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Design and prototypical implementation of a user-optimized online Tools, for organizing trainings in Refugee Settlements in Uganda and South Sudan.

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Affidavit

I hereby declare that Bastian Walthierer has written this master thesis independently without the help of third parties and without the use of sources and aids other than those indicated. All passages taken verbatim or in spirit from the sources used are identified as such individually.

This work has not yet been submitted to any other audit authority and has not been published.

I am aware that a false statement will have legal consequences.

Berlin, February 26, 2023

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I. Introduction

A. War in South Sudan and its effects

In 2011, South Sudan, which had already been declared autonomous, gained its independence and founded a republic. The new government of the young state collapsed in 2013, leading to a five-year civil war. The causes of the conflict stem from the "distribution of political power and economic resources along ethnic lines."¹ The peace treaty signed in 2018 between former Vice President Riek Machar and South Sudanese President Salva Kiir Mayardit ended the civil war, leading to a slow-moving peace process that established a transitional government in February 2020.

Despite the official peace, the country's population is dependent on humanitarian aid due to the many years of war. For example, more than 50 percent of the population is affected by extreme food insecurity.²

The civil war and its aftermath are driving the country's inhabitants to flee - some "2.3 million"³ South Sudanese are fleeing to neighboring countries. Uganda is the country that takes in the most people, with around "854,000"⁴ South Sudanese who have fled.

Uganda's liberal refugee policy lays the foundation for several refugee settlements in the north of the country, such as the Pagirinya Refugee Settlement in Adjumani District. This huge influx of people brings with it additional challenges for the region. As many communities are unable to cope with these pressures, assistance is needed to achieve economic resilience. The goal

¹ *South Sudan*. (n.d.). Federal Ministry for Economic Cooperation and Development, from <https://www.bmz.de/de/laender/suedsudan>

Accessed: 09.01.2023

² *South Sudan*. (n.d.). Federal Ministry for Economic Cooperation and Development, from <https://www.bmz.de/de/laender/suedsudan>

Accessed: 09.01.2023

³ *Situation south Sudan*. (n.d.). Unhcr.org, from <https://data.unhcr.org/en/situations/southsudan>

Accessed 09.01.2023.

⁴ *Situation south Sudan*. (n.d.). Unhcr.org, from <https://data.unhcr.org/en/situations/southsudan>

of this aid is to strengthen the community of refugee settlements and host communities in such a way that a sustainable and self-sufficient economy is guaranteed.⁵

The Federal Republic of Germany and its Federal Ministry for Economic Cooperation and Development (BMZ) consider these goals to be worthwhile, which is why it supports institutions and non-governmental organizations (NGOs). In the area of refugees, support is provided in particular to South Sudanese refugees and host communities in northern Uganda. The focus is on education and job creation.⁶

An example of such an NGO is the r0g_agency, a nonprofit gGmbH whose motivation they express as follows: "The r0g_agency's mission is to promote open, innovative, and peaceful societies through programs that focus on open tech, open knowledge, and peacebuilding activities."⁷



Figure 1: Pagirinya Refugee Settlement

⁵ Patrick Poehlmann, *Supporting refugees and host communities in Northern Uganda*, from <https://www.giz.de/en/worldwide/74940.html>

Accessed: 09.01.2023

⁶ Uganda. (n.d.). Federal Ministry for Economic Cooperation and Development, from <https://www.bmz.de/de/laender/uganda>

Accessed: 09.01.2023

⁷ R0g Agency; r0g_agency for open culture and critical transformation gGmbH. *About*, from <https://openculture.agency/about/>

Accessed:

B. #ASKnet

The r0g_agency describes its **ASKnet** (Access to Skills and Knowledge Network) project as, "#ASKnet is a capacity-building and hub-development program that links together five community-based, youth-led innovation hubs in South Sudan and Uganda. "⁸

1. TARGET

The ASKnet network, which is located in South Sudan and Uganda, is an association of South Sudanese media organizations and media professionals. The population in the regions where the network operates suffers from a high level of educational poverty and a low level of media literacy. The network offers training courses to counteract this problem. The ASKnet pursues the goal of providing free access to information and establishing, or rather promoting, media literacy by means of these training courses, which are also referred to as trainings. Thus, the overriding aim of the members is to contribute to the reconstruction of their country by strengthening civil structures and promoting peacemaking measures.⁹

2. MEMBERS AND ORGANIZATION

The network is divided into five independent media organizations, called **hubs**, and consists of about 50 media experts and trainers. Characteristic of all the hubs is that they were founded out of self-motivation and interest, and the subsequent, self-managed organization of the educational offerings. The hubs operate independently of the government and focus their training on young people, refugees and women. The hubs act as a conglomerate of training center, youth meeting place and coworking space, which transfer the exchange of experiences, ideas and knowledge. In most cases, the hubs rent buildings for this purpose. The YEF hub (Youth Empowerment

⁸ #ASKnet access-to-skills-and-knowledge-network. (2019, November 27), by R0g Agency; r0g_agency for open culture and critical transformation gGmbH, <https://openculture.agency/asknet-access-to-skills-and-knowledge-network/>.

Accessed: 13.01.2023

⁹ Bellinghausen, 2021 Project proposal, project number: p5751, by r0g_agency for open culture and critical transformation gGmbH, https://docs.google.com/document/u/0/d/1yFfhoGUnJs-Y5v2GSKM47vjcKUTgNm5BLChsctp-C9oE/mobilebasic_p.6

Accessed: 13.01.2023



Foundation) in Pagirinya goes a step further and independently constructs a building (Figure 2) from sustainable and low-cost raw material en.¹⁰



Figure 2: Hub in Pagirinya

C. ASKtraining

In order to support hubs in the planning and design of Trainings, the project ASKtraining is being launched, which will be able to present a first prototype as early as 2021. "The online tool (Figure 3) allows users to create a training plan from a set of predefined modules by dragging and dropping. In addition, the system calculates certain elements such as for example: number of days and hours, material costs, minimum number of trainers, maximum number of participants, etc. and displays them in an overview . A training consists of

¹⁰ Bellinghausen, 2021 Project proposal, project number: p5751, by r0g_agency for open culture and critical transformation gGmbH,

¹¹ #ASKtraining - HedgeDoc. (n.d.). Bmen.cc, from <https://md.bmen.cc/training-generator> Accessed 01/16/2023.

<https://docs.google.com/document/u/0/d/1yFfhoGUJJs-Y5v2GSKM47vjcKUTgNm5BLChsctp-C9oE/mobilebasic> p.6 et seq.

Accessed: 13.01.2023

¹¹ #ASKtraining - HedgeDoc. (n.d.). Bmen.cc, from <https://md.bmen.cc/training-generator>
Accessed 01/16/2023.

modules, which in turn is made up of various resources.¹² This structure is discussed in more detail in Section II.E.4, *Functional Scope and Principles*.

Figure 3: Prototype ASKtraining 2021

The screenshot displays the Prototype ASKtraining 2021 interface. On the left, a sidebar titled "Filter modules by tags" lists categories like "Web&Software", "Hardware&Repair", "Community&Moderation", "Organizational_Development", "Media&Art", "Data_Security&Research", "Open_Source&Knowledge", and "Sustainability". Below these are three training modules:

- Community Repair Café - Simulation**: 0 Hours 30 Minutes, advanced, \$ 207 material costs. Resources included: Unit: ASKotec Introduction | Unit: DIY LED Light | Unit: DIY Solar Charger | Unit: Open Guides Introduction | Tool: Open Hardware Guide | Tool: Open Documentation Guide | Tool: #ASKtec Kit.
- Media Hub Business Model Canvas Workshop**: 1 Hours 0 Minutes, easy, \$ 1000 material costs. Resources included: Tool: #ASKtec Kit.
- Minimal Module**: CC-BY-SA 4.0 ASKtraining, view on Github | #ASKnet Website

The main area shows a training schedule for "#ASKtraining - Title of the Training". The schedule includes:

- Introduction into the training** (9:00am - 9:15am)
- Theory of Change Workshop** (9:15am - 9:30am): Introduction into the module. Duration: 2 hours 15 minutes, medium, \$ 0 material costs. Source: CC-BY-SA 4.0 International.
- Theory of Change** (9:30am - 11:30am): Be clear about the impact you want to create. License: CC-BY-SA 4.0 International.

A large orange button at the bottom right says "Drag and drop more modules to add". At the bottom, a summary section shows: 1 day(s), 2 hours, 30 minutes, total time of your training.

Since this prototype is being developed in Germany without a previous, comprehensive user survey and is not yet in use, it is decided to start the development of the tool again, focusing on the front-end area. The cultural, technical and local conditions of the region of use are to be taken into account. Therefore, a technical and primarily scientific approach is sought for the new development, which takes these circumstances into account during the development. The goal of this development is a first prototypical implementation of a user-optimized online tool for the organization of trainings especially in Uganda and South Sudan. To pursue this goal, the Usage-Centred Design method developed by Larry Constantine and Lucy Lockwood was chosen.

¹² #ASKtraining - HedgeDoc. (n.d.). Bmen.cc, from <https://md.bmen.cc/training-generator>. Accessed 01/16/2023.

II. Usage-Centered Design

After the beginnings of work with large computers reserved for only a few people in the 1960s, the term **user-centered design was** coined by Don Norman in the mid-1980s. For the first time, the human being - the user - was the focus of the development of new technologies. In user-centered design, as the term clearly indicates, the users are the center of the design process for systems. Constantine praises this development, but is of the opinion that a main focus on users does not automatically lead to more suitable tools, because a tool is useful if it primarily serves its purpose.¹³

Constantine believes that users do not always name their problems clearly.

In addition, during the communication between designers and users, functionalities that are urgently needed are often not named.¹⁴

"To design dramatically more usable tools, it is not users who must be understood, but usage-how and for what ends software tools will be employed. "¹⁵ With this view Constantine lays the foundation for his **Usage-Centered Design**, in which not the user, but his goals, which are tried to be reached with the use of the software, are in the center.

A. User groups

The user groups describe the different types of users of the application. In order to define these groups, the key question of the type of users and their interaction with the system must be answered.¹⁶

The tool ASKtraining will be used to plan workshops and trainings, to document, and to share teaching and learning materials. The website of the r0g_agency gives answers in which environment the application to be developed will be used for the time being.

¹³ Larry Constantine, Lucy Lockwood, 1999 p. 22 f

¹⁴ Larry Constantine, Lucy Lockwood, 1999 p. 9

¹⁵ Larry Constantine, Lucy Lockwood, 1999 p. 23

¹⁶ Larry Constantine, Lucy Lockwood, 1999 p. 30

The aim is to establish a "five community-based, youth-led innovation hubs in South Sudan and Uganda "¹⁷.

The purpose of the ASKnet community is: "Providing access to skills and knowledge through ToT (Training of Trainers) workshops. These workshops include open source hardware and software using ASKotec [- a kit that work as a mobile training set -], entrepreneurship, media production, gender equality awareness, trauma healing, and financial literacy. "¹⁸

It should be noted that the future users of the tool are members of the ASKnet and work in an interdisciplinary way. The common framework is both the residency in a region with a weak infrastructure and the aspiration to impart education.

B. Interviews

In order to design software, it is important to ask for certain information up front. To begin the design process, Constantine suggests the following questions:

- "What will the users of this software be doing?
- What will they be trying to accomplish?
- What do they need from the system to accomplish it?
- How should the system supply what they need? "¹⁹

In order to get an overview of these questions, several people will be interviewed at the beginning. It is assumed that the respondents can be divided into two groups, trainers and participants of workshops / trainings. After the recommendation

"End users are the primary and ultimate source of information to guide usage-centered design "²⁰, the main focus will be on talking to people who are familiar with the cultural context of the application's provisional area of use - Refugee Settlements in Uganda.

¹⁷ #ASKnet access to skills and Knowledge Network. (2019, November 27). R0g Agency; r0g_agency for open culture and critical transformation gGmbH. <https://openculture.agency/asknet-access-to-skills-and-knowledge-network/>.

Accessed: 16.06.2022

¹⁸ #ASKnet access to skills and Knowledge Network. (2019, November 27). R0g Agency; r0g_agency for open culture and critical transformation gGmbH. <https://openculture.agency/asknet-access-to-skills-and-knowledge-network/>.

Accessed: 16.06.2022

¹⁹ Larry Constantine, Lucy Lockwood, 1999 p. 69 - translation by the author

²⁰ Larry Constantine, Lucy Lockwood, 1999 p. 70

and South Sudan - are close to, or belong to. Thus, two different user groups are defined and the following areas are determined for which questions are formulated:

Trainer:

A trainer is a person who plans and holds workshops / trainings (survey: 5 - 10 people):

- Information about the person, profession / activity
- Information about participants
- Venue information
- Information about the trainings
- Organization within the hubs
- Funding

Participant:

A participant is a person who takes part in a workshop / training (survey: 2 - 5 persons):

- Information about the person, profession / activity
- Information about the teaching materials
- Application of learned skills
- Infrastructure information

The interviews are conducted online. For this purpose, the tools **BigBlueButton**, "an audio and video conferencing system "²¹, and **Telegram**, "a cloud-based mobile and desktop messaging app "²², will be used.

Due to the inadequate digital infrastructure, the implementation of the in
The interviews are problematic - connections are regularly broken off or do not come about at all. Moreover, only ASKnet trainers are interviewed, because training participants are difficult to reach online. The majority of trainers began their careers as participants in training courses, so the interviewees can provide information about both groups of people.

It is

²¹ *BigBlueButton server*. (n.d.). Bigbluebuttonserver.de, from <https://bigbluebuttonserver.de/>
Accessed 03.01.2023.

²² *Telegram - a new era of messaging*. (n.d.). Telegram, from <https://telegram.org/>
Accessed 03.01.2023.

It should also be noted that the group of participants is of secondary importance for the development and design of the application.

C. Role Modeling

"The relationships between users and the system. "²³ The role model describes the different user roles of a system, which are represented in the user role map with their different interrelationships and dependencies to each other.

1. USER ROLE

"A user role is an abstract collection of needs, interests, expectations, behaviors, and responsibilities characterizing a relationship between [...] users and a system. "²⁵ When designing user roles, it is important to consider, on the one hand, which behavior is very characteristic for a user and, on the other hand, which users are also necessary to support the application or to provide it with content. In a first analysis, the following preliminary roles emerge, as already stated in the user groups:

Trainer:

- Enters information into system
- Arranges information logically
- Links outsourced information to the system
- Receives information from the system

Participant

- Reads information from the system

In order to be able to describe the user roles even more precisely, the statements from the interviews are first checked for similarities and differences. The extent to which the differences are significant or negligible is assessed. These points will be summarized in a document (*X. Appendix D. Services provided by application*) and divided into potential and possible services that the ap-

²³ Larry Constantine, Lucy Lockwood, 1999 p. 30

²⁴ Larry Constantine, Lucy Lockwood, 1999 p. 30

²⁵ Larry Constantine, Lucy Lockwood, 1999 p. 79

plication should provide, reformulated. These tasks are then used to define the user roles. Figure 4 illustrates the process of deriving roles from the individual structured requirements, which correspond to the different tasks from the requirements analysis. It can be seen that the group of trainers in particular has different requirements for the application.

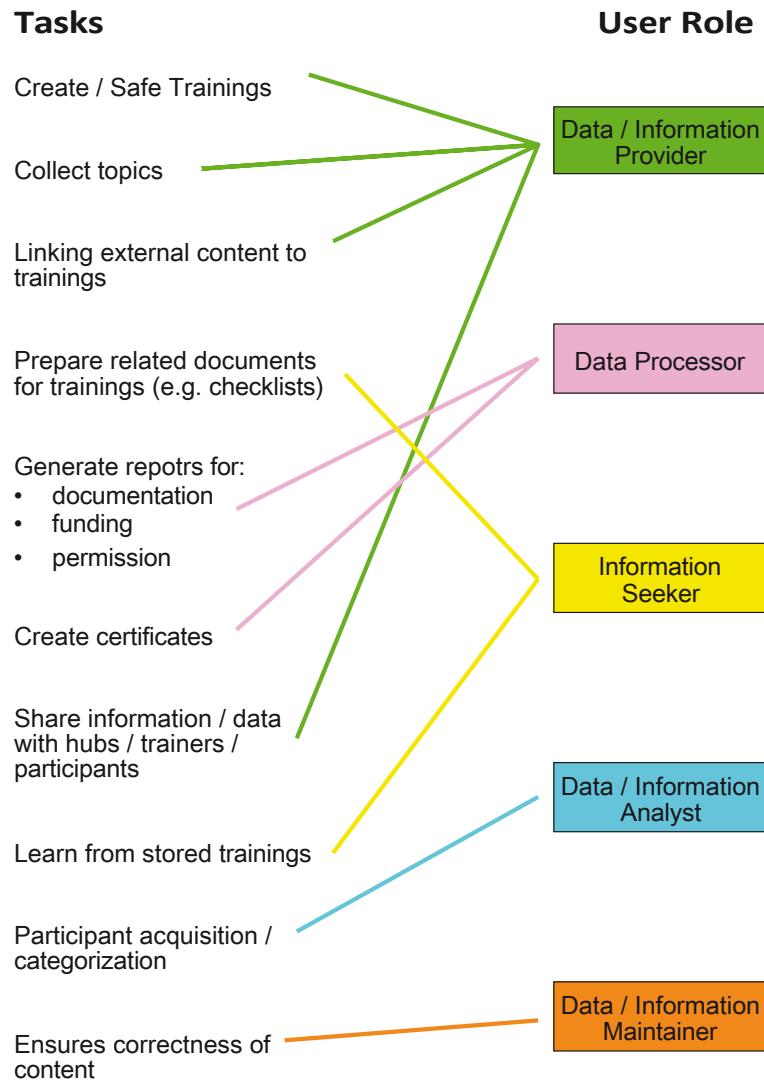


Figure 4: User Roles and Tasks

The following principle is taken into account in the choice of role names: "Each role is given a name that typifies the relationship of such users to the system."²⁶ When choosing a name, care must be taken to ensure that it is clear how the role interacts with the system.

²⁶ Larry Constantine, Lucy Lockwood, 1999 p. 81

interacts. Constantine recommends that "the right name is less important than getting the right idea "²⁷.

The following User Roles are thus determined:

- **Data / Information Provider:** Person who creates and stores content (e.g., creates and schedules training).
- **Data Processor:** Person who receives data from the system and processes it further (e.g. for documentation purposes, generating certificates).
- **Information Seeker:** Person who receives content from the system (e.g. participants, or trainers from another hub who want to offer similar training)
- **Data / Information Analyst:** Person who analyzes data from the system (e.g. participant acquisition, categorization of participants).
- **Data / Information Maintainer:** Specialist in a subject area to verify information and content.

2. FOCAL ROLES

"Focal user roles play a special part in helping to shape and define the user interface. "²⁸ This is why it is important to determine these roles, since it can be assumed that they are "the most common or typical, or that they are considered particularly important from a different perspective. "²⁹ The focal user role in this case is that of the **data/information provider**, since it is considered to be the main actor for the use of the application due to its tasks. In addition, as the user role map (Figure 5) shows, the focal role includes a large proportion of the other user roles.

3. USER ROLE MAP

The user role map is a tool for the clear representation of the different roles of a system. Roles are related to each other according to similarities, group membership or the composition of their properties.³⁰ "The user role map

²⁷ Larry Constantine, Lucy Lockwood, 1999 p. 81

²⁸ Larry Constantine, Lucy Lockwood, 1999 p. 82

²⁹ Larry Constantine, Lucy Lockwood, 1999 p. 83 - translation by the author

³⁰ Larry Constantine, Lucy Lockwood, 1999 p. 84 f.

is a way of capturing the big picture; it reveals how all the various roles fit together in defining who will use the system and how.³¹

As the map shows, several roles are derived from the focal role of the **data / information provider**. A special feature is the role of the **Data / Information Maintainer**, which is, so to speak, a superordinate or specialized form of the **Data / Information Provider**. This role can, for example, be assumed by educational institutions or similar official bodies in order to verify learning content and formally recognize the completion of a training course.

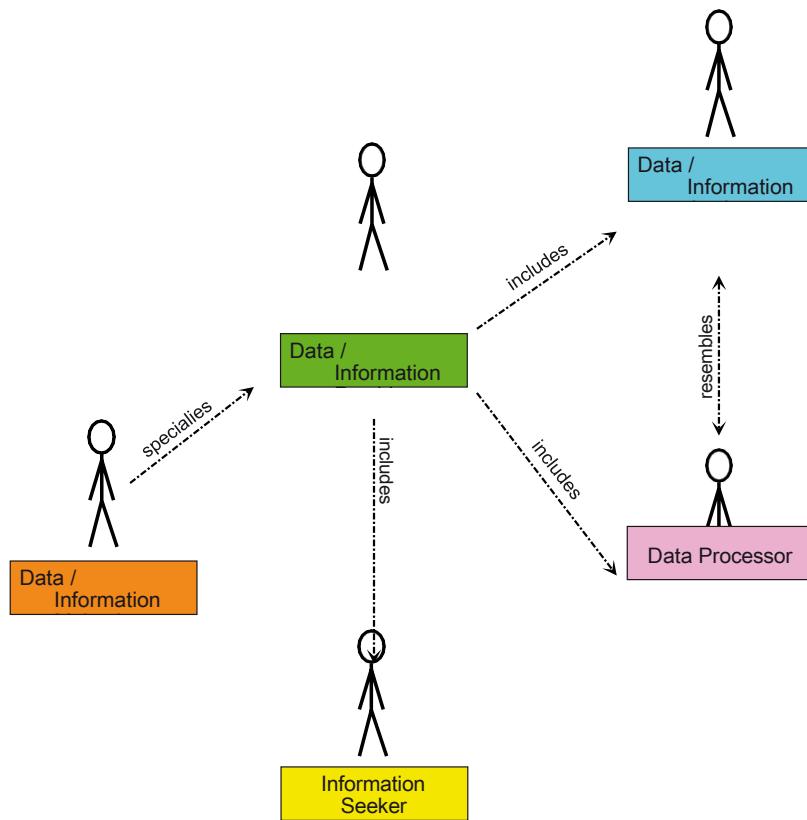


Figure 5: User Role Map

D. Task Modeling

The interviews reveal what the users' tasks are. In order to better understand the individual work steps for task modeling, people are again interviewed about specific aspects that are considered particularly important for the development of the tool.

³¹ Larry Constantine, Lucy Lockwood, 1999 p. 84

worthwhile. "To give people better, more useful tools with which to work, we must understand what they are doing and what they are trying to do. "³²

The focus will now be on a detailed account of the following processes:

- Participant acquisition
- Issuance of certificates
- Achieving and setting training goals
- Agreements with authorities from the education sector
- Project documentation
- Funding from additional donors (mostly projects are funded only with the financial resources provided by the r0g_agency).

One member from each of the Platform Africa and GoGirls ICT hubs was interviewed. Both hubs are considered to be particularly well established. The interviewees also hold key positions in their hub. In addition, they provide documents that they use during the planning of trainings and workshops. This information is a key factor in the development of the personas and scenarios.

1. PERSONAS

In order not to lose touch with the future users during task modeling, personas are developed. These should represent typical users and reflect their needs and expectations. In doing so, they promote the detection of universal functionalities. "The purpose of personas is to create reliable and realistic representations of your key audience segments for reference. "³³ Personas help in testing and prioritizing options and properties of the applications to be developed by establishing a connection to reality or the context of the application. The personas have a name, age, marital status, profession, a photo, etc., in order to get as accurate an impression as possible of this fictitious person.³⁴

³² Larry Constantine, Lucy Lockwood, 1999 p. 97

³³ Assistant Secretary for Public Affairs. (2013). *Personas*. <https://www.usability.gov/how-to-and-tools/methods/personas.html>.

Accessed: 03.08.2022

³⁴ Assistant Secretary for Public Affairs. (2013). *Personas*. <https://www.usability.gov/how-to-and-tools/methods/personas.html>.

Accessed: 03.08.2022

In order to make the personas as realistic as possible, the impressions from the interviews are mainly used for the development. In addition, elements from the persona descriptions of the LEAD (Local - Expert - Action - Directory) were taken over. "LEAD is a directory of #ASKnet experts in your area who are there to provide guidance and assistance."³⁵ This web platform is part of the ASKnet, which members of the various hubs use to network. As a rule, they introduce themselves with a short biography and a description of their personal skills and knowledge and can contact other members accordingly.

Figure 6 shows a persona. The structure of the document with photo, personal data and description is based on a resume or motivation letter.

AMANYARA WILLIAM

Age:	24
Nationality:	South Sudanese
Marital Status:	Single
Hub:	Community Creativity for Development (CC4D)
School Education:	no graduation or degree
Languages:	English, Arabic, Kakwa, Pojulu, Kiswahili
Mobile Phone:	Smartphone with access to internet



Amanyara William is a 24 years old South Sudanese male, living in Eden at Rhino Camp Refugee Settlement, Uganda. He left South Sudan due to the civil war that erupted back in 2016.

This negatively affected his education, he couldn't graduate high school. Hence he was quite happy when he found out about the #ASKnet trainings in his settlement. He became very interested in informatics, open source projects and repairing broken mechanical and electronic devices.

Soon after his first trainings he became a member of the CC4D hub and they started to organize a community repair cafe event, where participants are able to fix broken devices. Amanyara also planned and organized trainings for women only. This training consists of two different parts: empowerment and hands-on training on repairing.

Furthermore Amanyara is developing technical devices with the open source hardware and software project Arduino.

Figure 6: Persona

³⁵ LEAD is a directory of #ASKnet experts in your area who are there to provide guidance and assistance (n.d.). Asknet.community, from <https://lead.asknet.community/> Accessed: 21.07.2022

2. SCENARIOS

"A scenario in general is an episodic description of tasks and activities in their context.

Scenarios are used as tools. Through them

the facts are to be better illustrated.³⁶ The scenarios are thus used as tools are used to derive the resulting use cases. When designing the scenarios, care is taken to do justice to the everyday situation of the people in the refugee settlements as much as possible. At this point, reports and information from the interviews are incorporated. The scenarios are described with the two persons identified from the personas.

"Scenarios for user interface design narrate the interaction between a user or type of user and a system.³⁷ For this reason, the technical component is also considered in the reports.

The description of the technical component is sometimes difficult when working out details of certain work processes, as it is not always clear from the interviews how to proceed precisely with certain activities. Therefore, additional documents from the various hubs are included for a complete description. For the elaboration of the scenarios, templates for project documentation and proposals from r0g_agency, certificates for trainings from GoGirl ICT and Google forms for the application for participation in trainings from CC4D are used.

3. CONVENTIONAL USE CASES

"A weakness of scenarios as an integrative construct is that, as informal representations, they are usually written in natural language and are often inadequate or flawed for difficult discussion among users, developers, usability experts, and other stakeholders, each with different motivations

and backgrounds are not sufficient.³⁸ Nevertheless, according to DATech's guide Usability the scenarios are necessary in order to derive the use cases from them. "In the design project, the usage scenario is the most important prerequisite for the design of a use case, the specification of functional requirements. First use scenario, then use case. This

³⁶ Brigitte Eller, 2009 p. 74

³⁷ Larry Constantine, Lucy Lockwood, 1999 p. 101

³⁸ Brigitte Eller, 2009 p. 75

The sequence is mandatory if the functional requirements are to be specified from the usage perspective.³⁹ The conventional use cases are derived from the previously developed scenarios.

The method of use cases was developed by Jacobson as early as 1992, since when it has become a widely used tool in software development. The use cases are divided into individual dialog steps and are divided into **User Action Model** and **System Response Model**. A user interacts with the system and the system responds accordingly. Thus, a clear distinction can be made between the interests of the user and the tasks of the system, regardless of the content of the task. The use cases are designed linearly, starting with the first action and ending with the completion of the task. Care must be taken to describe the interaction completely, in detail, and in a meaningful way.⁴⁰

The use cases are linked to the usual tasks for the processing of these specific tasks. Tools described, such as Google forms, GitHub via web browser, tabulation programs, etc....

USE CASE: CONDUCTING SAVED TRAINING

User Action	System Response
Click on web browser	Open web browser
Enter „github.com“	Display website
Click on „Sign in“	Display login page Request username / email address Request password
Enter Username Enter Password Click „Sign in“	Verify login data Display dashboard
Click on „DIY Solar Generator“ repository	Display repository
Click on „materials.md“	Display „materials.md“
Press „Ctrl + P“ for printing	Print document
Navigate back to „DIY Solar Generator“ repository	Display repository
Click on „tools.md“	Display „tools.md“
Press „Ctrl + P“ for printing	Print document

Figure 7: Use case described with GitHub via web browser

³⁹ DATech, 2009, p. 167

⁴⁰ Larry Constantine, Lucy Lockwood, 1999 p. 101 f

4. ESSENTIAL USE CASES

"Conventional use cases typically contain too many built-in, premature assumptions, often hidden or implicit, about the form of the user interface do be designed."⁴¹ Accordingly, it is necessary to reduce the detailed descriptions of conventional use cases to the essentials. This is achieved by changing the two models: the User Action Model is the **User Intention Model** in the Essential Use Case and the System Response Model is the **System Responsibilities Model**. Thus, an Essential Use Case describes the user's intention and expectations of the system during use. In the subsequent development of the interface, this aspect is essential, because the change from the mechanical or technical description to the description of the user's intention avoids that design decisions are included. This is because a conventional use case is developed using a specific software, tool, device, etc. and therefore also indirectly describes the barriers, properties, and behaviors of the software, tool, or device within which a use case was developed.⁴²

Constantine defines Essential Use Cases as a "structured narrative, expressed in the simplified, generalized, abstract, technology-free and implementation-independent description of one task or interaction that is complete, meaningful, and well-defined from the point of view of users in some role or roles in relation to a system and that embodies the purpose or intentions underlying the interaction."⁴³

Figure 8 shows the comparison of a conventional use case with the essential use case derived from it. It can be clearly seen how the description of the task is shortened in the Essential Use Case by the change of the two models.

⁴¹ Larry Constantine, Lucy Lockwood, 1999 p. 103

⁴² Larry Constantine, Lucy Lockwood, 1999 p. 103 f

⁴³ Larry Constantine, Lucy Lockwood, 1999 p. 103

USE CASE: PLANING TRAINING

Extends: Creating Resources
Selecting existing Resources

Conventional Use Case		Essential Use Case	
User Action	System Response	User Intention	System Responsibility
Click on web browser	Open web browser		
Enter „github.com“	Display website		
Click on „Sign in“	Display login page Request username / email address Request password		
Enter Username Enter Password Click „Sign in“	Verify login data Display dashboard		
Click on „new“ - button	Display „create a new repository“ site	Creating new content	Possibility to create new content
Click on text Feld beneath „Repository name“	Show flashing cursor for text writing		
Enter repository name Choose bullet „Public“ Click „Create repository“ - Button	Display „Quick setup“ site	Label the content Make it public	Possibility to name new content Provide public access to content

Continues on this point with Use Case: Creating Resources and Use Case: Selecting existing resources

Figure 8: Conventional and Essential Use Case

5. USE CASE MAP

The use case map graphically depicts the relationships of the various use cases to one another and in this way makes it possible to describe the overall scope of the tasks that are processed with the application. Related use cases - also called **subcases** here - are grouped into so-called **supercases**. By means of this generic summary of the use cases, it is possible to simplify the general purpose of the application. The subcases are a specification of the respective supercases and correspond to the previously elaborated essential use cases. Accordingly, it is not necessary to present all use cases in the use case map; it is sufficient to use an appropriate number of meaningful use cases.⁴⁴

⁴⁴ Larry Constantine, Lucy Lockwood, 1999 p. 109 f

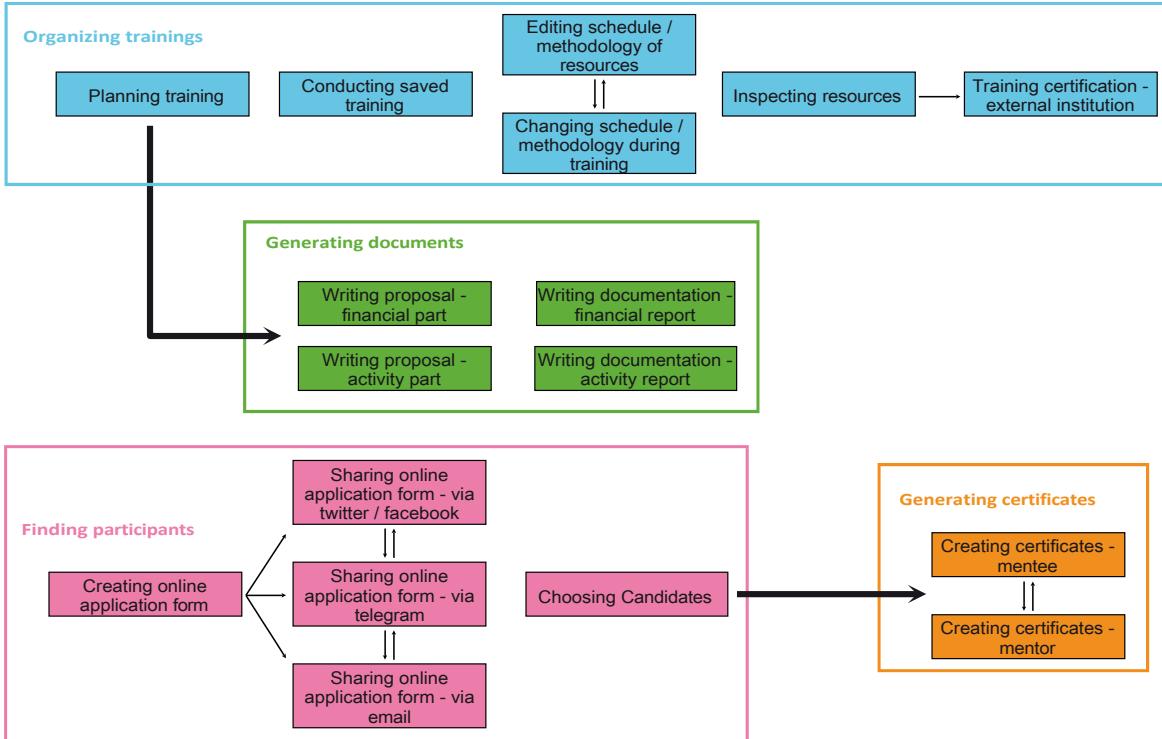


Figure 9: Use Case Map

The use cases are organized into the following four supercases:

- **Organizing trainings**: These are all tasks related to the creation, editing, modification, etc. of trainings.
- **Generating documents**: This Supercase deals with the generation of documents for the documentation as well as for the project proposals.
- **Finding participants**: Describes the search for suitable participants for trainings.
- **Generating certificates**: The creation of certificates for participants of trainings.

6. FOCAL USE CASE

The Focal Use Cases are chosen to determine where the development will initially focus. In the course, they help to organize the design of the interface in sequence, because they serve as a starting point for the design process. The choice of focal use cases takes into account what is defined as a requirement for the system at the beginning of the project and what is named as particularly useful from the point of view of the user survey in the interviews. This results in the following supercases for the focal use cases

"Organizing trainings" and "Generating documents". The Focal Use Cases are also linked to the Focal User Roles; for these, the role of Data / Information Provider was chosen, which is to be regarded as the main actor in the Focal Use Cases.⁴⁵

E. Interface Contents and Navigation

The next step links the modeled tasks with the various components of an interface. The goal is to create a basis with which the tasks from the use cases can be processed with the help of the tool to be developed.

1. INTERACTION CONTEXT

Interaction context refers to the various areas in which users interact with the user interface and all its elements and information.

The contents of the various interaction contexts are functions and data that the application uses to fulfill the tasks of the use cases. The interaction context also serves as the cornerstone for the interface design.⁴⁶

Figure 10 shows the interaction context map. Here, for the first time, the various use cases are arranged in a form that on the one hand corresponds to the workflow of the users; and on the other hand, they are structured in classes, as within the use case map. The map also shows which use cases are derived from others; for example, "Planning training" includes "Creating resources" and "Selecting existing resources".

⁴⁵ Larry Constantine, Lucy Lockwood, 1999 p. 115

⁴⁶ Larry Constantine, Lucy Lockwood, 1999 p. 125 ff.

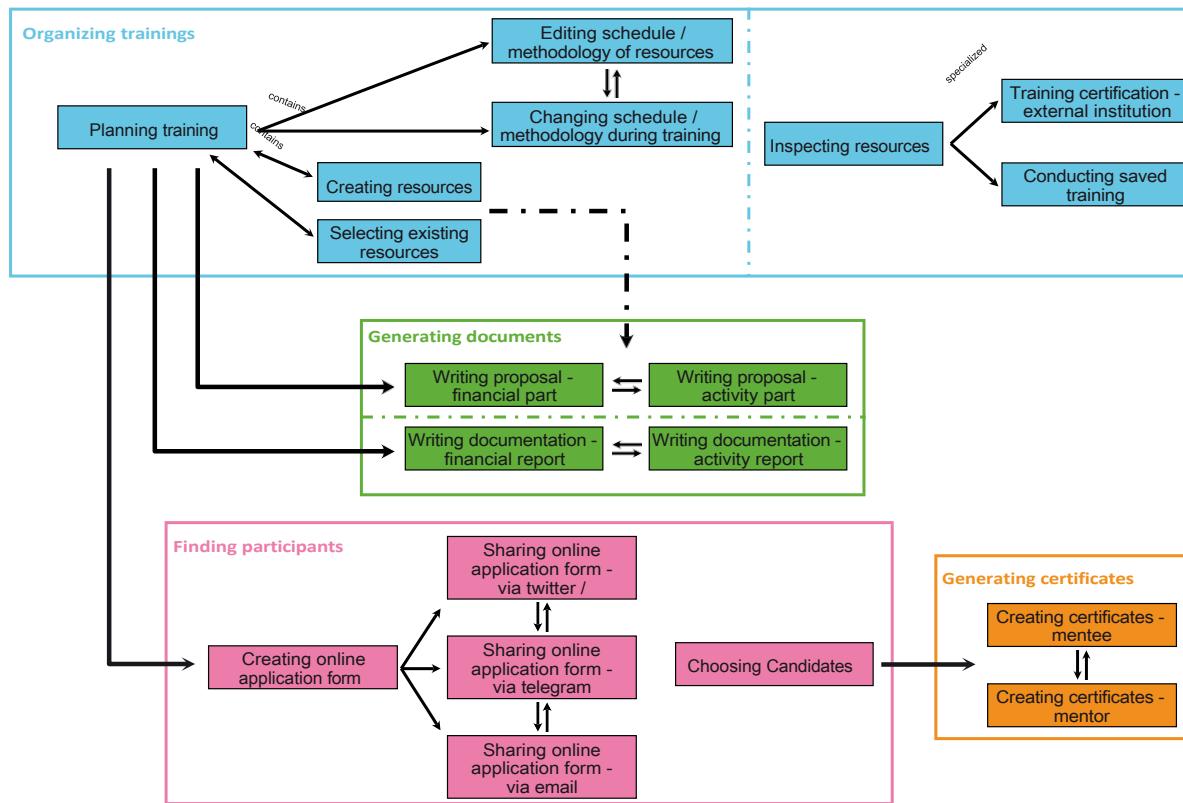


Figure 10: Interaction Context Map

2. TOOLS AND MATERIALS

After preparing the Interaction Context Map, the tools and materials should be defined within the framework of the Usage-Centered Design. Here, the tools are comparable to functions and capabilities that serve the fulfillment of a specific task. Materials are data and domains that are in turn processed by the functions, i.e. the tools, . These abstract components serve as placeholders for visual attributes of the interface and are helpful in designing the interaction.⁴⁷ Essential Use Cases are used to develop the Tools and Materials, which in their abbreviated form describe the essence of the workflows. Paired with the abstract components of the Tools and Materials, this provides a further basis for the design of the interface - free from influences of that software from the Conventional Use Cases. The designations are chosen in such a way that they exemplify the respective purpose . The color choice is, as Constantine it in "hot colors"⁴⁸ for tools and in "cool co-

⁴⁷ Larry Constantine, Lucy Lockwood, 1999 p. 133 f.

⁴⁸ Larry Constantine, Lucy Lockwood, 1999 p. 133

lors⁴⁹ for materials. Figure 11 shows the different components for the Interaction Context Generating Documents.

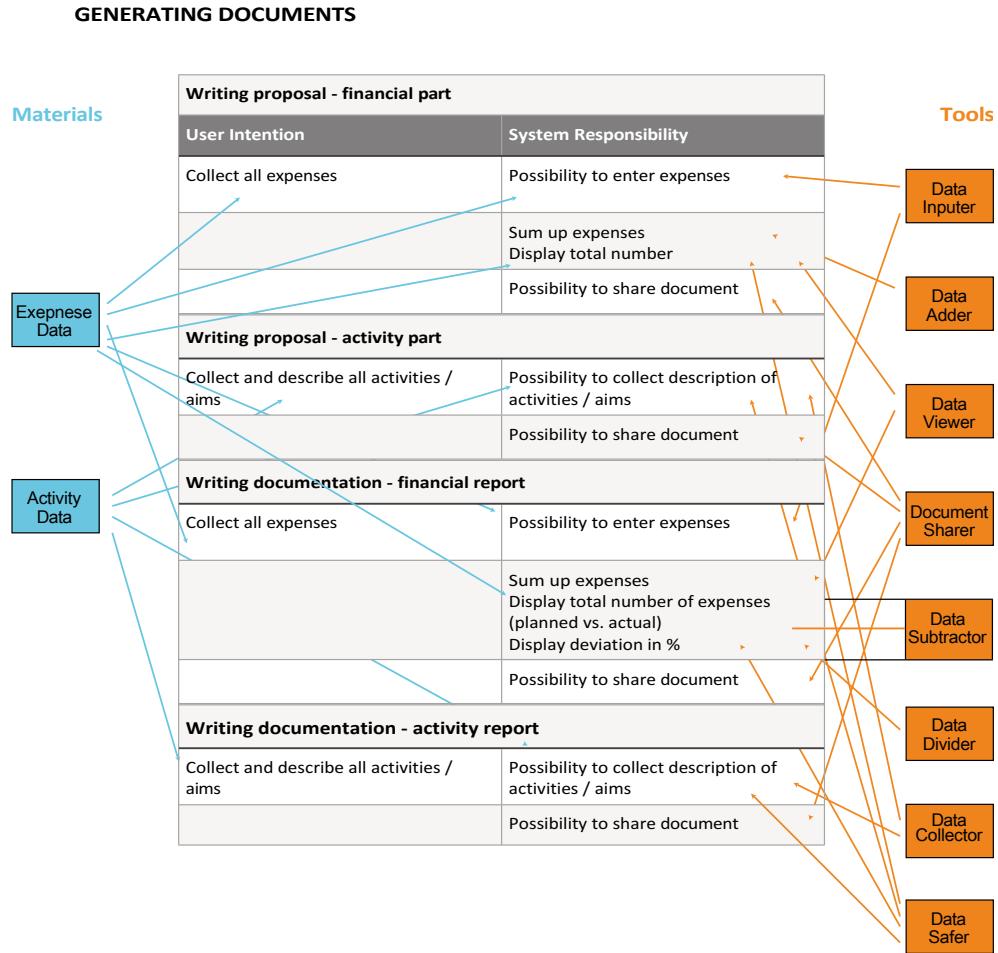


Figure 11: Tools and Materials

3. CONTEXT NAVIGATION MAP

The Context Navigation Map represents the complete interface architecture and shows the scope of the system's complexity. It consists of different elements that are related to each other by arrows. The map also describes the relationships of the interaction contexts and consists of the same. It is created taking into account the tools and materials, i.e. the data types described therein and the associated necessary functions for the respective interaction contexts. The arrows describe the change between different areas and can be compared to a navigation through an application via buttons, menus and the like.

⁴⁹ Larry Constantine, Lucy Lockwood, 1999 p. 133

Furthermore, the map can be used to check whether all defined use cases can be processed with the application to be developed and its interaction contexts. It is advisable to work through each use case step by step on the map. If you frequently switch back and forth between the different levels of the map during this process, it is an indication that the various interaction contexts are not optimally arranged.⁵⁰

When designing the context navigation map, the first decision to be made is the depth of the structuring of individual interaction contexts. Larry Constantine specifies the alternatives, either by simplifying and expanding the contexts, or by reducing the number of contexts while increasing the complexity: "One of the most important trade-offs is whether to keep each interaction context small and simple, thereby proliferating the number of contexts, or to reduce the number of separate contexts, thereby increasing the complexity of each one.

It can be deduced from this that simple, clear interaction contexts with a manageable number of functions help inexperienced users to find their way intuitively into the tool. However, a certain grouping of similar functionalities should not be dispensed with in order to avoid an unnecessarily deep nesting of the application. In addition, care should be taken to ensure that similar elements and functions in the different interaction contexts always have the same logical structure. In the context navigation map, for example, it can be seen that when browsing content, it is always possible to view it in detail, edit it and, if necessary, share it (Browse ... -> Display / Edit /...). Such a repetitive structure not only contributes to keeping the application simple in its operation, since learned work processes take place again and again at different points in the system, but also has the effect, with regard to the design of user interface attributes such as buttons, menus, etc., that these can always be continuously structured.

⁵⁰ Larry Constantine, Lucy Lockwood, 1999 p. 135 ff.

⁵¹ Larry Constantine, Lucy Lockwood, 1999 p. 135

Context Navigation Map

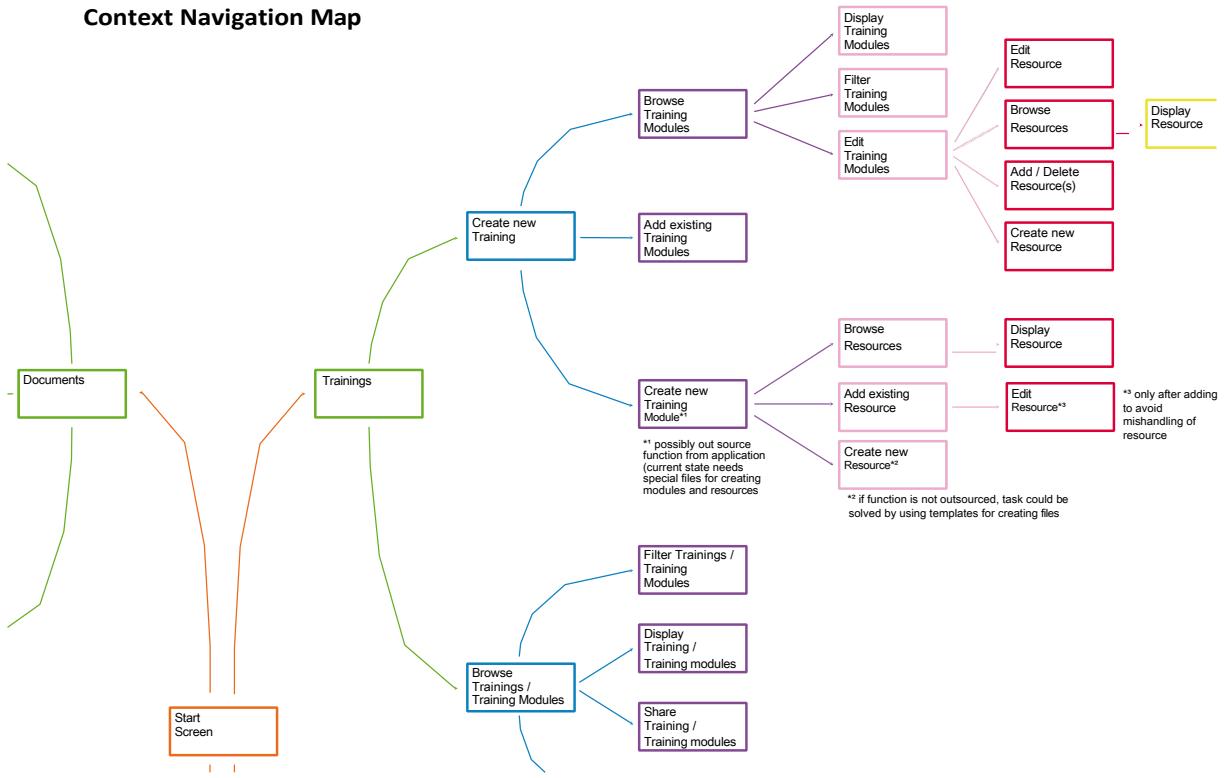


Figure 12: Section of the Context Navigation Map

4. SCOPE OF FUNCTIONS AND PRINCIPLES

The system is divided into the following four areas corresponding to the sub-areas, as shown in the Context Navigation Map:

Trainings:

A training consists of three levels, the first one is the training in general. On this level new courses are created, already existing courses are listed and can be edited.

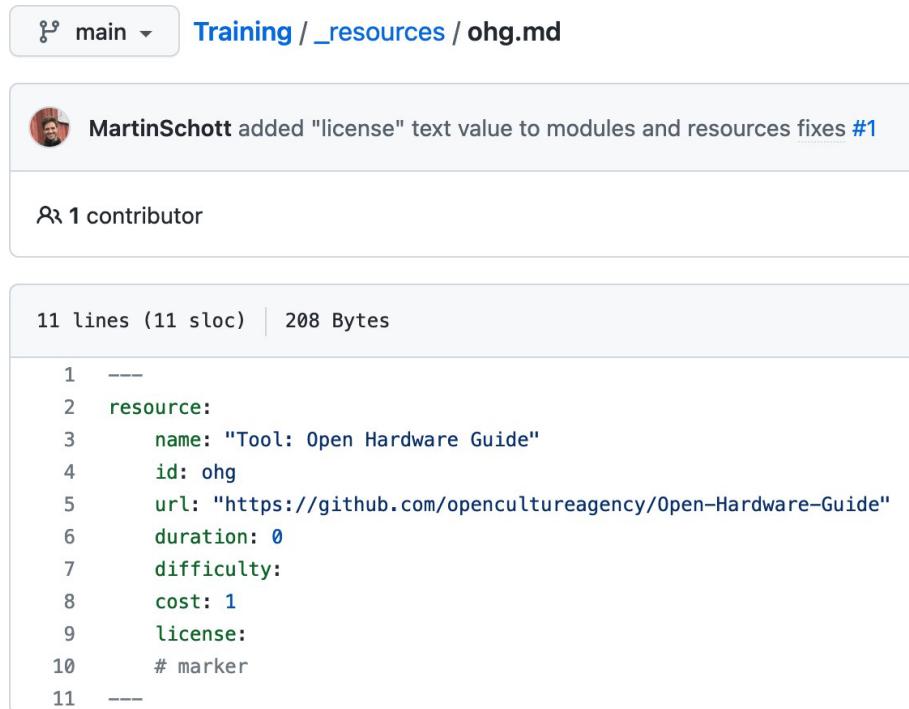
Based on the existence of an already functional prototype,⁵² which deals with the organization of trainings, its architecture, structure and functioning will also be taken into consideration in the course of the development of this application.

The structure of the first prototype can be found in the three levels of training. A training course consists of **modules** (on the second level), which in turn are re-

⁵² Prototypical online tool: #ASKtraining. (n.d.), from <https://training.asknet.community/training/>

sources (on the third level). New modules and resources can be created and existing ones can be edited.

A module represents a teaching unit on a specific topic, such as **Open-Tech Basics** - a training module that deals with publicly available technologies. One element of this block is the **Open Hardware Guide**, a poster that provides an overview of projects and examples that use Open Hardware methods.⁵³ This poster is a resource of the module. Such Resources files are created within the first prototype on GitHub. Figure 13 shows the resource file of the Open Hardware Guide. The Resource here has various attributes such as name, id, a URL pointing to the poster, duration, cost, etc.... These structures have to be taken into account in order to merge the existing prototype with the newly developed frontend, if necessary.



The screenshot shows a GitHub repository interface. At the top, there is a navigation bar with a dropdown menu labeled "main" and a link to "Training / _resources / ohg.md". Below the navigation bar, a message from a user named "MartinSchott" is displayed, stating they added a "license" text value to modules and resources fixes #1. Below the message, it says "1 contributor". The file "ohg.md" is shown with 11 lines (11 sloc) and 208 Bytes. The content of the file is as follows:

```
1  ---
2  resource:
3    name: "Tool: Open Hardware Guide"
4    id: ohg
5    url: "https://github.com/opencultureagency/Open-Hardware-Guide"
6    duration: 0
7    difficulty:
8    cost: 1
9    license:
10   # marker
11  ---
```

Figure 13: Resource from the current tool

Furthermore, it is possible to print out, comment on, share and save trainings as well as individual modules locally on a device.

⁵³ Open Hardware Guide: The Open Hardware Guide gives examples of hands-on skills possibilities and projects applying open hardware methodologies. (n.d.). - Translation by the author

Documents:

The documents section is divided into two categories, so-called **Proposals**, which are applications for grants and similar concerns, and **Reports**, which are reports for completed projects. Subsequently, existing documents can be retrieved, shared, viewed and edited.

For writing a document of the two categories, specific templates, prefabricated patterns that give clues regarding content, scope, layout, etc., must be used, since different funding agencies have different requirements for proposals and reports. Therefore, each new document must first be assigned a specific template. There is also the possibility to add further, not yet existing templates to the system.

A course must also be assigned to each report. This step is optional for the proposals. This assignment is important so that documents can receive the data from the courses (more precisely, from the resources) and content can be generated automatically from it. For this automated assignment of data, the application provides a possibility to mark corresponding areas in the templates with attributes. In this way, for example, the costs of the resource **Open Hardware Guide**, which are listed in the corresponding file under the item **cost** (see Figure 13, line 8), are transferred to the project report, listed accordingly and added up with other costs incurred in the training.

In addition, there is the option to print reports and proposals and to comment on them, share and store locally.

Certificates

This area is used to browse and create certificates. Due to the increasing popularity and relevance of the hubs in their regions, certificates are handed out to participants of trainings, which become important (for example) in job application documents, as they prove the possession of explicit skills, competencies. Certificates can be shared internally, and they are equipped with a recognition mark that proves their authenticity.

Participants

The application offers the function of creating application forms for participants of trainings. An application form consists of a series of questions regarding

of residence, age, experience, etc.. This form is published online and can be answered and submitted by applicants. In order to be able to retrieve the forms and avoid having to recreate them, they are saved and can be edited if necessary.

The limited number of places available in training courses makes an application procedure unavoidable. In this case, the procedure is schematic. In this respect, the tool offers the possibility to categorize applicants on the basis of the application forms and to filter them according to attributes.

III. visual design

With the modeling completed, the next stage of the project begins - the visual design of the application. The challenge at this point is to adequately, practically and effectively transform the requirements previously captured and developed in the various models into a visual language. The development of this visual communication layer happens in phases that build on each other.

Since the application will initially be used in the context of the hubs, it is important to make it accessible to as many users as possible. The survey of the users made it clear that although only some of them have access to desktop computers, all of them have a smartphone. Consequently, the **mobile-first approach**, a concept primarily optimized for use via mobile devices, is being pursued in the design.

In advance, a concrete mobile operating system and its visual language are defined as a basis in order to be able to make use of existing, familiar and omnipresent interaction elements during the design. Figure 14, published on the website of the company Statista, provides an insight into the worldwide distribution of the various operating systems.

Under these circumstances, the decision falls on the Google purchased and further-developed Android operating system,⁵⁴ which, with a share of nearly 72 percent (as of September 2022) dominates the market.⁵⁵

⁵⁴ *The history of Android - Google*. (n.d.). About.google, from https://about.google/intl/ALL_en/stories/history-android/.
Accessed: 10.10.2022

⁵⁵ *Mobile operating systems - Internet usage market shares worldwide to September 2022*. (n.d.). Statista, from <https://de.statista.com/statistik/daten/studie/184335/umfrage/marktanteil-der-mobilien-operating-systems-worldwide-since-2009/>.
Accessed: 10.10.2022

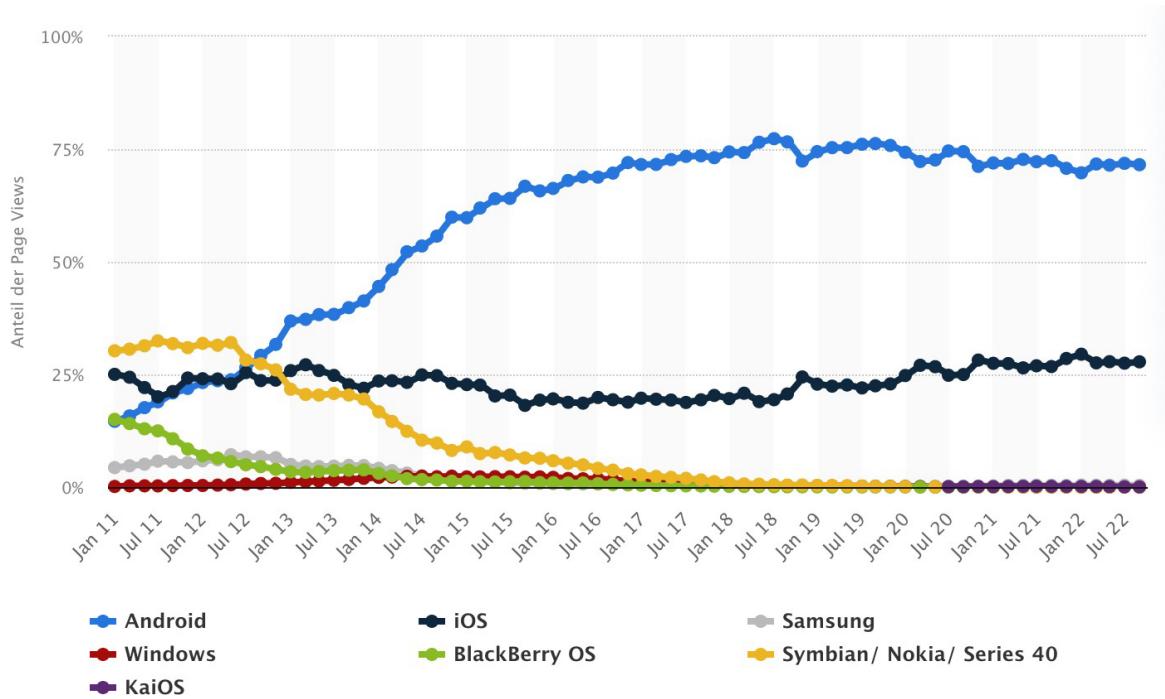


Figure 14: Market shares of the leading mobile operating systems in Internet usage with cell phones worldwide from January 2011 to September 2022

(Source: *Mobile operating systems - Internet usage market shares worldwide to September 2022*. (n.d.). Statista)

A. Sketching

At the beginning of the design phase, the first concepts are produced in the form of sketches, i.e. simplified drawings on paper - sketches. This form of prototyping is characterized by its simplicity and experimental nature - numerous, diverse variations are created spontaneously. These designs are also referred to as **low fidelity prototypes**.⁵⁶ From the resulting multitude of designs, the most suitable one serves as a template for the next steps in the design process.⁵⁷

The usability guide published by DATech also describes this method of sketching as **explorative prototyping**. The preparation of various solution approaches is characteristic of this approach. With the help of a visually concise comparison of the most important aspects, an optimal solution can be found.⁵⁸

⁵⁶ Carla Viviana Coleman, 2018, p. 51 ff.

⁵⁷ Kantamneni, P. *Rapid prototyping*. Medium, from https://medium.com/@kprasad_88078/rapid-prototyping-db44fefd464f

Accessed: 23.09.2022

⁵⁸ DATech, 2009, p. 28

When adapting the prototype to the Android operating system, the examination of Google's **Material Design** as a guideline already begins in the sketching phase. "Material (Design) is an adaptable system of guidelines, components, and tools that support the best practices of user interface design. Backed by open-source code, Material streamlines collaboration between designers and developers, and helps teams

quickly build beautiful products.⁵⁹ The guideline that Material Design provides for using of the interaction elements on the one hand helps to choose appropriate functions in advance and on the other hand clarifies which interface attributes are unsuitable for certain purposes.

Here is an example of how the **bottom navigation** in the first sketches is replaced by a **bottom app bar** in later drawings (Figure 15, red arrow). In the first variant, the material guidelines classify the initially planned use within the application as unsuitable.

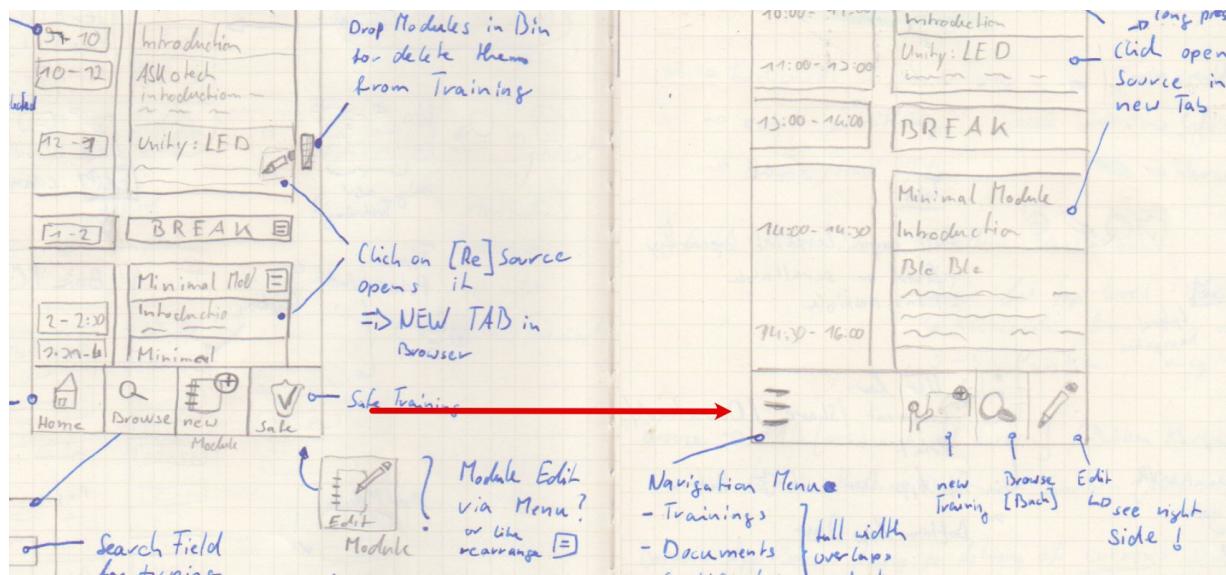


Figure 15: Excerpt from Sketches - Development of the navigation in the lower screen

The used elements essential for the user interface from the material De-sign:

- **Bottom App Bar:** A menu bar at the bottom of the screen with the option of up to four different controls relevant to the screen in question.

⁵⁹ *Material Design*. (n.d.). Material Design, from <https://material.io/design> Accessed 10.10.2022.

can be accommodated. In addition, a **FAB** (floating action button) can be accommodated for the most important and most common interaction at that point in the application.⁶⁰⁶¹

- **Modal navigation drawer:** The modal navigation drawer is opened by an icon that is always located in the bottom app bar. A new window appears as an overlay in the foreground and covers about three quarters of the screen. It functions as the main navigation element of the application.⁶²
- **Top App-Bar including Overflow Menu:** It is located at the top of the prototype and tells where in the system a user is located. An integrated back button (not included on the first level) leads to the last screen.
At the appropriate places, an icon appears to open the Overflow Menu, offering the options to comment on the current content, share it with other users, download files and print them.⁶³
- **Time picker / Time input:** This element allows users to transmit a desired time to the system. A kind of clock face is used to enter the hours and minutes.⁶⁴
- **Tabs:** In the Documents section, tabs are used to navigate between the agenda description (Activity Part) and the cost statement (Financial Part).

⁶⁰ *Bottom app bar - Material Design 3rd* (n. d.). Material Design, from <https://m3.material.io/components/bottom-app-bar/overview>.

Accessed: 24.10.2022

⁶¹ *FAB - material design 3rd* (n.d.). Material Design, from <https://m3.material.io/components/floating-action-button/overview>.

Accessed: 24.10.2022

⁶² *Navigation drawer - material design 3rd* (n.d.). Material Design, from <https://m3.material.io/components/navigation-drawer/overview>.

Accessed: 24.10.2022

⁶³ *Top app bar - Material Design 3rd* (n.d.). Material Design, from <https://m3.material.io/components/top-app-bar/overview>.

Accessed: 24.10.2022

⁶⁴ *Time pickers - material design 3rd* (n.d.). Material Design, from <https://m3.material.io/components/time-pickers/overview>.

Accessed: 24.10.2022

Tabs are used to represent hierarchically equivalent, but mutually unrelated content.⁶⁵

The focus of the sketches is mainly on the area of "Organizing Trainings", which is incidentally defined as a Focal Use Case. The interaction concepts developed for this area are transferred to the other areas of the tool.

B. Interactive prototype

To make it easier for programmers to develop a planned tool, it is helpful to create an **implementation model** - a visual design that resembles the final interface. However, not only the design implementation is important, but also the description of the functionalities and behaviors. The focus is on processing the previously defined use cases with the help of the model. In addition, the implementation model is a medium for presentation, communication and evaluation of the application.⁶⁶

There are different approaches to realize such a model. The model implemented in this project is called **Vertical Prototype** by Constantine. The prototype is characterized by a differentiated representation of one or more areas of the user interface and the essential functions. The prototype represents and simulates the system behavior.⁶⁷

The Usability Guide, on the other hand, speaks of **Evolutionary Prototyping**, in which a previously minimalist system (in this case, the Sketches) is further developed in the area of core tasks (Focal Use Cases). It is recommended to implement the use cases step by step and to evaluate them iteratively with users. Here, too, it is important to simulate the behavior of a functional system in which the prototype interface offers all the necessary interaction options.⁶⁸

⁶⁵ *Tabs - material design 3rd* (n.d.). Material Design, from <https://m3.material.io/components/tabs/overview>

Accessed: 24.10.2022

⁶⁶ Larry Constantine, Lucy Lockwood, 1999 p. 212

⁶⁷ Larry Constantine, Lucy Lockwood, 1999 p. 213

⁶⁸ DATech, 2009, p. 29

The web-based, open source prototyping and design platform **Penpot** is used to develop the prototype. The functionality of the platform is comparable to common vector-based graphics and drawing programs and allows linking different drawing areas - each drawing area represents a screen - to imitate interactions and behaviors. Furthermore, the platform offers the option to integrate libraries and templates created by the community.⁶⁹ In the prototype tested in Uganda, the online application is operated in a container virtualization using Docker software for reasons of unreliable digital infrastructure.



Figure 16: Logo of the Prototyping and Design Platform
(Source: *Bring Design Freedom to your Product Team*. (n.d.). Penpot.app, from <https://penpot.app/>)

1. DESIGN

As with the Sketches, the design process for the interactive prototype also begins with the Focal Use Case **Organizing training**. First, the designs from the sketching phase are transferred and, if necessary, elaborated in more detail. For this purpose, the Penpot platform is operated in **Design mode** - this is where the various screens and their elements are designed.

For components of the interface, prefabricated elements from a publicly available library are used. The components used include navigation bars, individual icons and list elements. However, at the time of the prototype's development, the library used already contained obsolete compo-

⁶⁹ *Design freedom for teams*. (n.d.). Penpot.App, from <https://penpot.app/>
Accessed 24 Oct. 2022.

nents, which is why they are manually adapted to the updated design specifications of Material Design 3.

In the design area, the individual components are first created and placed on different layers, as is usual with other vector-based drawing applications. You can link these layers together, group them and designate them as so-called **assets**. Assets are all components that are stored in the project or in libraries and are most frequently used, such as icons. The advantage of such assets is that any modification of the main element will have an equivalent effect on the other duplications of the same.

Google specifies eight **device independent pixels** (dp for short) as the basic grid for the design and layout, a format in which dimension and size ratios represent a multiple of eight pixels. The consistent visual grid is ensured by a "consistent visual rhythm "⁷⁰ (eight-pixel cycle) that runs through screens and their components.⁷¹

The screen area of the prototype is 360 pixels wide by 640 pixels high. This proportion is recommended by the library used and is justified because it is the most common screen size before the development of this prototype. At the time of development, the most common display measures 360 by 800 pixels, which differs from the selected screen proportion by an extended length ratio.⁷²

For the design of the interface components, such as buttons, lists, menus, etc., the length of the display is less important than its width, because all elements are placed within the format of the width of the screen and lined up one after the other.

⁷⁰ *Design for large screens - Material Design 3*. (n.d.). Material Design, from <https://m3.material.io/foundations/adaptive-design/large-screens/overview>.

Accessed: 26.10.2022

⁷¹ *Design for large screens - Material Design 3*. (n.d.). Material Design, from <https://m3.material.io/foundations/adaptive-design/large-screens/overview>.

Accessed: 26.10.2022

⁷² *Mobile screen resolution stats worldwide*. (n.d.). StatCounter Global Stats, from <https://gs.statcounter.com/screen-resolution-stats/mobile/worldwide>.

Accessed: 26.10.2022

The use of colors in the prototype is very limited; only the navigation bars at the top and bottom of the screen are highlighted in color. This deliberate avoidance of color stems from the subsequent project phase, the evaluation of the prototype. "When evaluating a prototypical implementation of the task flow, the user should concentrate as much as possible only on the logical flow, but not be distracted by the features of the interface design."⁷³

In the prototyping tool, the individual **screens** and **overlays** are each created as drawing areas and each object is assigned a unique name. This procedure is essential for the implementation of the interaction, since the links are based on these designations. Overlays, such as system messages or menus, are elements that appear on a screen and can be faded in as needed.

2. PROTOTYPING

In the **Prototype mode**, the created drawing areas can be linked to each other. For this purpose, individual components are selected and provided with an interaction option. The possibilities of this interaction include, for example, navigating to another screen or opening an overlay menu.

The interactions can also contain animations. For example, the navigation menu is pushed into the screen from the left when the assigned button in the bottom app bar is clicked. If the user moves deeper into the system, the new content is pushed onto the display from the right. This animation is supposed to be reminiscent of page turning.

The drawing areas, or the different screens, are already laid out on the prototyping platform in the form of a flowchart that symbolizes navigation through the application and provides an overview. When the platform is operated in prototype mode, the links between the individual elements are represented by lines (see Figure 17).

⁷³ DATech, 2009, p. 29

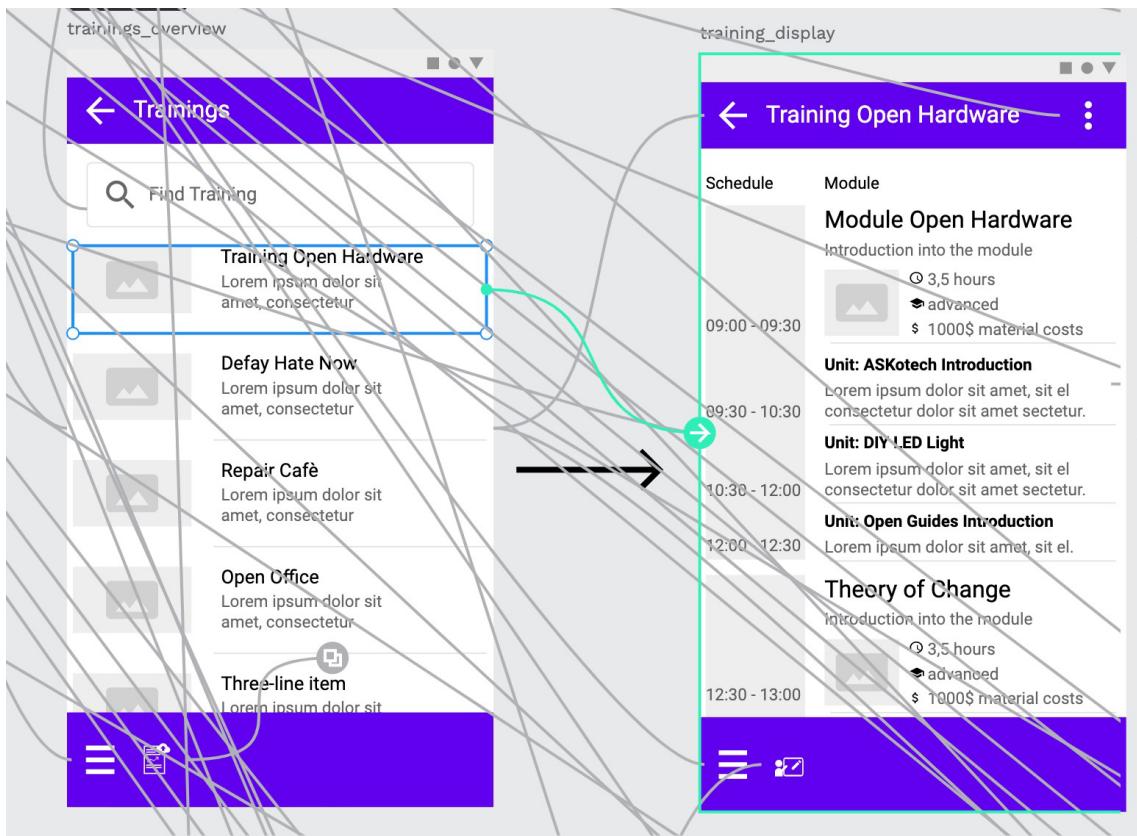


Figure 17: Linking of two Screens

3. ICONS

Icons are graphic symbols that describe attributes, tools, or similar (auxiliary) means of a user interface. The characteristics of a function are symbolized with understandable, reduced design elements. The operation of the software should be simplified by an intuitive reading of the pictograms. At the same time, icons contribute to increasing **learnability** and **rememberability** and lead to a positive user experience.

Unfavorably designed icons that cannot be grasped by users due to their complexity have an undesirable counter-effect and impair the learnability of software. When designing icons, it is recommended to fall back on tried-and-tested designs that are known from various software.⁷⁴

In the prototype, accordingly, already designed icons are used, such as for example the "hamburger" consisting of three bars placed above each other.

⁷⁴ Larry Constantine, Lucy Lockwood, 1999 p. 166.

Menu Icon, (see Figure 18, first line, first icon), which is used to call the Navigation Menu. The prototype also includes newly designed icons. These include the icons for the training areas, their modules and resources, as well as for proposals and reports. Care is taken to incorporate familiar elements as far as possible or to combine them with each other. The icons of these areas are used in different stages, which is why they are equipped with extensions. Regularly used elements that complement the icons are: a plus inside a circle, which means an addition of the respective component, and a pencil, which symbolizes the editing of the component.

An additional object used in the documents area and complementing the pictograms - an upward pointing arrow inside a cloud - illustrates the upload of templates. The counterpart, a downward pointing arrow enclosed by a cloud, symbolizes the possibility of downloading (Figure 18, third line, second icon from the right). Figure 18 shows the designed and used icons in overview and structured by category.

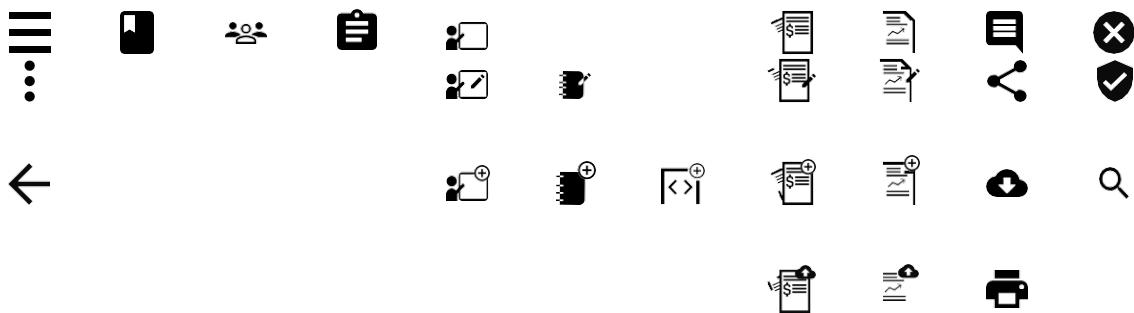


Figure 18: Icons

Google's Material Design specifies a maximum size of 24 by 24 pixels for the icons; each icon is centrally positioned in a container of 48 by 48 pixels.

M. Tests and evaluation

The functional scope and the possible uses of the prototype are largely based on the statements of the future users from the interviews at the beginning of the project. Using Constantine's methods and models, a visual, interactive prototype is designed step by step. Because such a development process contains numerous sources of error, the essential purpose of a prototype is to detect these through testing.

"Prototypes make the most sense when used for proof of concept or a test of feasibility, and such are their primary uses in every engineering field save software."⁷⁵

A. Usability test

The usability test not only evaluates the quality of a prototype, design proposal or model, but also serves to determine whether usage requirements are sufficient and to what extent they have been adequately implemented. Ideally, the test is carried out at an early stage of a project cycle in order to be able to change basic requirements, areas, or elements more easily if necessary. Accordingly the testing of prototypes plays a crucial role for the quality of the software.⁷⁶

1. PLANNING THE TEST

The test is preceded by the planning of the test. It is fundamental to design the test criteria in such a way that not only the usability or userability of the prototype, for example in the sense of readability of the icons, is tested, but also the validity of the test is taken into account.⁷⁷ It must be ensured that the test measures those areas that are relevant for a complete understanding of the interaction with the system. Thus, for example, it is interesting to identify whether not only the navigation or interaction to or with a certain area is successfully accomplished, but also to what extent users understand the concrete purpose behind that performed action.

⁷⁵ Larry Constantine, Lucy Lockwood, 1999 p. 216

⁷⁶ DATech, 2009, p. 41

⁷⁷ DATech, 2009, p. 7

As a result, a document is first prepared that defines the scope of the test and also describes the purpose of the various tasks. In addition, the document also specifies the following:

- Schedule & Location: number of tests per day, environment / location of the test, number of participants
- Sessions: duration, breaks
- Equipment: required equipment
- Participants: Number and environment / background of the participants
- Scenarios: number of tasks during the test
- Metrics: methods used during the test, type of questioning
- Quantitative metrics: Determine how and what data will be collected during the test.
- Roles: contributors and distribution of tasks⁷⁸

Based on these previously defined conditions, the tasks to be performed during the test are planned.

First of all, care is taken to ensure that the test takers have an easy start to the test. A task that is too complex right at the beginning of the test can have a discouraging effect and influence the test result. Because the software and not the candidates undergo a test, the interviewer should eliminate (person-related) disturbing factors during the test that affect the behavior of the participants, such as performance anxiety.⁷⁹

Each task is introduced with a short scenario that describes the situation in which a certain action is to be performed with the help of the prototype. "A scenario puts the task into context and, thus, ideally motivates the participant."⁸⁰ This frame of reference makes it easier for subjects to empathize with a situation that may be foreign to them.

⁷⁸ Assistant Secretary for Public Affairs. (2013). *Planning a Usability Test*, from <https://www.usability.gov/how-to-and-tools/methods/planning-usability-testing.html>. Accessed: 29.12.2022

⁷⁹ *Ethical aspects and principles of usability testing*. (n.d.). Thegeekettez.com, from <https://www.thegeekettez.com/ethical-aspects-usability-testing/>. Accessed: 29.12.2022

⁸⁰ *Task scenarios for usability testing*. (n.d.). Nielsen Norman Group, from <https://www.nngroup.com/articles/task-scenarios-usability-testing/>. Accessed: 29.12.2022

It is important to avoid using the same terms in the scenario and in the question as in the interface, in order not to anticipate any solution paths.⁸¹

As previously discussed in the Visual Design chapter, only the focal use cases are initially considered for the usability tests. These describe the core use of the tool to be planned. All navigation strategies are merely transferred to other areas. As a result, the occurrence of only isolated (to none) different interaction elements for other sectors of the tool is to be expected, so these areas, which have not yet been designed, can initially be neglected in the initial test phases.⁸² "As soon as the core prototype proves to be standard-compliant in the usability test, extensions to the system (partial products) are also tested with regard to their minimum usability quality and released if necessary."⁸³

2. EXECUTION OF THE TEST

In order to make the tests as realistic as possible, the selection of the participants is of decisive importance. The persons participating in the test should be actual users of the system, or at least have experience in the area of activity or field of work in which the tool is to be used. Furthermore, it is advisable to distribute the selection of participants according to the user roles with regard to the demands on the tool and the intensity of interaction with the system.⁸⁴

For this reason, testing will be conducted with members of ASKnet at Pagirinya Refugee Settlement in northern Uganda and for the duration of the ASKnet Gathering in Kampala. The test is carried out with eight test persons in order to obtain **qualitative results**. **Qualitative** results are findings, examination results and anecdotes about certain situations that occur in the test. The collection of such quali

⁸¹ *Write better qualitative usability tasks.* (n.d.). Nielsen Norman Group, from <https://www.nngroup.com/articles/better-usability-tasks/>.

Accessed: 29.12.2022

⁸² DATech, 2009, p. 7

⁸³ DATech, 2009, p. 7

⁸⁴ Larry Constantine, Lucy Lockwood, 1999 p. 458

tative data is a best practice for identifying problems related to user experience.⁸⁵

The following figures provide information on the demographic distribution of the test candidates.

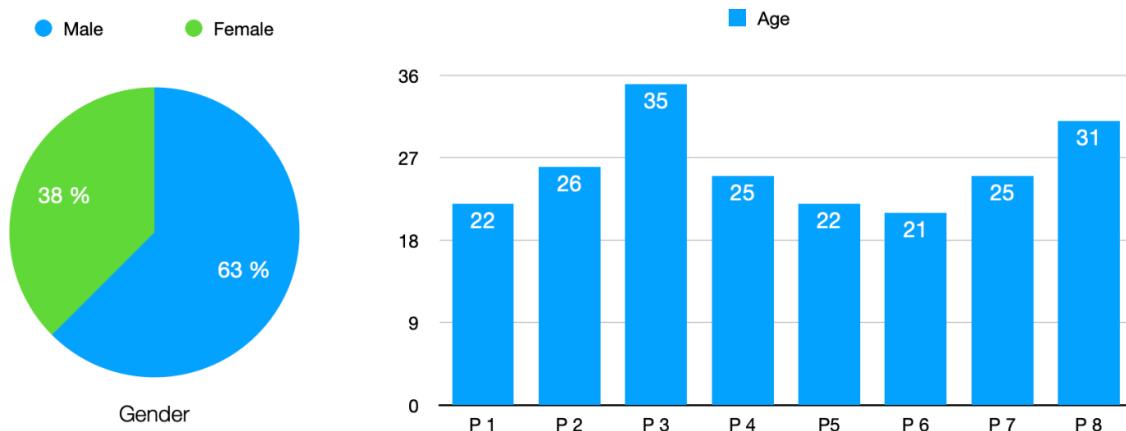


Figure 19: Age and gender of the participants in the usability tests

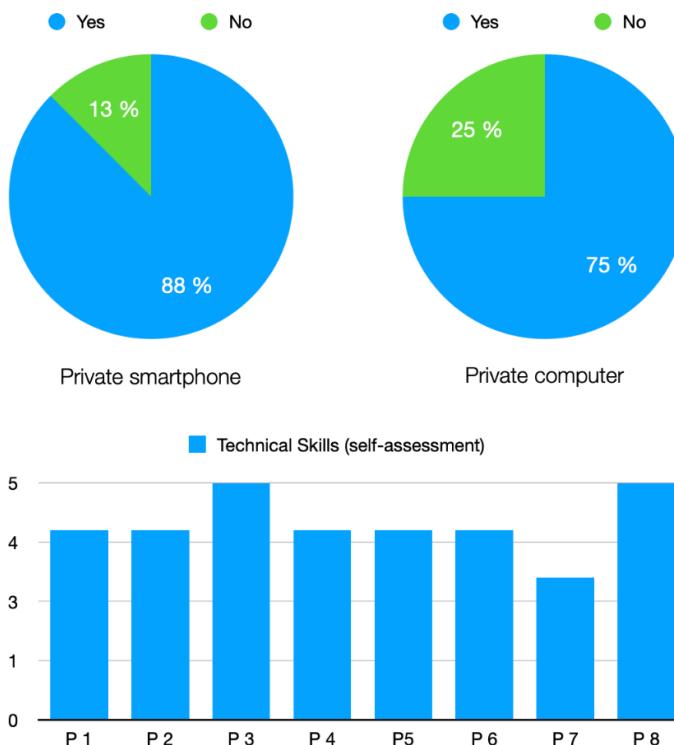


Figure 20: Ownership of technical devices and self-assessments of technical skills

⁸⁵ Moran, K. (n.d.). *Usability testing 101*. Nielsen Norman Group, from <https://www.nngroup.com/articles/usability-testing-101/>.

Access: 30.12.2022

During the test, the screen of the notebook used and what is said is recorded. For the purpose of audio recording, the test participants are asked to use the thinking aloud **method**. Jakob Nielsen defines this method as follows: "In a thinking aloud test, you ask test participants to use the system while continuously thinking out loud - that is, simply verbalizing their thoughts as they move through the user interface.

This method helps the interviewer to understand the intention behind the subjects' actions, how certain elements are perceived, which parts of the system are perceived as problematic, and/or the overview is lost. Despite many positive aspects of this method, subjects should not be pushed too much, because for many people sharing their own thoughts is an unnatural situation. Also this method encourages to analyze facts more exactly than usually alone and without observation. In this way, the first impulses of a user cannot be captured.⁸⁷

In order to elicit the subjects' thoughts in a natural way, a conversational situation is created by simply asking them about the current situation. Questions such as "Where are you in the system?" or "What do you think has happened now?" encourage the subjects to share their thoughts.

⁸⁶ Nielsen, J. (n.d.). *Thinking aloud: The #1 usability tool*. Nielsen Norman Group; from <https://www.nngroup.com/articles/thinking-aloud-the-1-usability-tool/>.
Access: 30.12.2022

⁸⁷ Nielsen, J. (n.d.). *Thinking aloud: the #1 usability tool*. Nielsen Norman Group; from <https://www.nngroup.com/articles/thinking-aloud-the-1-usability-tool/>.
Access: 30.12.2022



Figure 21: Usability test in Pagirinya

B. Evaluation

The evaluation is probably the most interesting part of the usability test with regard to the further development of the tool. The records of the test are searched for recurring patterns in the operation and the behavior during the use by the test persons. The problems that occur in the operation are called **findings**, which can be classified according to their effect on the usability of the application. It is essential for the overall evaluation to document all findings already during the first analysis. For example, attention is also paid to which path the respondents choose to reach their goal, what kind of problems they encounter in the process, and how they comment on and describe them.⁸⁸

For the analysis, a table is first created, which is sorted by respondent and the elements queried in the test. During the review of the recorded screen-recordings, the findings are entered into this table. It is also described how elements and principles are perceived and felt. The passing or understanding of a certain task is indicated by a color in the table.

⁸⁸ Assistant Secretary for Public Affairs. (2013). *Reporting Usability Test Results*, from <https://www.usability.gov/how-to-and-tools/methods/reporting-usability-test-results.html>. Accessed: 03.01.2023

are recorded separately. The cells are colored accordingly - allegorically based on a traffic light. Red is equivalent to a failure, whereas orange symbolizes a partial pass and green a complete pass or understanding. This color classification of the table enables a quick and easy comprehension of the results.

After the table with the findings for all participants has been completed, the focus is on the processing of the individual tasks by all test persons. In this way, it can be determined whether the same behavior patterns emerge during the completion of certain tasks. If test candidates repeatedly fail at the same points in the system, it is assumed that elements are too cumbersome, too complex, or even incorrectly designed. These findings are then organized in a document according to interaction elements, such as buttons, icons, or menus, and functional principles.

Starting with the description of the examined elements, the test criteria that occurred in the course of this follow, and the evaluation concludes with the assessment of whether these objects are usable. Each finding is also divided into the following evaluation categories:

- **Critical:** If we do not fix this, users will not be able to complete the scenario.
- **Serious:** Many users will be frustrated if we do not fix this; they may give up.
- **Minor:** Users are annoyed, but this does not keep them from completing the scenario.

This should be revisited later. ⁸⁹

After evaluation of the test, the developed prototype is considered to be successfully designed, since only one finding each is classified as "critical" and "serious". The remaining test points have none, or findings of the category "minor".

The area in which it is possible to add existing resources to an existing module is not found by the respondents in most cases. This finding is classified as "critical", since the creation of a training module without accessing and quickly selecting existing resources would require a considerable amount of additional work. A consequence of this would be multiple resources, which would make the system grow unnecessarily.

⁸⁹ Assistant Secretary for Public Affairs. (2013). *Reporting Usability Test Results*, from <https://www.usability.gov/how-to-and-tools/methods/reporting-usability-test-results.html>. Accessed: 03.01.2023

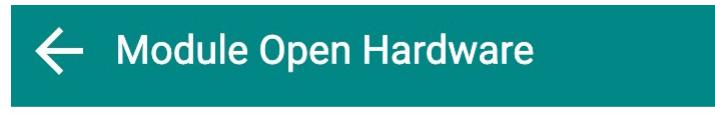
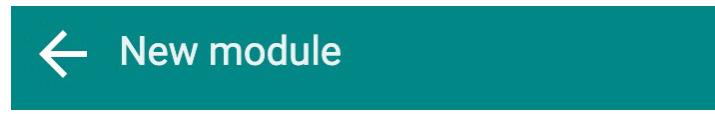


Figure 22: Area for adding resources to a module

In the current version of the prototype, new modules are created with a template that is very reminiscent of source code (Figure 23). Although this template is understood by some test persons, it is still categorized as "serious". This presentation can lead to discouragement and frustration for less tech-savvy people. Therefore, it is recommended to visually adapt the template design to the application. The same recommendation also applies to the area of creating new resources, which is designed very similarly to the previously mentioned area in terms of presentation and function.



```
1  ---
2  module:
3    name: ''
4    id: ''
5    url: ''
6    tag: ''
7    description: ''
8    pic-url:
9    duration: ---numbers
10   max-participants: ---numbers
11   min-trainers: ---number
12   difficulty: ---number
13   license:
14   res: [' ', ...]
15   # marker
16  ---
```

Figure 23: Template for creating new modules

The fact that the majority of the test candidates can understand the principle of subdividing a training course into modules, which are made up of different resources, is seen as particularly positive. This scheme is already used in the first functional prototype, which was not developed further at first. Since the method of subdivision proves to be useful and practicable in the test, the backend of the prototype, which was completed in 2021, can be used in future further development of the system.

The screenshot shows a mobile application interface for a training session. At the top, there is a teal header bar with a back arrow icon, the text "Training #defyhatenow", and a vertical ellipsis icon. Below the header, the screen is divided into two main sections: "Schedule" on the left and "Module" on the right.

Schedule	Module
09:00 - 09:30	Welcome Introduction into the module 3,5 hours 🎓 advanced \$ 1000\$ material costs
09:30 - 10:30	Unit: Welcome Lorem ipsum dolor sit amet, sit el consectetur dolor sit amet sectetur.
10:30 - 12:00	Unit: Social Plattforms Lorem ipsum dolor sit amet, sit el consectetur dolor sit amet sectetur

Figure 24: Overview training with modules and resources

V. Perspective

With the design of a visual prototype and its subsequent usability tests, the first iteration for this project is completed. In the next phase, the findings from the test must be revised accordingly and adapted in a meaningful way.

In addition, the Documents area must be expanded. Particular attention should be paid to the design of the interface between the training and the documents, i.e. the extent to which the two areas are linked to each other by certain attributes. Due to the expected complexity of this process, another usability test should be planned. It is also recommended to think about security measures, especially for the sensitive area of documents, in order to protect the hubs as well as the money-issuing institution from criminal attacks.

Version management is an important aspect because users must be able to work together on documents and trainings. This requirement is met because GitHub is used in the first prototype to maintain content, and only its code is used for the further development of the project.

The Certificates and Participants sections can be disregarded for the time being in a second iteration because they are of very little importance in the day-to-day work of the Hubs.

Unrestricted access to the Internet is extremely problematic, especially in South Sudan, and is associated with high costs.⁹⁰ For this reason, thought must be given to the possibility of operating the application without a permanent Internet connection. This problem can be solved by implementing the tool as a **Progressive Web App** (PWA). Progressive Web Apps are applications that can be operated from mobile devices as well as from desktop devices. Unlike conventional applications, they are also able to function without Internet access.⁹¹

⁹⁰ Ninrew, C. (2022, November 15). *S. Sudan internet cost is 7 times higher than in Kenya*. Eye Radio, from <https://www.eyeradio.org/s-sudan-internet-cost-is-7-times-higher-than-in-kenya/> accessed Jan. 25, 2023.

⁹¹ *Progressive Web Apps (PWAs) Overview*. (n.d.). Microsoft.com, from <https://learn.microsoft.com/en-en/microsoft-edge/progressive-web-apps-chromium/>. Access 25.01.2023

V. Reflection

The survey of potential users at the beginning of the project proves to be particularly difficult. This is mainly due to poor Internet connectivity. Collapsing telephone calls disturbed by noise artifacts and an additional language barrier, the interviews are conducted in English, hinder communication. These difficult conditions are countered by patience and understanding on both sides, which makes it possible to obtain relevant information.

Usage-Centered Design, with its sequential methods and models, is a practical and purposeful design method for developing systems that are optimized for use. The emphasis is on usage and not on the user as is usually the case - a welcome paradigm shift for the specific design of software. Nevertheless, the users' opinion is not irrelevant for the development of the system, since they are the users of the application. In the context of the usability test, which is not mandatory for Constantine, the users are involved again.

The experience gained during the processing shows that the influence of individual models on their successors varies. The Tools and Materials model has a rather small effect on the development of its successor, the Context Navigation Map. The model is mainly used for understanding the planning of the interface, which is why it is useful for a team of several developers. This added value is not apparent to me as the sole developer.

The more extensive a system is, the more important is the differentiated elaboration of the models. A careful approach guarantees that all contingencies are taken into account.

In summary, and confirmed by the results of the usability test, it can be said that the Usage-Centered Design process is a suitable method for software development. The step-by-step approach enables a comprehensible and well-founded design of a first prototype that meets the needs of its users. A distinguishing feature of Usage-Centered Design is the transformation of the Conventional Use Case to the Essential and the associated detachment from the barriers of the Conventional Use Cases. This detachment enables innovative design decisions to be made and processes to be made practicable.

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