author's research cluster. Research findings were progressively discussed with the community co-designers for confirmation. The author's research cluster colleagues were part of all the co-design workshops and reviewed the field trip reports to ensure that the authors believe, values, perspective, or assumptions did not dominate the findings of this study.

3.4.4 Dependability

Dependability involves employing techniques to prove that similar results can be obtained if the same study is replicated in the same context, using the same methods and with the same participants. In action research it is recommended to document the research in details to make it easier for replicating termed as "recoverability" by Holwell (2004). Inquiry audit (external expert evaluations) can be used as techniques for enhancing dependability (Lincoln and Guba, 1985). Researchers that were not part of the author's research cluster were invited to observe the co-design sessions, and their comments were welcomed.

3.5 Chapter Conclusion

In this chapter, we discussed Community-based Co-Design (CBCD) as the umbrella research methodology guided by Action Research (AR) aspects of planning, taking action and reflections. CBCD was simplified by first defining community from our perspective and then outlining co-design. Our CBCD engagement practises such as being culturally sensitive, reciprocity and obeying the community ethics and protocols were highlighted. Co-design approach on co-creation of the software product has been introduced.

AR theoretical perspective and epistemology of pragmatism and constructive were discussed, informing its validity to this study. AR cyclic iterative process was also described in detail by outlining the five standard steps (1) diagnosing, (2) action planning, (3) action taking or implementing, (4) evaluating or observing, and (5) reflection step.

Research design provided a blueprint for data collection and co-design techniques. The selected research communities indicating their geographical location and rationale for selection for the study was introduced. Data collection techniques were discussed. Data collection and co-design techniques such as video recording, taking photos, paper prototyping and walking in design were also discussed.

Our ethical research standpoint was discussed focusing on informed consent, the risk of harm, honesty and trust, privacy and voluntary participation. Research evaluation was also outlined, looking at credibility, transferability, conformability, and dependability. The next Chapter 4 starts with the first AR cycle (*crowdsourcing conceptualisation*) unveiling our research approach, Afrocentric epistemology, and co-design techniques.

Chapter 4

Crowdsourcing Conceptualisation

4.1 Introduction

This chapter provides further details of the first CBCD cycle interactions with the rural indigenous communities. CBCD cycle one simulated IK holders together with researchers how the rural communities would crowdsource three dimensional (3D) models to graphic designers on the World Wide Web. A common consensus of basic understanding of how crowdsourcing would be carried needed to be agreed upon with the researchers and with the rural communities before proceeding with further community co-design activities. Part of this chapter is published in (Stanley *et al.*, 2013; Stanley *et al.*, 2015; Stanley *et al.*, 2016; Stanley *et al.*, 2017).

The IK holders communicate to graphic designers by sending images of their traditional objects together with narratives for graphic designers to model the traditional objects into 3D models. The IK holders then evaluate the delivered 3D models, if not satisfied, they can add or clarify the request's narratives and send back to graphic designers for refinement. If the IK holders are content with the completed 3D models, the models are then imported into existing IK visualisation tools such as the HomeSteadCreator (HSC). While engaging with the IK holders during this crowdsourcing conceptualisation cycle, two Research Theme Questions (*RTQs*) were formulated as below:

1. What are the conditions to establish and maintain a beneficial embedded community engagement?

2. How to appropriate a community crowdsourcing technology with rural communities?

A simulated creation of a crowdsourcing request was carried out in Opuwo, and Epupa falls with the ovaHimba and ovaTjimba communities and with the ovaHerero communities from Okomakuara and Erindi-Roukambe. Crowdsourcing in the traditional sense is inherently present in the Otjiherero speaking communities, especially within their cattle farming activities. In rural communities, there is a mutual obligation or a common practice to help one another, mainly when a particular homestead is busy with an activity that requires assistance from others. For example, in winter, the calves are branded for owners' identification. People from other homesteads spontaneously join to help the home that is busy with calves branding and the helpers are usually rewarded for that

by slaughtering a goat or sheep to be eaten while working. However, modern crowdsourcing through the internet is different; it is very much about *individual tasking* rather than the communal effort that involves shared companionship.

It was knowing those as mentioned above that the rural communities were already practising crowd-sourcing in their traditional customs. It was interesting to find out how the rural communities would move from their everyday physical interactions to a new environment of a virtual concept of crowdsourcing on computers. In this novel shifting, it was also noteworthy to find out the success and challenges emerging in safeguarding IK.

4.2 Chapter Structure

The following main sections are structured to simplify how the crowdsourcing conceptualisation was conducted in a chronological order starting from the earliest interactions with the communities in 2013. First, the planning phase in Section 4.3 outlines the scheduled plans for the workshops. The planning phase involved identifying and framing of the research topic, reviewing related literature and developing the research plan. Second, the action phase in Section 4.4 outlines how the drafted plans were carried out. Lastly, the reflection phase in Section 4.5 shares lessons learnt about the research actions taken before concluding the chapter.

4.3 Plan for Community-Based Co-design Cycle One

In the upcoming paragraphs, we discuss our scheduled plans for the first CBCD cycle, that is, crowdsourcing conceptualisation with the ovaHimba community from Ohandungu and Opuwo, and ovaTjimba from Epupa, and with the ovaHerero community from Okomakuara and Erindi-Roukambe village. During this cycle, we conducted six workshops, see Figure 4.1 for the workshops' dates and places. See, Appendix B for detailed travelling logistics. The scheduled activities

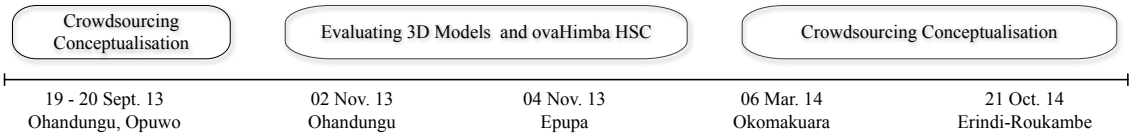


Figure 4.1. Depicts when and where the main activities were carried out during the crowdsourcing conceptualisation cycle.

outlined here are as carried out in the action phase (see Section 4.4) of this cycle. It was our first time to interact with the ovaHimba community we, therefore, had to find someone from the ovaHimba who could introduce us. One of our former student from NUST introduced us to John Tjipurua to be our contact person for the ovaHimba community.

The aspiration was to understand how the rural communities would prefer to crowdsource their traditional objects to be modelled into 3D models to safeguard

their cultural heritage digitally. We conducted the *first* workshop (a focus group discussion) on the 19th in Ohandungu and *second* workshop on 20th of September 2013 in Opuwo with about three to five ovaHimba IK holders. Ohandungu is a village 49 kilometres from the northern side of Opuwo, see the map in Figure 3.6 from the previous Chapter 3.

The objective of meeting the OvaHimba community for the first time was to discuss IK sharing in general and then introduce the elders to the HSC a tablet-based application as a *technology probe*, a new tool to facilitate IK sharing. Then to reflect on the user experience and ideas on how the HSC could be enhanced or replaced to be suitable for the IK holders. Finally, introduce the crowdsourcing concept to request for 3D models of their traditional objects.

Three months since our first workshops with the ovaHimba IK holders in Opuwo we conducted the *third* workshop on the 2nd of November 2013 with the same IK holders from Ohandungu. The plan was first to show the images to the IK holders taken by them in the first workshop so that we could easily link this workshop with the previous workshop held on the 19th of September 2013.

A second version of the HSC was developed based on the ovaHimba homestead drawings from the Opuwo workshop held on the 20th of September 2013, see Figure 4.1. The updated HSC was developed to simulate that specific community preferences adaptation of the HSC was possible using graphic designers from around the world. The graphic designer that was used in this simulation process was one of our research team member who developed the HSC. At this point, the community crowdsourcing platform proposed by the author (Stanley *et al.*, 2013) was still in its conceptualisation phase, we, therefore, simulated the process of sending the request to the community crowdsourcing website.

We conducted the *fourth* workshop on the 4th of November 2013 in *Epupa falls*[1] which is about 130 kilometre from Opuwo, see the map in Figure 3.6 from the previous Chapter 3. We introduced the prototype of the ovaHimba HSC to the ovaTjimba community that we did not work with before so that we could do an independent evaluation of the new HSC. Usability evaluation of the HSC is not the focus of this thesis; hence, it is not discussed in detail. Besides introducing the ovaHimba HSC, the overall idea was still to simulate the crowdsourcing concept that if there are still elements of their tribe missing in the HSC app, they could request for those.

We scheduled to conduct the *fifth* workshop on the 6th of March 2014 with the ovaHerero community from Okomakuara village. The aim was to introduce the crowdsourcing concept so that the community could also contextualise it from their perspective. The workshop started with the IK holders discussing certain aspects of their culture that they felt the youth should know. The IK holders then simulated how they could create crowdsource requests for 3D models of their cultural objects that were essential for the youth to know and were missing in the HSC.

We also wanted to find out how the IK holders from Erindi-Roukambe would simulate this novel concept of crowdsourcing besides being familiar with the software co-design activities. The same co-design community members of four elders

[1]Epupa in Otjiherero means it flows or foams named after the waterfall from the Kunene river creating the border between Angola and Namibia (Detay, 2017).

that have been involved in the long-term project for safeguarding IK since 2008 were invited to be part of the focus group discussions on 21st of October 2014. The primary goal of this *sixth* workshop was to introduce the crowdsourcing concept by trying it out with scenarios demonstration using *card sorting* or any *impromptu technique* that would be suitable during the workshop.

4.4 Cycle One Action

In the following subsections, we describe how we interacted with the rural communities to conceptualise crowdsourcing.

4.4.1 Introducing Crowdsourcing at Ohandungu and Opuwo

The first-day workshops were conducted at Ohandungu and the second day in Opuwo. It was easy to get five IK holders for the workshop in Ohandungu because the ovaHimba stay in prominent families with cousins and brothers' children and wives. In total, we had nine IK holders, three males and six females. We conducted a separate workshop with the three men and another one with the six women. The separation was done to have a limited number of people for a productive focus group discussion. The separation of men and women is not always standard in our workshops.

When IK holders noticed that among the researchers there were Otjiherero speakers they asked about their patrilineage and matrilineage family line. The ovaHimba and ovaHerero share the same family relationship identification of using both the patrilineage and matrilineage, as mentioned earlier in Chapter 3, Section 3.2.1. During this family identification, the author found out that one of the ovaHimba men was his brother as they both share the same *"eanda"* (maternal family line) meaning that in their ancestry, their grand-grandmothers were from the same mother.

The workshop started with one of the Otjiherero speaking researchers discussing our research background and its objective. The researcher briefly mentioned that we co-design software applications with rural communities to safeguard IK. Further stated that we have been working with the ovaHerero community from Erindi-Roukambe since 2008 and now we would like to work with the ovaHimba. Next, the IK holders were asked for permission to take photos and record videos during the workshop. The IK holders were further questioned whether they would be angry if their names and images are published in a newspaper or any publication. The ovaHimba elders replied that they would be more than happy to be part of this project of safeguarding IK and would also be pleased if their real names and images are published concerning safeguarding IK as it would be a sign to other community members that they are busy with something beneficial for the community. It was also well explained that the IK holders should voluntarily participate and could stop partaking in the research if they were not happy at any given time.

The IK holders were asked to discuss the elements that constitute a typical ovaHimba homestead. The elders listed several essential items such as a kraal,

holy-fire, cows, huts (houses), eating utensils among others. Besides that, they mentioned that trees are significant for them referring to trees as "the eyes of their culture" metaphorically meaning their houses (huts) are built from trees, their livestock eats trees, and people eat and use certain plants for healing. The discussion mentioned above was a significant activity as the subsequent event was to introduce the IK holders to the HSC previously co-designed with the ova-Herero community. The HSC was used as a technology probe so that we could easily reference the elements the elders listed before to compare whether they are happy about the features present on the HSC.

The workshop facilitator first demonstrated how to use the functionalities on the HSC and then allowed the IK holders to construct their homesteads. When the IK holders were given to use the HSC, they feared to move the objects around and were amazed by the 3D models' orientation by shaking their heads. Besides the hesitation to tap on the tablet at the beginning, the IK holders were very excited when they managed to drag a particular object to their desired position. Figure 4.2 shows one of the ovaHimba IK holders Uariaike who was very enthusiastic after he managed to move an object to a location where he wanted it to be on HSC for the first time. It should be noted that the IK holders agreed for their real names to be mentioned and photos to be used as stated earlier in Chapter 3.

Figure 4.2. The author was holding the tablet for Uariaike to drag a 3D object on the HSC.

Figure 4.3 shows when Uariaike was done constructing his homestead and showing it to another IK holder. The HSC application was circulated among all to allow them to construct a typical ovaHimba homestead. When Uariaike had finished constructed his residence on the HSC, he was asked by one of the researchers whether anything was missing to make his home complete. He replied saying a chicken was missing but one the researchers politely asked him whether it was not a woman missing, he responded with a joy of laughter in agreement by poking the two Otjiherero speaking researchers. IK holders instantly noticed

Figure 4.3. Uariaike one of the ovaHimba elders was showing the homestead he constructed for the first time on the HSC to another IK holder.

that most objects on the HSC were not of their homesteads but the ovaHerero. As such Uariaike could not find an omuHimba female to place in his homestead he had constructed, and so he joked saying that "now omuHimba man is forced to marry an omuHerero woman." In overall, the IK holders stated that most elements like the kraal construction and houses were not theirs including the trees were also not from their region.

After constructing a typical homestead on the HSC, the elders were informed that all their missing elements could be included in the HSC. At this point, the crowdsourcing concept got explained that they could request the missing items by making drawings or taking pictures, recording videos, or describing and sending those to a crowd of people via the World Wide Web who will then transform their images into 3D models. This process we refer to as a *task formulation* whereby the communities create the request so that graphic designers worldwide would model the requested elements. The task of evaluating the completed 3D models whether they were shaped correctly we refer to as *task evaluation*.

After the crowdsourcing explanation Uariaike was given a tablet with an embedded camera to take photos of the missing elements he thought are relevant to be modelled. It was fascinating observing Uariaike taking photos of the traditional objects. He started taking photos of the *holy-fire* area. Then he took photos of other several traditional items such as the kraal, *otjoto* (thatched roof) which is an important place in the ovaHimba homestead where the groom and bride are taken to sleep during the wedding ceremony. Lastly, around the kraal area he took photos of the *ozombande* (ozombande are poles where meat is kept as a

table). After the kraal area he proceeded to the main hut of the homestead.

While Uariaike was walking towards the main hut he instructed one of the young girls to go collect eating utensils, for example, calabash for storing *omaere* (soured milk), *ehoro* (a cup made of wood) to drink omaere from, and *ombako* (funnel) used to pour milk into the calabash. After taking pictures of the eating utensils, he took photos of the ovaHimba women and many more traditional objects. While Uariaike was taking pictures, he conveyed vital information about the significance of the conventional objects or structures and how they are used, see Figure 4.4 where Uariaike is pointing at the *otjoto* and explaining its usage, what it symbolises in ovaHimba culture, and the customs associated with it.

Figure 4.4. Uariaike was explaining the ovaHimba homestead arrangement to the author while holding a tablet during the crowdsourcing simulation workshop at Ohandungu village.

We held a second workshop with three ovaHimba women in a similar way with the men. The first discussion concerned the importance of safeguarding IK and what will happen to it when the IK holders passed on. They replied that IK is a survival kit in their community by providing an example that if the youth does not know about IK, they might starve from hunger or die from sickness when they are in the field. They replied that when they die, they would have taught their children to keep IK for the next generation. One of the researchers pointed out that not all children are keen on learning about IK nowadays and if IK is not captured on computers there is no way to retrieve all that valuable IK. The women agreed with this rationale.

When the women were asked to list the essential elements of the ovaHimba homesteads they mentioned the huts, eating utensils, holy-fire, cooking place, and trees. They said there are many more that they could not remember all at once. We introduced the HSC by showing how to use its functionalities, and the women were also given a chance to construct their homestead, see Figure 4.5.

Figure 4.5. ovaHimba women were constructing their homestead for the first time on the HSC and the children assisting and observing with curiosity.

While constructing their homestead, the ovaHimba women also made comments that most of the traditional objects were not theirs and some of the trees were also not from their region. After constructing their homestead, they were also informed that they could take pictures of their traditional objects they wish to be included in the HSC thus a tablet with a camera was given to one of the women who felt comfortable operating on the tablet. She took similar pictures taken by Uariaike by starting with the holy-fire, then the kraal, and photos of the huts. The woman was accompanied by a young girl who requested the woman to take pictures of the *oturia* (small food store hut) and dogs. OmuHimba woman asked the girl to take photos of her. She took pictures of goats and then finally some of the cooking pots.

After the photo taking sessions, we sat down with the elders for the last meeting of the workshop that was to select the images they preferred from the set of the photos taken. The purpose was to choose the best images to send to graphic designers so that they can create 3D models. The selection criteria were based on choices of the picture quality and the importance of the objects in their homestead. We had a simple demo of selecting images by allowing the IK holders to tap on the pictures they have taken as an action that they wanted those images to be modelled in 3D. The selection demo did not have the functionality to remember the selected images; we, therefore, took screenshots of the pictures chosen and made notes. The chosen images by the women were mainly of the kraal, hut, calabash, *oturia* and the ovaHimba women. After selecting the photos one of the women asked "so what should we (the ovaHimba women) do with these images now?", the facilitator replied that those selected images would be given to a graphic designer to be modelled in 3D models so that they can also be imported into the HSC.

The concluding activity was to thank everyone and give tokens of appreciation (see Chapter 3, Section 3.2.3 for full details of the tokens of appreciation). The elders were very pleased with this gesture and wished us a safe trip back to Opuwo.

After the Ohandungu full-day workshop, the following day on the 20th of September 2013, we conducted another workshop with IK holders in Opuwo. Our contact person John took us to another group of ovaHimba elders in Opuwo that agreed to participate in the workshop.

The workshop introduction was done in a similar manner starting with formal greetings to the four elders, the project background and verbal consent agreement to conduct the workshop and finally permission to take pictures and do video recordings. The elders agreed to work on this project and had no problems with photos of them to be taken. After the consent agreement, a question was asked to the elders about the procedures adopted when one wants to start building ovaHimba homestead. They explained that they first have to find a suitable habitable area. To stay at the new space is also determined by the success of making their fire for the first time. They make fire by rubbing a stick on stones instead of matches, if the fire flamed easily without any difficulties, then that is a good sign to stay at the new area. After the fire burnt then the calves' kraal is made, they continued with the discussion of constructing items one by one until the homestead is complete. The IK holders shared information about some medicinal plants that are used to heal stomach ache, headache and malaria.

After the discussion mentioned above, the workshop facilitator introduced the HSC usage by making use of the talks the IK holders just shared. The IK holders were also given a chance to construct their homestead on the HSC. They used the HSC based on their earlier discussion. Thus they started by selecting the ones of the appropriate trees to be dragged to the area where they are wanted to construct their homestead. They mentioned that their kraal and hut would be made from the trees that they have dragged. They, therefore, noticed that no yard that looks like theirs. All the IK holders were giving each other ideas and a chance to move the objects around constructing the homestead. There was a lot of laughter and jokes shared.

After the HSC usage, the elders were informed that they could take pictures or draw the images of their missing objects. They all agreed that the complete ovaHimba homestead was not present and thus they opted to make a drawing of the ovaHimba homestead, see left image in Figure 4.6. The sketching was done in a collaborative way of two groups. Everyone in each group was observing the one busy with drawing. The IK holders shared ideas on how best to draw the pictures and at times taking the pen from the one working with a sketch if they noticed he was not sure how to draw something. The drawing of the homestead was drawn with precise details that the main hut door is facing the cattle kraal gate.

Following next was the image selection process. Pictures of the drawings were taken with the tablet camera so that the IK holders could select the images from the tablet application that they wanted to be sent to graphic designers to model

Figure 4.6. Left image: IK holders were collaboratively drawing the ovaHimba homestead to be sent to graphic designers for creating 3D objects. Right image: image selection activity using the image selection prototype.

into 3D objects. We use the same image selection prototype that we used in Ohandungu. Right image in Figure 4.6 shows the author assisting with the image selection functionality. The IK holders selected all the pictures of what they drew.

4.4.2 Evaluating 3D Models and the HomeSteadCreator

We held a workshop in Ohandungu on the 2nd November 2013 and another one in Epupa on the 4th of November 2013 according to the plans mentioned earlier in Section 4.3. Some of the photos taken from Ohandungu workshop were modelled in 3D and brought back to the communities for evaluation. We also tested the prototype of the ovaHimba HSC.

Upon arrival in Ohandungu, there was a funeral of a family member of Uariaike. Despite this sorrow moment, the IK holders agreed to have a workshop with us. We showed the IK holders the pictures on the tablet that they took during the first visit to recognise them. Uariaike replied with joy that the images were precise of the items he captured. We explained to the IK holders that the photos they were viewing were the ones they took nothing was done to them; they were still in 2D not in 3D. The tablet was passed around also to the women for viewing the pictures. All the elders were excited to see the images they previously took, and smiles and laughter ensued. IK holders wanted hard copies of the photos to keep for memories, we took note of that and promised them to bring along printed copies of the images on our next trip.

The followed up activity was to show the IK holders the 3D models created from the pictures they have taken. One of the researchers who created the 3D models demonstrated how the 3D models could be rotated in all directions, see Figure 4.7.

Figure 4.7. One of the researchers sat down on the ground to show how to rotate the 3D models.

The IK holders expressed amazement towards the 3D models, seeing the 3D of the *hut*. The IK holders claimed these not to be exact representations in real life. For example, they wondered whether the roof of the 3D hut represented that the roof is made from grass or not, see Figure 4.8 for comparison of the actual hut image and the modelled 3D model. They explained that it was too smooth according to them, to what Uariaike said "who built this beautiful hut, this hut is not ours, though it could be from other people around here." He further mentioned that their hut' roofs are not that straight especially at the edges. He said that he had seen roofs that are built like that but not of the ovaHimba. When questioned whether they would accept such a smoothly done hut to be part of the ovaHimba HSC, or would they prefer the one that is a bit messy, he replied "we would prefer the one with the flat roof, it is stunning all over." He asked what we used as a reference to model the 3D model of the hut; he thought we used other peoples' huts. One of the researchers assured him that the hut was modelled using those same pictures that he took.

The next 3D model for evaluation was the *oturia* (small hut built off the ground for food storage). On the first view, they commented that the oturia should not have two doors as modelled beside that there were no other mistakes on it. They signalled that if a model is wrongly modelled it should be rectified; otherwise their culture will be wrongly represented. Several other 3D graphics for example the *calabash* were evaluated with positive comments.

An extensive critique was made on the representation of *ovaHimba women*, the men then first burst into laughter seeing the 3D model of their ovaHimba women. In turn, they questioned from where was that ovaHimba women, "that is not our women". Whether the 3D model of the ovaHimba women was modelled based

Figure 4.8. Left: Photo of the actual hut, Right: 3D Model of the hut.

on the images they took or from somewhere else and jokingly claimed it being a "ghost or piece of wood", she is "naked", or that she was otherwise a "paralysed female". He made a comparison that the 3D model looks like a "ugly crafted wood". It was explained to Uariaike that creating a 3D on the computer is not that easy and that is similar to taking a piece of wood and trying to craft it so that it looks like the real object. When asked on what was wrong with the model, they mentioned the clothing as the main issue; the 3D graphic did not have enough flare as compared to the real women. The workshop facilitator asked Uariaike what should be corrected on the women, he replied that we "should instead throw it away and remodel a new better one." Further, Uariaike pointed to some female sitting close by to stand up for comparison, while also requesting comparing the model with original photos (see Figure 4.9 for comparison).

When the ovaHimba women 3D model was passed to the women for viewing they mentioned similar comments that the 3D model was not correctly modelled pointing out that specific wearing attires missing. The women were shown a 3D model of the ovaHimba men to comment on and also listed several dress code items missing that should be on the ovaHimba men. More images of the ovaHimba women wearing the full traditional attire were retaken from all angles.

After the 3D models' evaluation, it was time to use the ovaHimba HSC version. First, the IK holders were shown how to use the new features of the ovaHimba HSC. Uariaike was now happy to see the ovaHimba objects when constructing his homestead on the HSC although some objects were still missing. He said the following "come stay longer at my home to know more about my culture"; he explained that the daily short visit is not enough to thoroughly do specific activities.

Additional pictures of other traditional objects were taken, for example, *otjihanda* that is used to perfume clothes of the ovaHimba women. Garments are placed on top of the otjihanda when perfumed and myrrh and other aromatic herbs, which are lit with glowing coals, are placed under the otjihanda. Photos of the myrrh and aromatic herbs were also taken for task request for 3D models.

Figure 4.9. Left: Photo of the real ovaHimba women, Right: 3D Model of the ovaHimba woman.

We concluded the workshop by giving out tokens of appreciation and thanking the IK holders for their valuable time.

We conducted another workshop in Epupa with two ovaTjimba elders. OvaTjimba is a sub-clan of the ovaHimba as mentioned in Section 3.2.1 of Chapter 3. We started the workshop with the casual in-depth greetings, project background briefing, and verbal consent agreement whereby the elders agreed to partake in the project and for us to record the workshop. The workshop facilitator demonstrated how to use the functionalities of the new ovaHimba HSC and gave the two men a chance to construct their homestead see Figure 4.10 left: two ovaTjimba men busy constructing their homestead and on the right: their homestead created.

It was interesting to note the differences of the ovaTjimba homestead set-up, for example, their huts' door does not face on the west side of the sun sets direction as compared to the huts of the ovaHimba and the ovaHerero, see Figure 3.5 from Chapter 3. The ovaTjimba' huts entrance doors are built to face on the east side of the sunrise direction. They also do not build kraals, because they do not own any livestock. OvaTjimba men also mentioned that some of the 3D objects of the ovaHimba were different from theirs, for example, their food storage huts' roof is built from grass instead of cow dung as one of the ovaHimba. The two men shared considerably insightful information about their culture while constructing their homestead. For example that there are certain seeds from a grass called *obuma* that they eat and which is also a delicacy to the ants thus the ovaTjimba search for the ants' nest to collect those seeds. After constructing their homestead, we had a thorough discussion about the usability issues encountered while using the ovaHimba HSC prototype.

After the usability discussion, we introduced the crowdsourcing concept by

Figure 4.10. On the left is the ovaTjimba men busy constructing their homestead, and on the right image is the ovaTjimba homestead built on the new ovaHimba HSC.

an illustration of using a mobile phone to ask someone to do something for you. It was explained taking the example of the mobile usage for communication that a community member can communicate to other people around the world requesting them to create the missing 3D objects that he wanted to be included in the HSC.

Further explanation about 3D models was made that the images he saw on the HSC was not 2D; they were 3D; that is why he could rotate them in all sides and top view. The workshop facilitator explained that IK holder could take pictures from different angles of the missing object he wanted to be modelled in 3D. It was made clear that it was necessary to take pictures of the same object from different angles as those will aid in creating accurate 3D models. The IK holders emphasised that the trees present in the HSC prototype were not the ones they know, the *Marula* and the *Mopani* tree were missing. These trees to them were life-saving; for example, they use the Mopani to build their huts and make firewood for cooking and also use them to heal stomach ache and cut wound and among other uses.

After the discussion mentioned above, one of the men were given a tablet embedded with a camera to take pictures of the Mopani and Marula tree. We then concluded the workshop by giving tokens of appreciation for the two men for their valuable time. They were pleased with the project idea of safeguarding IK and gave us their contact details so that when we are coming next time to Epupa to contact them in advance.

4.4.3 Introducing Crowdsourcing in Okomakuara

At the beginning of the workshop, the elders did not seem to be interested in sitting down for discussion. They mentioned that it was a drought season and thus they were worried about the well being of their livestock. However, after the initial discussion about the research aims the elders conveyed pride in being part of the project. Having the communities interest from the beginning has taught us that it is imperative for long-term collaboration.

We started the workshop with the customary briefing about the research purpose and verbal consent agreements. The elders showed immediate interest in the project; though they asked which IK we exactly wanted to safeguard. We answered that our research does not focus on a specific IK but instead it was about co-designing software application that would allow the IK holders to voluntarily capture the IK they consider as valuable to them at any given time.

After the project briefing, the IK holders were asked to share any IK they deemed essential to be known by the youth. One of the elders started discussing how a child should be raised in the ovaHerero culture. He pointed out two aspects to consider: (1) how a child was parented in the olden days and (2) how it is done in modern times. He stated that children used to ride donkeys, but these days they ride bicycles, and therefore he found it difficult in sharing such comparatives in ovaHerero' culture. Another elder took on a further example of how to raise a young girl.

Elders were informed that the knowledge they just shared could be transferred and visualised in the HSC application. They were invited to identify the missing objects in the HSC application that would fully demonstrate their discussion we had earlier. Crowdsourcing concept was brought in at this point by asking them how they would communicate to people around the globe to create the missing 3D models for them. One of the IK holders quickly answered that they would take pictures and send them to those who can create 3D models. They began by taking photos of the objects that were part of their discussion, that is, walking sticks see Figure 4.11 the left image. The man uses sticks to walk with as an elegant status and as a protecting weapon. There are walking cane for different events. Good looking ones are used for formal events such as a wedding. Sticks can also represent significant protection; for example, the father gives his best walking stick to his daughter as a sign of protection to go with to her new family. There are also sticks used when chasing cattle or for hunting. The elders were eager to make sure that they have selected all the types of walking sticks and shared their usage.

Figure 4.11. Left: ovaHerero elder taking pictures of walking sticks to be modelled into 3D, Right: OmuHerero women drawing a pregnant lady

For example, the elders shared that only married men are allowed to walk around with sticks and when your father is alive you are not supposed to lean on

the sticks when walking. The elders carefully took pictures of the walking sticks taking one by one without background obstruction.

After taking photos of the sticks, one of the women instructed her daughter to bring myrrh and the aromatic herbs so that pictures of it could be considered too as this is given to the girl when she is being married. After that, we referred to their discussion that there was a pregnant lady and there was no pregnant lady at their homestead they agreed to make such a drawing (see 4.11 right image where one of the women is busy drawing a pregnant lady). At the beginning the women were hesitating to use the tablet to make drawings claiming it was difficult, asking whether it was possible to erase, after trying a few times she managed. The picture of the drawing on the tablet was passed around for approval.

When the elders were tasked to discuss the procedures they would prefer before sending the images, they replied the following: several good quality pictures or drawings have to be made before sending out. They were informed that they could send drawings even if they were not in a perfect state so that the graphic designers could create for them their desired 3D model. They further agreed that they would like to discuss the items they wish to be sent out to the public. They mentioned that not one single elder would know everything about IK, and therefore a group discussion is required. The IK holders agreed that there should be someone who knows how to operate the device that would be responsible for sending the request.

The next question was about how they would evaluate the 3D models. They answered that the community as a group would do the approval of the 3D models. To illustrate that the 3D models can be wrongly modelled an example of their sticks was used that a stick of brown colour they sent as a request is delivered back in different colour, for example, in black or the completely wrong shape. One of the elders highlighted that it could have been their camera that had other colour reflections on the sticks. They wondered what could have possibly caused this error. They finally agreed that the graphic designer could have made a mistake and should correct it. They would not be happy with the wrong 3D model because it will misrepresent their culture. They further mentioned if the graphic designer keeps on modelling the wrong model instead another graphic designer should be contacted. They agreed that they would be willing to provide more details to clarify their requests if they are not clear.

For the last activity, we gave the elders cards with drawings of the traditional objects present on the ovaHerero HSC to view and critique. Elders from Erindi-Roukambe selected the traditional objects on the HSC. The IK holders from Okomakuara mentioned only one correction on the dress of the ovaHerero women that the sleeves were too short; it should be longer.

4.4.4 Introducing Crowdsourcing in Erindi-Roukambe

We started the workshop with the formal greetings and thanking the IK holders for their time to have reserved the whole day for the workshops. When conducting a workshop with our long-term collaborators, the consent agreements are not discussed in every workshop unless there are new IK holders participating.

We introduced the crowdsourcing concept with a scenario whereby an IK holder may wish to safeguard IK. At this point, the IK holders were given cards which had drawings of the objects on the HSC to select and place on the ground to portray their scenario, see Figure 4.12.

Figure 4.12. Crowdsourcing concept exploration using cards in Erindi-Roukambe.

The IK holders noticed that there were still some items missing on their cards that they wanted to be part of the items for safeguarding; for example, the horse was missing. The IK holders were notified that crowdsourcing comes in handy in situations where there are missing objects that they needed. To elaborate further, the HSC was used as an example that the missing objects on the HSC could be requested to be modelled in 3D. At this stage, the elders did not understand how this would work. The workshop facilitator further illustrated with an example of how the ovaHimba community had taken pictures of the objects they wished to include in the HSC since the original objects present in the HSC belonged to the ovaHerero. This example provided the IK holders with an understanding of crowdsourcing.

The IK holders were then tasked to demonstrate a scenario with cards how they would communicate to the outside world to request the missing objects. One of the IK holders questioned us "*how can I communicate to the outsiders while I only talk to you in Otjiherero?*" One of the researchers informed him that is why we have included them to think together (co-design) with us on how best this could be achieved.

Having an idea on how to continue the IK holders decided to take pictures of a horse' dung thinking that this was clear enough to represent a horse. They were informed that this would not let the graphic designer know that by seeing the horse' dung that a horse should be modelled. IK holders then decided to draw the horse that was missing on the cards they placed on the ground. After the drawing, they were given a tablet embedded with a camera to take a picture of their horse drawing.

When the elders were asked how they would like to use a tablet that will allow them to request those missing objects, they expressed that they would rather have a sole representative (youth) of the community that communicates with the outside crowd. The criterion to select such a representative should be based on

whether that individual has basic computer literacy and being able to communicate in English. The elders emphasise that they would initiate the requesting process by instructing the community representative to take pictures of the items they want to be crowdsourced. They instructed one of the youth to take pictures of the items they wanted to demonstrate this scenario.

The IK holders will then have a look at the pictures taken by the representative. To review the pictures taken by the youth was also demonstrated and the IK holders noticed that the dog and chicken were missing and requested the youth to take a picture of the dog from the card and to take pictures of the actual chicken since it was close by the house.

The IK holders further mentioned that if the images are not of excellent quality, they would decide on those images to be erased. They expressed a preference in having a consultative meeting to select those pictures. There was a fear that the community representative might send images which do not truly represent their culture.

The discussion went further to deciding how to make sure the graphic designers will understand their images. The elders decided that they would use the community representative to write the name of that traditional object on the physical image itself in English and take pictures. If the community representative is not around at the time of creating the requests and if the elder can write they would write in Otjiherero. Otherwise, they will take pictures and later a community representative would translate or provide the missing names consulting the elders. Then elders would talk about the images taken to provide the specification. Finally, after the elders' consensus agreement about the items selected for the request, the community representative should use the tablet to send the request.

IK holders were asked how would they like to preserve something that is intangible known as a concept. They mentioned that in those cases voice recording would be sufficient. When asked whether there are certain events or objects they would not prefer to be sent out the public. They answered that certain events such as the men circumcision should not be sent to the public.

Next, how to evaluate the delivered 3D models was discussed. An example of the picture of the dog they have taken from the cards was used. The IK elders were tasked to imagine that the 3D model of the dog was without a tail and in a different colour (brown). At first, they mentioned that this could not be possible "*how can the computer make a mistake*" as one of IK holders commented. IK holders said it must have been them that made a mistake and will remove all the images and take the pictures again.

The IK holders were then made to assume that they validated the images correctly and the image of the dog they sent was with a tail in right black colour. Then the IK holders pointed out that the graphic designer made a terrible mistake. When asked whether they would be satisfied with the wrong model, they said that "*I gave you something good and now you bring me something incorrect, how can we be happy about that?*" They agreed a refinement should be done until the 3D model was correct regardless the number cycles it would take to refine it. IK holders also agree that they can take additional pictures of the same object if needed.

Furthermore, the IK holders stated that the youth operating on the tablet should not make their own decisions and that when 3D models arrive, the youth should bring them to the elders for them to discuss and select the 3D model they would find acceptable. When asked about their reaction about a 3D model that is well designed, they mentioned that graphic designer should be praised that he has done a great job. Praising in ovaHerero culture is regarded as an honorary gesture as it is given to brave men and women and traditional leaders as mentioned in Section 3.2.1 of Chapter 3.

4.5 Reflecting on CBCD Cycle One

In the following sub-sections we report on the reflections for every workshop we undertook with the communities as described in the previous Section 4.4.

4.5.1 Reflecting on Ohandungu and Opuwo

There were some problems that we only experienced during the workshop; for example, video recordings of the discussions were poor on capturing audio, especially during strong winds. To avoid poor sound recording due to strong winds, we planned to buy a tent that could be closed on the sides. Sun reflection on the tablet was an issue that made seeing on the tablet screen difficult even under trees. The tree shade was not sufficient to prevent sun reflection.

The built-in tablet camera features to notify the user that an image has been taken successfully was not obvious to the IK holders. The IK holders kept on tapping several times when capturing an image of an object from the same angle especially if the audio feedback click sound is low on the tablet. We increased the tablet audio feedback sound during these situations. We observed that the tablet features that were easy to us were not trivial to IK holders such as tapping on the screen. The IK holders sometimes touched too fast causing the tablet not to respond to that interaction. The IK holders were not patting a bit slow and holding on for few seconds on the tapped icon. We realised that at times this was because their daily handy work activities caused IK holders fingertips to be hard. We then demonstrating how to use the application and then allowing the IK holders to use it.

Although the IK holders never used a touch-based tablet application using the HSC as a technological probe made the introduction to crowdsourcing easy as we could refer to the graphics in the HSC that they were not happy about and wanted to be replaced as those to be crowdsourced.

Uariaike was prompt to share insightful IK when the researcher was around while taking pictures of the traditional objects. We wondered whether Uariaike will share this valuable information when taking pictures on his own without a stranger that he thinks should know about his culture.

The IK holders sequentially took pictures to be modelled based on their importance in their culture, for example, starting with the holy-fire. We noticed that the children enjoyed observing the elders operating on the tablet and at times were suggesting ideas on what to be done. This collaboration seems fruitful as the

children were fascinated by the technology and they can assist the elders when they get stuck and at the same time learn about IK.

We noticed that the ovaHimba strictly follow their cultural practices and any activity that seems to violate their culture should be well explained for them to accept or reject. For example, when the women were given the HSC to construct their homestead they said: "why do you expect a woman to construct a homestead, women do not own homesteads in our culture." The workshop facilitator informed them that the HSC would be used as an IK learning tool so that the ovaHimba women could teach their children how the men construct the ovaHimba homestead. We are aware that this might bring conflicts on what is taught by the women and by the men, it was made clear that they could use the HSC in relation to who is responsible for transferring specific IK. We also learnt to respect the communities if they say they cannot start the workshop at our arrival or planned time due to their farming activities.

IK holders collaboratively worked together constructing their homestead on the HSC and also with the drawing of pictures. This collaboration showed us that this aspect of teamwork should be incorporated into the software functions.

When the IK holders in Opuwo were asked to hold a workshop with us, they asked for cash payment, and later towards the end of the workshop, they asked that the agreed amount be increased. The reason for the increment was that the workshop took very long for them and they had planned other activities to do that they missed. Observing this taught us to also state the duration of the workshop to the IK holders before starting with the workshop.

4.5.2 Reflecting on Evaluating 3D Models

After evaluating 3D models and the prototype of the ovaHimba HSC, we reflected on the good and bad of what we encountered for future community engagements. Uariaike signalled us that a one-day workshop for several activities was not enough. He, therefore, suggested that we should come and stay longer at his homestead. This request for us was a good sign for long-term collaboration. We at the beginning felt that we were invading the ovaHimba private space by coming into their homestead and not knowing all their cultural protocols. Uariaike assured us that we will always be welcome in their homestead.

Much insightful IK was shared while evaluating the 3D models similarly to when the IK holders were taking pictures during the first crowdsourcing simulation workshop. The IK holders doubt whether they requested the 3D model if it was not close to their real object; this showed us the importance of possible accurate representation of 3D models to the actual object.

Providing too perfect well designed 3D models can be misleading the requesters (IK holders) to accept the 3D model because it is "*too well-designed*" and yet missing essential details. Taking pictures of the same object from different angles was a crucial activity for the requesters to do so that they submit complete requirements needed to model an approximate accurate 3D model. Thus, 3D models most criticised were those created from photos not taken from all angles. We showed that the HSC could be used and the 3D objects can be updated and thus the need for crowdsourcing the missing 3D objects.

4.5.3 Reflecting on Crowdsourcing from Okomakuara

The IK holders were eager to perfect the requests before sending them to graphic designers. Improving the requests showed that IK holders understood the importance of creating a complete request without missing crucial details for accurate modelling of the 3D objects.

We have found that it was worth to start discussions about the culture of the rural communities before technology co-design discussions for oral traditions. The IK holders were asked to share any IK they thought was essential to be known by the youth. The idea of trying out different graphic designers if the same graphic designer keeps on modelling wrong 3D models showed that they did understand the crowdsourcing concept well. This suggestion brings in a worth noting technical implementation on the crowdsourcing platforms functionality to ensure that the same graphic designer who modelled wrong designs should be omitted from receiving the same request.

4.5.4 Reflecting on Crowdsourcing from Erindi-Roukambe

It was difficult at first to let the IK holders understand the crowdsourcing concept. It was useful to use similar scenarios from other rural communities workshops to aid with explaining crowdsourcing.

IT skills will be required for IK holders to use the tablet to formulate and evaluate the task requests. IK holders felt that they might not have the required IT skills and thus a youth with the required IT skills should operate the tablet to represent the community.

Having a community representative is different from the global crowdsourcing platforms of individual accounts for every requester. This working relationship of having a youth operating the device but still following orders from elders is a clear representative of the ovaHerero practises. It is a custom in the ovaHerero culture that the youth should accept to be instructed by the elders and be conscious that full authority remains with the elders. Another different angle of crowdsourcing from the rural community perspective is that the community consensus has to take place before sending a request and approval the delivered 3D models.

IK holders agreed that several refinement cycles are necessary to have a perfect 3D model. IK holders mentioned that their culture is their pride of ownership and would, therefore, ensure those correct models of their culture are created. It was interesting to note that their proposed reward will not be like the standard approach of using stars for rating that we are familiar with but praises (*Omitandu*, see Section 3.2.1 of Chapter 3 for details) for the rewarding the graphic designer that modelled the best 3D model. We noted that the drawings were made from one side and thus we should warn the IK holders that this will make it difficult if accurate details of the 3D object are required. The idea of writing names on the physical images gave us the idea that on the system there should also be an option to allow the users to write the name on the picture of the object they have taken.

4.6 Chapter Conclusion

During this crowdsourcing concept familiarisation cycle, a total of six workshops were conducted with IK holders who showed interest in safeguarding IK and raised their concern that the youth is forgetting about IK. Thus, the elders whom we engaged with for the first time also agreed to collaborate with us on co-designing software applications that will enable them to safeguard their IK.

How the crowdsourcing app should function from the communities understanding was simulated. The rural communities should be able to make requests for their traditional objects to global graphic designers on the Internet. The objective of the simulation was to get the rural communities perspective on how they would formulate the task request and evaluate the delivered 3D models to inform the development of the crowdsourcing TMA.

The crowdsourcing process was simulated in detail from the initial step of task request formulation, that is, capturing pictures, audio, videos or description of their traditional objects, sending that request to graphic designers on the Internet and receiving the completed 3D models for evaluation. What came out is that some elders would prefer a community representative with basic ICT skills to operate on the tablet for taking the pictures and their narratives, sending and receiving the completed 3D models. Other IK holders could operate the tablet after the necessary usage demonstration.

We observed that there were differences in how the rural communities would use a crowdsourcing application as compared to how the mainstream crowdsourcing platforms. The concept of having a group representative is different from the crowdsourcing platforms with individual accounts. The IK holders had consensus that they should first approve the requests formulated to be crowdsourced before sending out to the public. It was feared that wrong information might be sent out, ultimately misrepresenting their culture. Moreover, cultural pride and importance to have a sense of identity were among the reason to send correct information about their culture. Evaluating 3D models was discussed which intuitively was hard to grasp that 3D models might be wrongly designed. Repetitive refinement cycles were agreed to be necessary until satisfying 3D models are achieved.

We have come to learn that in the process of modelling an object in 3D, the designer takes conscious and unconscious decisions of omission and emphasis. These choices are, among others, determined by the designers' cultural background and *aesthetically* understanding. "We have already established that some of those omitted, seemingly insignificant, features were of utmost importance to the community. Thus we have explored different methods to ensure 'the obvious and significant' features for the community, but 'insignificant' to the designer are made explicit" (Stanley *et al.*, 2016).

Consequently, the envisaged TMA must ensure that the indigenous community can express those narratives to obtain satisfactory 3D models. Throughout the years of co-design, we realised that the community only expresses the tacit and apparent, once there was a misunderstanding. In other words, the mistake of the first 3D models triggered communities to explicitly express what they had taken for granted and communicated back to the graphic designers. The feedback

loop communication of IK holders with graphic designers may present particularly new challenges such as language barrier and acceptance of other cultures.

We noticed that to digitise IK entirely in a virtual representation of 3D models for a particular community will be an ongoing activity as long as there is a need to preserve IK and while new IK discoveries are made. Refinements on making the request as well as the evaluation cycles, will have to be considered to ensure a satisfactory solution. With the ovaTjimba (a sub-clan of the ovaHimba tribe) community, we showcased the ovaHimba HSC constructed from the drawings done by ovaHimba. Although ovaTjimba could relate to most 3D models on the new HSC, they identified missing graphics that adequately represent their culture. This experiment showed us again that software applications tailored for specific cultures has to be adapted to remain relevant and satisfactory entirely.

We learnt that access and benefit-sharing with the communities were not only about the tokens that we provided. The communities ought to appreciate the little things that we do when we visit our families, such as giving physical cards or pictures that we took of them. These human gestures shared light on what entails *Oundu*.

Reflecting on the overall crowdsourcing simulation cycle brought us to a set of puzzling questions on how the rural communities will prepare their requests to crowdsource for 3D models and evaluation thereof. To organise the rural community' requests sparked the idea of *how to co-design* the *TMA* while embracing *Afrocentrism* epistemology and Oundu values. We have decided to co-design the community crowdsourcing TMA and deploy with the ovaHimba communities with Uariaike as the main community co-designer before replicating the co-design with the other ovaHerero communities from Okomakuara and Erindi-Roukambe. We have thus come to the next CBCD cycle two of co-designing the TMA detailed in the following Chapter 5.

Chapter 5

Co-Design with the ovaHimba Community

Having gone through the crowdsourcing simulation process that was discussed in the previous Chapter 4, brought us to light that it was feasible for the rural communities to crowdsource for 3D models of their traditional objects. It was time for us the researchers and the IK holders to see how best the crowdsourcing TMA could be developed. In the previous chapter, we showed that rural communities could operate the tablet application with minimal training. The rural communities were already familiar with mobile devices usage, during our first CBCD cycle interactions with the communities; there was always one or two IK holders with a mobile phone.

The rural communities comprehended the idea of taking images of their traditional objects to be sent to graphic designers on the World Wide Web that would then construct 3D models from those images. We then import the satisfactory accepted 3D models into IK safeguarding visualisation tools such as the HSC. The aspiration is to automate the import process of 3D models from the crowdsourcing TMA application to the HSC or any IK visualisation tools.

5.1 Chapter Structure

This chapter is structured to simplify how we carried out cycle two CBCD activities with the ovaHimba community for the development of the IK Multimedia Collection Tool (MCT) and the crowdsourcing TMA. Thus this chapter is outlined in the following sections.

First, in Section 5.2, we highlight on the action plan for this cycle. Second, in Section 5.3, we provide an overview of the co-design activities carried out and reflections and the lessons learnt before concluding the chapter in Section 5.4.

5.2 Plan for Action Research Cycle Two

Cycle two CBCD activities were conducted from early 2015 to mid-2016, as shown on the timeline in Figure 5.1. As indicated on the timeline on the 20th March 2015, we started with a technology probe to initiate co-design discussions for the MCT. The technology probe technique was chosen to assist with the co-design process

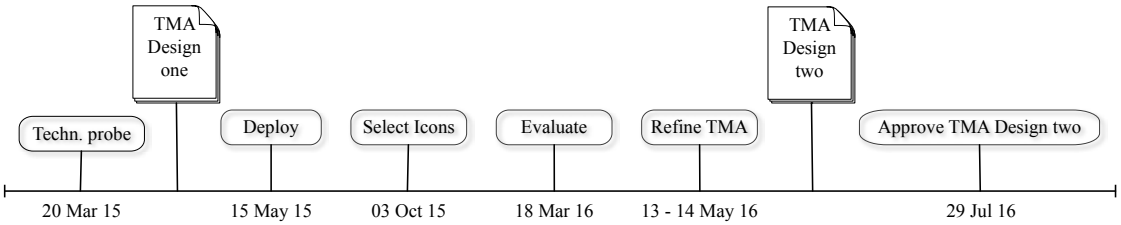


Figure 5.1. Depicts the main activities and deliverable and dates as carried out during our CBCD cycle two (co-design with the ovaHimba Community).

to allow all co-designers to rethink about pre-existing multimedia collection tools, whether they were suitable for the ovaHimba rural community context or not.

The purpose of the MCT application is to allow IK holders to capture multimedia of their traditional objects for crowdsourcing 3D models or collect their IK in general for safeguarding. Using the MCT the research team also had an agreement with Namibia National Commission on Research Science and Technology (NCRST) to allow the IK holders to gather their IK for archiving it on the IK National Database. After realising that the standard MCT was not user-friendly and neither could manage the task request for crowdsourcing we started with the TMA co-design with the ovaHimba community.

The first TMA prototype was handed over to Uariaike on 15th May 2015 as shown on the timeline in Figure 5.1. After four months, we selected the TMA interface icons. We then evaluated the updated TMA prototype and noticed that Uariaike found it challenging to use specific functionalities. We, therefore, refined the TMA and produced the revised TMA design two. Uariaike approved the updated TMA design two on 29th July 2016.

5.3 Cycle Two Action and Reflections

5.3.1 Technology Probe and Co-Design

The first co-design activity with ovaHimba community was to use the MCT tool as a technology probe as introduced. We conducted a workshop on 20th March 2015 with Uariaike and his family at Otjisa village. Three research co-designers and one developer took part in this workshop. Uariaike's family (community co-designers) consisted of three men, including our contact person (John Tjipurua) from Opuwo, and three women. John is the one who introduced us to Uariaike for our crowdsourcing conceptualisation cycle discussed in the previous Chapter 4.

The facilitator started the workshop by introducing the MCT prototype designed with standard Western icons (see Figure 5.2) to Uariaike. We wanted to find out whether Uariaike could relate to those standard features of capturing multimedia. Figure 5.2 shows the MCT home screen, with the standard software icons denoting (1) drawing, (2) video recording, (3) taking photos, (4) text input, and (5) audio recording. To test out those features, we let Uariaike gather

information about medicinal plants that are used for healing in his village as a technology probe.

Figure 5.2. This figure shows the home screen of the standard Multimedia Collection Tool, which was used as a technology probe during the first CBCD cycle interactions. Each icon has a description below it, for example, the first icon from the left is denoted with a pen, and a paint container and text below written 'Draw / Paint' to indicate drawing or painting operations.

In Figure 5.3, the facilitator was showing Uariaike how to use the five multimedia capturing functionalities on the MCT prototype. Looking at the icons, especially for video recording, taking pictures, and audio recording Uariaike asked the facilitator what those icons meant. After several explanations, Uariaike said the icons did not make sense to him. The other community co-designers observed the training. The other research co-designers were taking pictures and video recordings of the workshop, while the developer was making notes.

Figure 5.3. Uariaike was operating on the tablet and the author guiding him.

After showing Uariaike how to use the MCT we preceded with testing it in the field. To address the aspects, Uariaike was unhappy. He examined the MCT by taking pictures and recordings of any plant that he thought to be important. He walked to a specific plant used for healing, and that was close to the workshop

area. He started to dig out some roots on that plant, and one of the research co-designers was recording him while doing this. We noticed that Uariaike should also do the recording himself. We then gave him the tablet to record. He called his son to continue to dig out the plant roots while he was taking photos and recording videos. Noticing this, we asked him whether he would be able to teach his son how to operate the MCT. He replied that he has not mastered the application and thus could not yet train someone else. We also noticed that Uariaike was taking photos against the sun reflection; this reminded us that Uariaike needed to be well informed on how to take pictures to avoid obstructions.

It was difficult for Uariaike to notice whether the video recording had started, as he kept on asking whether it was recording or not. At this point, we saw that there was not sufficient feedback about the current state of the video recording and that necessary training on how to record and stop recording was crucial. Uariaike then tested the audio recording. He looked at the sound icon, which showed a person in the process of voice recording (see Figure 5.4), and laughed about it; He said, "Now, who is this?" "Maybe it is a white person?" After this he commenced with a voice recording.

Figure 5.4. Multimedia Collection audio icon for indicating sound recording in progress that Uariaike laughed about when he saw it for the first time.

After Uariaike tested the MCT in the field, we went back to the workshop area to allow him to view the images and video recordings, and listen to the audio recordings he had just captured. Uariaike looked at the pictures and happily stated, "It is precisely the plant I took". Searching for the videos, he took some time; the developer had to assist with the navigation. The app did not save the videos in the default image and video gallery but in a separate MCT folder. Overall, Uariaike was happy about the visual and sound quality of the recordings. For two main reasons, Uariaike found it challenging to use the MCT:

1. The standard software icons on the MCT were meaningless to Uariaike, and therefore, he found it difficult to relate to their intended functionalities.

2. Visibility of the application was poor, due to the black background and white text, as well as the sun reflection.

We indicated to Uariaike that we should think about new icons that would be more meaningful for him for capturing the multimedia items. Explaining what

we wanted to do was a long conversation. One of the community co-designers took a leaf and a stone for demonstration. He told Uariaike to imagine that the rock is for video recordings and the leaf is for audio recordings, and if Uariaike wanted to video record, he would not touch the leaf but the stone.

The stone and leaf demonstration did not make it easier for Uariaike to understand; he then asked the women to express their thoughts. Uariaike's wife, Mukamberenge, explained, "you have to think about what should be on the buttons". "For example, to trigger the action for taking a picture of a tree, you would press something that represents taking photos. If you press on another that serves voice recording, it will trigger the operation for recording your voice." Mukamberenge further explained that it is the same concept that they use for saving the names of people on their cellular phone for saving contact list. Those that cannot read or write use icons, for instance, a butterfly for Lilian instead of typing her name. After this explanation, there was laughter, and Uariaike finally understood the idea of icons functionality representation. He said that "you people were talking about representatives for someone that does not read!" One of the community co-designers told Uariaike that we would leave the tool with him, and that is why the research co-designers wanted him to think about MCT icons he would understand easily.

The facilitator then asked what an excellent representative icon might be for taking pictures. Our contact person asked the facilitator whether he was also allowed to give input. The facilitator replied that everyone was welcome to present his or her ideas. The contact person suggested a picture of an eye to represent picture taking and a mouth for video recording. One of the women agreed with the idea of having an eye icon, given the rationale that one first looks at the object with one's eyes before taking a picture of that object. Uariaike stated that a mouth would make more sense for audio recordings.

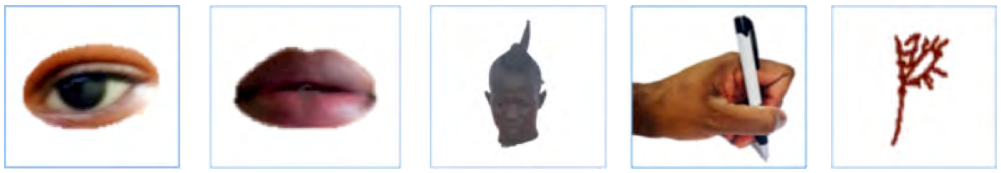
Considerations about the icon for video recordings resulted in a long pause of concentration. One of the women suggested to put a picture of a person and pointed to Uariaike's son. The other co-designers commented on being careful, so as not to choose something that will quickly be forgotten. However, Uariaike agreed with the idea of taking a picture of his son's head for video recording and suggested that his son's hairstyle should be visible. Although the community co-designers were not asked in detail about their rationale for this selection, it could be linked to the fact that Uariaike' son was on the first video recording about the plant during the tablet usage session.

The next icon under discussion was for text input. Mukamberenge suggested a picture of handwriting, but Uariaike quickly interrupted his wife, who immediately stopped talking. Uariaike indicated that it should be the letter *A*. The facilitator then asked whether both the *A* and a picture of handwriting should be used. John (contact person) suggested that it should be a hand with a pen. Uariaike and the others agreed with the idea of having a hand with a pen as the icon for text input.

One of the Otjiherero speaking facilitators did not like the fact that John (our contact person) was dominating the discussion with his ideas, and therefore did not translate all his proposals. The facilitator informed the other research co-designers that translations had been omitted, although John had mentioned some

sensible ideas. The translator responded that John is not going to be the one to use the MCT and therefore felt that he should not have as much influence in the co-design. The facilitator suggested that John should first allow the community co-designers to provide their ideas, and can comment if the suggestions are not making sense.

Lastly, our discussion came to the icon for drawing, which again was quite time-consuming. In Otjiherero the word for *drawing* is the same as the word for *taking a picture*. The lack of Otjiherero words for taking a photo and drawing may have been the reason for the prolonged time to come up with a good icon. Uariaike first mentioned that the icon should be a car, then the tent that we were sitting in, and then a house. Finally, he suggested that we should use the picture of the tree that he had drawn earlier on the tablet. He said that he would easily remember the drawing icon because he did it himself. Thus the picture of his tree drawing was selected for the drawing icon on the MCT. Figure 5.5 depicts the five final icons chosen by the community co-designers for the MCT.



(a) (b) (c) (d) (e)

Figure 5.5. Multimedia Collection Tool icons selected for (a) taking pictures, (b) audio recordings, (c) video recordings, (d) text input, and (e) drawing.

We also discussed the gallery icon that allows users to view all of the recorded multimedia. The community co-designers proposed to put a picture of a cellular phone, as this is where they store all their images, videos, and contact numbers. They are familiar with using cellular phones as both Uariaike and Mukamberenge had their mobile phones.

After having settled on a final decision about the icons, the discussions moved onto individual functions that have caused complications. For the drawing function, we wanted Uariaike's input regarding the symbols for saving, not saving (that is cancelling), and erasing. Uariaike suggested a closed fist for saving; he said that the closed fist signals that he is happy with the drawing and wants to hold onto it tightly. For not saving symbol, he suggested closed cupped hands; trying to completely hide the drawing as he is not happy with it. For erasing, he suggested a pointing finger; representing the action, he completed while erasing something on the tablet. See Figure 5.6 for the three symbol choices.

The last discussion was about the arrangement of multimedia for viewing. After a lengthy explanation of this task, Uariaike said, "this process is difficult". Uariaike first suggested that the multimedia should appear all at once, as the screen of the tablet was wide enough. He then changed his mind, indicating seeing one image or video at a time. Lastly, as an example, he stated that a picture

(a) (b) (c)

Figure 5.6. The drawing function symbols selected for (a) saving, (b) not saving, and (c) erasing.

of a tree should be grouped with the audios, videos, and text that were captured about that specific tree.

Uariaike further mentioned that images of the trees should be grouped according to their treatment purposes. For example, all photos of the trees which are used to cure stomachaches should be in one group, and that a symbol (to be selected) of that sickness should be placed on the group. The research co-designers discussed this idea and noted that this was a categorisation of multimedia that would be good for exporting the multimedia to the NCRST national IK database and might also aid in the selection process when collating pictures with their associative narratives (audios, videos, and text). We agreed to discuss the categorisation process in another co-design workshop thoroughly.

With this, our workshop was concluded, and we provided the community co-designers with tokens of appreciation (for details on tokens of appreciation see Section 3.2.3 from Chapter 3). The facilitator asked Uariaike if the research co-designers could come back to his village, and whether they could bring other researchers from the medical department from the University of Namibia (UNAM). The UNAM research team had to go with us for the joint research collaboration on collecting medicinal plants information for NCRST. Uariaike replied that we were welcome to visit at any time even with other researchers.

5.3.2 Reflecting on Technology Probe and Co-Design

The first co-design interaction with the ovaHimba community left us with a lot to reflect. Firstly, Uariaike was surprised that we had followed him to his new village; he started understanding the value of the project, as well as his importance and usefulness in the project. We, on the other hand, were reminded that the ovaHimba are semi-nomadic herders, which was reconfirmed by Uariaike moving to Otjisa from Ohandungu, see map in Figure 3.6. Fortunately, his new village was not very far (about 54 kilometres) from Opuwo from where the research co-designers were travelling.

Furthermore, we realised that it is vital to keep communicating with our contact person. As the contact person is related to Uariaike, he knew the whereabouts of Uariaike. He would be able to inform us in advance if Uariaike was elsewhere or had other commitments. It was also essential to give a monetary payment (N$

200, USD 14.68) as a token of appreciation; our contact person preferred to be given money instead of food.

The technology probe prepared and enabled Uariaike in a short time to operate the tablet, to understand the purpose of the technology and to be ready for the co-design. Uariaike managed to link the operations he had performed while testing the MCT prototype to the co-design session. This linking was especially noticeable when Uariaike wanted his tree drawing to be used for the drawing icon. Using the MCT prototype that had Western images representing functionalities for capturing multimedia gave the community co-designers an opportunity to critique ICT tools that are not well suited for them. Uariaike humorously asking, "Now, who is this?" "Maybe it is a white person?" in response to the audio recording in progress icon (see Figure 5.4), signifies that he saw the application as coming from outsiders. After testing the prototype, he was proud of his drawing and the images he had captured.

The community co-designers internalised the new icons they have selected based on their perception instead of sticking to the Western or the technological images present on the MCT prototype.

Although the technology probe had the advantage of providing Uariaike with some quick skills to operate the MCT prototype and inspiration for the co-design discussions, there was also a drawback. The technology probe could have influenced the suggestions given by the community co-designers. For instance, Uariaike was quick to select the letter *A* for the writing icon; the lettering on the MCT prototype could have influenced this, which used *ABC* as the writing icon (see Figure 5.2).

We have noticed how the community co-designers showed creativity with impromptu usage of objects from their surrounding or technologies they were familiar with. For example, the community co-designers took a stone and a leaf to demonstrate video and audio recording icons, or cellular phone to explain representative symbols and even selecting the mobile phone as the gallery icon. We thus also acknowledge the benefits of impromptu co-design techniques. Every co-design technique or material has its context and situation where it fits well to be used.

We have learnt to first keep our ideas to ourselves, to allow the community co-designers enough time to think about what they wanted, that is, regarding the MCT interface and the functionality thereof. The research co-designers were used to be in control when operating on the tablet, and at times found it challenging to give the power over to the community co-designers. At one point during the workshop, the facilitator was holding the tablet and taking pictures but was reminded by one of the research co-designers that Uariaike should be the one using the tablet. It was also difficult to communicate ideas about software applications with the rural communities, as most basic technological usage terms, for example, taking a picture with a camera are not yet available in Otjiherero.

There were divisions among the research co-designers, regarding whether the icons should be chosen and agreed upon by all or whether Uariaike should dominate it. Some of the research co-designers thought that Uariaike would be responsible for training others, and so it is okay to have icons that he can relate. The facilitator wanted the other community co-designers to have more of a say

since the ovaHimba communities will use the MCT. For example, with Uariaike's choice for the not saving symbol (closed cupped hands), he believed this to be a symbol that most people could not relate to or even interpret. The final agreement was that the icons should not all be selected by Uariaike, that others should be invited to partake in the co-design discussion, and that Uariaike can train others once he has mastered the application.

Another issue that arose was that the contact person dominated with the co-design ideas and that as a result one of the Otjiherero speaking research co-designers omitted translations to English for the other research co-designers. It was agreed that in future workshops all co-designers would be informed of their roles. Furthermore, outside attendees would be instructed first to let the main co-designers come up with ideas and only afterwards contribute their ideas. We appreciated the benefit of having at least two Otjiherero speaking facilitators responsible for the translations. We published part of these findings with Kapuire *et al.*, 2016.

5.3.3 Creating Task Management Prototype One

In this section, we provide a brief description of the TMA prototype one. After the technology probe and co-design workshop mentioned in the previous Section 5.3.1, the MCT application was extended to include the features for managing the crowdsourcing task requests for the rural communities. The basic functionality of collating pictures of a traditional object with their associated narratives (audios, videos, and text) was now an additional module of the MCT application.

The author of this thesis created the TMA screen designs, see Figure 5.7 for a sample screen for creating a task request. The sample screen reveals that when the 'Create Request' tab is selected[1], the 'Image', 'Audio', 'Video', and 'Text' icons are displayed. The user can then select, for example, the image icon to choose the images they wish to crowdsource for 3D models.

After selecting the image icon, all the available images will be displayed in a white rectangular area on the left side of the screen (see Figure 5.7). The selected images need to be moved to an open space on the right side of the screen, denoted as 'Representative Image'. The *representative image* for a specific task request is selected among the set of selected pictures taken from different angles (sides, top, and bottom). Images chosen to be sent as part of the task request should be taken from different angles for accurate creation of the 3D models.

The icons on the right area (see Figure 5.7) tagged 'Audio', 'Video', and 'Text' Icon below the representative image heading indicate the videos, audios, and texts that were selected as narratives relating to that specific traditional object. The complete specification of the first version of the TMA module, including the case diagrams and screen designs, were given to the developer for implementation.

Image (a) in Figure 5.8 shows the first step when formulating a task request on the TMA prototype one. For demonstration purposes, we selected four images of pumpkin among the set of images. Once selected, they were moved to the area

[1]The selection in this context is on a tablet touch screen by tapping on the preferred multimedia item.

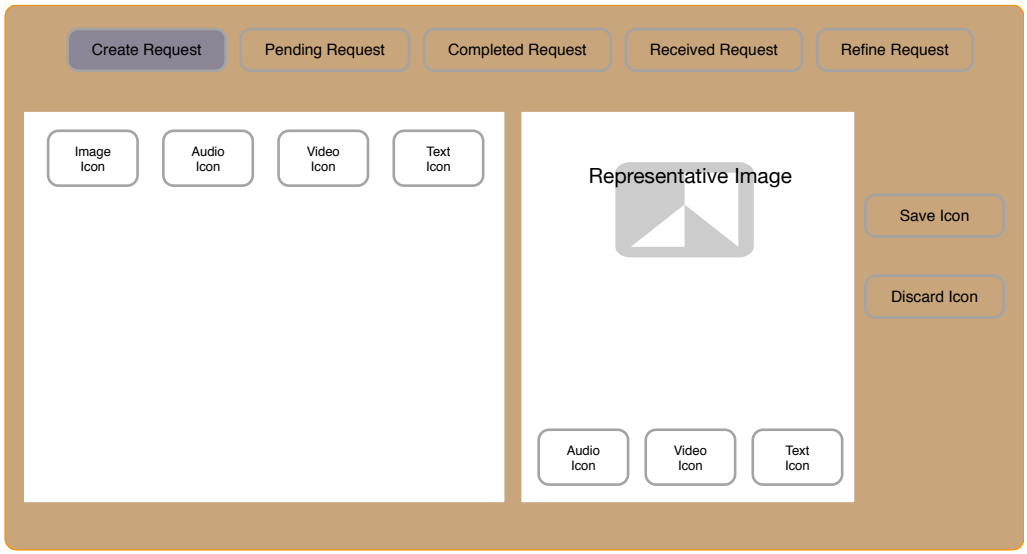
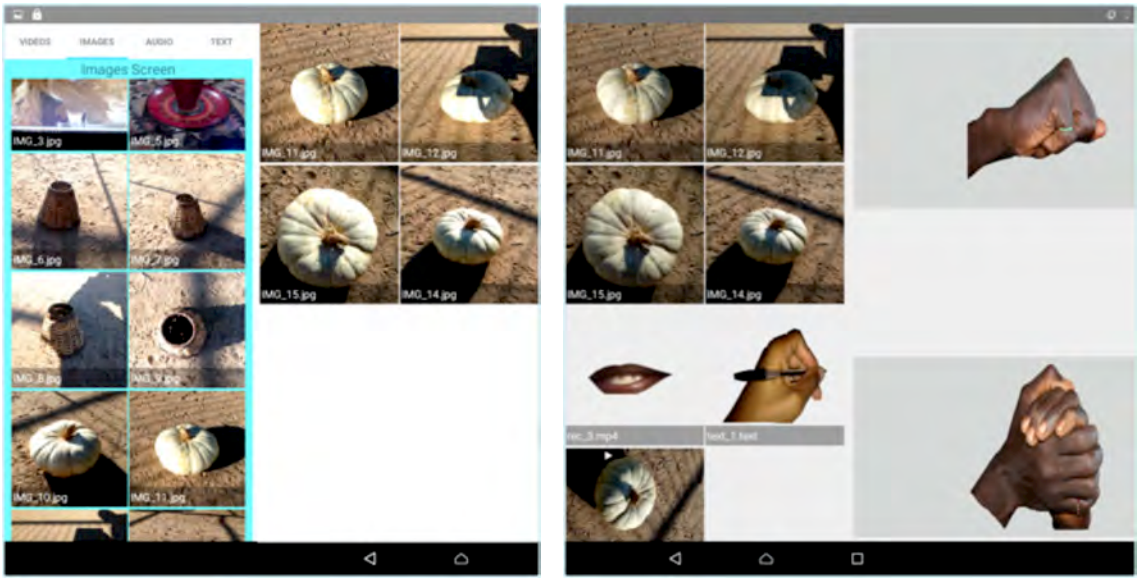


Figure 5.7. The screen shows that the 'Create Request' tab has been selected, and icons for images, audios, videos, and text are displayed for selection. There are tabs for different types of requests, for instance, pending requests that are not entirely formulated and completed requests.

on the right, see in the image (a) of Figure 5.8. Image (b) in Figure 5.8 shows that



(a) (b)

Figure 5.8. (a) Shows that four images of a pumpkin were moved to the right by selecting them among the set of pictures on the left. (b) Indicates that audio (denoted by an image of a mouth) and text (denoted by hand with a pen) was added to the pumpkin task request as an example.

the video, audio, and, text captured about the pumpkin were also selected to be part of the pumpkin task request formulation. The audio file is indicated with the mouth icon and text file with the hand with a pen icon plus their file names.

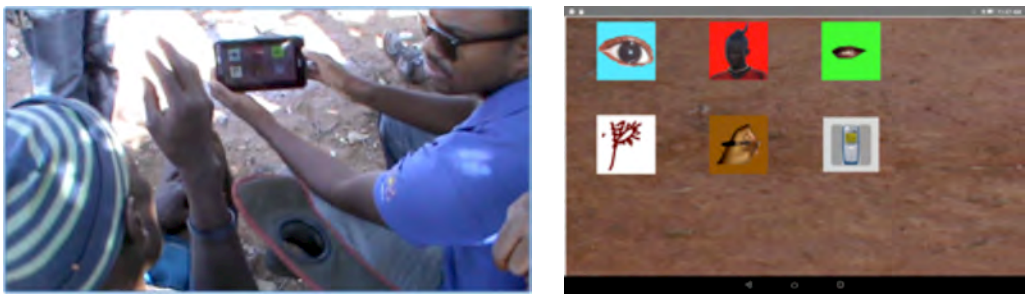
Once the IK holder is happy with the selected pictures and their narratives, she or he will select the save icon (closed fist), and for cancelling (the cupped hand) icon will be chosen, see Figure 5.8. After we tested the TMA prototype, we arranged for the testing and deployment workshop described in the following section.

5.3.4 Deploying Task Management Prototype One

The research co-designers together with the UNAM research group from the Multidisciplinary Research Centre, had a one-day workshop on 15th of May 2015 with Uariaike at his homestead in Otjisa village. We informed Uariaike before that we would be coming with research colleagues from UNAM as mentioned in Section 5.3.2.

The purpose of the workshop was for Uariaike to test the updated version of the MCT that now also had TMA functionalities (see Section 5.3.3). Additionally, to leave one tablet with Uariaike that had the TMA application installed in it so that he could capture and collate multimedia about IK on his own. The MCT used as a technology probe, as discussed in Section 5.3.1, was updated with the icons that were selected during that co-design workshop.

The workshop participants consisted of three research co-designers and one developer from NUST, three researchers from UNAM and three community co-designers. On the request of the UNAM team, the workshop began with Uariaike sharing IK about medicinal plants. After this, we showed Uariaike the updated MCT and asked him if he recalled the operations of the icons we had selected in the technology probe and co-design workshop (see Figure 5.5 for the images chosen). Uariaike pointed to the eyes (picture icon) and said that it was for taking pictures (see Figure 5.9).

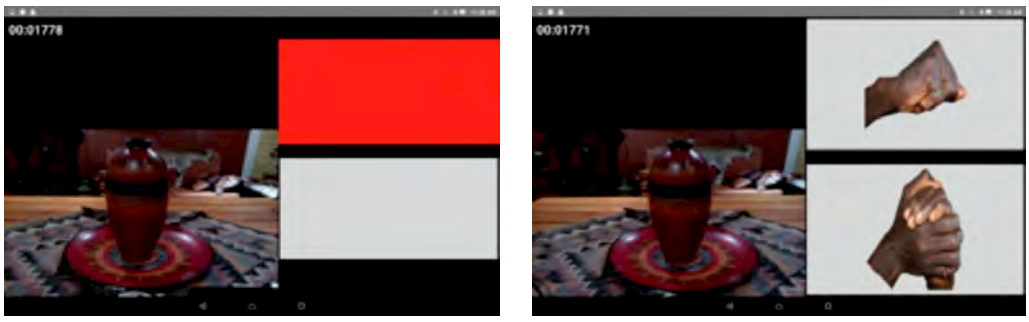


(a) (b)

Figure 5.9. (a) Workshop facilitator holding the tablet, while Uariaike recalls the function of the MCT icons. (b) Shows the MCT version two with an updated interface co-designed during the technology probe workshop.

Uariaike then pointed at the video recording icon and after a while said, "that is when I am recording, for example, a boy moving." Uariaike could recall the meaning of all symbols, except for the cellular phone (gallery icon). He first asked, "did we select the phone icon?" There was much guessing about what the phone icon represented. One of the community co-designers guessed that it was to record events, such as weddings. After a long pause, Uariaike stated that he forgot what the purpose of the phone icon was. The facilitator reminded him that it was the gallery for all the multimedia pictures, videos, audios, drawings, and written text.

The next step in the workshop was for Uariaike to test the second version of the MCT. Uariaike selected the video recording icon, and immediately noticed that the video recording environment was different; he said that "this thing is different from the one I used last time." The video recording screen now had a large red and white tab button (see Figure 5.10, on image (a) right side the red tab button is the top rectangular area and below it is the white tab button). The developer decided these features, and we now wanted to test whether they were easy to use for Uariaike.



(a) (b)

Figure 5.10. (a) MCT video recording window and (b) showing the option to save (closed fist) or not to save (closed cupped hands) the video recording.

After selecting the red button, video recording would commence; furthermore, the default digital stopwatch indicated that the record was in progress. When tapping the white button, video recording would cease; proceeded by the option to save (closed fist hand icon) or not save (closed cupped hand icon) the recording (see Figure 5.10). The red and white buttons were used temporarily until future co-design sessions could lead to appropriate action tab icons. These buttons were added to the app because we noticed that Uariaike was struggling with the progress indicator on the default tablet whether the video or the audio recording have started or not during the technology probe workshop (see Section 5.3.1). Uariaike quickly recalled the meaning of the hand symbols he had previously chosen. We informed Uariaike that besides recording multimedia, there is the part of combining the images with their related videos and audios.

The next activity was for Uariaike to use the TMA module for formulating a task request (see Figure 5.11). This activity involves selecting specific images,

Figure 5.11. Uariaike formulating a task request on the first crowdsourcing TMA prototype.

from the entire set of images that show a particular traditional object. After choosing the preferred images, videos and other multimedia about the traditional object are also selected (formulated as a task request). As Uariaike had only captured one video recording, the facilitator suggested that Uariaike should record more images and videos to illustrate the task request formulation scenario fully. Thus, Uariaike and the facilitator went off to take pictures of medicinal plants. Again the sun reflection on the tablet was a problem, and Uariaike took several minutes to see the plant on the screen while taking photos of it because he was facing the tablet against the sun reflection. Uariaike also recorded how a specific plant is prepared for medication. After these recordings, Uariaike completed the task formulation by selecting the pictures of the plant he just took and also selected the videos and audio he recorded about that specific plant and saved the task request. At the end of the workshop, we handed the tablet to Uariaike, as well as a solar-powered charger. Uariaike received instructions on how to use the solar-powered charger.

5.3.5 Reflecting on Task Management Prototype One

Meeting with Uariaike on 15th May 2015 that was two months after the initial MCT co-design workshop that was held on 20th March 2015, seemed to have been beneficial as Uariaike could still remember the chosen icons. However, Uariaike called the author several times a few weeks later, asking about the functionality of the ovaHimba hairstyle icon (video recording). When discussing the images, Uariaike described them as the icons "we" had chosen, referring to the community and research co-designers. This union showed us that we were heading towards the ideal a community-based co-design approach, just as we had hoped.

ICT usage training for the deployed application is crucial. The training should be done in a real-life setting to observe early user experience. For realistic usability testing of the co-designed application, it should be utilised by the community for a more extended period. Follow up workshops should be done to evaluate the progression of the usage and arising usability problems.

We clarified to Uariaike that the usage of the MCT was twofold. The MCT is used to collect information about medicinal plants (for the Namibian National IK Database). The multimedia of traditional objects captured with the MCT are also used in the TMA to formulate the crowdsourcing task request. This clarification was necessary so that he could realise that he had been involved with the MCT co-design since the first crowdsourcing conceptualisation cycle.

Another important aspect was to provide Uariaike with proper training to be conscious when he is recording information for crowdsourcing using the TMA application. The multimedia consolidated on the TMA is to be sent to graphic designers on the Internet, and thus it should not contain certain specific IK details, for example, information regarding the use of a particular plant for healing. IK holders should record certain IK solely for the Namibian National IK Database.

5.3.6 Selecting Icons for the Task Management Application

We held a workshop with Uariaike in Otjisa village on the 3rd of October 2015, five months since the last visit. The aim of the gathering was fourfold. First, to evaluate the data that Uariaike had collected since the deployment trip in May 2015. We wanted to find out how many multimedia items were recorded, and requests were formulated by Uariaike. Second, to find out what usability issues Uariaike had encountered while using the TMA application. Third, to let Uariaike test the new added TMA functionalities. The TMA application left with Uariaike only had the basic functionality of assigning videos and audios to the selected images. The latest update of the TMA module had the option to modify requests. Finally, to conduct a co-design session to choose the icons that would be used for the TMA functionalities; namely, (1) creating a request, (2) viewing requests, (3) modifying a request, (4) sending requests to graphic designers, and (5) viewing completed requests.

In the first session, we addressed the usability issues by asking Uariaike what difficulties he had experienced with the application. He responded that he had forgotten the meaning of specific icons. He mentioned that it was challenging to access the audio recordings he had captured. Instead of tapping on the gallery icon (that is, the phone icon), he had touched on the video recording icon (that is, the ovaHimba hairstyle icon), expecting to hear the audio he had recorded. He said that after facing this challenge, he opted not to use the MCT application for all his data collection. Instead of using the MCT, he used the default tablet functions to record and take pictures, with the assistance of his son.

The second usability problem that Uariaike experienced concerned about the collating of related multimedia. He found organising the multimedia somewhat challenging. After failing to combine the multimedia, he said to himself; the researchers will come to carry out the problematic collating process themselves. In the workshop, he stated that he expected the application to group the multimedia

he captured per plant automatically and what is used for healing and how to prepare it. The facilitator reminded Uariaike that the computer program could not group the multimedia elements automatically if it was not programmed to do so. The facilitator explained that it was up to the co-designers to think about the best way in which the grouping could be accomplished. The research co-designers enquired whether Uariaike would be happy if the application had allowed him to create his categories, for example, for the type of sickness cured by the medicinal plants. He responded that this would be a welcomed improvement to the tool. The development team noted this feedback and resolved to make the grouping feature less difficult.

Uariaike stated that he was pleased to have been able to keep the tablet. He said that his fellow community members, even from the surrounding villages, approached the device with curiosity and found it fascinating. He informed the research co-designers that the charging cable had broken in an unfortunate event. Thus he had to send his son to walk to another village to charge the tablet. Due to this, he did not use the application as often as he wanted to. The research co-designers gave Uariaike another charging cable.

Uariaike also mentioned that occasionally he got a slight headache when using the application. He stated that this was not something to be worried about, as the problem was caused by frustration and not by the device. The headache would occur when he could not figure out how to perform a particular action; however, once realising what was wrong, Uariaike was encouraged to try again and felt better.

Furthermore, Uariaike mentioned that he was not using the application as often as he would have wished, as he was busy with his farming activities. This rare use resulted in him having to relearn how to use the app. After this discussion, one of the research co-designers retrieved the multimedia captured by Uariaike. He copied the files from the MCT gallery and the default tablet folders. It was needed to copy the data from both locations because, at a certain point, Uariaike stopped using the MCT and used the tablet default multimedia recorder that does not store its files on the MCT gallery folders. Table 5.1 display the total number of multimedia files captured by Uariaike. The 'Total on MCT' column indicates the sum of multimedia files recorded while using the MCT application and the 'Total on Tablet' shows all the data that were recorded without the MCT application.

In the second session of the day, the research co-designers aimed to recap the purpose of the TMA application, and demonstrate how to use the added functions. The app usage session commenced with the facilitator providing Uariaike with a brief recapitulation on what the objectives of the community crowdsourcing platform were. Uariaike quickly followed the recap, relating it to the example whereby an omuHimba woman was wrongly modelled, in the evaluating 3D models' simulation workshop of CBCD cycle one (see Chapter 4, Section 4.4.2).

We continued the session by showing Uariaike how to create requests, view them, as well as how to modify the requests. Uariaike called his son to observe the training, saying that his son usually helped him when he got stuck and therefore should also be trained. It was worth noting that during this training session, we observed that Uariaike was trying to memorise the functionality of each of the action tab for viewing the pictures, videos, audios, text and drawings icons

TABLE 5.1

The total number of multimedia files captured by Uariaike over four months. 'Total on MCT' column indicates the sum of all multimedia files recorded while using the Multimedia Collection Tool (MCT) and the 'Total on Tablet' shows all the data that were recorded without the MCT.

Media item	Total on MCT	Total on Tablet
Images	34	12
Videos	15	27
Audios	40	0
Drawings	0	0
Text	0	0

in the sequence suggested. This memorization, we argue that was so because the TMA operations at this stage had no icons yet, but had only squared boxes for the events mentioned above. The same MCT icons selected for capturing the multimedia were to be used in the TMA module. That is to say that when a user wants to view pictures, the user will tap on the eye icon and if the user wants to browse through audio recordings, the user will touch on the mouth icon. Uariaike suggested that a short text description (in Otjiherero), should accompany the pictorial symbols. Thus, if he forgets the meaning of the icon, he could read the depiction and continue using the application with confidence.

After the demonstration of the TMA functionalities, we moved the discussion to choose the icons that would represent those functionalities. In this session, both Uariaike and Mukamberenge, four youth, three researchers, and the developer took part in the co-design session. We first explained the purpose of the TMA operations to the community co-designers. They were informed that the action tabs did not yet have pictures (icons) that depicted their purposes. There was a long pause from the participants before they started to discuss what icons they would like to see on the action tabs. They all spontaneously agreed that they would prefer to use traditional objects for the TMA module, as its purpose was to safeguard IK.

Firstly, the community co-designers were asked what icon they would want to be used to launch and as the home icon for the TMA module. Their first suggestions were a traditional baton and a spear. Uariaike sent his son to bring traditional utilities from the main house so that they could make a better decision while looking at the objects.

When the actual objects were delivered, the community co-designers decided to use the funnel as the module icon. The community co-designers selected a spear to represent creating a request; the spear was not present, and thus one of the community co-designers drew it on the facilitator's notebook. For modifying the requests, a knife was chosen; the community co-designers stated that a knife is used to alter things, which also applies to change a request.

A traditional baton was selected for viewing requests, a calabash for sending the request, and a regular wooden cup for viewing pending requests. An ovaHimba teenage boy hairstyle was chosen as a representative image to view

completed requests; a picture of Uariaike's son's haircut was taken.

Figure 5.12 illustrates the selected icons, as well as providing more details about the rationale for selection. Most of the images were chosen on the basis that they represent the ovaHimba tradition than logical reasoning on the functionality that would be executed when the icons are tapped on the application.

Application function	*Name and image*	*Traditional use*	*Reason for choice*
Home icon - allows the user to navigate back and forth within TRM and IKMC	Funnel (Ombako) 	Used for pouring milk into the calabash	One of the valuable traditional utilities used daily
Create request - allows user to select task request representative images and collate them to their related videos, audios, or text	Spear (Eonga) 	Used as a weapon to strike something with	One of the valuable weapons used in war
View created request - to allow the user to view and browse through created requests	Baton (Ombani) 	Used as a weapon to hit something with	One of the valuable weapons used in war
Send request - allow the user to send approved requests	Calabash (Ondjupa) 	Container to store milk for fragmentation to sour milk (Omaere)	One of the valuable traditional utilities used daily
Modify request - allow user to make changes to the previously created task request	Knife (Oruvio) 	Used for cutting	Knife is used to cut something to remove a certain part of it
View pending request - allow the user to view pending requests	Wooden cup (Eehoro) 	Used as a cup to drink omaere from	One of the valuable traditional utilities used daily
View completed request - allows the user to view all completed tasks	Teenage boy hairstyle 	OvaHimba teenage boys' hairstyle	One of the OvaHimba age group identification symbols

Figure 5.12. The selected Task Management Application icons' descriptions.

We concluded the workshop by thanking everyone for his or her valuable time. We gave Uariaike printed photos of him and his family that we had taken during the last workshops. The community co-designers requested that the next time we come, we should bring along photos of them taken during the first CBCD cycle. We exchanged Uariaike's old tablet with a new one with the updated MCT and TMA modules.

5.3.7 Reflecting on Task Management Icon Selection

Uariaike was finding it difficult to collate the multimedia. Although he managed to record the multimedia, he failed to organise pictures with their narrative of videos and audios appropriately. We, therefore, arranged another workshop to evaluate and refine the TMA functionalities.

We observed that the module functionalities must be easy to use, to keep the user active. When Uariaike was unable to remember the TMA functionalities or icons, he opted not to use the application and found an alternative approach. Uariaike seeking alternative ways to use the app showed us that he was committed to preserving IK using technology. Creatively searching for a solution, instead of simply giving up, shows his determination and ability to cope with technological setbacks, even in the absence of the research co-designers.

We also concluded that it was necessary to separate the TMA operations from the MCT. MCT performs the data collection for both the TMA and the National IK Database; however, the after collection processes differ for both. When IK holders are using the MCT to transfer multimedia about IK to the NCRST National IK Database, as shown in Figure 5.13, the grouping of IK is required. The grouping

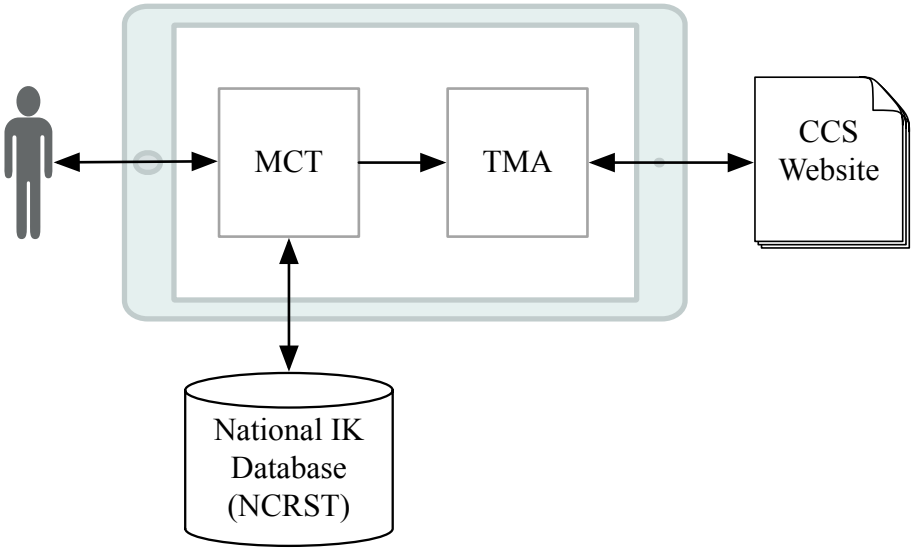


Figure 5.13. This diagram shows the interaction of an IK holder with a tablet that has both the MCT and TMA installed. The IK holder uses the MCT for data collection for both the TMA and for the National IK Database. The TMA communicates with the Community Crowdsourcing website (CCS) to send the requests for 3D modelling and receiving the completed 3D models.

of IK multimedia items is a complicated process; we agreed that the clustering of these multimedia was not the focus of the TMA module, and therefore, it was not a priority for implementation in this study.

Organising and managing the multimedia about traditional objects for crowdsourcing should be done on the TMA module. The TMA communicates with the

CCS (also named Otjiuana[2]) to send the requests and receive the completed 3D models, as indicated in Figure 5.13.

The community co-designers chose to use their traditional objects to represent the TMA icons, which, on the one hand, proves the pride they have for their tradition. On the other hand, it also shows that for some icons selected, for example, the knife that it is for cutting something to represent modification, there was logical reasoning of the physical object and the intended functionality on the application.

Furthermore, for community co-designers requesting for physical objects at the workshop venue signified that this should be done often in co-design sessions. Before the physical objects were not present, the community co-designers randomly mentioned a list of traditional items for a specific icon, but once the artefacts were present, they made their decisions more precise. This selection helped them from worrying about the broad spectrum of all available traditional objects. The objects that were not present drawings of it were made, for example, the spear. For the research co-designers, this was a realisation that things do not always have to make sense for them as the baton selection for viewing created requests left the research co-designers in doubts. We also acknowledge that all the co-designers needed time to reflect on the selected icons, whether those not logically linked to their intended functionality on the application would cause any usability issues.

We agreed to alter the viewing options of pending and completed tasks request on the TMA module until the task request formulation was better adjusted or understood. The tabs to view pending and completed requests were combined so that only one tab needed to be tapped to see the requests.

5.3.8 Evaluating the Task Management Application

The TMA module evaluation workshop took place at Uariaike's homestead in Otjisa village, on the 18th of March 2016. The aim was to evaluate the usability of the updated TMA module that had been left with Uariaike for five months long.

After greeting each other and setting up, we informed Uariaike about the purpose of our visit. During the greeting, Uariaike mentioned that due to other commitments, such as his farming duties and his mother's funeral, he did not record much information. Furthermore, he stated that he did not capture a lot because there were not a lot of traditional events that took place. He suggested that the research team should come back for another visit in June or July so that the researchers could witness the ovaHimba annual events that usually take place during that season. Uariaike wanted us to see some of his community regular events even though we were focusing on co-designing the TMA. He mentioned that this was important for us to have a better understanding of his culture. We noted this and the facilitator reminded Uariaike to continuously or randomly record information about traditional objects for the TMA module that he felt the younger generation should know about rather then only waiting for the annual events to capture.

[2]Otjiuana means community in Otjiherero.

Uariaike mentioned that his children like playing with the tablet and they sometimes help him when he gets stuck. The research co-designers informed Uariaike that their children, too at their homes, also play with the tablets. Mukamberenge disclosed that possessing this new expensive device had made them nervous, especially while working in the garden. The community co-designers were afraid that people will take the tablet without their permission as their huts are not locked. They sometimes had to cease their duties earlier to come back to the house, fearing that the tablet will be stolen.

Uariaike informed us that the charging port of the tablet was damaged, making it difficult to charge the tablet. He had to tie the power cable with a thread to the slot, to power it. Thus the tablet had to be powered with one of the research co-designers' solar charger before it was ready for use in the workshop.

Uariaike was asked to share any positive experiences and or challenges with the TMA application in general. He stated that audio and video recordings, as well as taking pictures, was easy to use and that he did not struggle with these. When describing his experience with the functionalities, he named them according to their icon, for example, mouth for audio recording. However, he mentioned that after recording a video, he could not hear its sound. Mukamberenge commented that this indeed happened. The video sound could be listened to, as the device volume was set too low. Uariaike was shown where on the tablet he could increase the volume. Uariaike also noted that combining the multimedia items for the crowdsourcing task request was difficult.

After the tablet was fully charged, the research co-designers were surprised to find that the application (executable) icon of the TMA application was not available. The research co-designers searched the entire tablet, but the TMA application icon was nowhere to be found. The only explanation was that the TMA icon was accidentally uninstalled; this can quickly occur without being noticed. Furthermore, there were many applications on the screen, so even if the TMA icon were available, it would be hard to spot. Although the TMA application icon could not be recovered, the research co-designers managed to copy the task requests formulated earlier by Uariaike. The research co-designers took a new tablet, which had the TMA application installed, to continue the session.

Finding the task request formulation difficult, Uariaike stuck to only collecting the multimedia. The facilitator demonstrated the task request process by selecting images and videos that were on the tablet. While operating on the tablet, the facilitator explained that the first step was to choose good photos of a specific traditional object that he wanted to be modelled in 3D. The facilitator stated that the selected images should then be combined with related videos and audios; this is done by tapping on the videos and audios which are then automatically placed in an allocated space on the screen, away from all the other captured multimedia. At this point, Uariaike mentioned that it was difficult to select images or videos without having seen or listened to it beforehand. The research co-designers agreed with Uariaike that there should be an option to preview multimedia before selection.

The TMA prototype one did not yet include the multimedia icons, for example, mouth for listing recorded audios. Instead, the application had coloured

rectangular tabs, representing the different types of multimedia, see Figure Figure 5.7 from Section 5.3.3. Uariaike memorised these square tabs, stating, "this first thing is for photos and the second one is for movement (referring to video recording)".

The facilitator told Uariaike that the icons selected for the MCT would eventually replace the coloured rectangular tabs. Uariaike agreed that it would be better than what was on the TMA prototype one. He also reminded the facilitator that he had asked for Otjiherero descriptions below the icons (see Section 5.3.6). The facilitator replied that the TMA would be updated as requested by Uariaike. The facilitator then asked Uariaike whether he had any difficulties with the saving and cancelling operations. Uariaike said there was no problem with that, and he quickly remembered the corresponding icons.

Uariaike feared that the lack of tablets could results in dominance by the person using the tablet. He suggested that two tablets should be used in the subsequent workshop; one for him and one for the research co-designers. He said that with just one tablet, the person holding the tablet dominates the interaction with the application. He said it is better when we have two tablets, then "you press on yours and I press on mine". The emphasis that Uariaike made here was for him to follow the instructions while it is demonstrated to him.

The next discussion revolved around the collating the related multimedia. In a previous session, Uariaike had stated that he would like combining multimedia for crowdsourcing be simplified (see Section 5.3.6). One of the research co-designers suggested that items could be pre-grouped according to the time they were captured using time stamps. The reasoning being that photos and recordings taken at the same time would very likely be related. Uariaike was then asked whether he obtained the images and audios about a specific traditional object all at one time. Uariaike affirmatively replied that he would first take pictures and then make audio and video recordings. Uariaike thought the idea of multimedia being pre-grouped according to periods was good.

The research co-designers agreed that the TRM in its current state was not easy to use and therefore did not expect any task request processing from Uariaike. Uariaike's tablet was replaced with a new tablet, which included the updated TMA module. We agreed with Uariaike that we would come back to him for refining the TRM application.

5.3.9 Reflecting on the Task Management Evaluation

The research co-designers learnt that it is challenging to follow a pre-defined plan. The community co-designers have their daily obligations, which need to be respected and taken into account when planning. We experienced this upon arriving at Uariaike's homestead, and he was searching for his cattle. The research co-designers ended up searching for Uariaike the whole morning, and the co-design workshop started at midday. Communicating to Uariaike in advance was difficult due to inadequate telephonic network coverage in Otjisa. Otjisa is surrounded by mountains blocking the cellular signal from nearby cell towers. All these challenges reminded the research co-designers to be able to think on their feet, as unforeseen circumstances can ensue.

Uariaike shared obstacles that he experienced while using the TMA application. The charging port of the tablet that was left with him was damaged. Due to this, Uariaike could not charge the tablet regularly affecting him to capture many multimedia. Even though he experienced this technical set back, he tried to fix the tablet by tying the charging cable with a thread to the tablet, and this showed Uariaike continuous commitment to this project. He also previously mentioned that he experienced usability problems with using the updated icons of the MCT but rather continue using the tablet default multimedia recording assisted by his son (see Section 5.3.6). Noticing this the research co-designers have learnt that they should always have a back-up tablet that is installed with all IK co-designed applications for that community that they are visiting.

The research co-designers also became aware; deploying ICT in rural areas may result in unforeseen consequences. Mukamberenge mentioned that possessing the tablet resulted in fear and changes in their work activities. The research co-designers agreed to buy Uariaike a small lockable suitcase so that they could continue their daily routines without a worry.

The research co-designers noticed that there were too many applications scattered on the tablet screen, and resolved that only the essential applications will be placed on the home screen. The TMA executable icon to launch it was missing. We concluded that it was accidentally deleted and therefore it needed to be re-installed and restrict users not to uninstall it. Uariaike was unable to turn up the volume to hear audio, and video recordings revealed to us that another training would be necessary. The community co-designers mentioned that they found the task of linking related multimedia (task formulation) difficult to perform. The community co-designers also said that there was no preview of the multimedia before selecting them. All co-designers agreed that other co-design sessions should be scheduled to clarify the task request formulation and evaluation process.

5.3.10 Task Management Application Refinement

We recorded that Uariaike was finding it difficult to use the TMA module from our previous workshops. We, therefore, held two days co-design workshops on 13 to 14 May 2016 to refine the TMA operations.

Day one workshop participants consisted of three community co-designers, including Uariaike, two research co-designers, and two developers. The session started with the facilitator showing Uariaike the overall CCSP diagram, see Figure 5.14. The CCSP is composed of the TMA application and the community crowdsourcing website. Figure 5.14 shows how all the CCSP components interact with each other and how the main stakeholders are involved. The rationale for explaining the CCSP diagram to Uariaike was so that he could get the overall picture of what he was contributing and with whom he is working. The technical specifications of the CCSP were not the focus.

The workshop facilitator explained to Uariaike that he "Uariaike" was the person labelled *IK holder* as an example. The facilitator explained that as an example, that Uariaike, as the knowledge holder can request a hut to be modelled into 3D by creating an application for it to graphic designers to the CCS website. The

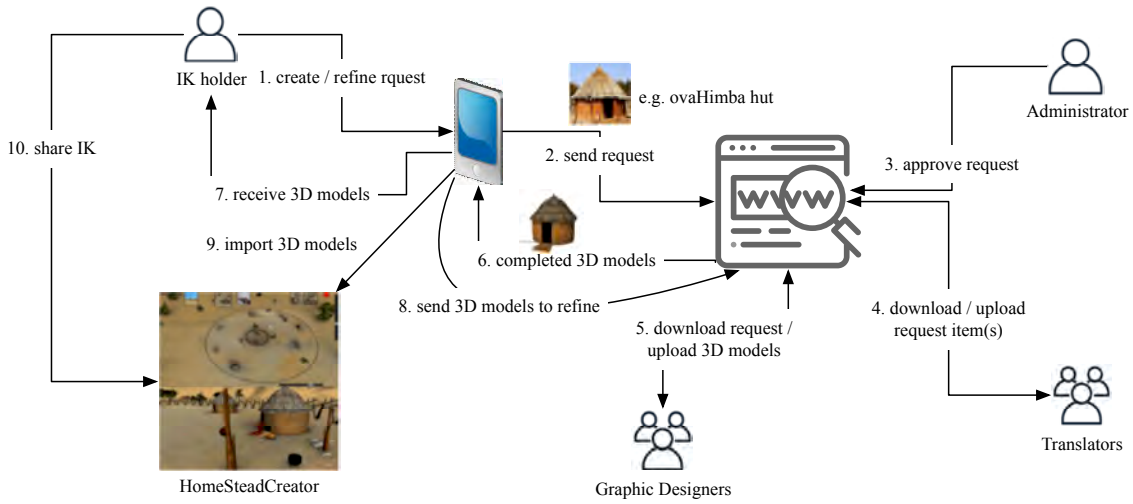


Figure 5.14. The Community Crowdsourcing Platform diagram depicting interaction to the HomeSteadCreator and the involvement of all the users.

administrator performs the approval and the translators, and graphic designers can download the request and upload their contribution. The administrator also checks for malicious submissions before approval.

Then the completed 3D models would be sent to the TMA for him (Uariaike) to evaluate. If not satisfied, he has to provide some details on what is wrong and send back the request to the CCS website. If Uariaike is satisfied with the delivered 3D model, those models would be imported into 3D IK visualisation tools such as the HSC.

Finally, at step 10, the HSC can be used as in the old classical way of orally sharing IK but this time with the aid of visualisation of dragging 3D models on a tablet. It was made clear that the tablet labelled TMA on the diagram represented the tablet that he was using.

Uariaike managed to understand the CCSP layout quite easily, although, at first he found it difficult to relate to the HSC. The workshop facilitator reminded him about the crowdsourcing conceptualisation session, in which he interacted with the ovaHerero HomeSteadCreator, see Chapter 4, Section 4.4.1. With this explanation, Uariaike clearly remembered the encounter. He was pleased that he understood the diagram and even explained the layout with the example of the 3D model of the omuHimba woman that was modelled incorrectly.

Next, we discussed the chosen TMA icons, for example, the funnel as the home icon or as the point of start, the spear as the create request icon (see previous Section 5.3.6) to recap on these details. The TMA evaluation uncovered that there were several icons that Uariaike was finding difficult to remember on the MCT, for example, he called the author to find out what the purpose was for the video recording (ovaHimba teenage boy hairstyle) icon. He also found it difficult to formulate the task request for crowdsourcing, as discussed in Section 5.3.8.

We printed each image representing the TMA's operations on a piece of paper and placed them on a whiteboard, see Figure 5.15. We then discussed whether

each icon fully described its functionality that it should be executed when selected. All the participants agreed that the icon representing the TMA app should

Figure 5.15. The whiteboard, with the Task Management start icon (the funnel) and create a request icon (spear) printed on paper.

remain as the funnel, because of its simplicity and ease to remember. The home or start icon also allows the user to navigate back and forth within TMA and from MCT to the TMA module. Once the user has selected the start (funnel) icon from MCT; TMA environment would be launched with the create request, view request, modify the request, send request, and view completed request options with their icons will be displayed.

The community co-designers agreed that the create request icon, that is, the spear should be changed because it did not relate to its functionality. Therefore, the spear was crossed out on the white, as shown in Figure 5.16. Since the first step in creating a request was selecting and collating multimedia from the whole range, Uariaike suggested that a handbag would be a good representation. He reasoned that you put your things in a bag for an organisation. Mukamberenge instructed one of their children to get her handbag from their hut so that a picture of it could be taken. The facilitator explained to everyone that once the create request (handbag) icon was selected, they would see the five multimedia icons, for example, an eye for viewing pictures collected from the MCT.

Figure 5.16 demonstrates the affinity diagramming conducted during the icon re-selection and the TMA module flow refinement that is discussed in the following paragraphs. Affinity diagramming is a technique that allows the co-designers to visualise the problem being solved, as discussed in Chapter 3, Section 3.2.3. Figure 5.16 shows how the user had to navigate through all the images for selection. During the workshop, Uariaike mentioned that he was finding it challenging to browse through this long list of images. Everyone agreed that the current display of images was challenging to browse through. After a lengthy discussion about the appropriate show, all agreed that an image slider would make browsing through the pictures easier. Uariaike proposed the following idea: When the

Figure 5.16. Affinity diagramming: Icons displayed after the create request icon (handbag) and the eye icon was selected to view the images collating them with related multimedia for crowdsourcing.

icon for images have been selected a small set of photos should be displayed horizontally in a row. If someone touches on the picture icon (eye) again, the next collection of pictures should be displayed, and so forth. In this way, the user would not be prompted with a large number of images, nor would they need to use the scrolling down function. Figure 5.17 shows Uariaike explaining his idea.

The next discussion point was how to select the images for the task request formulation or arrangement for crowdsourcing. It was agreed that the users should select all the photos that they wanted of a specific traditional object and then tap on the eye icon (or a new yet to be decided icon). Selecting the eye icon would then remove all the unwanted or unchecked images, leaving behind only the chosen images. This operation introduced that the eye icon would now have two functions on the TMA module, one to add images to the preview display once touched and two to remove all non-selected pictures from the image preview display.

The facilitator emphasised the importance of selecting a representative image as a thumbnail that will be seen or used when assigning further multimedia to the group. It was agreed that the picture that is selected first would be the representative image (thumbnail) for that crowdsourcing task request. Furthermore, it was

(a) (b)

Figure 5.17. (a) Uariaike was proposing his idea of how the pictures should be displayed. (b) A demonstration of Uariaike's image display approach on the whiteboard.

decided that the selection process would be the same for all the other multimedia items, that is, for videos, audios, drawings, and text.

The TMA application behaviour for selecting the preferred images and removing the unwanted ones was also demonstrated on the whiteboard (see Figure 5.18): pictures of the ovaHimba headrest were selected (image a), and subsequently all unwanted images were removed and placed on the right side of the whiteboard (image b). The importance of taking pictures from all angles of the same object was also emphasised, as we noticed that most photos were taken from one side only; taking photographs from all sides helps the graphic designers to create a correct 3D object.

The video recording icon (ovaHimba teenage boy hairstyle) was replaced with a picture of feet. The rationale for selecting feet was that they signal movement. The idea of using feet was suggested by one of the research co-designers. The reason for replacing the video icon was based on the fact that Uariaike had called the author several times to ask what this specific icon functionality was. Uariaike commented that when the icons were selected the first time, there was no deeper thinking about their operations. Furthermore, all agreed that there should be a preview option for all the multimedia, for example, that will allow the user to view the videos and hear the audios before selecting them.

Next, the discussion was about the icon for viewing the created requests. The co-designers agreed that since the image for creating a request was a handbag, the figure for viewing requests should be an opened handbag, instead of the traditional baton previously selected. Once the view request icon is touched, the created requests should be seen in a similar way to the pictures display idea proposed earlier, see Figure 5.17. The selected representative image should be displayed as a thumbnail that encompasses all related multimedia.

The calabash icon for sending requests and the knife icon for modifying requests were not replaced. The knife represents modification through cutting, and

(a) (b)

Figure 5.18. (a) Headrest images selected among the set of images. (b) All unwanted images were removed and placed on right side. Thumbnail image is numbered one (1).

the calabash was kept as a valuable household utility for ovaHimba community; thus, both were deemed to constitute a deeper connection to the proposed icons. Uariaike again reminded the researchers to write the names and a brief description, in Otjiherero, below the icon.

The workshop on the second day started with the community co-designers thinking about the icon for received 3D models from graphic designers. The facilitator asked, "How should the IK holders be notified once the completed 3D models are delivered to their tablet?" Uariaike said a notification sound, similar to a mobile short message, can be used. He joyfully started singing a song in Otjiherero, which roughly translated into, "look carefully, something has been delivered to you." He proposed that this phrase should be a song to be used and everyone was happy with his suggestion.

Next, the facilitator asked "What would be an ideal symbol to represent received 3D models?" There was silence, as everyone was buried in their thoughts. Uariaike said that it should be an icon representing something good. Then one of the developers commented to Uariaike that he should remember that not all delivered 3D models might be right and Uariaike agreed on this comment. Mukamberenge proposed a picture of the ovaHimba women to be used and looked at his husband for approval. Uariaike replied he would be happy with whatever is used, as he will remember it. One of the research co-designers asked Uariaike and Mukamberenge whether they would prefer the picture of the ovaHimba women to be represented in a 3D model or not. They both replied that would be an excellent idea to have the image portrayed in 3D rotating in all angles to adequately represent that what is delivered is in 3D and everyone agreed that this was now the ideal representation to be used.

The discussion proceeded with a recap on the TMA application flow. Uariaike was asked to recall the functionality of each icon. In the beginning, Uariaike struggled a bit, especially with the new icons selected on the previous day, but after a few minutes and with the help of the facilitator, he recalled the meaning of the icons. To find out whether Uariaike really mastered the application, the facilitator asked Uariaike "On what would you select if you want to navigate to the start screen of the TMA app?" Uariaike replied "I will touch on the funnel", and went on to explain the whole cycle (for example, that after touching the funnel, he will see the bag icon). Uariaike elaborated on the TMA operations several times, and during one explanation he discovered that the modify request icon (that is, the knife) could be used if he was not happy with the delivered 3D model to provide new narratives for the 3D model refinement. The 3D refinement process would follow the same procedure for creating a new request.

For the process of approving a completed request before sending it, everyone agreed to use the same symbols for saving and not saving as in the MCT. The facilitator showed them the tablet with those icons to confirm that they were talking about the same symbols. The facilitator ended the workshop by thanking Uariaike and his family for having hosted them for two days and allowing them to sleep at their homestead.

5.3.11 Reflecting on the Task Management Refinement

During the workshops, Uariaike had stated that for the first time, he had adequately learned the operations of the TMA. He had enjoyed the fact that we slept at his homestead as he had previously requested. He said, "you slept here and we recapped on the ideas again which was very helpful." He mentioned that after the first-day workshop, he reflected in the evening about the co-design activities; the next morning, he was able to clarify questions and propose new design ideas.

The research co-designers reflected that their relationship with the community co-designers had reached a level of mutual trust and reciprocity. Uariaike offered omaere for the research co-designers to drink even though it was a drought season. He felt that we always gave him tokens of appreciation and therefore, he also wanted to share the little he had. This gesture was Oundu principle to share what you have with others.

Uariaike further mentioned that the co-design sessions were very productive, primarily due to the techniques used. The affinity diagramming on the whiteboard, with the pictures of traditional objects taken by Uariaike, made relating to the design decisions more straightforward. Writing with whiteboard markers on the photographs and drawing arrows to show what happens when a specific operation was executed, was very helpful. This ideation of the application allowed the community co-designers to understand the system flow and the research co-designers received information about early user experiences. New ideas were proposed on how the system should behave, for example, on how to select the preferred multimedia elements and removing the unwanted ones.

It was crucial to conclude the workshop once the concentration level of the co-designers was low. In the co-design workshop, the community co-designers only focused on the TMA application. To focus on one item at a time proved to be

productive for both the research co-designers and the community co-designers. In most of our previous workshops, we had co-design sessions for several applications and research topic discussions.

Giving the community co-designers ample time to conceptualise co-design ideas, before intervening, also seemed productive. When Uariaike had run out of ideas, he would urge the research co-designers to provide their views. The resulting ideas came from both parties, therefore fulfilling the ideal co-design process. The only drawback for the research co-designers to initially withhold their opinion is that they might forget them. We recommend that the research co-designers note down their ideas, which can then be discussed later.

The planned training of the TMA prototype one was not done because it did not include the newly co-designed requirements. The researchers felt that Uariaike should not be trained on an application with old elements that were going to be changed, as this would bring about confusion. This update caused this CBCD cycle two to be prolonged as the TMA application needed to be updated. Implications of this delay can make the next CBCD cycles to be rushed insulting insufficient research work to be done or extension of the research period increasing research budget.

Uariaike understood the CCSP diagram shown in Figure 5.14 very well. Uariaike's quick understanding could be attributed to the fact that we previously held several co-design sessions with him. This presentation also indicates that Uariaike has understood the general objective of the CCSP platform. Uariaike came to realise that co-design itself need to go through several cycles of refinement. He mentioned that some of the TMA icons selected earlier did not make much sense for their intended operation.

Prominently that the app processes should be well co-designed, reflected on and refined if necessary. Uariaike understood the co-design idea of cooperatively building an application with the research co-designers. We came to realise that the co-design process requires several cycles, which builds mutual trust and reciprocity, understanding, testing, and refining the deployed product and accepting all the co-designers' values and skills.

5.3.12 Task Management Prototype Two

After the TMA co-design refinement workshops (see Section 5.3.10), the author modified the initial TMA screens (see Section 5.3.3) according to the new requirements. Figure 5.19 shows the updated TMA interface with description in English. The function description below the icons should be in Otjiherero on this updated TMA module, here the text was provided in English for the developer.

Once the create request (closed handbag) as shown in Figure 5.19 is selected, the create request interface will be launched as shown in Figure 5.20. The create request interface has the same features as in MCT for viewing the multimedia items, that is the eye for seeing the pictures, mouth for browsing through audios, 'feet' for videos, 'hand with pen' for text, and 'tree drawing' for viewing the created drawings.

Screen (a) in Figure 5.21 shows that the user has chosen his or her preferred images after tapping on the eye icon. Screen (b) shows that once the unwanted

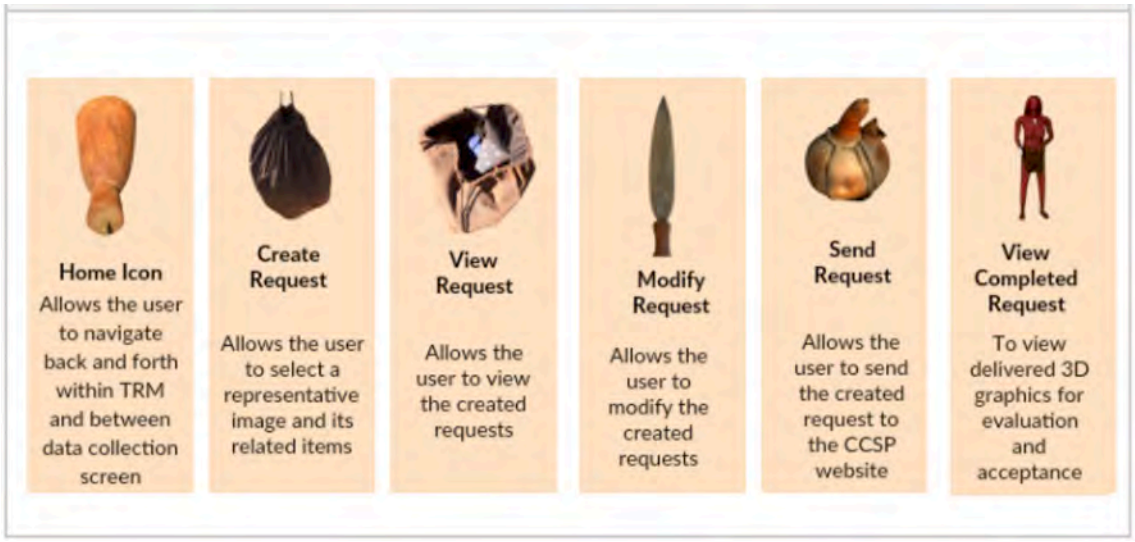


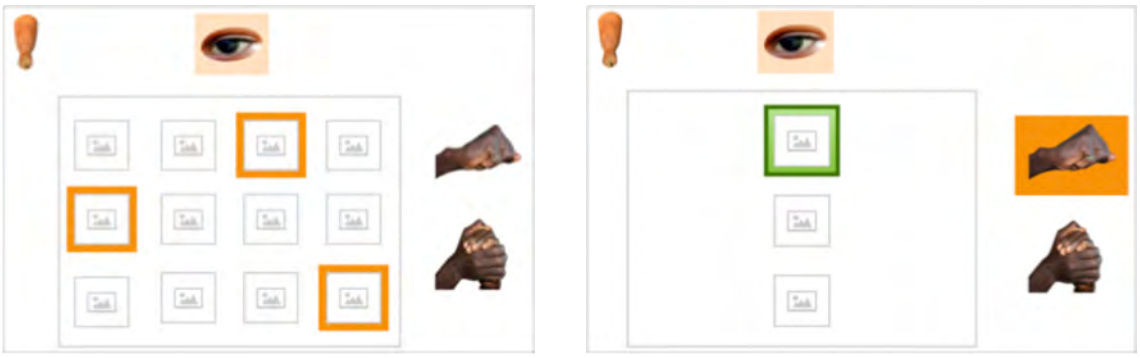
Figure 5.19. Crowdsourcing TMA interface prototype two. The starting point depicted by the funnel (first image on the left) once touched at this level moves the user back to the MCT, the remaining operations are as described in the interface.

Figure 5.20. Once the 'Create Request' closed handbag (see Figure 5.19) is touched, this screen is displayed to view the different multimedia items such as the photos, audios, and videos for collating them for formulating the crowdsourcing task request for 3D models.

images were removed after the eye icon was touched again and the saving icon (closed fist) is selected for adding those images to the task request.

Similarly, screen (a) in Figure 5.22 on the left depicts that images, audios, videos, and text have been added to a specific task request. The middle area in screen (a) of Figure 5.22 shows that a user has made a drawing of a cow as part of the task request formulation. Screen (b) still on Figure 5.22 shows that if a user has tapped on the view request (opened handbag), the screen display all the available task requests on the left side. Once a particular request is selected, it is moved to the right side where the user can modify it (by choosing the knife icon) or send it (by tapping on the calabash icon). If the user selects the funnel icon from any of the subsequent screens within creating the task formulation process, the user is taken to the start of the TMA interface, as shown in Figure 5.19.

Figure 5.23 shows that the user has selected the send request icon from the



(a) (b)

Figure 5.21. (a) Selecting preferred images for task request, and (b) saving the chosen images to the task request.

(a) (b)

Figure 5.22. Screen (a) shows that the user is adding a drawing of a cow to a request. Screen (b) shows that all the available task requests are displayed on the left, and once a specific represented by a thumbnail is selected, it is displayed on the right side area for inspection.

start interface of TMA shown in Figure 5.19. The selected requests are moved in the middle of the screen. Figure 5.23 also indicates that the closed fist icon for saving is tapped for saving the selected requests to the sending list. The user can send the list of task requests by tapping on the calabash.

Figure 5.24 shows that user has selected the view 3D model option by tapping on the 3D model of the OmuHimba woman from the TMA start interface shown in Figure 5.19 and that a specific 3D model is selected for evaluation. As an example, the original ovaHimba hut image taken by Uariaike is displayed on top, and the 3D model of the hut is shown in the centre for comparison. The saving icon is for approving. The cancelling icon is for disapproving a 3D model. Once the modify (knife) icon or the cancel icon is tapped, the 3D model will be modified by adding or removing multimedia narrative information. In the following section, we discuss how we conducted the approval of these screen designs before proceeding with the development.

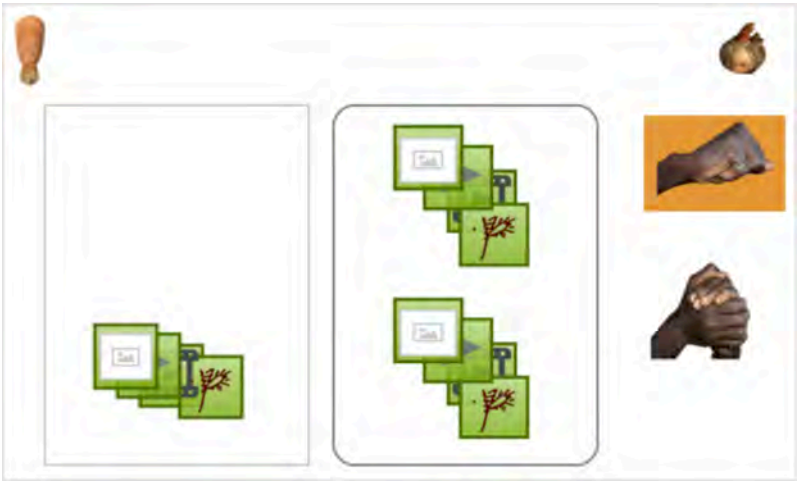


Figure 5.23. Shows that the user has added two task requests to the list for sending to the ccs. Note that a thumbnail image represents every task request.

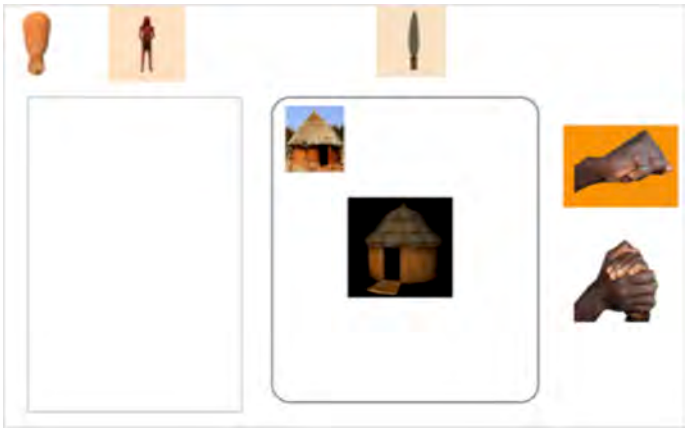


Figure 5.24. This screen shows that the user has selected the image of the Omuhimba woman to view the completed 3D models for approving.

5.3.13 Reflecting on Task Management Prototype Two

We realised that approving application designs before development is a crucial activity that gave all the co-designers a satisfaction that the TMA development was progressing well. The community co-designers did not approve TMA prototype one screen designs before developing the first TMA prototype. We acknowledge that missing this approval in the initial TMA prototype could have been the contribution to Uariaike to find it challenging to perform the task request formulation. We, therefore, suggest that community co-designers before further development should first approve the outcome of the designs from the co-design workshops.

5.4 Chapter Conclusion

During the TMA application co-design, several important points were reflected from the six workshops conducted. We showed that the rural communities were finding it challenging to use or relate to the standard multimedia recording interface. We, therefore, with the community co-designers updated the MCT so that it made more sense to us.

The community co-designers internalised the operations for recording multimedia elements relating to their context. For example, a picture of an eye was selected as an icon to represent the functionality for taking photos. A picture of a mouth was selected as an icon to represent audio recording. The rationale behind these choices can be linked to the fact that IK is embodied. The reasoning was when taking a photo of an object; you first look at that object with your eyes; thus eye icon was the best choice. The mouth was chosen on similar thoughts that a person talks with their mouth and therefore them seeing a picture of a mouth they would know if they select the mouth, they should speak into the application.

The community-designers made their decision based on what they could relate to their bodies rather than sticking to the western multimedia collection interface that had different representations, for example, a microphone to represent voice recording. The standard multimedia collection interface was meaningless for the community co-designers. We showed that it is possible to co-design with the African rural indigenous communities while encompassing their Afrocentric frame of reference in constructing embodied knowledge.

We learnt that the CBCD has to undergo several cycles with reflections for all co-designers to carefully re-think about the research process and chosen ideas. CBCD is a continuous learning process for all co-designers. We have learnt to find out the consequences and remedies of deploying the ICT tools to the rural communities. That our technology intervention could bring about issues that we might not foresee from the beginning, for example, Mukamberenge from the ova-Himba community mentioned that the expensive device that we had given them made them work fewer hours in their garden fearing that the device would be stolen. When the tablet charging cable was broken, let Uariaike send his son to walk to a remote village that had electricity to charge the tablet. These are underlying human social issues that can be caused by the deployed technologies that

computer scientists at times do not witness to consider in further implementations.

We also learnt that mutual trust, reciprocity, co-design conflict resolution, skill transfer, and flexible planning have to be achieved among all co-designers to reach a mature CBCD level. Co-design activities are not only aimed for the final artefact but also skill transfer and friendship building, understanding values and cultural differences. Clear roles and objectives of the co-design workshop should be explicitly stated to avoid co-design ideas to be dominated by outsiders who are temporary taking part in the co-design discussions. Our interactions from cross-cultural viewpoint should mature into trans-cultural. At cross-culture level, we concentrated on the cultural differences or who proposed which idea, but at a trans-cultural level, the views did not belong to an individual but rather to all co-designers.

We learnt to allow the community co-designers to use the tools and terms they are familiar with freely. They were enabling to spark creativity, innovation, and fully understanding the concept being co-designed. The community co-designers spontaneously took out their traditional objects during co-design sessions. Once again, similar to CBCD cycle one, there was much valuable IK shared while in the co-design process by the community co-designers. The research co-designers also shared their technical knowledge of how computers execute certain operations. This knowledge sharing reaffirmed us that skill transfer in the co-design process is implicit.

We witnessed that it was necessary to deploy the prototype as early as possible for refinement and bug fixing to improve usability and build trust in the research progression. Through evaluations, the software bugs were identified and rectified in the next version of the application. We realised that if some of the functions of the application are not easy to use, the user will most likely not use the developed application at all.

After having co-designed with the ovaHimba communities and deployed the TMA application, we planned to replicate the co-design process with the ova-Herero communities and simulate the process of creating and evaluating the 3D models as part of our third CBCD cycle. The final CBCD activities are discussed in the following Chapter 6.

Chapter 6

Co-Design with the ovaHerero and Creating 3D Models

6.1 Introduction

The activities discussed in this chapter are part of our third (CBCD) cycle. Hence this chapter is structured in three main sections of planning, action, and reflection. Since the TMA was mainly co-designed with the ovaHimba community, it was time to get input from the ovaHerero communities. It was also the right time to get input from the global graphic designers on how they would create the 3D models based on the requirements specified by the IK holders. The question in mind was that *what difficulties might arise for graphic designers when creating a 3D model from a series of photos taken from all angles?*

To get more insight into the question mentioned above, we organised an interactive exhibition workshop at the 14th PDC 2016 in Denmark. In that workshop, the conference participants simulated the graphic designers creating the 3D models. One of the researchers role-played an IK holder evaluating the designed 3D models. We purposely prepared the task requests with the apparent information omitted as IK holders do it; which however may be significant to the graphic designers to produce accurate 3D models.

6.2 Plan for Action Research Cycle Three

In this section, we describe our plans for the four workshops, that is, two with the ovaHerero communities from Okomakuara and Erindi-Roukambe and two with the PDC conference participants.

6.2.1 Plan for Co-Design with the ovaHerero Communities

In the second CBCD cycle described in the previous Chapter 5, we experienced that the ovaHimba IK holders could not relate to the standard multimedia collection icons for capturing photos, recording videos and audios, sketching drawings, and text input. We wanted to find out whether the ovaHerero community will find the same challenges in using the standard multimedia collection interface. We conducted workshops with the same community co-designers that were part of our first CBCD cycle.

The TMA co-designed with the ovaHimba took us approximately a year, resulting in the ovaHerero co-design period to be short. Therefore, we planned one workshop with each of the ovaHerero communities at Okomakuara and Erindi-Roukambe village to replicate or share the co-design ideas we did with the ovaHimba community. With the Okomakuara community, we focused on the selection of icons for the multimedia collection tool (MCT) and with the Erindi-Roukambe community on the TMA collating the captured multimedia items. Okomakuara is 80 kilometres north of Namibia's capital city, Windhoek. Erindi-Roukambe is on the eastern side of Namibia about 300 kilometres from Windhoek, see the Namibian map in Figure 3.6 of Chapter 3.

6.2.2 Plan for Simulating Creating and Evaluating 3D Models

We conducted two workshops, with a duration of 30 minutes each. One of the researchers' colleagues was selected to role-play the IK holder evaluating the 3D models. He was selected based on the rationale that he was from the ovaHerero community with a similar culture of the ovaHimba community. The description on what to concentrate on for assessing the drawings was printed and given to him.

Due to limited time and the unavailability of graphic designers, it was not practical to create 3D models on computers. We, therefore, took different photos showing the same picture of the traditional object from different angles to be given to the workshop participants to draw all possible dimensions of them (representing a 3D model) on a piece of paper.

Some of the photographs were purposefully taken upside down and information about the essential parts of the traditional objects for the participants to focus on their drawings were omitted, to simulate a real situation that can occur when the IK holders do not specify adequate task requests. For example, for the ovaHimba traditional headrest it is crucial that the bottom part is bigger than the top part (for balance), and that the top portion has rounded smooth edges (for comfort), see Figure 6.1 image with caption (a). The pattern in the middle section

Figure 6.1. Pictures of some of the ovaHimba traditional objects: (a) headrest, (b) body powder container, and (c) hair decorator.

of the headrest does not necessarily need be the same, as it is only a decorative

pattern which varies among different headrests. Three ovaHimba traditional objects were planned for the drawings (a) ovaHimba headrest, (b) a body powder container, and (c) an ovaHimba women hairstyle decorator, see Figure 6.1. The actual objects were brought along to show the participants during the evaluation.

6.3 Cycle Three Action

In this section, we provide details on how we conducted each of the four workshops in the third CBCD cycle. We conducted the workshop in Okomakuara on 20th July 2016 with four community co-designers (Mika Ndisiro and Nokokure Heuva as the community lead co-designers), two research co-designers, a visiting professor at NUST faculty of Computing and Informatics, and two undergraduate students.

In Erindi-Roukambe the workshop was held on the 23rd July 2016 with two community co-designers (Veheha Katjangua and Alex Kamaze) and two research co-designers. We conducted two PDC workshops on 18th August 2016. The first workshop had nine participants, and the second one had ten participants.

6.3.1 Co-Design at Okomakuara

After official greetings, the facilitator started the workshop by reiterating the project background. The facilitator also explained the purpose of the workshop in Otjiherero. The community co-designers replied that they are still well aware of the project. We informed them that we have been co-designing the crowdsourcing TMA application with the ovaHimba community and that we now seek their input on that.

The facilitator asked the community co-designers to share some information about medicinal plant treatments so that we could have a similar discussion that we held with Uariaike and use the shared knowledge in the co-design session. The community co-designers took the facilitators to a specific plant that grew near their homesteads. One of the community co-designers cut off a small leaf and demonstrated how to prepare it to heal stomachache.

After the demonstration, we commenced with the co-design process of the multimedia collection tool (MCT), with the first step of choosing icons for capturing photos, videos, audios, drawings, and text input. In the beginning, it was difficult for the community co-designers to understand the concept of icons, which resulted in several long explanations. We used their cellular phones to demonstrate what icons are, for example, pointing at the call icon or writing a short message icon. The community co-designers were asked to think about what image they would want for taking photos. After a long pause, one community co-designer replied that eyes would make sense. The facilitator asked her to explain her choice. She explained "*you first look at something with your eyes before you take a photo of it. Therefore eyes would be straightforward to relate to taking pictures.*" When asked about the icon for voice recording, the community co-designers replied that a tongue would make sense because it is for speaking. The facilitator informed the community co-designers that the ovaHimba community also chose eyes for

taking pictures, and a mouth for audio recording with similar reasoning. The community co-designers were happy to hear this and commented that they are the same people as the ovaHimba.

When the community co-designers were asked to think about the icon for video recording, Mika suggested using a knife or a hand with a knife. He explained that this related to the process of cutting a leaf from the medicinal plant, which was demonstrated earlier. There was a disagreement with this suggestion. One of the community co-designers mentioned that the icon of a knife was problematic to relate to movement; he said the icon should be easy for someone else who was not part of the co-design team to easily understand. The community co-designers stated that it was challenging to think about an icon for video recording. The facilitator agreed with the community co-designers, relating it to the idea that in Otjiherero, there is no word for it. The community co-designers agreed with this complexity. After a long pause of silence, Mika asked why everyone was so quiet. Then one of the community co-designers said that an image of a walking person should be used and everyone agreed on this choice. The facilitator commented that this was similar to the feet chosen with the ovaHimba community.

The visiting professor asked the community co-designers whether they would prefer any arrangement of the icons; for example, they could have eyes on the first level, and when the eye is tapped they would be presented with the option to take a photo or a video recording. Again after a long pause, one of the elders suggested to have a picture of someone cooking porridge[1] on the high-level icon, and when tapped the icons for capturing photos and videos will be presented. There was also a suggestion to use an image of a person standing on the top-level. We agreed that a picture of a person performing an activity could be misleading. There was a long debate about arranging the icons which resulted in the community co-designers coming to a consensus that they would rather not have any arrangements of the icons. The community co-designers suggested that there should be a description of the operation of each icon. We agreed that a recorded voice explaining every symbol would also be helpful for someone who does not read.

The next discussion was to choose an icon for drawing and writing. One of the community co-designers suggested putting a hand with a pen. The community co-designers decided that the symbol of a hand with a pen was sufficient for both drawing and writing, reasoning that when someone holds a pen, they can either draw or write. The facilitator reminded them that the application should be informed about the predetermined operation so that it can provide the right environment (that is, a keyboard window with a text field or a drawing board with drawing utilities). After understanding this, one of the community co-designers tried to distinguish these two functionalities by drawing with his walking stick on the floor. He suggested a hand with a pen that has written a few words for writing — a hand with a pen that is busy drawing a sketch, for drawing. The community co-designer was provided with a pen and paper to demonstrate his idea.

[1]Porridge is one of the staple food in Southern Africa. Maize is prepared from ground maize.

The next discussion was about the icon for the gallery. The initial idea was to put a group of people, similar to how we were seated in the workshop. Again the same community co-designer who said icons should be generic as before stated that the gallery icon should be generic so that even someone who was not part of the co-design workshop could easily understand the purpose of the icons. One of the female community co-designers commented the following about the gallery, "does this means that it is like a storage container to be opened to view everything inside it, for example, an *ehoro.*[2]" Mika liked the idea and suggested that they should think about traditional objects for this icon. Several objects were mentioned randomly, such as an otjibaba (basket), and an ehoro. Everyone agreed that an ehoro is the perfect icon for the gallery considering its significance as a household utility. One of the female co-designers sent her daughter to bring the ehoro so that a picture of it could be taken, see the picture of ehoro in Figure 6.2.

Figure 6.2. Picture of ehoro selected for the gallery icon at Okomakuara co-design workshop.

Lastly, the facilitator explained in great detail the idea of combining multimedia for task request formulation. However noticing that it was getting late and everyone was tired, we decided not to have that discussion. The facilitator told the community co-designers that developing a software application is like building a house; it cannot be done in one go, but it is instead a step-by-step process. He informed community co-designers that the research co-designers would incorporate their ideas into the application and come back for an evaluation.

6.3.2 Co-Design at Erindi-Roukambe

The same idea used in the workshop at Okomakuara to let the community co-designers share information about any medicinal plant treatment they knew initiated the discussion. Then the facilitator reminded the community co-designers about the concept of crowdsourcing to formulate requests for creating 3D models which they had engaged in the first CBCD cycle. The community co-designers

[2]Ehoro is a big cup made from wood used for pouring in omaere from which people can drink using a wooden spoon. Omaere is unpasteurised milk that is fermented naturally for two to three days in a calabash.

could recall this very well; they even asked the whereabouts of some of the research community co-designers that were part of the crowdsourcing conceptualisation workshops.

Since the focus of the workshop was to replicate the co-design of the TMA, the facilitator started by asking the community co-designers how they would like to group the multimedia that they had collected. Alex, one of the community-designers, suggested that the device should group the multimedia items in a *kraal*[3] by their treatment referring to the medicinal plants. The facilitator commented that the application could not group related pictures and audios by itself if it is not programmed to do so; it was up to the co-designers to think about how to arrange media items. The facilitator also pointed out that Uariaike, the ovaHimba lead co-designer, had also found the idea to group items difficult. The facilitator then asked Alex to draw the kraal in a notebook for grouping the images. Alex happily took the pen and drew the kraal and inside it with a few rectangular shape blocks to represent images.

Veheha said that he preferred the multimedia to be grouped by categories, for example, a tree group or an animal group. The facilitator then asked the community co-designers how the application will know that a specific photo is of a tree or an animal. They replied that they could enter that information after or when taking a picture; they could voice record whether it is a plant or an animal, as well as its name. The facilitator questioned about the arrangement of multimedia, for example, how the images in kraals should be displayed as there might be many. The community co-designers said that only a few pictures should be displayed per kraal. The community co-designers further elaborated that only a few kraals should be shown, as a page of a book; when one page is full of kraals, a new set of kraals would be created on the next page. Veheha explained that "*it should be similar to looking at a photo album, you do not look at all the pages at the same time, you look at one page at a time.*" All multimedia should be arranged and displayed in a similar manner of divided kraals.

Next, the community co-designers were asked to think about the icon they would want for text input functionality. The community co-designers immediately said a hand with a pen. For the gallery icon, the community co-designers mentioned that it should be a branch of the *omuvapu tree*[4] and a *ondjupa* (that is, a calabash). One of the research co-designers drew the proposed icon in a book, receiving affirmation from the other community co-designers.

When the community co-designers were tasked to think about the icon for video recording, they replied that it should be a picture of a person seated cooking at the fireplace. This icon was selected to signify action or movement. The rationale behind this was that seeing someone performing an activity (cooking) means motion, which suits video recording.

[3]A kraal is an Afrikaans word for a fenced area where livestock are kept at night and for feeding and treatment.

[4]Branches of the omuvapu tree are placed on the ground when cattle and sheep are slaughtered. Meat from the slaughtered animal is placed on the branches so that the meat does not touch the soil. Once the meat is placed on the branches, the area is called *ovihuno.* The ovihuno, located between the kraal and homestead, is an important area (called omuvanda) that should not be crossed by strangers.

6.3.3 Simulating Creating and Evaluating 3D models

For the *first workshop*, we had three groups. Two groups were given the ovaHimba headrest, while the other group was given the hair decorator. In all the groups, the participants helped each other with ideas on how to perfect the drawing. For example, there was a discussion on whether the shadow of the hairstyle decorator appearing in the picture was part of the actual traditional object or not. The participants drew the objects from all angles.

During the evaluation session, the participants mentioned that it was challenging to draw the pictures since some photos were taken upside down (for example, the headrest). They suggested that it is *important that the orientation of the object is presented in the right way*. The headrest drawings done by one of the participants who was a graphic designer was drawn very well. She drew the headrest correctly, with the bottom part being larger than the top part, and she was the only participant that included decorative patterns in the middle section. See Figure 6.3 for the drawing created in the first workshop.

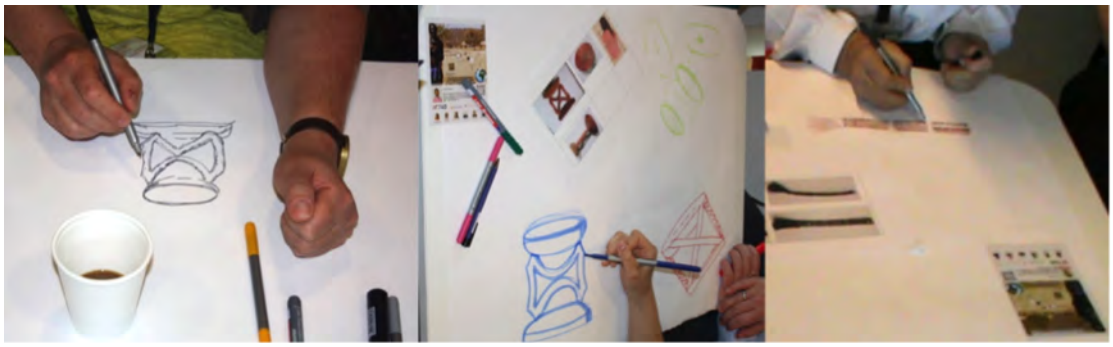


Figure 6.3. Drawings created in the first PDC 2016 workshop simulating the creation of 3D models.

After the participants had completed their drawings, the researcher that was role-playing Uariaike revealed the actual headrest and asked what they thought it was. Different participants answered that it could be a headrest, a ritual thing, and two people sitting next to each other (the upper part being combined heads). When looking at the drawings of the graphic designer, the evaluator commented that the drawings were exquisite. He said that he liked the fact that the bottom part was drawn thicker (as it should be) and that it was drawn in the right position. Looking at the drawing of another table, he also commented that the bottom part of the headrest seems sturdy. Few pictures were drawn upside down, to which he mentioned that it is incorrect. When the participants were asked what they thought the hair decorator was, they replied that it was perhaps something used to put the red ointment of the ovaHimba women on their hair. "Uariaike" complimented the drawings, saying that they were perfect and immense detail was given to the decorative patterns.

During the discussion session, the facilitator asked the participants what valuable information the IK holders should provide besides the photos. The participants mentioned that the IK holders should send videos demonstrating the object in use and an indication of the actual size of the object.

In the *second workshop*, we again had three groups. Two groups were given the ovaHimba headrest, while the other group was given the body powder container. There was much discussion about the actual size of the objects, especially for the body powder container. The participants spent most time guessing whether it is a container to store something and whether the top part was a cap that could be taken off. The participants were curious about what it was used for and which part was the top and the bottom. One of the groups drawing the headrest decided that everyone in the group should draw the headrest from one specific angle. Some of the participants focused on creating quality drawings. See Figure 6.4 for the drawings created in the second workshop.

Figure 6.4. Drawings created in the second workshop PDC 2016 simulating the creation of 3D models.

The participants were amazed when they saw the actual headrest as some thought it was a chair. They stated that the correct representation of the traditional objects was significant. One participant elaborated that some details are more important than others, so the IK holders should indicate which aspects are essential for graphic designers. When the powder container was shown, one participant commented that it was apparent after seeing the actual object (body powder container) that the middle part is made out of a cow horn and that the bowl is not that big. The participants commented that the size dimension was missing and recommended that the photo of the traditional object should be taken along with size indicators, such as a pen or ruler, someone holding it, or being positioned where it is usually placed in the house. One participant suggested that perhaps the graphic designers should send their interpretation of the object to the IK holders; the IK holders should then reply whether it is correct or not. The participant stated that it is crucial that there is no knowledge gap between the IK holders and graphic designers, especially about the shape and usage of the traditional object. Another issue raised was concerning licensing that the graphic designers should be aware of the conditions or limitations that the IK holders are giving regarding the multimedia items.

6.3.4 Approving Task Management Prototype Two

There was a historical-political background that Uariaike travelled from his Otjisa village situated in Kunene region in the northwest of Namibia about 55 kilometres from Opuwo and some 800 kilometres to Windhoek, see Chapter 3, Section 3.2.1 for detailed geographical location. Uariaike was part of the South West Africa Territorial Force (SWATF) army before Namibia's independence.

After Namibia's independence, the Namibian government wanted to minimise unrest and peacefully integrate former soldiers (war veterans) in the community for reconciliation; thus the War Affected People (WAP) project was established (Preston, 1997). It seems that the WAP project did not recognise those from SWAFT as war veterans to receive war veteran's benefits (New Era, 2016). According to New Era newspaper, former SWAFT members were mobilising themselves in 2016 to protests in Windhoek to appeal to the Namibian government to also accept them as war veterans. Uariaike came to Windhoek to attend these meetings and also saw this as an opportunity to meet us as well to confirm whether the TMA screens were designed correctly (described in the previous Chapter 5, Section 5.3.12) as agreed in the TMA co-design refinement workshop held at his homestead, see Section 5.3.10.

Uariaike's appointment with us fitted well with our iterations to have a reflection with him on the updated TMA specifications. All the screen designs were printed out on a piece of paper and were discussed with Uariaike one by one. Uariaike agreed on all TMA prototype two screens that they were correct based on the co-design TMA refinement workshop discussions.

The research co-designers also used this opportunity while Uariaike was in Windhoek to showcase a scenario of how we conduct our CBCD sessions by a role-play at NUST research day on 29 July 2016. The purpose of this role-play was planned to get academic researchers' input to improve this study. Uariaike and his wife Mukamberenge agreed to take part in this CBCD role-play. The role-play was rehearsed a day before the research day.

Two Otjiherero speaking research co-designers were part of the role-play for the usual translation from Otjiherero to English. Two developers who were part of the IK in Digital World research cluster acted as the research co-designers, one video recording the discussion (demonstrating the usual data collection process) and the other presenting the project introduction and background to the audience. Two intern students were also part of the role-play. One student was taking pictures of the role-play and while the other was video recording the whole role-play. The TMA prototype two interface design (see Figure 5.19) was printed out on a large sheet of paper and placed on a flip board. See Figure 6.5 for the role-play arrangement.

The role-play started with the extended causal greetings by one of the Otjiherero speaking research co-designers asking Uariaike and Mukamberenge about their well-being and the weather condition since it was wintertime in Namibia that season. They replied that they are doing fine, although it was cold. After formal greetings, Uariaike was asked for permission to take pictures and to video record the role-play. He quickly replied that it is not a problem to take pictures and to record a video of the session.

Figure 6.5. CBCD role-play at NUST research day, 29 July 2016.

Uariaike was reminded about the last trip that the research team slept at his homestead in Otjisa (see Section 5.3.10) as a recap on the purpose of the co-design role-play. He nodded his head in agreement to the occasion. Uariaike was then asked to recognise the icons and explain why they were selected for the TMA app.

Uariaike started by introducing himself and mentioned that he had worked with the research co-designers for some time. Uariaike said "I have been teaching my fellow people (research co-designers) about indigenous knowledge and they have been teaching me about computer tools that capture indigenous knowledge." Then pointed to the flip board starting with the funnel (the first icon from the left in Figure 5.19). He mentioned that the funnel was chosen as a starting process for combining associated multimedia. Then he preceded to the second icon, the closed handbag, till the calabash icon recalling their functionality very well and asked his wife Mukamberenge to help him remember the last symbol (3D image of the OmuHimba woman). Mukamberenge could not recall the feature and Uariaike assisted her by explaining that it is for viewing the delivered 3D models from graphic designers.

Uariaike was then asked whether he was happy about the discussion where he replied that he indeed was pleased about this learning process for him and the researchers. The whole conversation was then translated into English for the audience to understand.

After the role-play, the audience was informed that they could ask Uariaike questions directly for those who could speak Otjiherero. Several questions were asked to Uariaike, for example, what his benefit was in this research project where he answered that is about learning from each other and at the same time safeguarding IK, see Appendix F for more details about this dialogue.

The role-play ended as usual by thanking Uariaike and Mukamberenge for their time. After the role-play, the Electricity control board of Namibia (ECB) donated two tablets to the IK in Digital World research cluster, and one was given to Uariaike for the project. According to ECB management, the donation symbolised the importance of academic institution partnership with the industry that it was a gesture of appreciation to support the initiative of research activities.

6.3.5 Multimedia Copyright Discussion with Uariaike

The author, together with the research colleague who role-played Uariaike at the PDC workshop, visited Uariaike on the 30th of August 2016. We informed Uariaike that the conference participants liked the research that we do with him; he was thrilled with this feedback.

The author informed Uariaike that a question about licensing was raised in one of the workshops. The author mentioned that he could not answer it at that time of the workshop since we did not discuss it with him beforehand. It was difficult for the author to translate the proprietary rights of electronic items to Otjiherero. The author, therefore, used the general term of ownership. When we asked Uariaike, he thought about the proprietorship of the images that he would send out to the graphic designers on the Internet. Uariaike answered, "What ownership of mine are you talking about if I have already posted the photos to the public? ... I have given away my right of possession by sending the images in the first place". The author explained to Uariaike that if he gives something to someone, he has to state how that person is allowed to use it. The author further illustrated with an analogy, that not specifying copyright is the same as putting them on the side of a road and any passer-by can take the images and do whatever they want with them. On this remarks Uariaike replied, "*that is fine, that is why I have placed it on the street if I do not want people to take it, I would not put it on the road.*"

We further emphasised the risk of having no ownership of the images and videos. We stated that if Uariaike does not have proprietary rights anymore on the media items, then someone else could sell his photos and make money from it. Uariaike replied, "I would not be worried about whether someone is selling it or not, I am more concerned whether the completed 3D models is satisfactory or not". We agreed with Uariaike that we should have another more extended meeting to discuss the consequences of having no usage conditions on the media items that he would send to the graphic designers.

6.4 Cycle Three Reflections

In the following subsections, we report reflections from each of the workshops and also provide a general comparison of selected icons for the MCT.

6.4.1 Reflecting on Co-Design at Okomakuara

The community co-designers stated that they were displeased that the research co-designers did not come back with results from the first CBCD cycle (that is, the crowdsourcing conceptualisation). The community co-designers disappointment showed us that the community co-designers wanted to see progress and receive feedback from the previous activities. For example, during the first CBCD cycle (see Chapter 4), the research co-designers took photos of walking sticks, which were meant to be modelled in 3D. The 3D model of the walking sticks was submitted to a 3D enthusiast website as a design challenge, and no feedback was received. Furthermore, most of the research time was dedicated to the TMA co-design with Uariaike. We learnt to build long-term continuous CBCD engagement; we have to continue communicating with all our community co-designers even though we are busy with a specific community at a given time.

We realised that the activities or shared stories before the co-design session influenced co-design decisions. For example, Mika initially suggested a knife for the icon for video recording because it was used for demonstrating how to prepare the plant for stomachache treatment. Similarly, Uariaike selected the tree drawing that he had done before the co-design discussion (see Section 5.3.1). We, therefore, caution to pay special attention to activities done before co-design discussions and how they could affect the co-design decisions. We also came to realise that long quietness pause during co-design discussion should be allowed for people to have ample time to think about their ideas. After some time, this quietness is spontaneously interrupted by any co-designer that had an idea.

For the icon selection, we noticed that there was careful reasoning by community co-designers that the selected icons should relate to the intended functionality on the application thus proving to understood ease of use and purpose of the symbols. Lack of technological terms in Otjiherero again hinders useful co-design discussion, for example, there is no word in Otjiherero for video recording and the same word used for hand drawing is used for taking a photo and video recording. To discuss these concepts without Otjiherero words, we had to explain the process of performing that activity in detail.

6.4.2 Reflecting on Co-Design at Erindi-Roukambe

It was also complicated to communicate computer terms with the community co-designers, and thus we relied on using detailed descriptions. The community co-designers used words that they were familiar with, such as a *kraal* for section blocks for grouping the multimedia. The research co-designers then easily communicated with the community co-designers using those words that the community co-designers were using.

The focus group discussion had a good rapport, consisting of just two community co-designers. The reason for this could be due to the close relationship that community co-designers had with one of the research co-designers who was from the same village and related to them. More community co-designers could have been better for more input ideas. We have noticed from our previous co-design workshops from CBCD cycle one that when the Erindi-Roukambe community co-designers are in a workshop, it is very interactive with discussions.

Erindi-Roukambe community co-designers have gained experience in co-design since they have been co-designing with the research team since 2008.

The community co-designers could relate to photo grouping by using their experiences of photo album viewing and grouping their livestock in kraals. In the old physical photo albums, photos are seen by paging through one page at a time, and community co-designers used their experience with this to suggest how the electronic images should be viewed. For the community co-designers to use the photo album as an example to demonstrate how they would prefer the photos to display on the application taught us that the community co-designers use their experiences of similar operations in the co-design decisions. Similarly, the ova-Himba community co-designers also used their skills with cellular phone usage to explain the icons for selection, see Section 5.3.1 in Chapter 5. We have noticed that the drawings could be drawn inaccurately, thus resulting in unsatisfactory 3D model designs.

6.4.3 Reflecting on Creating and Evaluating 3D Models

The main take-home message from both the workshops was that video recordings showing the object in use and indication of size should accompany the pictures. Furthermore, the correct orientation of the traditional object is critical for creating an accurate 3D model. From the requested background information, we found that the graphic designers would prefer working on something that they know. Without this information, there is a lot of ambiguous interpretations from the graphic designers, and they might create all sorts of 3D models, in turn creating a lot of wrong objects and wasting their time. A lot of unnecessary thought or discussion will be devoted to figuring out what the traditional object is, the actual size, and its usage.

There was great excitement when the actual objects were presented to the participants. Perhaps graphic designers will appreciate having the object or a replica thereof being sent to them as a reward for their contribution. The question of whether participants would be graded for their drawings gave us an indication that some incentives for the graphic designers should exist. For example, the IK holders could engrave the name of the graphic designer who modelled the approved 3D on the actual traditional object as a token of appreciation. We agreed to have further workshops to discuss the IK holders and graphic designers views on incentives needed. There were many questions about the tradition of the ova-Himba community. We considered that this might be the reality of the dialogue between the IK holders and graphic designers on the community crowd-sourcing platform, thus cross-culture learning experiences to be envisaged.

6.4.4 General Comparison of Selected Icons

A general comparison for the icons selected from the three pilot research sites is highlighted here. The co-design workshop at Okomakuara which was part of the second CBCD cycle described in this chapter focused on selecting icons for the multimedia collection tool and therefore a comparison with icons selected at

Otjisa village with ovaHimba community (at the second CBCD cycle, see Chapter 4) is shown in Table 6.1.

TABLE 6.1

Description of icons selection from two pilot research sites.

Functionality	Otjisa	Okomakuara
Taking photo	eyes	eyes
Audio recording	mouth	tongue
Video recording	feet	person in motion
Drawing	sketch of a tree	pen sketching a drawing
Text input	hand with a pen	hand with a pen
Gallery	cellular phone	ehoro

As displayed in the table there was close similarity regarding reasoning and icons selection for (1) taking a photo, (2) audio and (3) video recording, (4) sketching drawings, and (5) text input. The community co-designers used the same reasoning for taking a photo that they would prefer to have a symbol of eyes instead of the default camera icon because that would make more sense for them that they first look with their eyes at the object before taking a photo. Similar arguments were used for the audio, video, sketching a drawing and text input.

The similarity of the icon selection and reasoning was also visible at the workshop at Erindi-Roukambe. For example, the community co-designers at Erindi-Roukambe chose a hand with a pen do depict text input instead of the default alphabet icon and selected a picture of someone sitting at a fireplace to represent video recording for the action of cooking. The community co-designers at Erindi-Roukambe picked branches of a tree (omuvapu) used for a sacred area of the ovaHerero homesteads, see Section 6.3.2. It can be seen for the icon selected for the gallery that it was completely different from the two research sites and Erindi-Roukambe. The reason for the disparate for the gallery icon can be argued that the concept of grouping items can be easily understood differently depending on the context at any given time. A higher level reflection on the research process, co-design, and Afrocentric epistemology are shared in the conclusion of this chapter.

6.5 Chapter Conclusion

Co-design activities with the ovaHerero communities shared valuable input into collating associated multimedia. They proposed that the grouping can be made possible by allowing the IK holders to input the name of the traditional object being captured and its type. The application can then use that multimedia information to pre-group the multimedia. Having this pre-grouping in the system will allow the IK holders to quickly navigate to the preferred traditional object when formulating the task request for crowdsourcing. The idea mentioned above from

the co-design session at Erindi-Roukambe shows that the icon selection was secondary. The real reflection from this third CBCD cycle is on the functionality of the system and its impact on the co-design and the research process.

The community co-designers' idea of pre-assisting the application with their voice input for grouping of the multimedia items is an indication that their expertise can be used for implementing the system functionalities and do further analysis on the captured information. For example, the new categorisation of plants, animals, people, treatment or any other from the indigenous people perspectives can be established and mined. Community co-designers' lived experiences (IK) should be accepted as a valuable contribution to the co-design. Allowing the community co-designers to use their IK in the design process is a fundamental element of Afrocentric canon of embracing subjectivity and allowing the IK people to validate the research findings.

Different co-design techniques, including role-play, were used in different situations. We learnt to allow the community co-designers to use tools and terms they know — the freedom to choose sparked creativity, innovation, and fully understanding the concept being co-designed. The community co-designers spontaneously took out their traditional objects during co-design sessions. Once again, similar to CBCD cycle one, Uariaike shared valuable IK while in the co-design process. The research co-designers also shared their technical knowledge explaining how computers execute certain operations. We learnt that expertise voluntarily transferred skills in the co-design process complimenting the AR premise of mutual learning and Afrocentric knowledge sharing and creation for the well-being of the community.

The CBCD role-play was an excellent initiative to get other academic research input about this study. Uariaike and Mukamberenge were a bit uncomfortable whether they did well in the role-play. Uariaike asked the author after the role-play whether he performed well on the role-play or not. The author assured Uariaike that he did very well and that there was nothing for him to worry. Uariaike's concern showed us that although he was uncomfortable being in a lecture auditorium set-up, he is committed to this research project. Community co-designers should also visit the research co-designers work area. For Uariaike and his wife to see the work side of the research co-designers allowed sharing of skills and lifestyles.

The author waited for an extended period for a discussion between Uariaike and the research co-designers before translating. One person from the audience that he felt that the translation was not a direct quote but rather paraphrased mentioned this. There was agreement among the research co-designers that for future role-plays translation should be tried to be done in a shorter time interval even though this is generally tricky.

We also learnt to accept and understand the political background of Uariaike. This understanding was essential to empathise with Uariaike's well-being as part of us for actual Oundu realisation.

In both workshops at the PDC 2016 conference, the participants plainly stated that accurate information about the traditional objects should be provided. What the traditional object is, what it is used for, and its actual size. Without this information, the graphic designers would be left ambiguous interpretations of the

traditional object. The participants suggested that the information could be supplemented with video recordings showing how the traditional object is used. An indication of its size should be incorporated in the photos sent for the task request. The purpose of creating the 3D models should also be communicated clearly.

The correct orientation of the traditional object on the photo is significant in order to create an accurate 3D model of it. Task request photos should be simple and clear, if possible, without shadows or background objects. Such obstructions make it very difficult for graphic designers to distinguish the actual traditional object. The participants suggested that the IK holders should specify the essential details of the traditional object so that the graphic designers can focus on these to create the perfect 3D model. An appropriate reward system for graphic designers should also be considered. The question remains whether sending the actual traditional object to the graphic designers, providing monetary payment, or a rating mechanism should be used. An intermediary is needed for investigating what graphic designers would want as a reward and what the IK holders would or can offer. The intermediary could facilitate this negotiation, helping to overcome language and cultural barriers.

The interaction among the participants during the PDC workshop (simulated creating 3D models) should be taken as a significant input for the implementation of the community crowdsourcing (CCSP) website. There were many discussions before the participants started with the drawings. Thus the CCSP website could include discussion forums or chat rooms for the graphic designers. The CCSP website should allow graphic designers to collaborate on creating the 3D models. The interaction between the graphic designers and the IK holders provides for feedback loop communication, in which the crucial details that should be included in the request are specified. Moreover, we see a transfer of knowledge from this interaction.

We have seen Oundu values being intrinsically applied in our engagement with the communities. Entering the community co-designers homesteads with respect and giving the tokens of appreciation after the workshops are valued as a sign of giving something to your family that you visited, not as a payment. The food sharing was reciprocal. The community co-designers at Okomakuara gave the researchers omaere to drink and to taste the butter that they produce from omaere. The community co-designers have accepted us the research co-designers to be part of their community. Moreover, the commitment of the community co-designers to see the progress of the research deliverable was an indication for us research co-designers to continuously provide tangible results to avoid disappointment and lose trust from the community.

Lastly, licensing policy needs to be put in place, specifying what the graphic designers will be allowed to do with the photos, videos, or audios sent by the rural communities. This issue was briefly discussed with Uariaike, to which he pointed out that he is not worried about the ownership of the media items once he has sent them to graphic designers. A thorough discussion with Uariaike and other community co-designers should be done to discuss the licensing consequences of not stating usage conditions on the media items that would be sent to graphic designers. The next Chapter 7 presents an in-depth discussion about

the themes selected from all our three CBCD engagements.

Chapter 7

Reflection

This chapter provides the findings from all three CBCD engagements discussed in Chapter 4, Chapter 5, and Chapter 6 aimed at the overarching enquiry on how to co-design a crowdsourcing task management application for safeguarding African indigenous knowledge. The results are discussed based on the *themes* (topics) that were raised from the CBCD cycles interactions to find solutions to our opening three research theme questions (*RTQs*) outlined in Chapter 1, which are:

1. What are the necessary conditions to establish and maintain a beneficial embedded community engagement?
2. What are the suitable methods for technology co-design?
3. What does the communities' appropriate crowdsourcing concept entail?

To provide a broad overview for each of the RTQs, we identified three themes: (1) *Beneficial Embedded Community Engagement* (Research approach), (2) *Co-Design Methods*, and (3) *Appropriation of Technology*. These three central themes mentioned above divide this chapter. Each themed content was populated using a qualitative data analysis tool (`Nvivo`) by importing all 16 workshop transcripts and assigning the text sections from the transcripts to the related themes. See Chapter 3, Section 3.2.3 for a full description of this. The 16 workshops conducted are from all the three CBCD cycles.

7.1 Theme 1: Research Approach

In this section, we highlight our key contributions to the research approach. We report on the necessary conditions that should be established to maintain a beneficial embedded community engagement as an answer to the first research theme question. The four requirements identified were namely: (1) Afrocentric research approach (Afrocentrism), (2) Community engagement through Oundu (Ubuntu), (3) Mutual learning and knowledge creation, and (4) Understanding of ethics and copyright from the communities' viewpoint. We discuss these four conditions in detail in the following subsections.

7.1.1 Afrocentrism

Afrocentric research canons from the ovaHerero speaking community interpretation and how we experienced it is provided here. Assisted by Otjiherero speaking experts, we translated the five rules (canons) defined by Reviere (2001) on how to conduct Afrocentric research to Otjiherero. The five canons translated into Otjiherero (see Appendix E) were then discussed with Uariaike for his interpretation and suggestion. The Afrocentric principles outlined by Reviere were discussed in detail in Chapter 3, Section 2.1.1, in this section, we only refer to them.

Table 7.1 provides keywords comparison of Reviere's principles and the Otjiherero interpretation (full text in Otjiherero can be found in Appendix E).

TABLE 7.1

Reviere's Afrocentric canons comparison to Otjiherero interpretation.

Reviere's Canons	Otjiherero Interpretation
1. Ukweli (truth)	Owatjiri (truth)
2. Utulivu (justice)	Ohange (peace)
3. Uhaki (harmony)	Oupore (harmony)
4. Ujamaa (community)	Oupamue (togetherness)
5. Kujitoa (commitment)	Ounongo (knowledge)

It is interesting to note that some of the Otjiherero canon descriptions are different from the ones defined by Reviere (2001). The reason for these differences is that the rules were explained in Otjiherero vocabulary, and in most cases, a direct translation was not possible. However, this worked well as the Otjiherero speaking experts had a lengthy discussion about interpreting the canons from their perspective. We found the Otjiherero words to be more descriptive. For example, *knowledge* was selected as the keyword for the fifth cannon while Reviere chose *commitment*. Since the fifth canon is about constructing *knowledge*, that embrace subjectivity, as opposed to scientific objectivity, makes more sense to have the emphasise on knowledge instead of commitment.

Concerning the *first canon (truth)*: interpreted as **Owatjiri** in Otjiherero meaning the truth. The Otjiherero experts agreed that the indigenous communities should validate the authenticity of the research findings. We stress that the focus should not only be about the research findings but the indigenous communities should holistically have input and verification into the research conduct from the start till the end.

When we asked Uariaike for his comment on this canon, he agreed that research findings, especially about the communities' IK *in situ* without the communities' verification, cannot be accurate. He further stated that if someone is not from his community and did not consult his community, how can that person claim to have discovered new findings of his community? Uariaike's argument is, in essence, that IK is shared orally and practised in daily activities on the ground, and thus, researchers should verify with the indigenous communities to have accurate information. While we were busy constructing the 7C model (Maasz *et al.*,

2018) for safeguarding IK through co-designing technologies, Uariaike included the validation phase to ensure truth.

When we simulated the evaluation of the 3D models of ovaHimba traditional objects (see, Chapter 4, Section 4.4.2), we witnessed dissatisfaction of the communities when the 3D models were not representing their tradition correctly. The graphic designer creating the 3D models put more attention on the shape of the object omitting the finer details that has significant meaning for the communities. We also showed that if the IK of the communities is not adequately communicated, it can be inconspicuous to the outsiders (Stanley *et al.*, 2016). Continuous communication is crucial among the communities and the researchers or crowdsourcing contributors. We are aware in most cases that the language barrier might become an obstacle in this communication, to overcome this, we proposed that the translation can also be crowdsourced. For us, researchers to include the indigenous communities viewpoints in the research process and design of the TMA from the first and in all subsequent CBCD cycles was our mandate to fulfil the first Afrocentric canon. We agree with Banks (1992) and Higgs (2010) that fulfilling the first Afrocentric canon is a good start towards moving in the right path of integrating African epistemology to the general body of knowledge.

The *second canon (justice)*: **Ohange** in Otjiherero was understood as peace. The Otjiherero speaking experts interpreted ohange in the context that researchers should seek to maintain order in the community. Uariaike emphasised that the community-based research should be reciprocal the same rules should apply to the communities too. Uariaike made the following analogy, that often when the elders (Otjiherero speakers) are wishing you well they would say "let our ancestors be with you in *ohange* (peace) and *orusuvero* (love)".

Uariaike admitted that there might be divisions within the community, but that should not be encouraged but rather if possible rapprochement should be sought. He mentioned that division within a community is inevitable for that reason researchers should be prepared to handle it well without instigating conflict among the indigenous community members and themselves. Maintaining peace is one of the fundamental values of Oundu.

The challenge that we faced was on how to balance the engagement among the three pilot communities and within the ovaHimba community. We spent most of the time with the ovaHimba community. The other two ovaHerero communities were at times concerned whether the research was still ongoing or not, but when we explained to them that we had to finish the co-design concept with the ovaHimba community before trying it with them, they were happy about this.

Another instance where we could have caused division within the ovaHimba community is when Uariaike migrated from Ohandungu to Otjisa (see, Chapter 5, Section 5.3.2). We started visiting only Uariaike at Otjisa, and we were informed that this was not good. We then continued visiting Uariaike's relatives at Ohandungu and gave them tokens of appreciation even though no workshop was conducted there. This kindness showed that we become part of Uariaike's family and were required to behave according to his norms of family-hood of caring for each other.

About the *third cannon (harmony)*: **Oupore**, interpreted as harmony in Otjiherero, it was explained that a good researcher does not practice unfairness in

his or her research procedures. Uariaike explicitly reiterated that oupore should be a mandate for the community members too, not only for the Afrocentric researchers. He emphasised that the community members and the researchers should become one community, and therefore harmony should be maintained within the community.

Researchers should note that in most African indigenous communities, harmony is beyond human relations; it is also with the whole ecosystem and ancestors (Hiebert, 1998). Maintaining harmony is also among the core values of Ubuntu (Tutu, 2000, pp. 34-35), and if those values are properly harnessed, we believe that the research partners would be more open for information sharing and learning.

Fourth cannon (community): was interpreted as **Oupamue** in Otjiherero meaning togetherness. It was explained that the researchers' work should support the community mission and way of living. Uariaike mentioned that *oupamue* encompasses everything, including the living and the ancestors. He further pointed out that an individual could not exist in isolation. Uariaike's statements are complimented by the values of Oundu and are corroborated by authors such as Hiebert (1998), Mbiti (1990), and Shutte (2001, pp. 21-22).

We developed a good relationship with Uariaike. Uariaike demonstrated how easily such a relationship could be maintained. He would sometimes call the author of this thesis for greetings and to inform him if one of his relatives had passed on. Uariaike insisted that the research team should sleep at his homestead and when we did he was happy about this and informed the researchers that his home was also theirs (see Chapter 5, Section 5.3.11). The relationship between researchers and community members can vary depending on personalities, but maintaining a good one is the underlying humanness aspect of Oundu that Afrocentric researchers should strive to achieve.

Fifth cannon: ***Ounongo***, interpreted that Western practises and ways of living should not drive the research about African IK. Uariaike agreed that researchers, especially those who are from the African communities, should not be blindfolded by their Western-trained way of acquiring knowledge. Uariaike further mentioned the importance for one, is to understand the world from all different dimensions of knowledge. What is of utmost importance is how one can appropriately contextualise his or her perspective; for example, an indigenous African should contextualise from his or her understanding of the world when investigating Western knowledge.

We are aware of a subjective power imbalance in concerning the researchers and the community members. Our findings are in line with Pillow (2003) and Krauss (2013) that it is better to accept that uncomfortable reflexive thinking does exist in research. This reflexive learning acknowledges that our assumptions, values, and culture can be questionable. It was, therefore, critical that we had to establish an environment that would allow cross-examination. The cross-examination was made possible by allowing the indigenous communities to conceptualise the crowdsourcing concept from their perspective and then co-design the appropriate technology with them.

In summary, Figure 7.1 illustrates the ideal Afrocentric research approach with

the Otjiherero interpretation of Reviere (2001) canons. We discussed the Afrocentric research approach here in isolation from the bigger picture of Oundu and CBCD. In Chapter 8, we present a unique synthesis of these critical elements.

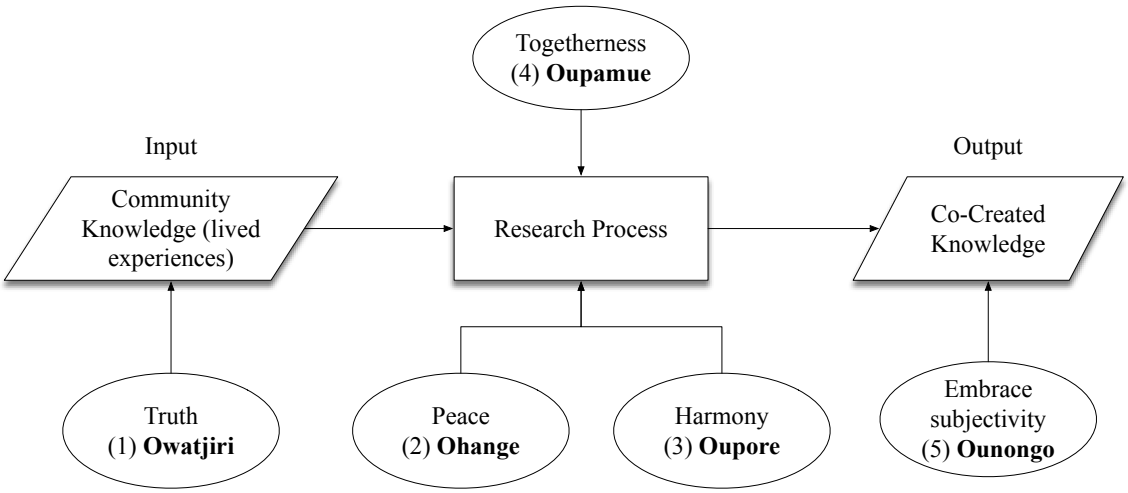


Figure 7.1. The diagram shows the ideal Afrocentric research process with the Otjiherero interpretation of Reviere (2001) canons. The Otjiherero words are indicated in bold font. Diagram constructed by the author.

Afrocentric research input should considers the lived experiences of the communities. The communities are the living testimonies of their knowledge experimented over years. The research conduct should be in line with the Afrocentric rules maintaining peace, togetherness and harmony. The co-created knowledge output of the research should also embrace subjectivity.

7.1.2 Community Engagement through Oundu

Oundu means to respect, love, value and appreciate another human being in all our doings. It is, therefore, essential to first pay special attention to know how we greet someone even if that person is a stranger to us before engaging in detail co-design discussions.

In Chapter 4, Section 4.4.1 in-depth greetings within the Otjiherero speaking communities was witnessed during the CBCD cycle one. The Otjiherero speaking researchers needed to mention their "eanda" (maternal family line) when they greeted the ovaHimba elders for the first time. Within the Otjiherero speaking community, everyone is related to one another somehow. The strong family relationship within the Otjiherero speaking communities relates well to Oundu values for knowing and caring for each other in the community.

We worked with the ovaHimba communities for the first time during this study; it is, therefore, worth noting how we entered their space. What worked well is that we found a *contact person* or *intermediatory* (John Tjipurua) that could speak Otjiherero spoken by the ovaHimba. John is related to Uariaike. A good starting point to try to find a contact person is from the researchers' colleagues, from the research institutions or the researchers' university students. We found

the rural communities were well receptive to the researchers when they noticed that they were with someone they knew. The first time we arrived at Ohandungu village, we witnessed the ovaHimba elders asking John whether the researchers are his friends that he informed them earlier. John first introduced the researchers initiating that first trust that these were "his friends" with good intentions to work with the ovaHimba communities.

Rural communities in Namibia have leadership institutions such as community resource monitors, village development committees, farmers' committees, and others under the traditional leadership of chiefs for that village or region (Baker, 2006; Keulder, 2010). The *traditional leaders should be informed about any research activities to be conducted with their communities*. Informing the traditional leaders is crucial to determine the *access and benefit sharing* for both the researchers and for the rural communities.

To *respect* these rural communities' etiquette, John informed the Ohandungu chief (who is also John's relative) about our visit to his village. The chief welcomed us and our first workshop with the ovaHimba community was therefore conducted at the chief's homestead. We are aware this might not necessarily always be the case where the chief sees research contribution as beneficial to the whole community without his or her gain. We advise nonetheless that the researchers should always inform multiple traditional leaders so that consensus among the rural communities can be reached. To take time to establish a strong relationship with communities before jumping into the research agenda of developing software is in support with Morrison (2016) guidelines.

If the communities see no value or no benefit in the research being conducted, then the investigation should not be forced onto the rural communities. It is better to try to find ways how the study could be altered to benefit all parties. The research background and the benefit for both the researchers and for the communities should be stated upfront. The research contribution should aim at *solving the communities concerns*; this proved well when we visited the ovaHerero community from Okomakuara for the first time for this study. It was a drought season, and upon on arrival, the elders said why would we want them to work on computers while they have significant worries to think about (where their cattle will graze). After explaining the research background and contribution, the communities agreed to take part in the research.

The researchers should build on a *friendship that is nourished* during the community engagements. Uariaike's communication with the author for greetings developed a trust relationship of finding out how others were progressing with their normal life and in return increased research progression feedback. To share sentimental items such as a physical printout of photos with the rural communities was seen as a lovely gesture.

The researchers should be comfortable to accept that sharing is both ways, the researchers were giving tokens of appreciations to the rural communities and in return, the rural communities at times also offered what they had. We also learnt to appreciate that it was sometimes necessary to sleep at the rural communities' homestead instead of sleeping at the hotels nearby the rural communities' village. For us to sleep at the rural communities homestead showed that we had immersed and accepted the rural communities as equal partners in collaboration.

This immersion into the community was necessary to fulfil Afrocentric research and Oundu principles of togetherness (Asante, 1990).

It helped the researchers to know more about the livelihood of the rural communities. Sleeping at Uariaike's homestead also saved much time travelling, the workshops could start early, and in the afternoon, we reflected with the rural communities on the activities done for that day.

Continuous communication is crucial, but telephonic network coverage was inadequate in Otjisa village, which is usually the case in most rural areas in Africa. We tried to communicate through our contact person to communicate to Uariaike, but this did not work well in most cases as our contact person could also not get hold of Uariaike in a reasonable time. There were cases we planned that we would start with the workshop early morning time in Otjisa with Uariaike, but on arrival, we found out that Uariaike was in the field searching for his missing cattle, we ended searching for Uariaike and started the workshop at midday. OvaHimba are semi-nomadic cattle herders so researchers should be aware that when working with them that they are on a constant search for better grazing for their cattle. Farming activities take priority for these communities as this generate their income and therefore, should be respected. After all, continuation depends on whether the rural communities have full interest in the research and see their benefit and value from the research contribution as mentioned when entering their space.

In this section, we presented our experience of embracing *Oundu* while engaging with the communities. We recommend respecting the great greetings that sometimes involve asking about the well being of the livestock of the communities and weather conditions before starting with the research agenda. Doing this shows respect and care about the well being of the community, which is customary to Oundu principles of living. We can now confirm Nussbaum (2003) statement about African Oundu greetings that: "*Greeting or not greeting people, and how this is done, becomes a critical factor – not merely to demonstrate how sociable one is, but rather how human one is.*"

7.1.3 Mutual Learning and Knowledge Creation

In this section, we highlight on the mutual learning and knowledge creation achieved through our Afrocentric CBCD cycles of engagement with the rural communities. Knowledge creation is also an essential output of Afrocentric research process as shown in Figure 7.1 of the previous section 7.1.1. In Chapter 2 it was pointed out, that what is unique about the created knowledge from Afrocentric research is that it is not meant for the benefit of only a single individual, but instead, it should be for the well-being of the whole community (Asante, 1987). Our Afrocentric CBCD research methodology was guided by AR which emphasis on mutual learning from all research participants. AR aims at creating knowledge that brings about change to real problems (Carson, 1990). Afrocentricity take on knowledge goes in hand with AR.

Knowledge sharing and creation in our study were achieved on different levels from our social communications to co-design interactions or in our research

meetings. We witnessed that knowledge creation and sharing is achieved in different ways of interactions as pointed out by Grønhaug and Olson (1999). For example, we witnessed how the rural communities shared their knowledge during all the CBCD cycles. Knowledge was shared either in a discussion or as a demonstration in the co-design sessions. The ovaHimba shared quite insightful knowledge about medicinal plants, how their homesteads are constructed, dress attires, and other interesting information such as how the ovaHimba women perfumed their clothes and how the ovaTjimba gather their food, see Section 4.4.2 of Chapter 4.

OvaHerero also shared their culture during the co-design workshops; for example, the rural community at Okomakuara shared significant information about sticks, see Section 4.4.3 of Chapter 4. The ovaHerero men use the sticks for different purposes such as for walking, hunting, elegance, a sign of protection given to their daughters when they get married, and the main walking stick is inherited by the father's firstborn son or his eldest brother. Walking stick inheritance is a sign that a person has inherited the homestead and full responsibility of the family.

During our co-design sessions, knowledge was shared among research partners (including community members). The community co-designers at times mentioned that the software should intuitively automate operations, for example, that the computer should sort pictures to their related audios and videos by itself. The community co-designers made this statement not knowing that people programme computers. The community co-designers were informed that if they wanted the computer to collate the multimedia automatically, the computer has to be explicitly directed on how to achieve this and they could provide ideas on how this could be best accomplished.

The community co-designers themselves mentioned that they learnt how to operate on the tablet and were assisted by their children when they got stuck. We have noticed from the crowdsourcing conceptualisation CBCD cycle, and when we deployed the MCT and TMA in the second cycle, the elders were assisted by the youth when they were capturing the multimedia of their objects. Uariaike at times instructed his son to be present in the workshops so that he got sufficient technical training and understanding of the research project to assist him better. We see the interaction of the elders with the younger generation in using technology as an excellent opportunity for recording IK and at the same time still orally transferring it to the youth.

The research co-designers replicated the co-design techniques they mastered from one rural community to other rural communities to speed up and perfect the co-design process. What we also found interesting is that the global graphic designers on the Internet would also gain insightful information about the rural indigenous communities' cultural heritage through the community's task request narratives. Besides knowledge sharing, knowledge was also co-created.

When the co-designers were finding it difficult to use or to relate to particular classical software operation sparked new ideas on how to make the system work for them better. These difficulties allowed the co-designers to creatively think about new ways that would make more sense in their situation. The community

co-designers, for example, mentioned that they preferred a group account representing their community in a specific village for a crowdsourcing platform. The co-created concepts were implemented on the actual prototype, evaluated tested, and refined or expanded if it was necessary.

The unique cultural icons selected by the community co-designers to denote software functionalities represents their worldview. The community co-designers demonstrated activities they were familiar with and used those scenarios in the co-design sessions. From these interactions the research co-designers learnt that everything does not have to make sense for them; for example, we (researchers) had to accept and respect some specific icons that made more sense for the community co-designers but not for us.

We learnt that there are two types of reflections (immediate and long-term) in CBCD. The prompt reflection is done immediately after the workshops when everything is still fresh to all. The immediate reflection should be done with the rural communities to summarise what was covered so that the goal of what was done is made clear. The long-term reflection should allow the rural communities and the researchers to reflect on their own and later come back to share experiences encountered. Long-term reflections reveal social positive or negative consequences of deploying the artefact.

In one of our long-term reflection at Otjisa village, Mukamberenge (Uariaike's wife) informed us that after we gave them the tablet, it made them not work their usual full-day hours in their garden, as they were afraid that the tablet would be stolen because their huts are not locked. This valuable feedback could only be notified after a more extended period and going back to the rural communities to have a thorough focus group discussion.

We have learnt that continuous monitoring of progress is crucial; whether there is progress regarding a promised delivery by the researchers or by the rural communities. There were times that Uariaike did not formulate any task request because he was finding collating related multimedia items challenging to use. This taught us that if specific functions of the application are not easy to use, the user might not bother using the app at all. It is, therefore, necessary to go back for evaluation of the deployed prototype as early as possible (after one month at least). On the other hand, there were also times that we worked on an update of the crowdsourcing task management application and planned to provide Uariaike with the new update, but upon arrival, we discovered a new complete set of requirements to be taken into account. In this case, it did not make sense to provide Uariaike with the update that we came with but to go back and update it according to the newly discovered requirements. In these situations, constant communication is essential to continually ask the rural communities whether they are experiencing any problems with the deployed artefact so that if they are experiencing problems, the developers should rather not waste their time continuing working on an update that would be deleted before use.

Researchers moving from the traditional lab research to CBCD have to learn that the indigenous communities ways of acquiring and disseminating knowledge is through different forms, such as storytelling, proverbs and practical application of the cultural practices. To re-position the IK holders to part of the IK digitisation process we constructed a knowledge creation and dissemination

framework with Maasz *et al.* (2018). The framework is composed of five phases namely: (1) generating the knowledge, (2) capturing the knowledge, (3) curating the knowledge, (4) disseminating the knowledge, and (5) assessing it.

Afrocentric CBCD research is utterly different from lab-based experimental research. Respect to the elders was mentioned as one of the core principles that should be maintained to fulfil the Afrocentric research approach. Respecting elders is essential for knowledge creation and transfer. The elders transfer knowledge to the youth, and if the youth are disrespectful, how can they learn Uariaike once emphasise. Uariaike further mentioned that if the youth is not respecting the elders, the elders tend to keep the IK to themselves. Young researchers, either from the indigenous communities or from outside, should understand that they should also respect the elders. Researchers should handle the interaction with the elders with ultimate respect in the co-design sessions, especially when questioning them. We second Rajapakse, Brereton, and Sitbon (2019) for their views on respectful engagement in co-design. Respectful design is about valuing all co-designers perspectives, interests to encourage self-expression and self-determination for mutual learning.

We acknowledged that for knowledge creation and sharing to be harnessed an opportunity that allows the co-designers to think and reflect on suggested ideas critically should be presented by taking action to solve problems of interest to the community, and that is Afrocentric CBCD underlying with AR principles.

7.1.4 Ethics and Copyright

What came out clear from the beginning was that the rural communities preferred *not to be anonymous* as contributors to this study. The community co-designers mentioned that they preferred their photos to show their full faces and their real names in publications. They indicated that they were proud to be part of a research project that is about safeguarding their cultural heritage and, therefore, wanted to be known by their community members and by everyone. We received this information during our first encounter with the ovaHimba community at Ohandungu village before recording the co-design session, for full details of this work workshop see Section 4.4.1 in Chapter 4. In our Afrocentric CBCD research, rural communities are co-designers, co-researchers and therefore receive full credit and mentions of their identity. They are not subjects; thus, anonymity is not a question.

It is against the background mentioned above that we mentioned the community research members by their real names and has shown the full face of their photos in this study and all our publications. The articles that we published with the community co-designers, we first translated them in Otjiherero for the community members to understand and make their comments. The Afrocentric togetherness canon (*Oupamue*) discussed earlier in Section 7.1.1 reminds us to rethink about the standard research ethics of anonymous representation of the community participants if they were equal partners in the research process and output.

In this study, we did not cover the details of the rural communities copyright terms and conditions for the multimedia (pictures, audio, videos, and text) that

they are sending out to the public on the Internet. Community co-designers are yet to be well informed about the consequences of sending multimedia without any ownership as proposed by Uariaike. Uariaike asked why should he be worried about possession of something (multimedia narrative for 3D modelling) that he has given away, his concern is whether the modelled 3D object accurately represent what he wanted, see Section 6.3.5 in Chapter 6. Uariaike's statement gives us a complete understanding of electronic ownership. His discourse resonates with Oundu principles that *if you give something to someone you entirely give it to that person without worrying how it would be used*.

Conversely, the rural communities stated that specific information about their tradition should not be sent out to the public, for example, men circumcision or any false representation of their culture. Uariaike mentioned that at times they are at fault as they allow tourists or researchers to take pictures of them while not correctly dressed in their traditional attires. The rural communities suggested that the elders (a group) should approve the multimedia before sending out to the crowdsourcing website.

The community crowdsourcing website (not co-designed with the rural communities) was suggested by the author to be open source, as stated in Section 3.3.1 of Chapter 3. Open source code can be shared with other developers for improvement. Those that distribute it or its derivative work should also make it under the same terms and conditions; this is called copyleft, see the GNU General Public License (2007) documentation for the full explanation. Copyright license agreement for the crowdsourcing task management application, which was co-designed with the rural communities, are yet to be thoroughly discussed with the community co-designers. Research co-designers should not make copyright decisions about applications that they co-created with the rural communities on their own.

Research ethics are established on so-called internationally accepted guidelines and principles. These international rules, at times, do not consider the rural communities contextual views and feelings. Moreover, research institutions that partake in community engagement research adopted these criteria. Community engagements are being guided by patronising ethical guidelines, objectifying communities under the pretends of "no harm", rather than establishing symmetric and mutually beneficial collaboration agreements. To take as an example, the Research Ethical Guidelines recently established at NUST (see Appendix A) contain specific policies that do not apply to all type of community engagement research projects. The guideline enforces the researchers to state the copyright of the artefacts when submitting their proposal to obtain the Ethical Clearance Certificate to start conducting the research.

It is difficult for the researchers that conduct CBCD with indigenous to know the nature or value of the artefact before its conception; the researchers can only honestly know after adequately engaging with their research partners. The community co-designers should fairly decide the copyright owner of any produced artefact after clearly knowing the value and contribution of it. We, therefore, suggest that *institutional research ethics should consider to have an open clause or to have Memorandum of Understanding (MOU)* that can be verbally updated as the research

project progresses, as mentioned earlier in Section 7.2.2. For instance from the beginning of this study the IK holders (see Chapter 4, Section 4.4.1) clearly stated that they preferred that their real names and photos to be used in the publication as a sign of pride for what they are doing for their community.

The institutional guidelines or policies tend to overprotect indigenous communities and in return, limit their rights. IP rights for collaborating researchers among universities are equally shared. On the other hand, when researchers are partnering with indigenous communities to conduct research, the IP belongs to the universities. That is why we proposed MOU with all research partners irrespective of whether they are indigenous communities or not. In the MOU the IP rights can be stated that satisfies all partners. To have an adjustable MOU with the indigenous communities is a new approach to researching that will foster respect and fairness to all research partners.

Another issue is verbal consent. Continuing with NUST research ethics as an example, guideline provided makes provision for verbal consent to be obtained from illiterate participants. However, it again states that there should be a literate witness who should verify the verbal consent in writing. We still see this approach as satisfying the international policies that, a somehow written consent form is more valid than only having a verbal consent agreement. Some rural communities mentioned that they are not comfortable with a legal document that is signed by them or on behalf of them. The fear of signing documents originated from the colonial apartheid era in Namibia where the rural communities were told to sign some documents, not knowing that they were signing off their land (Werner, 1993). Several other authors, such as Darch (2014) and Anderson (2010), have mentioned the same sentiment that Western ethics are imposed on non-Western knowledge. However, there are good initiatives such as the *San Code Research Ethics* (Callaway, 2017) that are moving towards the right direction of establishing ethical research code of conducts written by the indigenous communities from their point of view to protect themselves from exploitation in research. The San peoples of Southern Africa have grounded their code of research conduct on four core values, namely, *fairness*, *respect*, *care* and *honesty*, which are inline with Oundu values.

ICT4D researchers also realised that they, for long, have not considered the indigenous communities ethical point of view. Moreover, there are not agreed shared written ethical standards which can guide researchers. To mitigate this problem, Dearden and Kleine (2019) have collaboratively worked with ICT4D researchers to co-create a set of minimum accepted ethical standards using a participatory process. They also acknowledged that an essential extension of their work is to get input from the researched communities.

To empower the indigenous communities, we invited Uariaike to academic events to present his research experience such at the second African HCI conference 2018 and NUST research day, see Section 6.3.4 in Chapter 5) with us and also remunerated him. We were often questioned by the NUST research office why we paid a community member for facilitating workshops. This questioning is undermining the indigenous communities capabilities and prefers that only academic research partners deserve to remunerated, which is not fair.

7.2 Theme 2: Co-Design Method

The original critical characteristics of the co-design methods and techniques that were brought out from this study are the impromptu usage of any traditional objects in the co-design to demonstrate concepts and for the selection of the interface icons. An essential aspect is for computer experts to accept that everything should not necessarily make sense for them, especially in reasoning the choose of the selection of icons. Computer experts should also appreciate the pragmatic approach of co-designing in action while the communities are busy with their daily activities. In the following subsections, we share the critical co-design methods that we found to be successful as well as the challenges we experienced.

7.2.1 Icebreaker for Co-Design

Co-design activities were started by allowing the rural communities to share stories and using those shared stories in the co-design session. This approach put the rural communities in front as experts and allowed them to quickly see the relation of their IK domain transferred in the computer world. It also brought in the sense of ownership from the very start. We, however, caution that stories shared before the co-design session can influence the design decisions.

7.2.2 Co-Design Process

To successfully empower the IK holders with the necessary skills to co-design technologies we devised a community contextual design process. We identified eight co-design steps process (Maasz *et al.*, 2018) as shown in Figure 7.2 and outlined after that.

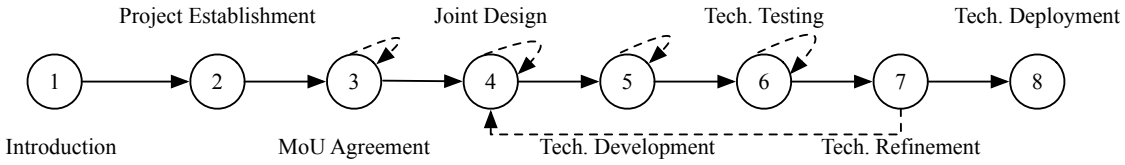


Figure 7.2. Proposed Community Based *Co-Design Process*. Published with Maasz *et al.* (2018)

1. *Initial Introduction*, we had initial discussions to find out whether the communities were interested in working with us or not. The initial introduction does not include any conventional recording materials; it is purely a bonding session to establish common interest and mutual respect. An intermediatory person can conduct this step on behalf of the researchers as it was in our case. Researchers should take note of how to engage with indigenous communities as elaborated in Section 7.1.2.

2. *Project Establishment*, at this step, we provided our project background and objectives. We established a common ground of understanding by clearly

stating the expectations from both partners (researchers and the rural communities) and other stakeholders. We also explicitly stated our benefits as researchers, for example, publications and promotion and allowed the indigenous rural communities to state what they foresee to benefit from the research. We recommend that the communities should be given ample time to think about what benefits the research will bring about to them. Researchers can leave and come back after some weeks as the researchers had thought about their benefits when applying for grant applications. The rural communities should also be given a reasonable time to think about the benefit of the research for them.

3. *Commitment Agreement*, we realised that this step was necessary due to the fact the universities research ethical clearance applications does not consider the real insights of the communities, we have provided more details on this in the next Section 7.1.4. We did not follow this step; however, recommend being mandatory as part of the community-based co-design process.

   The purpose of MOU is for research partners to outline the possible terms and conditions such as the IP and copyrights. The MOU should be revised as the research progresses, as indicated in Figure 7.2 with the dotted arrow line pointing back at step 3 . The MOU can be a verbal agreement with the community supported by the community's traditional leader.

4. *Joint Design Activities*, the researchers and the community, put ideas together on how best to design the application required. We used different co-design techniques such as technology probes, focus group discussions, card sorting, and scenario creations (using any impromptu material) to produce the design concepts jointly, see Section 7.2 for more details. Tangible outcomes from this activity can be screen designs as demonstrated in Chapter 5, Section 5.3.3. The joint co-design activities can take several cycles before the technology development starts because the rural communities should approve the screen designs first. The co-design activities and discussions were recorded for translation, transcription, and analysis.

5. *Technology Development*, at this stage the developers developed the application based on the co-designed ideas. Technology Development were done separately from the rural community as this step revolves around purely technical activities such as coding, debugging, testing, and refining.

6. *Technology Testing*, the developed prototype is taken to the community for testing. We first demonstrated to community members how to use the application. The prototype is left with the community to use while performing their daily operations and later reported on the challenges they had encountered.

7. *Technology Refinement*, at this step, the researchers got feedback from the rural communities by recording user experiences, usability issues and any technical or social issues experienced by the rural communities. If there are refinements to be made, researchers, along with the community redesigned

(step four) the application to improve the usability and functionality (step five). After refining the application, step six is executed again until no further improvement are required (all parties agreed on the final version of the app).

During this study, we encountered the prototypes deployed had bugs that needed to be fixed and usability issues that had to be resolved. For example, during the evaluation of the TMA in CBCD cycle two, we discovered the task request formulation was challenging for Uariaike to use and that he had accidentally uninstalled the TMA, see Section 5.3.8 in Chapter 5.

8. *Technology Deployment*, after thoroughly testing and refining the application, the TMA application was deployed to the community to use on their own in their regular daily routines. Deployment allows the communities to enhance their understanding not only of the developed technology but also on other positive and negative social aspects contributed by using the technology. Technology implementation at this stage includes long-term maintenance for sustainability.

Researchers should adopt a *flexible research plan* to consider that their monthly or yearly scheduled plan might have to be changed depending on what the rural communities are engaged with at that given time. Rural communities do not plan on an annual plan so trying to ask the rural communities in advance on what they would do on a specific month is not worth it. Commitment to duties is handled as they come based on priority. For the community-based co-design to be sustainable, *all stakeholders' commitment* is required.

Initially, we thought the community-based co-design steps was only for us the research team, but when we discussed it with the communities, they agreed that it was indeed what we had followed. They appreciated that included the MOU in the process. They mentioned that going through this process made them better understand what they were doing, and it also prepared them well for future co-design research projects.

Community-based research projects costing are very high. On average one research trip to the rural communities of about 700 kilometres cost the research team fifteen thousand Namibian dollars (USD 1000). Researchers should consider research third-stream income. On top of the funding provided by the Namibian NCRST and bilateral agreement funding with the South African National Research Foundation, we contacted the Electricity Control Board of Namibia management to sponsor the research project with tablets. We needed to get sponsors for additional tablets (since the tablets charging ports were damaged) so that we could deploy at least one tablet at all three communities sites plus to have one or two tablets used by the developers for testing the prototypes.

The community contextual design process outlined in this section should be undertaken while embracing Afrocentrism and Oundu' values that were discussed earlier. In the concluding chapter, we showcased how the community-based co-design process should be integrated into the bigger picture of an ideal Afrocentric research approach.

7.2.3 Co-Design Techniques and Evaluations

We have learnt that it is crucial to print out all the screen designs and go through them one by one with the community co-designers. Screen design printout allowed the community co-designers to relate well to these physical co-design techniques used, for instance, affinity diagramming, card sorting and sketching (see Chapter 3 for more detail). Moreover, it provided all co-designers with the opportunity to correct the screen designs by drawing on them and early user usability evaluations (Snyder, 2003).

At times the community co-designers were forgetting the co-designed functionalities. For instance in CBCD cycle two when Uariaike was tasked to recall the icons of the MCT that he had selected, he could not remember the gallery icon (cellular phone) to a point asking whether it was indeed him that have chosen that icon. We realised that this was due to several issues, for instance, (1) not well thought co-designed ideas were quickly forgotten, (2) infrequent use of the deployed application due to other farming duties commitment, and (3) research co-designers taking too long to come back to the rural communities for feedback. All the issues mentioned above were discovered after the CBCD reflections engagement with the communities. For the experiences mentioned above, it is evident that shorter successive CBCD cycles are essential in rectifying problems early before they escalate.

It was also tricky for research co-designers to explain and translate software application operations that did not have Otjiherero words. For instance, as mentioned earlier in Chapter 6, Section 6.3.1, there is no word in Otjiherero for video recording, and the same word that is used for drawing is also used for taking a photo. To explain software operations that do not have native words, we recommend demonstrating those functions by using the application instead of just verbal communication.

There were times in our co-design sessions whereby our contact person (John) dominated the co-design ideas instead of the community elders who were intended to use the application. This issue was resolved by informing John to allow the community co-designers sufficient time to think and communicate their ideas before he would suggest his. We had to resolve this issue as soon as possible to fulfil the Máat Afrocentric canon of always striving for peace and harmony (Asante, 1990).

7.2.4 Hardware Challenges

The hardware durability was a significant problem in this study. We had to replace tablets due to damaged charging ports, replace tablet broken charging cables, and also had to replace the solar panel cables. Environment conditions of gusty winds in Opuwo and sun reflection were issues. Due to sun reflection on the tablet screen, it was difficult to operate on the tablet and see the prompted response from the application. We had to think of convenient ways to provide application feedback in these situations; for instance, we had to adjust the media recording notification alerts by increasing its font size. Considering what we

experienced, as mentioned above, there is a need for co-designers to communicate their challenges to the hardware manufacturers to develop hardware that is durable in rural conditions.

7.3 Theme 3: Appropriation of Technology

What came out evident from the technology probe to refinement and deployment of the task management application is that we appropriated the technology within an African context, not based on intention-behaviour theories (Kambunga, Winschiers-Theophilus, and Goagoses, 2018). The communities adjusted the standard multimedia collection application interface to resonate with their culture and meaning-making which is what Muller *et al.* (2016) and Lindtner, Anderson, and Dourish (2012) highlighted should happen for an authentic community technology appropriation.

In the following subsections, we look into the third theme, that is, appropriation of the technology. The discussion starts with the trans-cultural interactions, understanding crowdsourcing from the indigenous knowledge holders' perspective, how cultural values resonated in the final artefact, how the application was modularised, and finally the crowdsourcing task request significance details.

7.3.1 Trans-cultural

There is no doubt that when different ethnic groups of people work together, diffusion and influence of knowledge systems and cultural values can occur. Our research community, including ourselves as researchers, is composed of different people with diverse skills, ethics and cultures. Previous studies by Rodil, Winschiers-Theophilus, and Jensen (2012) with the same ovaHerero communities have shown that to ensure sensitivity towards IK and not overlooking essential aspects of the communities' culture and worldview can be only be achieved once roles are interchanged, the designer becomes part of community, and the community becomes part of the designers, and when the object of design becomes a tool to participation.

We believe in Bohm (1996) theory of dialogue of accepting different opinions and putting assumptions aside before engaging in a discussion. In this type of dialogue, people are not attempting to make everyone agree but instead making something in common, that is, *creating something new together*. This type of communication is only possible when people are willing to listen to each other without preconception and without trying to control each other. Creating something new together in our context can be seen from the co-designed tangible output of the crowdsourcing task management application.

We acknowledge that the technological knowledge superiority pointed by Keita (2014) and discussed in Chapter 2 does exist. For example, there were times that the rural communities made remarks that now that the *white* people' (referring to the white academic researchers) devices capture their IK it would never die. Even though the research team had black researchers from the same rural communities, technologies were seen to be known by the white academic

researchers. We noticed more acceptance from the communities as the research progresses that the researchers that were from their community were also knowledgeable technological experts.

From our experiences in co-designing crowdsourcing systems with the indigenous, we have seen that the distinctive characteristics of community technology design endeavours have been the indigenous people' cultural stance which directs the agendas, interactions, and outcomes of the collaboration. We recommend applying different cultural lenses to community technology design that look beyond cultural differences to enter a trans-cultural mode of engagement (Winschiers-Theophilus, Zaman, and Stanley, 2017). A trans-cultural community technology design approach underpins continuous creation and re-creation of new meanings, which originates from the individuals blended and continuously being reflected within the existing design. At this level, a unity of epistemologies and relevance can be achieved.

7.3.2 Crowdsourcing from IK Holders' Perspective

The appropriated crowdsourcing application denotes the differences from the conventional crowdsourcing platforms. In our context, the requesters are the indigenous knowledge holders of the ovaHerero and ovaHimba rural communities. The contributors are the crowd of graphic designers and translators. The task requests are to create 3D models of the rural communities' traditional objects and translations (Otjiherero to English) of the task' narratives for the graphic designers to understand.

As mentioned in Chapter 1, contributors and requestors swapped roles in our crowdsourcing scenario. Researchers such as Ipeirotis (2010) and Ross *et al.* (2010) reviewed crowdsourcing platforms and found that most contributors were from developing countries and requesters from developed countries. In our context, the requesters are from a developing country (Namibia) rather than them being contributors from developed countries. This shifting introduced us to a couple of challenges.

Firstly, before we could engage in co-design activities, it was necessary to do a crowdsourcing conceptualisation cycle with the rural communities to understand the crowdsourcing concepts on their terms. It was essential first to explain this concept with what the ovaHerero indigenous rural communities are familiar with, for example, we used a scenario of the rural community members from the same village help each other with their farming activities, see Stanley *et al.* (2013). Using the scenario mentioned above let the rural communities imagine on a large scale of helpers whom they do not know and who would not physically see them from other villages assisting them free or for a particular reward. This conceptualisation might be thought to be a trivial task, but it is not as most technical terms are not yet defined in African indigenous languages thus a need for well thought detailed explanations is required as mentioned in Section 7.2 and pointed by Osborn (2010).

During the crowdsourcing simulation, the indigenous communities informed us on certain specific operations they preferred to be done differently on their

crowdsourcing task request management application. They desired that the community should have a group account instead of individual accounts for every community member. They also wanted the approval consensus to be done outside the application for them to have a physical group gathering to look at the collected requests and decide whether they should be sent out or not. The group rationale relates well to the Oupamue Afrocentric principle that everything that is done for the community should consider the togetherness practices of the community.

During the crowdsourcing simulation, we were also surprised that the indigenous knowledge holders were finding it difficult to relate to the icons located on the standard multimedia collection tools. This disassociation resulted in us to have focused co-design sessions with the rural communities on getting what they found to make more sense to them, for example, a picture of an eye, made more sense for them to be the right icon for taking photos instead of the picture of a camera. It is not just a matter of having a different crowdsourcing interface for requestors but deep-rooted reasoning of lived experiences affected their ideas on how the requests could be arranged. Their farming experience, for example, was used on deciding how the recorded multimedia should be displayed, they thought of presenting the multimedia types, that is, videos and images separated in a way they usually divide their livestock into fenced sections for proper management.

The TMA interface instructions are written in Otjiherero for those rural communities that can read. A reminder that the TMA is the tablet-based app co-designed with the rural communities to manage their crowdsourcing requests. It was also crucial for the rural communities to acquire required basic IT skills to participate in crowdsourcing. During the crowdsourcing simulation cycle, the rural communities were given a tablet to attain the necessary basic IT skills to work on a tablet. The rural communities mentioned that if they failed to operate the tablet, they would instruct a youth who has the IT skills to represent the community by sending and receiving the task requests.

7.3.3 Cultural Values and Technologies

The importance of traditional objects was signified from the beginning of this study during the CBCD cycle one. When the community elders were tasked to take photos of the objects they wanted to be transformed into 3D models, they first started from taking pictures of the holy-fire, then the kraals, to the huts (houses), and household utensils.

When the community co-designers had to select icons for the gallery of the TMA, the ovaHerero community from Erindi-Roukambe, for example, chose a branch of a particular tree called omuvapu and a calabash. Here the branches of the omuvapu tree represent rooted necessary customs for the ovaHerero communities. The branches are placed on the ground as a temporary table to put meat on it at an area called omuvanda where only cattle and sheep are slaughtered. Once the meat is placed on the branches, the branches area is called ovihuno. Omuvanda is a highly respected area between the elder of the homestead house and the cattle kraal that should not be crossed by strangers. The calabash here

represents its great significance of storing omaere (milk kept for a longer time to acidify) that is part of the ovaHerero and ovaHimba community traditional food.

Besides the rural communities selecting traditional objects, they also devise the software functions from their experiences in using technology and other materials. The ovaHimba community from Otjisa, for example, picked a picture of a cellular phone as a gallery for the entire captured multimedia item. The rationale for selecting the mobile phone was that they were aware that they store all their phone contacts in it and therefore they can easily relate to the tapping on the cellular phone icon on the MCT to see all the traditional objects or IK captured. The ovaHerero community from Erindi-Roukambe used their experience with the classical photo albums to demonstrate how the TMA should display the pictures as not too many on one page.

Cultural practices were also obeyed in the usage of software applications. When the ovaHimba women were given the HSC to construct their homestead, they informed the research co-designers that women do not own homesteads and therefore, they cannot be tasked to build them. The research co-designers had to explain in these situations that the women should imagine that they are only doing so to teach the youth how their men construct the homesteads.

7.3.4 Modularity

In this section, we provide a summary of what let us decouple the MCT and the crowdsourcing TMA. Initially, we had the MCT and TMA modules as one component. When these two were as one module, it was not clear to distinguish the process for collecting and collating (grouping pictures to its associated audios and videos) the multimedia to be sent for the archive at the Namibian National Database and collecting and organising (collating) multimedia for crowdsourcing 3D models. Having the two modules as one application resulted in the IK holders being confused, not knowing whether they are in the gallery of the MCT or in the create task request functions of the TMA.

Noticing the difficulty and confusing of using the combined module, we decided to divide the multimedia collection operations as a separate module. After separating these two modules, it was straightforward to describe their processes. There are known guidelines on how to decompose a module, for instance, when it is not very easy to define a specific module or if the module has too many functions that can be easily grouped in categories. After experiencing this problem of high cohesion modules, we agree with Hoek and Lopez (2011) that modularity should be an integral part of the designers that should cut across all the design cycle of the software.

The development of the TMA was done in scaffolding. The rationale behind this scaffolding strategy was to allow successful improvement of advanced features and also allow the user to use the application in sections and increment the additional features as the user progresses in mastering the developed functionalities. The scaffolding strategy has also been successfully used by Mbogo, Blake, and Suleman (2014) to create mobile applications that assist novice learners in computer programming.

7.3.5 Task Request and 3D Significant Details

To accurately develop an artefact, its specification should be clear and understandable by all involved in the development. The indigenous communities had to explicitly formulate the task requests so that the graphic designer design satisfactory 3D models. Some details are apparent to the indigenous communities, such as the information embodied in their traditional attires. Therefore, they did not see the importance of specifying them in the task request to the graphic designers. Those omitted details by the indigenous communities were of significance for the graphic designers to create accurate 3D models. Observing this predicament, we realised that we had to investigate what the essential details are for both the indigenous communities and for the graphic designers (Stanley *et al.*, 2016).

The indigenous communities task request essential details that have to be specified were mentioned from the crowdsourcing simulation CBCD cycle one, see Section 4.4.1 in Chapter 4. While Uariaike was taking photos of his traditional objects, he shared valuable information about those objects, especially when he was with the researchers who were not fully aware of Uariaike's tradition. This approach of Uariaike sharing useful information brought in the concern of whether Uariaike would do the same when he is alone. We reminded Uariaike that he should record that valuable information even when he was alone. After we evaluated Uariaike's usage of the first data collection prototype, we found that he shared insightful information; however, not as in detail when he was with someone who was asking him questions. In this regard, we suggest developing an agent that would prompt the IK holder to engage in an interactive dialogue. We are aware that it is natural that someone would not share much detailed information if not asked for and would also not be knowing what the other would like to know.

The task requests' essential particulars were also finally highlighted by the participants at the 14th PDC conference (2016) interactive workshop, see Section 6.3.3 in Chapter 6). After analysing the workshop transcripts, six essential task essential details for the task requests were identified as follows:

1. The task request specifications should be easy to understand.
2. The actual size of the traditional object should be indicated.
3. Pictures or videos should show the correct orientation (not upside down) of the object.
4. Information on what the traditional object is used for should also be provided.
5. The rural communities should indicate the critical parts of the traditional object for the graphic designers to focus on when creating the 3D models.
6. Copyright information of the multimedia narratives (pictures, videos, audios, and text) to be sent by the communities should be stated.

The rural communities agreed to state their specifications in their language (Otjiherero) so that they can openly express themselves. The rural communities agreed that the youth or elders that are proficient in Otjiherero and English should do the translation of the specifications. We are aware that there might not be enough skilled translators from the rural communities resulting in inaccurate translation. We propose to use the crowdsourcing website for sourcing for the translators and validating the translations.

The communities themselves realised that it was important for their task request specification to be clearly stated so that the graphic designers can create the correct 3D models for them. During the crowdsourcing simulation, the rural communities mentioned that they would like to decide as a group on the images to be sent out to the graphic designers to ensure that those images clearly show what they want to be modelled. They also acknowledged that if the delivered 3D models are not accurate, they could have caused this, and therefore they should redraw or retake the photos correctly. IK holders showed from the first CBCD cycle that they wanted a correct representation of their tradition, and consequently, they tried to create detailed, accurate drawings of their homestead.

In one of the crowdsourcing simulation workshops at Okomakuara, see Section 4.4.3 in Chapter 4, one of the IK holders (Mika) suggested that the rural communities should draw several drawings of an object to select the best ones for the task request. He emphasised that some of the drawings were not precisely drawn. Although this could be part of making the request clear, all the co-designers in that workshop agreed that the rural communities should not prioritise on making the drawings too perfect but rather on drafting sketches that are clear enough for the graphic designers to create the 3D models.

If the task request includes only pictures, the graphic designers would have no idea of the traditional object actual size in reality. We can argue that when someone is creating a 3D model that person does not necessarily have to know how small or big the real object is, as the 3D models are not designed in the actual size of the object. However, having an idea of the actual size of the object will reduce curiosity and let the graphic designers focus on the design. Pictures or videos showing the objects in the wrong (upside down) direction can result in the 3D object being modelled that way. To reduce the mistakes to be made by graphic designers correct, orientation should be taken, and the significant parts for the graphic designers to focus on the traditional object should be indicated by the rural communities.

There was a concern that the indigenous communities took multimedia items such as the pictures and videos which could be misused by graphic designers or by transcribers on the Internet. Initial discussions were held with the rural communities to inform them about the consequences of sending their multimedia about their traditions without any terms and conditions of them as they proposed as previously mentioned in the ethics Section 7.1.4.

7.4 Chapter Conclusion

This chapter gave an in-depth discussion of the themes that were raised from all the action research cycles discussed in Chapter 4 to Chapter 6. The topics

were identified inline to answer the three research questions (referenced as *research theme questions*).

To answer the first question: "*What are the necessary conditions to establish and maintain a conducive contextual community engagement?*" Five themes were namely as (1) Afrocentrism, (2) Community engagement through Oundu (Ubuntu), (3) mutual learning and knowledge creation, (4) Community-based Co-design process, and (5) Understanding of ethics and copyright from the communities' viewpoint. These five themes framed the conditions that should be established and maintained for beneficial embedded community engagement.

Based on our community-based co-design engagement methodology with the indigenous rural communities in Namibia, we derived Afrocentric epistemological foundations to contextually co-design software applications with people of different cultural heritage and value systems. Adequate community engagement process and etiquette should be followed. Knowledge sharing and creation is part and parcel of the Afrocentrism, Action research, and in the co-design process and should, therefore, be activated, refined, shared, visible in the co-designed artefact, and evaluated. Researchers should instead embrace subjectivity, as opposed to scientific objectivity when developing tools for the safeguarding indigenous knowledge of the African rural indigenous communities. Otjiherero interpretation of the Afrocentric canons shared insight that the canons should not only be applied to the researchers but to the rural communities to ensure reciprocity.

We understood Ubuntu named Oundu in Otjiherero as a fundamental phenomenon of humanness. Respecting elders was highlighted as one of the fundamental values of Oundu for one to learn. Knowing the fact that IK is orally shared from the elders to youth, this brought us to light that if the youth are not respecting the elders, they would not be able to learn. Mutual respect should be established first so that even if the youth are using the tools to learn IK, they appreciate what the elders have captured on the devices.

Everyone is related somehow within the Otjiherero speaking communities. A dual system of matrilineal and patrilineal has been kept for years and is occasionally used in greetings. Praises are used to complement one achievement and association with events and places. If someone is not from the Otjiherero speaking the communities always tend to establish a common bond, for instance, who of their community member introduces the outsider. Further bonding relations are established through the goodness of the outsider. Establishing a good friendship with communities is crucial for trust-building accepting that communities also give tokens of appreciation for working together for something that would benefit the researchers and the communities.

During community engagement, knowledge sharing and social bonds are voluntarily established on different levels of interaction, satisfying the ideal Afrocentric research approach. We have learnt that in ideal Afrocentric research created knowledge is not meant for the benefit of only a single individual, but instead, it should be for the well being of the whole community. Knowledge creation and dissemination in our study were achieved on different levels from our social communications to co-design workshop interactions or in our research meetings.

Project establishment based on knowing how the African IK is constructed

and the significance of Oundu values are crucial elements before community-based co-design process can be feasible. Memorandum of understanding considering all stakeholders values should also be established and updated as the research progresses. Joint design, technology testing and refinement should be treated as recurring activities to be excited only once a satisfaction level of deployment as been reached. An indirect consequence of the deployed application should be investigated. Researchers often deploy applications or methods without evaluating the effects of it that could relate to other social life issues.

International established ethical guidelines adopted by research institutions should be adjusted to cater for the indigenous communities views and values freely instead of overprotecting them. Researchers should stop treating communities as research subjects but rather as equal research partners. MOUs that clearly define the IP and copyright of the artefacts to be produced should be established when researchers are working with the indigenous rural communities. The MOU should be updated as the research project progresses to adjust copyright clause for the artefact being produced. The MOU does not always have to be a written document for the communities to sign; a verbal agreement should also suffice. Moreover, universities should institutionalise community engagement collaboration to fully harness the epistemology of indigenous communities as part of their curricula.

To solve the second question: "*What are the suitable methods for technology co-design?*" Appropriate community-based co-design techniques that the communities prefer should be used — for example, using their traditional objects for demonstration instead of the classical co-design techniques. Even though the native language of the communities might be limited regarding technological terms, researchers should be patient enough to use long descriptive explanations. During our co-design sessions, the researchers might carry out different functions such as workshop facilitating, video recording, or translating. In such situations, the researcher's input in the co-design process should not be discarded. Hardware durability issues and social consequences of the deployed artefact should be identified and diagnose as early as possible. Co-designing technologies with the indigenous communities established an excellent opportunity to get the communities' input into the research process and in the final artefact.

Concerning the third question: "*What does the communities' appropriate crowdsourcing technology entail?*" Crowdsourcing practitioners should take cognisant of the novice challenges brought by indigenous rural communities trading as crowdsourcing requesters instead of the usual big corporations. The crowdsourcing task being requested is specified in the rural communities languages and understanding to be translated into English or any other language. The research co-designers should allow the communities' cultural aspects to be incorporated into the technical implementation of the crowdsourcing application for the communities to make sense and usage of the technology entirely.

The rural communities are challenged to start seeing their traditional objects from a different angle; what seems obvious to them is not that obvious to others. This reflection makes it crucial that verification and validation of the delivered contributions are needed. A learning outcome for the rural communities is the

understanding that software tools are developed based on precisely defined requirements.

In the last Chapter 8, a unique synthesis of Afrocentrism, Oundu (Ubuntu), AR, and CBCD is presented as summarised findings of this study. Future work and recommendations are also shared.

Chapter 8

Conclusion and Future Work

This chapter is structured in six sections described as follows. Section 8.1 provides an overview of the study. The research contribution is summarised in Section 8.2. A novel synthesis of Community-Based Co-Design (CBCD) research methodology, Ubuntu (Oundu) values, and Afrocentrism as an African epistemology are shared. Section 8.3 list the limitations of the study. Section 8.4 discusses the recommendations for further studies, and in Section 8.5 a retrospective of the author is given. Concluding remarks are shared in Section 8.6.

8.1 Overview

The overarching question for this study was: *How do we co-design a crowdsourcing task management application (TMA) with the ovaHerero and ovaHimba rural indigenous communities for safeguarding their cultural heritage?* The purpose of the TMA is to allow the communities to make a crowdsourcing task request for 3D models of their traditional objects to be modelled by graphic designers on the Internet. The rural communities evaluate the delivered 3D models, and if they are satisfied, the models are imported into the communities' 3D homestead creator application (HSC). The HSC is then used by the elders to share IK with the youth. They set up their modelled homestead by dragging and dropping the 3D traditional models.

Three CBCD cycles were conducted. Firstly, crowdsourcing conceptualisation with the ovaHerero communities. Secondly, crowdsourcing simulation and co-design with the ovaHimba community. Thirdly, replicating the co-design with ovaHerero communities and simulating 3D models creation and evaluation. After reflecting on our CBCD engagements, we defined the following three questions to answer our overarching question stated earlier.

1. What are the necessary conditions to establish and maintain a beneficial embedded community engagement?

2. What are the suitable methods for technology co-design?

3. What does the communities' appropriate crowdsourcing concept entail?

Four necessary conditions were identified that should be set and maintained for beneficial embedded community engagement. (1) Afrocentric research approach (Afrocentrism), (2) Community engagement through Oundu (Ubuntu), (3) Mutual learning and knowledge creation, and (4) Understanding of ethics and

copyright from the communities' viewpoint. A detailed discussion of these four provisos was covered in the previous Chapter 7.

Suitable methods for technology co-design and what the communities' appropriate crowdsourcing concept entails were also identified. Five themes were established to be integral for the process of appropriating crowdsourcing technology with the indigenous rural communities. The five themes are (1) trans-cultural interactions, (2) understanding crowdsourcing from the IK holders' perspective, (3) cultural resonance, (4) modularity, (5) crowdsourcing task request significance details.

8.2 Contribution of the Study

In this section, we provide a holistic look at the synthesis of Oundu, Afrocentrism and CBCD coupled with Action Research principles to provide a clear depiction of the answer for the first research question mentioned above in Section 8.1. The three cases of co-design with communities, offered as exemplars to inform further community-based co-design research and practice. We also provide a summary of the answers for the second and third question.

8.2.1 Beneficial Embedded Community Engagement Conditions

The thesis contribution on the methodological and epistemological level is depicted in Figure 8.1 that shows the interaction of the Oundu, Afrocentricity, AR, and CBCD. To undertake CBCD with African indigenous communities there are

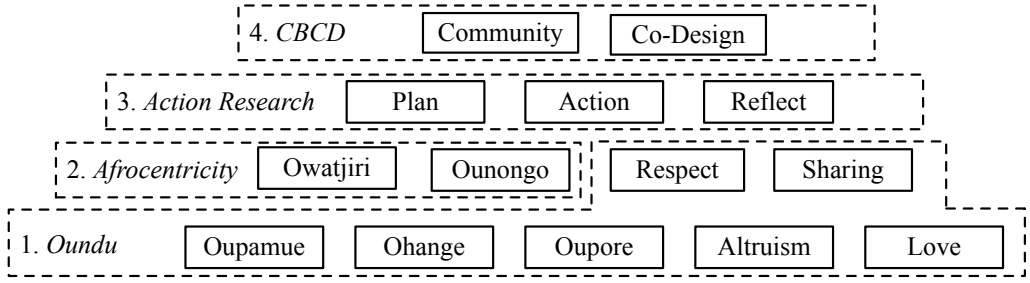


Figure 8.1. The diagram shows Oundu as the foundation that must be first understood and practised to implement Afrocentricity. Community-Based Co-Design (CBCD) is grounded on Oundu, Afrocentricity and Action Research principles.

essential interactive elements to integrate.

Oundu should be cemented (understood) as the foundation from where all the elements can hold on. The structure depicted in Figure 8.1 shows a brick wall similar for building a house whereby every brick matters. For example, the Oundu values are represented by seven bricks; 1. Oupamue (togetherness), 2. Ohange (peace), 3. Oupore (harmony), 4. Altruism, 5. Love, 6. Respect and 7. Sharing. The IK holders informed us that *respect* for the elders is a primary element for acquiring knowledge that should not be underestimated.

Once the Oundu has been solidly cemented, Afrocentric research can take place with the communities while embracing its core values of Sharing, Respect, Love, and Altruism. The integration of Afrocentric research canons and Oundu values can be seen in Figure 8.1, for example, to start with knowledge construction (Afrocentricity) there must be Oupamue (togetherness), Ohange (peace), and Oupore (harmony) which can be achieved if there is Altruism (selfless concern for others), Love, and Respect. We cannot ignore the fact that there can be conflicts and hatred in the community and among researchers. We believe that the absence of Oundu can be the cause of hatred and violence. Several authors such as Konyana (2013), Louw (1998), and van Binsbergen (2001) argued that Oundu support communism oppression, we disagree with this argument. Misunderstanding and wrong practise of Oundu can be the cause of hatred and limiting knowledge generation and transfer. Oundu or human engagement was crucial for us to understand and genuinely demonstrate it. For example, we had to be reciprocal to Uariaike by calling him for casual greetings and inviting him to our conferences for knowledge sharing from our side.

Figure 8.1 also illustrates that Owatjiri and Ounongo should be taken as the core canons for Afrocentricity use as an epistemological theory. When Afrocentricity is used as an epistemological theory, the focus should be on ways how Africans acquire knowledge based on the *Ounongo* canon and validated by the *Owatjiri* canon. The other three canons Oupamue, Ohange, and Oupore, are part of the core values of Oundu as depicted with a dotted line in Figure 8.1. This division of the Afrocentric research canons differs from the original rules presented by Reviere (2001). Ounongo canon states that all those involved in the research with the community should embrace subjectivity in the knowledge (Ounongo) construction. The truth (Owatjiri) rule states that the research findings and the research process can only be real and valid if the communities' lived experiences (Ounongo) were taken as input into the research.

The three bricks on the AR level numbered 3, depict AR phases of planning, taking action, and reflection. Undertaking CBCD methodology in a cyclic fashion of AR is essential, and it is linked to the Oundu principle whereby the researchers become part of the family (community) and visit them regularly. Moreover, it is essential to take a step back and reflect on the action performed for refining the following activities. It is also crucial to note the integration of introspective and retrospective proposed by Asante (1990) to be used in Afrocentric research relation to AR reflections. Retrospection is implicitly present in AR reflections after every cycle and introspection can be part of the planning phase.

Mutual learning and knowledge sharing as a tangible output of research integrate well with AR, Co-design, and Afrocentrism knowledge creation for the well being of the community. To constructively safeguard IK through co-designing technologies we invented a 7C knowledge model comprising of (1) **c**onceptualisation, (2) **c**ollection, (2) **c**orrection, (4) **c**uration, and (5) **c**irculation steps in parallel with (6) **c**o-design and (7) **c**reation of knowledge (Maasz *et al.*, 2018). The 7C model can be constituted to the Owatjiri and Ounongo Afrocentric research canons.

Taking a look back at the wall structure in Figure 8.1 it can be seen that on the CBCD level numbered 4, there are two bricks one representing the *community* and

the other *co-design*. CBCD constitute understanding the community first, and that can only be achieved by embracing Oundu values and choosing the appropriate epistemology. Second, conducting an holistic eight step-wise co-design process of (1) initial introduction, (2) project establishment, (3) commitment agreement, (4) joint design activities, (5) technology development, (6) technology testing, (7) technology refinement, (8) technology deployment as detailed in the previous Chapter 7, Section 7.2.2.

There is much done in mainstream human-computer interaction to include users in the design process; thus, the co-design concept was constructed, see Chapter 3 Section 3.1.4 for a review. Yes, we can include the users of the software in all phases of the design process; nonetheless, the question remains how we included those users. Are we considering their ways of understanding the world, their cultural and moral values, and diffusion of cultures to have a trans-cultural product? The answer to this question is demonstrated in Figure 8.1 that unless the suitable epistemology and underlying principles of interaction of the users are embraced the final artefact still a dream of the researchers not of the community. Using the structure depicted in Figure 8.1 we managed to demonstrate how to co-design a crowdsourcing task management application with the Namibian ova-Herero rural indigenous communities from Okomakuara and Erindi-Roukambe, and ovaHimba from Opuwo.

8.2.2 Suitable Methods for Technology Co-design

Co-designing with African rural indigenous communities who are not on a par with the designers in IT skills has to be given particular attention. Moreover, the indigenous communities might have different cultures and epistemologies from the researchers. Researchers should, therefore, establish a thorough understanding of the Afrocentric epistemology integrating all the essential research elements as discussed in the previous Section 8.2.1.

Different methods and tools can be used depending on the given context. For instance, when we used the HSC as a technology probe during the crowdsourcing conceptualisation CBCD cycle (see Chapter 4, Section 4.4.1), we started the workshops with different set questions such as to merely list the essential elements in the ovaHimba homestead and how one would go about to set-up a typical home at a new area. Then using the items or the knowledge shared on how their homestead is constructed from the initial discussion in the technology usage or co-design activities made it easier for the IK holders to relate to the purpose of the technology and their roles. We cautioned that although technology probes can be useful to speed up the skills required by the rural communities to partake in the co-designs, they can, however, heavily influence co-design ideas positively or negatively. The influence of technology reminds us co-designers of the difficulty of tracing probe results to the design proposals as mentioned by Gaver *et al.* (2004). We agree with Gaver *et al.* that the uncertainty should rather be seen as a valuable opportunity for our subjective interpretations but not a problem to be solved.

It was a clear sign that when we also used the Multimedia Collection Tool (MCT) as a probe, it contributed to the epistemological level in human-computer

interaction design as Boehner *et al.* (2007) put it. The probe initiated the community co-designers to critique standard technologies and rethink how those technologies could be redesigned to be easy to use for them. We learnt that using different tactics such as oral discussions, practical demonstrations, field walk and card sorting sparked different co-design ideas from the various workshops we held.

Technology exploration period should be planned to allow the indigenous communities to gain the necessary IT skills to have the skills needed to participate in the co-design process. Impromptu co-design techniques such as the use of traditional objects should be welcomed to spark creativity and a genuine demonstration of concept by the rural communities. Printout of the co-designed screens can be used to allow physical touch and writing for refinement. The printout of the screens can easily be used in affinity diagramming linking concepts and application flow as we have explored with the ovaHimba co-design sessions of our CBCD cycle two (Chapter 5).

The language barrier can be a problem. Therefore, a translator is crucial for translating and transcribing recorded recordings of the co-design sessions. Limited technical terms in African languages can give a constrained explanation; in this regard, it is a good idea to use metaphoric interpretations. At least two people who can speak the native language of the community and English should translate the co-design sessions. We are suggesting two for verification because we experienced that the translator can omit specific stuff to translate to English if she or he is not in support of the proposed ideas. Imbalance or conflicts in co-design decision should be identified and rectified, such as a community outsider dominating co-design ideas (see Chapter 5, Section 5.3.1).

The deployed prototype must be used frequently so that the negative consequences of the deployment and faults can be determined and refined early. For example, we witnessed that some of the MCT icons selected by the ovaHimba community during the first co-design workshop were challenging for them to remember their functionality after a few weeks, see Chapter 5, Section 5.3.4. We, therefore, had to quickly re-think with the community co-designers to select icons that they would be easy to remember for them. We are aware that the standard icons that were in the MCT application are a result of many years of designs and refinements for those communities, and the same would apply for the rural community-based co-designed artefacts.

8.2.3 Appropriation of Technology

The crowdsourcing TMA application was appropriated around five themes, that is, trans-cultural interactions, crowdsourcing from the IK holders' perspective, modularity, cultural resonance, and the significance details for a crowdsourcing task request . The technology appropriation themes were not in isolation from the Afrocentric synthesis mentioned in the previous Section 8.2.1. The five topics are briefly outlined below.

1. *Trans-cultural*, the crowdsourcing TMA that we co-designed with the indigenous Otjiherero speaking rural communities is a result of trans-cultural interactions. The research designers team itself was composed of different

people with their own cultures even though two were Otjiherero speakers. Achieving a trans-cultural design orchestrate a matured environment of blended ideologies, re-creating new meanings and reflections (Winschiers-Theophilus, Zaman, and Stanley, 2017).

2. *Crowdsourcing from the IK holders' perspective*, using the Oundu principle of the community helping one another made it easier to explain the crowdsourcing concept to the rural communities. After the crowdsourcing conceptualisation, the IK holders provided ideas on how they would prefer their crowdsourcing application features. For example, the IK holders preferred a group account for the community and consensus agreement meeting outside the system for approval of the task request before allowing the community representative to send the task request to the Internet. Group evaluation of the 3D models was also preferred.

   The rural communities suggested a different reward system for the graphic designers that have created 3D models that the rural communities have accepted. The rural communities proposed to generate an omitandu (praise) for the winner. One might think omitandu has no significant value, but for the ovaHerero speaking communities, this is something that is ordained to respected elders, chiefs, heroes for their valuable contribution for the community. It would be therefore interesting to see the acceptance of this reward for the crowdsourcing contributors who are most likely not of the ovaHerero speaking communities and are familiar to monetary payment.

3. *Cultural resonance*, icon interface as shown in Chapter 5, Figure 5.12 represent the community culture. For example, a calabash[1] was selected as an icon to represent the functionality for sending task requests. The research designers have to accept that everything does not have to make sense for them, the calabash is a good example that might logically not make sense for sending something, but for the communities, it is about representing their cattle, wealth and pride.

   We demonstrated that technologies could not be directly transferred without appropriation or adaptations even for those co-designed within sub-clan communities. From the first crowdsourcing simulation CBCD cycle described in Chapter 4 we witnessed the ovaHimba communities pointing out traditional objects that we were not theirs, and thus they could not relate to those as they were of ovaHerero. Even within the ovaHimba sub-clan (ovaTjimba), they also pointed out traditional objects that they would like to be in the ovaHimba HSC to adequately represent their culture.

4. *Modularity*, separating the multimedia collection tool from the TMA application, eliminated confusion and easy to use for both modules.

5. *Significance details for a crowdsourcing task request*, the rural communities to specify the crowdsourcing task request of their traditional objects according to the checklist below for designing satisfactory 3D models.

[1]Calabash is used as a container to allow unpasteurised milk to ferment naturally for two to three days (Misihairabgwi and Cheikhyoussef, 2017).

- easy to understand,
- indicate actual size,
- capture correct orientation of photos or videos,
- provide details of usage,
- indicate critical parts of the traditional object for accurate 3D modelling, and
- provide copyright information of the multimedia narratives.

The topics mentioned above regarding the appropriation of the crowdsourcing task management application were discussed in detail in the previous Chapter 8.

8.3 Limitations of the Study

In this section, we explore the limitations of the study. The study was conducted in Namibia with the Otjiherero speaking communities. However, similarities with other communities in Namibia and elsewhere in Africa could have been included to broaden discoveries.

The crowdsourcing was demonstrated as a simulation, not in full-scale implementation. The task crowdsourcing management was deployed, tested (by communities and sending task requests to the web) but due to poor network coverage at the rural villages, the crowdsourcing platform has not been tested on full-scale implementation.

It could have been more beneficial to have the coders of the co-design team stay longer at the village to work on the communities' immediate requests. Having the coders on-site with the communities could also have allowed a quicker approval and refinement of the task management application. However, it is not that trivial to have coders at the village with the community co-designers without adequate infrastructure. Coding with communities is novel as indicated by Soro *et al.* (2020), and besides the inadequate infrastructure it is not easy to code with community members as they participate based on their own terms and interest.

There is neither internet coverage as mentioned earlier nor reliable electricity at Uariaike's village or at the other selected communities to have allowed the coders more extended visits. Coding at times is not a quick fix. Coding may involve developing new application programming interface (API), restructuring functionalities and refactoring to a level of upgrading the operating system and these activities can take up weeks and months.

Lastly, copyright ownership of the multimedia items to be sent out to the web as crowdsourcing requests by rural communities have not been covered in detail. We started discussions with the indigenous knowledge holders and academics to tackle ethics and copyright ownership as contentious issues in community engagement research (Gallert, Stanley, and Rodil, 2018).

8.4 Future Works and Recommendations

We propose investigating how the rural communities could crowdsource software development and continue to collaborate in the design (co-design) of the software. Challenges to be considered would be first to have sufficient network coverage at the rural areas, language barrier, and tools that would allow fair participation in the online co-design. At Otjisa village where we deployed the task management application is not connected to any electricity grid and network coverage. On this basis, Chamunorwa, Winschiers-Theophilus, and Zaman (2020) have started investigating cheap alternative solutions using mobile rechargeable Raspberry Pis for data transfer to the cloud.

Inadequate network coverage could also be leverage by collaborating with other projects such as the `iNethi.net`. iNethi is a community network aimed at setting up a localised Internet content sharing services for communities living in the resource-constrained township and rural villages (Hadzic, Phokeer, and Johnson, 2016). According to Hadzic, Phokeer, and Johnson iNethi concept network architecture is to use fixed wireless backhaul infrastructure by a combination of Television White space and WiFi radios that make use of mesh routing.

We recommend that a more engaging way of working with the communities if possible, would provide extra profound rethinking and refinement of the co-designed artefact. The engagement can be in an informal discussion or frequent telephonic discussion for far remote areas.

We emphasise on the importance of respectively putting aside religious believes when taking Afrocentricity as an epistemological theory. Religions have been explicitly sidelined on the basis that Afrocentrism can withstand any ideology or religious (Asante, 2000). In the context of safeguarding IK, religion was not seen as a separate entity from IK as these are intertwined. Although religious and speculations have been pointed out to be part of Oundu, we recommend for that to be recognised and respected but not accepted as the core element for the construction of knowledge. Religious and believes cannot be refuted; thus, the focus should be on how the African indigenous communities create and disseminate their knowledge. We explained in Chapter 2 that African knowledge is mostly not in written format, transferred through stories, traditions, dances, and artefacts, derived from lived experiences tested over centuries of use, it is context and culturally specific, and that it is dynamic and changing (International Institute of Rural Reconstruction, 1996), these are the aspects to be examined. We also recommend that the quality of hardware should be a priority for durability due to the African village infrastructure as the devices would be mostly used outdoor in sunny, dusty conditions.

Further studies can also be explored in other African or Asian theories similar to Afrocentricity and Oundu to see whether they could be applied in the same way it was used in this study and produce similar findings. Finally, the results of this study advocate us to reassess the way that Computing is taught in African colleges and universities.

8.5 Retrospective

In this section, the author of the thesis provides his personal life experiences from undertaking this study. A retrospective is done to point out if any of the researcher's initial assumptions about the research participants, social, cultural, historical upbringing or political background hindered or facilitated the research findings for a fair and accurate conclusion of the study (Asante, 1990).

From the Afrocentric theory, I learnt that it is much ignorant for not unpacking Western epistemology to criticise and readjust or replace what is not suitable for the African way of understanding the world. Using Afrocentrism in this study, I learnt to transfer my learning by deconstructing and reconstructing the fundamental principles of Afrocentricity and apply it in community-based co-design. I once shared the Afrocentric theory with honours students at NUST, after my lecture a few students came to me and told me that it was their first time they could reflect and see how they were taught from primary school to university that most of their subjects were based on Western knowledge. The students mentioned that if only a few examples or scenarios could have been from their African ways of knowing it would have made a much better understanding.

The ignorance or lack of appreciation for Afrocentricity was also at the level of professors, in a curriculum review meeting I once proposed for the university to look into Afrocentrism when developing the curriculum framework. To my surprise, one of the professors angrily replied to my suggestion that we should teach students at an "international", not at "an African level". From the examples mentioned above, one can see Western knowledge superiority in Africa is still in existence as pointed out by Asante (2009) and Keita (2014), and many other Afrocentrism researchers. Moreover, Afrocentricity enlightened me that not much is done on mainstream technological devices to fit different cultures based on their context and way of understanding the world. Understanding of the world cannot be denied to be different depending on the history, culture and the survival tactics gained from the ecosystem where every community lives.

Oundu principles taught me to appreciate other cultures, respect for elders even in an academic environment where the term "freedom of speech" is often said invasion. We should practice freedom of speech with due regard for everyone more, especially to the senior academics. To appreciate other cultures in the Oundu sense that I need you to be in your fullest you for me to be me, from the famous phrase by Archbishop Desmond Tutu (Tutu, 2000, p. 34). I learnt to share knowledge and the little wealth that I generate for the benefit of humanity.

My interest in knowing about indigenous knowledge and tradition of the indigenous communities grew as the research progressed. My Otjiherero vocabulary also improved, and Uariaike noticed this and was very proud of me. I have learnt a lot about my culture and appreciated it a lot more. Above all, I discovered that mutual respect and love for one another is one of the fundamental human values (also part of the core values of Oundu, Mbigi and Maree (1995, pp. vi-vii)) that should be applied everywhere in life even during technology co-design and should be maintained whether the deployed software is working or not.

My assumption about the rural ovaHimba and ovaHerero communities was that they were not familiar with the technology. I was too careful to select the

terms that would make more sense to explain technical concepts in the co-design sessions. At times I oversimplify the explanations and return this made my descriptions not easily understandable, for example, in one of the initial co-design workshops I was trying to explain that the interface that we are going to design together will appear on the screen, I decided to simplify this and made an example of a screen to a glass bottle. The glass bottle made explanations more complicated until one of the community members asked me whether I meant the screen similar of the television when I replied yes, everyone laughed and said why did I not say that at the beginning. Trying to oversimplify technical terms taught me that although the communities might not have the technologies in their homestead, they could have seen or used them.

I came to realise that the CBCD, coupled with action research phases of; planning, action, and reflection, can be inextricably intertwined. I could reflect and plan while observing the work of a particular activity. It later became apparent to me why it was crucial for action research to start the study without a clearly defined hypothesis. I had a vague idea about my research topic; it was not possible to have a clear rationale or a definite outlined plan for my initial workshops. To start with detailed rigid plans was no need, it was better to start with general rough ideas, to take action and encounter the unexpected, for example, at times the co-design technique of using the probes did not make sense to the IK holders. I have to quickly unlearn my software requirement elicitation knowledge mastered over ten years and learn a new, different approach of spontaneously co-designing software with the communities allowing them the freedom to come with their design ideas.

I experienced that the first design idea does not have to be perfect; the idea is to allow the community co-designers to experience the tool in use and report difficulties. In that way, community co-designers could explore the refinement of the design. Examining the prototype allowed the IK holders to have confident in criticising standard software features. I started using the AR approach at my workplace of taking action to solve problems, for example, for the curriculum review, I would start doing something to discover the actual problem later.

I think my personality of maintaining a good relationship and preventing unnecessary conflicts contributed positively to the study and mainly keeping an excellent relationship with Uariaike. Uariaike has become my family. I introduced him to my grandmother, and my grandmother has started to send warm greetings when I am travelling to Uariaike's village.

Being raised in a mixed culture family of my late uncle Mr Gerhard Tehaa Kaumunika (his father was German) and my grandfather Mr Ludwig Stanley (his father was British) (may their souls rest in peace) made me acceptable and curious of other cultures and IK including the ovaHerero. My acceptance and curiosity for cultures I believe made a positive contribution to the success of this study.

8.6 Concluding Remarks

This study finding on the methodological and epistemological level provide appropriate conditions that researchers and community members can use and embrace to maintain a beneficial embedded trans-cultural technology community-based co-design engagements. We proved that the Afrocentric research approach is a logical and pragmatic foundation as an epistemological theory for developing tools to safeguard African indigenous knowledge.

Inspired by Reviere (2001), one of the first pioneers to direct Afrocentricity as epistemology, we practically applied the proposed Afrocentric canons in co-designing a crowdsourcing task management application with indigenous rural communities from Namibia. We holistically aligned the Afrocentric research canons with Oundu; we found similarities that the two can be integrated on the African moral principles of harmony, peace, togetherness, altruism, respect, sharing, and love. Owatjiri states that the communities should also validate the research process and findings. Ounongo states that knowledge creation should strive for embracing the cultures and subjectivity of all. Owatjiri (truth) and Ounongo (knowledge) Afrocentric research canons guided us on how to develop a software application based on how the indigenous communities constructed and shared their knowledge. These two canons should be taken similarly as a corner brick of a house if missed the house will collapse. We are not claiming that Western knowledge is irrelevant, however, are against generalisation and promote the integration of ways of understanding where possible and that no knowledge is generated in isolation as pointed by others such as Le Grange (2007) and Mazzocchi (2006).

What does it mean to take up Owatjiri and Ounongo when co-designing ICT solutions with African indigenous communities. That means to unlearn or unpack Western design patterns or theories and be ready for a new, different way of knowledge generation that is part of the communities tradition, that is performed in dances, storytelling, sang poetically, embodied, or observed in practice. Co-designers should take the dynamics of IK generation as an opportunity to explore new co-design techniques, innovation, knowledge creation and sharing, and cultural values or representations to be reflected in the final artefact. To embrace Owatjiri and Ounongo in co-design also means empowering the indigenous communities so that they can continue to use the technologies and appropriate it without much dependency from the researchers. If Owatjiri and Ounongo are not fully understood, the research process and findings remain to be of the Western ideologies.

The methodological results as highlighted in Section 8.2.1 also show that once the Afrocentricity and Oundu values have been laid correctly, a beneficial embedded Community-based Co-design research methodology can be conducted for safeguarding African cultural-heritage or ICT4D for human excellence. Underlying Action research principles of cycles, reflections and knowledge creation and sharing with CBCD synthesis a unique synergy of knowledge creation mutual learning supporting the principles of Afrocentrism and Oundu humanness of creating knowledge that benefits the community.

Appendix A

Ethical Clearance Certificate

NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY RESEARCH ETHICS COMMITTEE (F-REC)

DECISION/FEEDBACK ON RESEARCH PROPOSAL

Dear Prof: Heike Winschiers-Theophilus

Research Topic: **Namibian Communities Indigenous Knowledge Management Systems**

Supervisor (if applicable): N/A

Qualification registered for (if applicable): N/A

(Reference number of application: FACULTY RESEARCH ETHICS COMMITTEE REGISTRATION NUMBER: 01/2017)

Re: Ethical screening application No: F-REC-01/2017

The **Faculty of Computing and Informatics** (FCI) Ethics Screening Committee of the Namibia University of Science and Technology reviewed your application for the above-mentioned research. The research as set out in the application has been:

Approved | X |

(indicate with an X, and N/A if not applicable and proceed)

We would like to point out that you, as researcher, are obliged to maintain the ethical integrity of your research, adhere to the ethical guidelines of NUST, and remain within the scope of your research proposal and supporting evidence as submitted to the F-REC. Should any aspect of your research change from the information as presented to the F-REC, which could have an effect on the possibility of harm to any research subject, you are under the obligation to report it immediately to your supervisor or F-REC as applicable in writing. Should there be any uncertainty in this regard, you have to consult with the F-REC.

We wish you success with your research, and trust that it will make a positive contribution to the quest for knowledge at NUST.

Recommendation: The application is approved: Recommendations of FCI/F-REC stated in the minutes of the meeting held on 28 March 2017, were addressed to the satisfaction of the Chairperson.

Sincerely,

Signature removed

Prof. Hopolang N./MUYING

Chair: Faculty Ethics Screening Committee

Tel: +264-61-207-2888

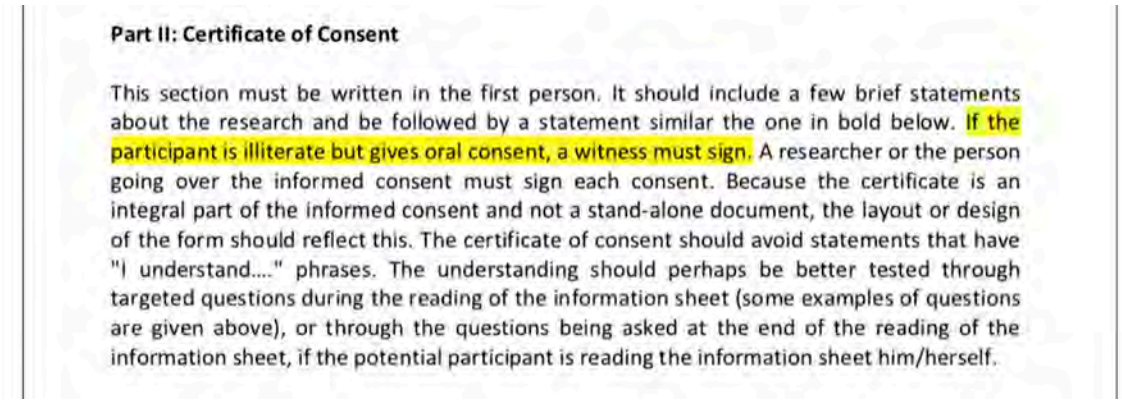
NAMIBIA UNIVERSITY OF SCIENCE AND TECHNOLOGY

2017 -06- 26

OFFICE OF THE DEAN

FACULTY OF COMPUTING & INFORMATICS

CC: Project team: Peter Gallert, Gereon Koch Kapuire, Colin Stanley and Juergen Sieck



Part II: Certificate of Consent

This section must be written in the first person. It should include a few brief statements about the research and be followed by a statement similar the one in bold below. If the participant is illiterate but gives oral consent, a witness must sign. A researcher or the person going over the informed consent must sign each consent. Because the certificate is an integral part of the informed consent and not a stand-alone document, the layout or design of the form should reflect this. The certificate of consent should avoid statements that have "I understand...." phrases. The understanding should perhaps be better tested through targeted questions during the reading of the information sheet (some examples of questions are given above), or through the questions being asked at the end of the reading of the information sheet, if the potential participant is reading the information sheet him/herself.

Figure A.1. This shows an extract of the ethics consent form application for the ethical clearance certificate at NUST.

Appendix B

Community-Based Co-Design Cycles

B.1 CBCD Cycle One

B.1.1 Opuwo Preliminary Planning Logistics

After conducting a general crowdsourcing literature review, we started with the travelling logistics to Ohandungu. Ohandungu is about 730 kilometre from Windhoek; thus, the research team had to travel one full day on the 18th of September 2013. All needed equipment such as cameras, note pads for writing, and video recorder were packed in advance. The devices that needed to be charged were charged as there is no electricity in most rural Namibia. Although NamPower has increased its budget for rural electrification from 20 million to 25 Namibian dollars for the 2013 and 2014 financial year budget rural electrification projects are still progressing slow (Nampower, 2015).

It was our first time to work with the ovaHimba community, so we had to contact someone from Opuwo who could direct us to indigenous knowledge holders (IK holders). Opuwo is the capital town in Kunene region formerly known as the Kaokoland north-western Namibia where most ovaHimba stays. The researcher contacted a former student from the author's university (NUST) who is from Opuwo region. The student then contacted a relative from Opuwo who would then take us to the community as we did not know the road to Ohandungu village. It is not easy to navigate around most communal villages in Opuwo region as there are many side streets with no road signs displaying the village name.

The plan to contact someone from that specific community that we want to work with for the first time has at most times proved to us that it makes the process of entering into a new community for the first time accessible. The communities welcome the researchers with less resistance when the researchers are introduced to them by someone whom they could relate to as a relative or who could speak the same language. Our research team was fortunate enough to have researchers who were fluent in Otjiherero as their mother tongue language.

B.1.2 Epupa Preliminary Planning Logistics

For the Epupa workshop, we did not have a contact person in Epupa, so we planned to move around from one homestead to the next relying on the Otjiherero speaking researchers to communicate to random people willing to take part in our workshop about safeguarding IK. There were few homesteads

around the Epupa falls area. The first two groups of people we met said no, they were too busy to take part in such a workshop. At the third homestead, we met two middle-aged men agreed to have the workshop with us.

B.1.3 Okomakuara Preliminary Planning Logistics

The research team travel to Okomakuara village on the same day 6 March 2014 of the workshops and back to Windhoek. We were well introduced before going by one of our former student from NUST that lives in Okomakuara with the family that we planned to have the workshop.

B.1.4 Erindi-Roukambe Preliminary Planning Logistics

The researchers had to travel from Windhoek that is about 400 km to Erindi-Roukambe on the 20th of October 2014 a day before so that we could have a full day to conduct the workshops. The research team sleep at the homestead of one of the Otjiherero speaking research member from NUST whenever travelling to Erindi-Roukambe.

B.2 CBCD Cycle Two

B.2.1 Co-Design with ovaHimba

After the first AR cycle discussed in Chapter 4, we decided to bring along a tent (gazebo) as a temporary workshop venue and chairs to sit on. This has taught us that our *in-situ* community-based co-design research methods require us to plan carefully; we need to include research equipment that we might not have needed to think about in an urban set-up. This careful planning can only be achieved by reflecting on experiences at the community site.
The temporary tent as a workshop venue and chairs that we brought along resulted in a comfortable work environment, even during high temperatures and sun reflection on the tablets.

B.3 CBCD Cycle Three

B.3.1 Co-Design with ovaHerero and Creating and Evaluating 3D Models

B.3.2 Okomakuara

We lost the community co-designers telephone numbers. Therefore, initially, there was some uncertainty by the research co-designers on whether the community co-designers would welcome their unannounced visit. It had been more than a year since any contact was made with the co-designers of Okomakuara; we thought the community co-designers might have reservations about engaging in the co-design process. However, the community co-designers

(three males and two females) were welcoming and willing to listen. The community members remembered the NUST research team very well from the crowd-sourcing simulation workshops. They mentioned that they had listened to the interview of the researchers on the Otjiherero national radio; the interview was about IK preservation using technology. On the radio, the researchers mentioned that they were also working with the ovaHerero community from Okomakuara. The community co-designers, therefore, knew that we did not completely forget about them.

We apologised to the community elders for not contacting them for such a long time and asked for their mobile numbers. Mika Ndisiro and Nokokure Heuva was identified as the main co-designers for the Okomakuara community during the crowd-sourcing conceptualisation workshop.

B.3.3 PDC 2016 Conference Workshop

The workshop flyer was circulated at the conference registration table to attract graphic designers to partake. Furthermore, to recruit graphic designers, the author specifically targeted a known graphic designer from the University of Porto who signed up to attend the workshop. Although we targeted graphic designers, our final set of participants also included participants from other fields.

We scheduled two workshops on Thursday the 18th of August 2016, each workshop to start with a brief introduction, lasting eight minutes. In the introduction session, the plan was to announce the workshop activities and to watch a video clip about the background of the research project. The video clip had snapshots of different community-based co-design workshops, with a voice-over done by the author. Twelve minutes were arranged for the drawing activity. The last ten minutes was scheduled for evaluating the drawings and feedback discussion of the workshop.

A research poster was created for the workshop, showing Uariaike with a TMA tablet and the CCSP diagram (see Figure B.1). Uariaike previously looked at the research poster (projected on the research co-designers' boardroom) and was happy with it.

The booth set-up for the interactive exhibition and carried out activities were as follows: Four tables were arranged with three chairs for participants. On each table, we placed a big sheet of paper with pens for drawing. Pictures of the traditional objects, taken from different angles, were printed out and also placed on the tables. Each table only received the pictures of one traditional object.

Figure B.1. Interactive exhibition booth preparation at PDC 2016 in Aarhus, Denmark.

Appendix C

Nvivo Coding and Sample Graphs

C.1 Sample Coverage of a Coded Theme

Internals\\Workshops\\Erindi Workshop 21 Oct 14 - § 5 references coded [9.06% Coverage]

Reference 1 - 3.53% Coverage

They decided to take pictures of a horse dung thinking that this was clear enough to represent a horse. They were informed that this would not let the graphic designer know that by seeing the horse dung that a horse should be modelled. Then IK holders decided to draw the missing horse on the cards on a piece of paper and to take a picture of it.

Reference 2 - 0.87% Coverage

If the images are not of good quality they would decide on those images to be erased.

Reference 3 - 2.16% Coverage

They expressed a preference in having a consultative meeting to select those pictures. There was a fear that the community representative might send images which does not truly rep- resent their culture.

Reference 4 - 1.29% Coverage

Then they would talk about the images taken to provide specification of it where this should also be translated to English.

Reference 5 - 1.21% Coverage

IK holders said it must have been them that made a mistake and will remove all the images and take the pictures again.

Internals\\Workshops\\Ohandungu Workshop 19th September 13 - § 2 references coded [1.05% Coverage]

Reference 1 - 0.61% Coverage

select the best images that they felt should be send to graphic designers to be modelled in 3D.

Reference 2 - 0.44% Coverage

The selection criteria were based on choices of the picture quality

Internals\\Workshops\\Okomakuara Workshop 6 Mar 14 - § 3 references coded [11.27% Coverage]

Reference 1 - 1.66% Coverage

The elders carefully took pictures of the walking sticks taking one by one without background obstruction.

Reference 2 - 5.98% Coverage

When asked about the procedure before sending the images. One of the elders replied that using the drawing, as example that it was not really good should not be allowed hence, several better drawings has to be made before sending out. They were informed that the idea was for them to send the image even if it is not in its perfect state so that the graphic designers will create the perfect graphic.

Reference 3 - 3.63% Coverage

An example of their sticks was given that what would they do if the 3D modelled sticks are now suddenly in black colour. One of the elders highlighted that it could have been their camera that there was other colour reflections on the sticks.

Internals\\Workshops\\Opuwo Workshop 20th of Sept 13 - § 1 reference coded [2.93% Coverage]

Reference 1 - 2.93% Coverage

The drawing of the homestead was well drawn with precise details that the main hut door facing the cattle kraal gate.

Internals\\Workshops\\PDC Workshop One 18th Aug 16 - § 1 reference coded [3.76% Coverage]

Reference 1 - 3.76% Coverage

they discussed whether the shadow of the object appearing on the picture was part of the actual traditional object or not.

Internals\\Workshops\\TREM Refinement 13 to 14 May 16 - § 1 reference coded [1.62% Coverage]

Reference 1 - 1.62% Coverage

The importance of taking pictures from all angles of the same object was also emphasised, as we noticed that most pictures were taken from one side only; taking pictures from all sides helps the graphic designers to create a correct 3D object.

The sample given above shows the coverage appearance in percentage for the coded theme about the accurateness of the communities' crowdsourcing task request discussions. This report the coverage from all the different workshops we conducted. For example, the sample shows that from the Erindi-Roukambe Workshop held on 21 October 2014 had five references to this theme with a total of 9.06% coverage. The workshop with the most coverage is the one held at Okomakuara on 6 March 2014 with 11.27%.

C.2 Crowdsourcing Task Request Significant Details

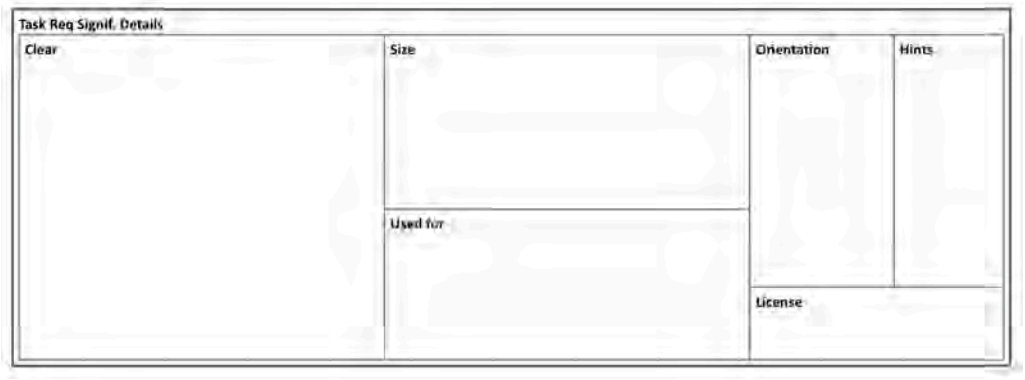


Figure C.1. Tree view of the crowdsourcing task request significance details of the traditional object from the coded nodes. It can be seen that *clear*, *size*, *used for*, *orientation*, *hints*, and *license* were identified as the significant details to be provided by the indigenous communities. To provide clear details or narratives was mentioned the most and license issues not that much.

C.3 Task Request and 3D Models Comparison

Figure C.2. This diagram shows a comparison of Task Request and 3D Models significance details sources from the different workshops where they were highlighted.

C.4 Themes Ranking

Name	Sources	Referen...	Created On	Created...	Modified On	Modified By	Color
CoDesign	14	188	17 Jun 2017, 12:28...	S	1 Jul 2017, 10:09 PM	S	
TMA Codesign	14	114	17 Jun 2017, 1:08 AM	S	24 Jun 2017, 3:46...	S	
Engagement	13	45	16 Jun 2017, 11:50...	S	1 Jul 2017, 10:40 PM	S	
Crowdsourcing	11	39	24 Jun 2017, 3:52...	S	26 Jun 2017, 3:28...	S	
Task Req Signif. Details	7	35	23 Jun 2017, 4:43...	S	26 Jun 2017, 3:27...	S	
3D Model Signif. Details	5	31	23 Jun 2017, 4:48...	S	24 Jun 2017, 2:23...	S	

Figure C.3. The table shows the themes from the most to the least reference theme.

Appendix D

Community Crowdsourcing Website Flow Chart

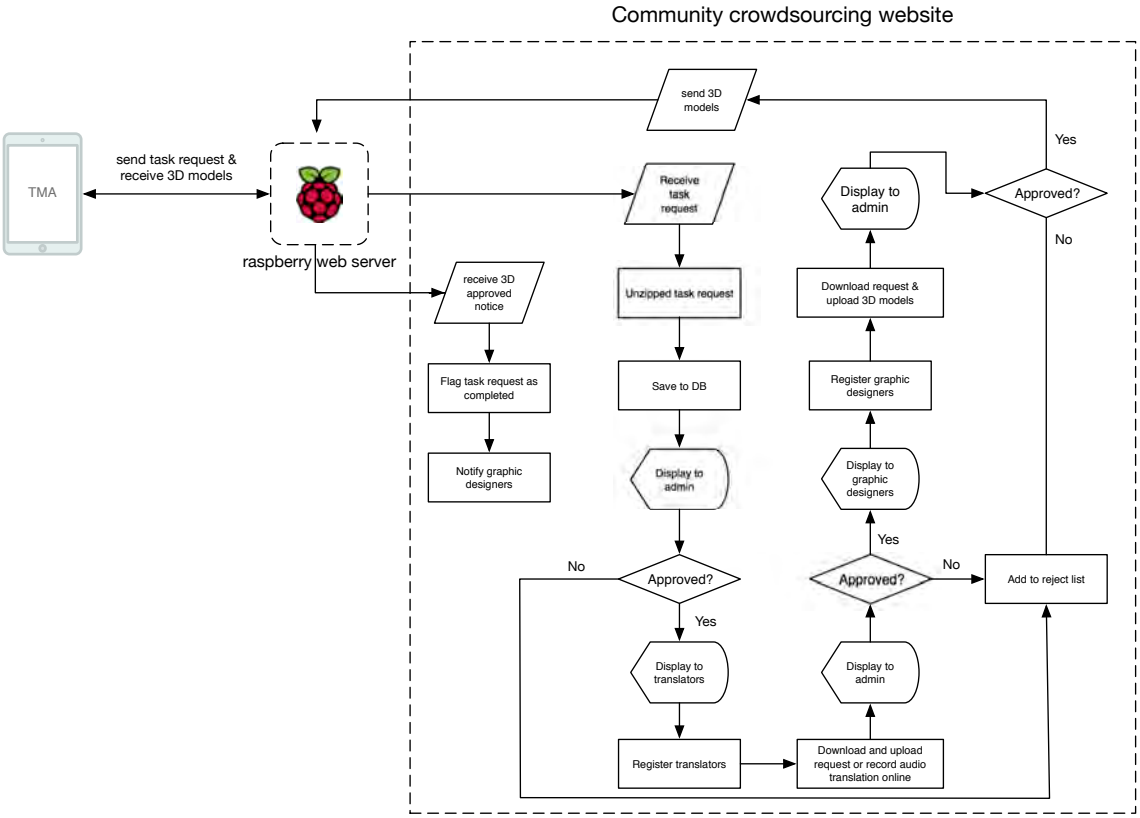


Figure D.1. The diagram shows the proposed Community Crowdsourcing Website (CCSW) Flow Chart. Interaction from and to the Task Management Application (TMA) to the CCSW are illustrated.

Appendix E

Afrocentric Canons translated into Otjiherero

1. Owatjiri: Owatjiri wongondononeno uza mOtjiuana.

2. Ohange: Omukondonone wa katjotjiri upaha okutiza ohange mOtjiuana.

3. Oupore: Omukondonone wa katjotjiri kakara nombangu komiano vyo makondononeno ue.

4. Oupamue: Oviungura vyOmukondonone viso kuzeuparisa ozondando, nongaro nOvitjitua vyOtjiuana (Ubuntu – Oundu, tjimuna ondengero kovanene vOtjiuana).

5. Ounongo: Omakondononeno uondjiviro ohunga nounongo nozongaro za Africa kazeso kutatera tjinene komazikamisiro uozongaro nomiano vyOuje uOpendje.

Appendix F

Questions asked at NUST Research Day 2016

After the Community-Based Co-design role play held at NUST research day in 2016, the audience asked the following four questions to the IK research cluster and Mr Uariaike. Answers to those four questions are also listed below.

Question 1: How would the situation be handled when the youth might not recognise the icons that the elders have selected?

Answered by the research team: *The icons are not going to be icons only there is text description written in Otjiherero describing full functionality of the icon. The audio recording will also be provided for those that cannot read. It was further elaborated that co-designing a crowd-sourcing platform with the ovaHimba or any other community is part of long term sustainability; to allow the community themselves request for more of their traditional objects from graphic designers. The requested 3D models could be used in rural community context as either in the interface co-design or for IK visualisation preservation.*

Question 2: Asked directly to Uariaike about his benefit in the research project.

Answered by Uariaike: "*Learning from each other and preserving IK so that it is not vanishing, which is very good. The youth of this generation get educated then they do not know about IK. Now with this project, even if they get educated, they can still have a look at IK that is preserved. The project introduction from the beginning was significant for me for preserving IK.*"

Question 3: One professor asked why Mukamberenge was seated on the floor.

Answer: *Uariaike replied that in their culture, a woman does not sit on chairs. One of the research co-designers also added that the women always sit on the floor during all our co-design sessions. One person from the audience commented that she thought it was because of the red ointment that Mukamberenge had applied on her skin, that perhaps Mukamberenge was afraid that the red ointment might get on the chairs.*

Question 4: Asked directly to Uariaike in Otjiherero. Whether Uariaike thinks that the youth that speaks Otjiherero are at the point of throwing

away their culture, and if yes does he think that by creating these IK preservation tools that the youth will get interested in knowing about IK and continue to preserve it because they are educated?

Answer by Uariaike: "*OK, IK should be there even if the youth do not keep the rules taught by their parents, then it is up to them if they do not keep it. The one that keeps it, it will be beneficial to him or her, and the one that does not keep it will have no culture. Even this white person (pointing to one of the research designers who was part of the role-play) has his own culture. They keep their own culture too they do not go into our cultures, but our youth go into other people's culture, but it is up to the youth to decide.*"

Appendix G

Sample Transcript

Transcription details: This transcript is a sample from our Community-Based Co-Design Cycle One. It does not cover the complete workshop, only the first session of the workshop when the ovaHimba communities were given the HomeSteadCreator to use as a technology probe is provided as a sample.
Date: 19th September 2013
Place: Ohandungu
START

[00:00:01] This pot, when I click on it, it will display/show houses, but these houses are for ovaHerero. It shows if you are moving, what you move first. Our research is to test how people use the application. I clicked, and it is loading up! It is loading! Here is the soil/ground, can you see it? [00:00:40] inaudible. What is the most important thing in the community? The most important thing in the community? Yes. The most important thing in the community is people, cattle, the house where people sleep. Is it only inside the homestead, right? People must eat food! Pots to use for cooking. What else? I will just attempt! [00:01:41] laugh.

The yard!! [00:01:54] inaudible. It is a homestead! If it is a homestead, it is when it has a [Orumbo], if it does not have Orumbo then it is not a homestead anymore. Inside the homestead, the important things in order of importance are; people first, cattle, if you do not have people, you cannot have cattle, houses, food, pots in which to cook. I end there. Tree! For firewood. You cannot settle where there are no trees. When settling, you try to locate and settle where there are trees. The reason why we are asking such question is [00:02:39] inaudible. [00:02:42] inaudible. A tree is used to build houses, used to build Orumbo, kraal. Trees are traditional light. They are used to build homes and also used for firewood.

The reason why we are asking that question is, we asked the same question to people in the Omaheke region and from that question we came up with this application. This to show future generations how you practice traditions and carry out activities. Do you tell stories [Ozongano]? Stories [Ozongano] are done in the evening. Typically, they are told to kids/young ones. They are stories from long ago.

What stories are told daytime? I am not sure of stories told daytime. If you are sick, we use many plants to cure ourselves. Mopane tree leaves are used to cure stomach aches. Its roots are also used to relieve pain. The leaves of the mopane tree, we put the leaves in the pot and the same with its roots and then boil it with water. We then drink that water that is traditional pain killers. Nowadays,

we also use Otjingandue for pain relief. OK.
I am showing you how to use the application. Okay. You can press and drag the icon to the appropriate area on the screen. [00:09:15] inaudible. you can see the house from the top. This looks clear. Where is the house here? [00:09:36] laugh. Is it this one now? It is shown from the top. If you want to turn it, you do like this. Can I turn it? Yes, Who! This is great! [00:10:36] laugh. This is a good job! That is it right? Yes, the tree is here. If you want to add chicken, you select chicken. I want a goat! Drag it over, press a bit harder. Oh! I put it under a tree!! That is it. OK!! [00:13:11] inaudible. There many other items you can pick from to build your homestead.
[00:14:24] inaudible. Let us discuss while waiting for the application to get fixed. When you are discussing these things at home, do the young one/children come to the elders or the elders are the ones who call the young ones? Or what happens? The young ones... [00:15:36] inaudible... in our culture are called. We tell them to carry out some activities/tasks, and when done, they go back on their own, away from where the elders are. When called to where the elders are, he/she sits behind the elders quietly.
You may start building your home. You can drag. [00:18:09] laugh. [00:18:10] inaudible. I want a man who can work. You can select and drag the small one. Drag there, can I move it where I want it to be? Are finger a unique my son! [00:19:00] laugh. [00:20:11] inaudible... up! Up! [00:20:26] inaudible. There it is, you can drag it however you want. Uh ok. Drag it, yeah. It came along! I am done! It came in the middle. Is it this one? Yes, there is a cow in the middle. If you want to move it, you drag it along. If you want to bring it in the middle, you just click once here? Yes. The cow is together with the person. Are they together now? Yes. My gosh! White people are amazing! How amazing they (white people) are, how do we even talk with them? Any other item you may want to add gain? Maybe I select a tree! Are these trees from your area? Yes. Ok. Move it wherever you want it. [00:25:09] wow! My mate!! [00:25:10] laugh. I will select the pot now! Is the pot this one right? If you want to move it up, drag here? Yes. [00:26:24] laugh. [00:26:39] inaudible. Any other one you need? Is the fire here? Press on the pot for fire. Let me check. Is it this one? Do a press? Ys, you do it slowly. Like this? Yes. Here is the fire now. When I move here, I select what I want. It is on top of something! Ok is it on top of something? Yes. Oh! Tree? So let me drag it this way. [00:29:20] inaudible... all of them are there. Sharp!! [00:29:40] laugh. Ah! Wow!. You do this and tell kids/children how you go about building the homestead. Oh! Should I start talking now? No, this time, we are done. We will come back some other time to do more research with you. Who! I built a nice house. There are the objects, can you see the items; pots, cattle, [00:31:11] inaudible, fire, homestead, house, [00:31:20] inaudible, tree. Ok? Yes, I know now. Are these trees [00:31:39] inaudible, these trees are not here in our area. I never saw these trees before. It would be helpful if I knew these trees. Yes, definitely we would be better placed to know where to place Omuhama, where to place mopane tree. But these ones I just tree we do know. Maybe if these are tree we know, they look different in the application. Now you built all these, what else do you want? Chicken! Is it not a woman/wife?
[00:32:52] laugh; it is a woman! The important thing is a woman/wife! For the

homestead to be complete, a woman/wife is needed! Do you prefer a woman who…? I like a woman who looks like those ones! Maybe I take this one. Maybe she is beautiful. Select and drag her here close to the house. Yes. It would be best if you dragged a bit harder. If drag and the light come up, it means you dragged it correctly. Where is she now? She is here behind the tree. Drag again. Ok, there she is close to the house! Oh wow! This is a light of God. [00:35:27] inaudible. Is this it? Yes.

Is the woman here at the house? Where? Here! Is the woman a Herero? Yes, they are the ones here designed in the application. OK, now the pot is far. You may click here and drag it along. OK! Now I realise these educated kids play with computers, are these the things they play with? Yes, these are the things. That's what we teach. I was wondering, and when we are talking to kids, they keep staring at and clicking on some things. So, is this what they do? Yes, that is it, and that is what we teach. Looking at all these objects, what do you think is omitted and you would like added to your homestead? The house is added, the person is added, the cow is added, the woman is added, man is added, the tree is added, and the pot is added. What is left is sheep and goats. Are they in? They were here, right? If you click on the chicken, that is where you will find all animals. Is that where to find goats and sheep? Yes, I would like to add sheep, goat sheep and dog. Other than these, any other animals we omitted? That you think for you, they are important? For us, sheep and goats and dog, the dog for us is very important. If you select one [00:36:02] inaudible, are there any other animal you think should be added? Other than sheep and goat? No, we do not have any other animal we farm with. We farm with cattle, sheep, goat and dog. The dog assists in guarding the animals.

Other than that, we do not need any other animal. Animals, such as pigs, we do not farm with them. Ok, yes cats, those are not our animals. We do not know them. We also do not eat them (pigs). Do you not eat them? Yes, we do not eat pork/pigs. You will never find a Himba homestead with a pig, never! They are not our animals, our animals are cattle, sheep, and goats, and then you add a dog. The dog is our well-known policeman [00:39:29] inaudible… the dog is a policeman. One last thing for me, may you click/select this cow. Should we select a cow? Yes, press there. Is this the same breed you are farming with? They look the same, but cattle are different breeds. Breeds such as Simmentaler or Brahman. These breeds are only appearing nowadays with some farmers, but some people do not have them. Ok. But this is a cow. Yes, this is a cow if you see it you cannot miss it or you recognize it easily. It is a cow, and you see the udder (Otjiua) is here, the tail is here, but it does not have horns, but that does not matter. You can see that this is a cow — the whole body, including the skin (Omukova). We get milk from it by milking it. Do you use calabash? Oh! Yes! That is the most important one!! [00:40:44] laugh. Calabash, Ehoro and Ombako. Where are these located in the homestead? They are located in the house. Our calabash is located at the house with a woman and house. At that house, our calabash stays inside the house. When the cows are being given their calves/being milked, the calabash is taken outside (pekuma), on the side of the house.

OK, how about Ehoro? Where would you put it? Ehoro? Here? Together with

what would you put it? Calabash, Ehoro and Ombako(the one for putting milk into the calabash). These three (3) items stay at the house, nowhere else! They stay at the house [00:41:34] inaudible... so we should put them at the house here. So, therefore, the calabash, Ehoro and Ombako should be put together and must stay at the house. OK! That is where the calabash is placed. Calabash, Ehoro and Ombako.

On using the application, what was complicated for you? With this application? Yes. Nothing complicated at all. Only that we do not know how to use it, but it is not complicated to use. OK. Yes but if you do not know how to use it, you will it complicated to use. You would call it complicated because if you do not know how to use it, you would not know what would happen if a press here. You would also struggle to know where you should drag an object to move it to a particular area. Now, you drag here, try to. OH! OK. I dragged it now. OK now, I want to show you something. If you want to turn around the house, if you want to turn it this way, try turning it like this.

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