Handbook
of Digital Rehabilitation in Health Care for
East African countries

Welcome to the
"Handbook of Digital Rehabilitation in Health
Care for East African countries"

Great to have you here!

In this user guide, we want to give you an overview of this handbook. We want to share with you in what context it was developed, who the authors are, what the vision is, how you benefit from this handbook and introduce you to the content. After reading this user guide, you can navigate through the handbook and use it to your own benefit.

Let us start with the most crucial point: The handbook exists as an online version and can also be downloaded as a pdf. The online version is available via this link: https://www.jamk.fi/en/project/radic/handbook-of-digital-rehabilitation-in-health-care-for-east-african-countries. Both versions are identical apart from a few graphical representations.

Context

This handbook is a product of the multinational Erasmus + project RADIC (Rehabilitation for all through digital innovation and new competencies). RADIC started in March 2023 and runs until February 2026. The overall objective of the project is to contribute towards increased capacity of higher education to support and scale digital transformation in Eastern Africa, with the aim to ensure rehabilitation services for all. The project addresses the rehabilitation need for people living in East Africa with the support of digital transformation as it provides an opportunity to have more accessible and personalized models and system of rehabilitation in Eastern Africa.

Authors

This handbook was developed by the RADIC consortium, which consist of eight higher education institutions from Rwanda, Kenya, Tanzania mainland, Zanzibar, Finland, and Germany. For more details about the project and the project consortium, follow this link: https://www.jamk.fi/en/project/radic

Please note that the European Commission is not responsible for the content of this handbook. More information about the Erasmus+ programme: www.oph.fi/erasmusplus.

Vision of the handbook

This comprehensive handbook is designed to provide you essential knowledge and practical insights into the field of Digital Rehabilitation in East Africa. This handbook offers a foundational understanding of Digital Rehabilitation, exploring its concepts, principles, and applications in healthcare practice. You will gain insight into the evolution of Digital Rehabilitation technologies, their potential benefits to clients and the healthcare system, and their role in improving healthcare outcomes. Practical guidance and case examples will show you the effects

of Digital Rehabilitation and how you can apply the principles and technologies of Digital Rehabilitation in client's rehabilitation. By highlighting successful best practices, this handbook aims also to underscore the importance and relevance of Digital Rehabilitation in contemporary healthcare. Tips and recommendations are included to assist rehabilitation professionals in integrating Digital Rehabilitation into their clinical practice.

Target group

This handbook is designed for rehabilitation professionals, educators, and students of healthcare studies who are interested in gaining a deeper understanding of Digital Rehabilitation and its applications in healthcare practice in East Africa. This handbook is intended for people who have no prior experience or knowledge on that topic. Whether you are a seasoned practitioner, an aspiring healthcare professional, or an educator seeking to enhance your curriculum, this handbook serves as a valuable resource for expanding your knowledge and skills in the field of Digital Rehabilitation.

If you are an educator and want to learn more about how to embed the topic of Digital Rehabilitation to your curriculum, you can also read the handbook for educators for Digital Rehabilitation. The educator's handbook focuses on digital pedagogy and includes a toolkit of methods that empower the learner in a digital environment and facilitate the learner's digital competences. The handbook for educators is also a product of the RADIC project and will be published in 2024 via this website.

Navigate through the handbook

The handbook consists of eight chapters. Each chapter deals with a topic on Digital Rehabilitation. All chapters besides chapter eight stand alone and can be read and worked on without knowledge of the previous chapters. Therefore, if you are only interested in a specific topic, you can jump straight to it. Chapter eight represents Frequently Asked Questions (FAQ) about Digital Rehabilitation.

The handbook covers the following topics:

1. Introduction
2. Best Practices
3. Competencies
4. Accessibility
5. Potential barriers and strategies to overcome the barriers
6. Technologies
7. Ethics, security, and regulatory frameworks
8. Frequently Asked Questions

Each chapter is structured in the same way. First, the topic of the chapter is explained in a brief introduction. This is followed by the main content of the chapter divided into sub-chapters. At the end, all chapters have a brief summary and a list of references for the chapters. In some chapters, you will find practical exercises. The exercises are designed to deepen the content of the chapter, to reflect on it and to discuss the topic with other people. The exercises are designed so that anyone can solve them after working through the chapter,

regardless of whether you are a rehabilitation professional, educator or student. The type of exercise can vary per chapter. Some exercises consist of direct questions, others of case studies in which you must think of scenarios that contribute to a solution of the presented problem. Other exercises encourage you to think about the problem and invite you to discuss it with your peers. For some exercises, we also provide you with the answers, which you can find on the respective page of the chapter.

Finally, yet importantly - please read the following terms of use
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Now you are perfectly prepared to read and work with the handbook!

In case you have questions or suggestions concerning this handbook, please contact Angela Arntz via Angela.Arntz@hs-gesundheit.de

Your RADIC consortium

1 Introduction to Digital Rehabilitation

This chapter introduces the concept of Digital Rehabilitation, which is a way to deliver rehabilitation services by using technologies. We will discuss how using apps, computers, and other digital tools can e.g. increase the quality of rehabilitation and improve the availability of services, and what are the key aspects to be taken into consideration before conducting Digital Rehabilitation. We'll also look at, with the help of concrete examples, how these technologies can support clients and rehabilitation professionals, making the rehabilitation process more flexible and tailored to individual needs.

The aim of this chapter is to explain the following topics:

- Scope of Digital Rehabilitation
- History of Digital Rehabilitation
- Definitions of Terminologies/Terms
- Potentials of Digital Rehabilitation
- Prerequisites of Digital Rehabilitation

After you have gone through the content of chapter 1, you can carry out exercises to deepen the content:

- Exercises

To get an overview of chapter 1, look at the summary:

- Summary

1.1 Scope

The rapid growth of the internet and advances in digital technologies have not only an impact on our private life, but it has also an impact on healthcare and on the health care system. In the last years, digital technologies have increasingly been used in this sector. Digital technologies are based on (computer) hardware, software, and connections. This could include apps, computer programs, artificial intelligence but also devices like smartphones, tablets, and laptops and many more. For more information, see chapter 6 "Technologies".

When including digital technologies in rehabilitation, we call it Digital Rehabilitation. The term "Digital Rehabilitation" is not very widely used, yet. Digital Rehabilitation may be mixed with the term digital health and considered as a synonym. However, Digital Rehabilitation is not synonym with digital health even though there may be some overlaps. We define Digital Rehabilitation as a set of interventions using digital tools, technologies, and services to optimize functioning, reduce disabilities, monitor, and evaluate health status of people with health problems. Digital Rehabilitation is thus an umbrella term that means not only the tools that are used in rehabilitation; It aims to enable a digitally driven process. Digital technologies have many possible applications in the healthcare system. For example, they can be applied for the management of the client journey in the health care sector e.g. think of the registration at the health care provider and/or for the rehabilitation of clients as such [1]. In figure 1, you can see various application possibilities of Digital Rehabilitation during the client journey.
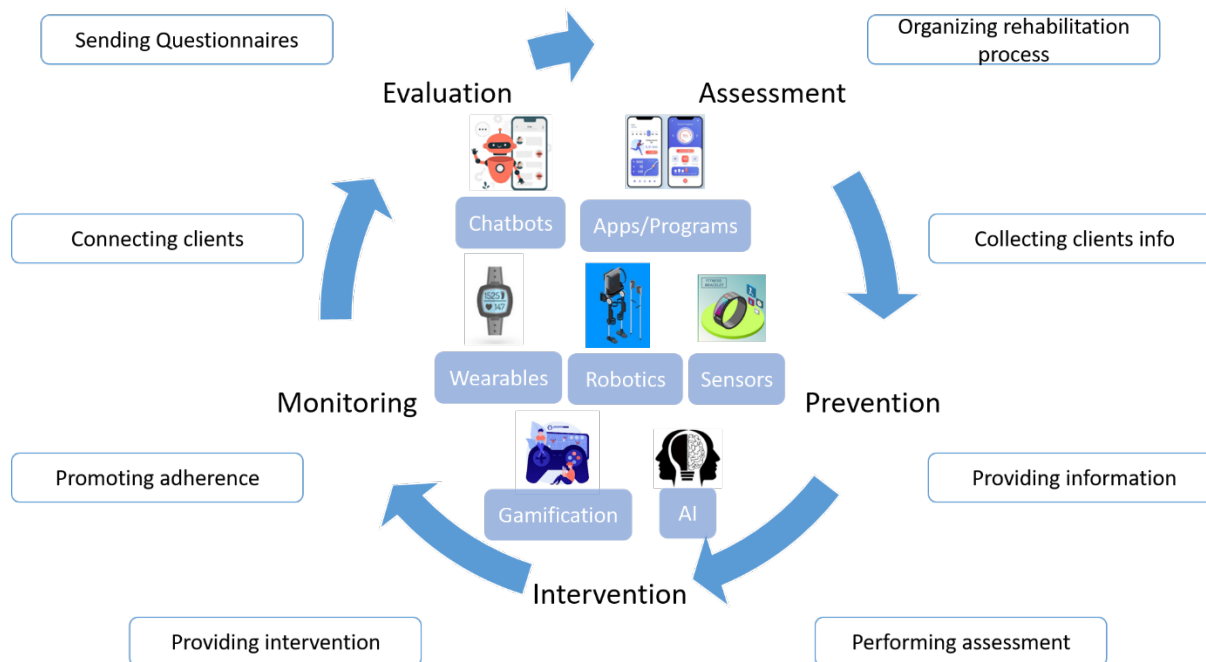
Figure 1: Application of Digital Rehabilitation in the health care sector

The decision to use Digital Rehabilitation is always based on the client's needs to optimize the rehabilitation outcome, reduce disability and empower the client and the community. The decision considers the client's daily life and the choices they make. The decision to incorporate digital technologies in rehabilitation is taken jointly by the healthcare professional and the client.

With Digital Rehabilitation, the rehabilitation process can be more than just activities tied to the presence of a healthcare professional, traditional guidance, and place. At its best, it can flexibly combine the self-management of rehabilitation and rehabilitation guided by a healthcare professional. Digital services do not fully replace competent healthcare professionals, but the combination may offer many advantages for the client, the healthcare professional and for the health care system.

1.2 History

The history of Digital Rehabilitation dates to the 20th century. Advancements in computing and telecommunications paved the way for innovative approaches to healthcare delivery, including rehabilitation.

- Origins and Early Developments: Digital Rehabilitation began with the advent of computer systems and digital technology integrated into medical care. The application of digital technologies in rehabilitation and medicine started in the 1980s and 1990s. One early example was the development of computer-assisted therapy programs for neurological rehabilitation, particularly for clients with stroke or other neurological disorders. Pioneers in this field included the Rehabilitation Institute of Chicago (now Shirley

Ryan AbilityLab), which began developing computer-assisted therapy devices for stroke rehabilitation as early as the 1980s. These devices allowed clients to perform targeted exercises to restore or improve their motor skills while their progress was digitally monitored and documented. Another early example is the use of Virtual Reality (VR) technology in rehabilitation. In the 1990s, researchers and clinicians began developing VR systems to create virtual environments in which clients with various conditions could train and undergo therapy. These VR applications were used for the rehabilitation of clients with stroke, spinal cord injuries, post-traumatic stress disorder, and other conditions. It is important to note that the application of digital technologies in rehabilitation and medicine is a constantly evolving field, with many researchers, clinicians, and companies continuously developing new and innovative technologies to improve client treatment and recovery.

- Advancements and Dissemination (2000s to present): Over the past two decades, Digital Rehabilitation has evolved significantly. Advances in Virtual Reality (VR), Augmented Reality (AR), robotics, sensors, and artificial intelligence (AI) have created new opportunities to improve rehabilitation. These technologies are used to develop personalized therapy programs tailored to the individual needs of clients.

- Future Perspectives: Digital Rehabilitation is expected to continue growing and improving as technologies such as machine learning and data analysis enable the continuous adaptation and optimization of therapy programs. The integration of telemedicine and remote monitoring will further enhance the accessibility and efficiency of rehabilitation, especially in rural areas or for clients with limited mobility.

1.3 Definitions of Terminologies

There are varieties of terms that are used in combination with Digital Rehabilitation, as synonyms or to define specific digital services. Therefore, in the following part we define these terms that are frequently used in this context to give a clear idea of the terms and to be able to distinguish between them. These definitions were established by the DIRENE project consortium. The consortium developed these definitions based on current literature. DIRENE was an Erasmus+ project that ran from April 2021 to March 2023. DIRENE is an acronym for "Competences for the new era of user-driven digital rehabilitation". Click on the link to learn more about the [DIRENE project](#).

o **Telehealth**

Telehealth involves the provision of healthcare services at a distance and can be delivered by healthcare professionals of all kinds using information and communication technologies. It aims to exchange valid information for the diagnosis, treatment and prevention of disease and injury, for research and evaluation, and for the education of healthcare providers, all in the interest of promoting the health of individuals and their communities.

o **Telerehabilitation**

Telerehabilitation is nowadays understood to be a process of providing rehabilitation services through digital technologies. The authorized rehabilitation professional cannot necessarily be present on site but initiates the necessary therapeutic measures remotely. Telerehabilitation is normally provided through videoconferencing solutions such a Zoom or videoconferencing solutions especially designed for rehabilitation. In some cases, it can be also provided through traditional telecommunication systems (phone).

- **Mobile health**

  Mobile Health (mHealth) is the medical and public health practices supported by mobile devices, such as mobile phones, tablets, client monitoring devices, and personal digital assistants.

- **E-health/Digital health**

  The term "electronic health" (abbreviated to "e-health") or "digital health" covers electronically supported activities and systems in the healthcare sector that collect, make available and/or evaluate client data and other medical information across distances, using technologies that are not yet considered standard. E-health/Digital health is understood by many authors as a generic term for all such electronic applications for medical care. It is difficult to draw a distinction from "telemedicine"; these terms are often used as synonyms.

- **Video therapy**

  Video therapy is understood as an intervention that takes place synchronously via means of video conferencing. Video therapy can take place 1:1, i.e. between a therapist and a client or between several interaction partners. The amount of time during which the therapy takes place can vary and is not specified by the definition of the term.

- **Gamification**

  Gamification is an umbrella term and is the application of game-typical elements to non-game contexts, such as rehabilitation or the work environment, to improve adherence, engagement, or productivity levels.

- **Digital Divide**

  Digital Divide can be described as the gap between people who have access to the internet and those who do not. Globally, the digital divide between the sub-Saharan African region and the rest of the world is much more pronounced than the divide within the region.

1.4 Potentials

An important component of universal health coverage (UHC) is to "ensure that all people have access to the necessary health services (including prevention, promotion, treatment, rehabilitation and palliation) in sufficient quantity and quality to be effective, while ensuring that the use of these services does not put the user in financial hardship" [2]. In essence, UHC means that all people everywhere should always have access to affordable health

services. UHC also implies a strong people-centred health care system based on primary health care. WHO (World Health Organization) (2020) also emphasizes three interlinked goals:

- Equal opportunities in access to health services - those who need the services should receive them, not just those who can pay for them.
- The quality of healthcare services is good enough to improve the health of those receiving services.
- Protection from financial risk to ensure that the cost of accessing care does not put people in financial hardship.

Aiming for UHC for all by 2030 is in line with the United Nations' Sustainable Development Goal (SDG) 3.8 [3]. An optimistic point of view for the realization of UHC and global health is the opportunities created by the rapid advances in digital technologies and the spread of mobile networks across the continent.

In the following, we are summarizing the potentials of Digital Rehabilitation from the perspectives of various stakeholders in the system that are relevant for East Africa, see also figure 1. On the one hand, Digital Rehabilitation could have advantages for society and/or the healthcare system. On the other hand, it has an impact on the client, caregiver and/or the rehabilitation staff. The healthcare provider can also benefit from the implementation of Digital Rehabilitation.

Client: A huge advantage of Digital Rehabilitation is to offer a rehabilitation possibility from a distant to all persons who can't or do not want to access public rehabilitation and thus does not get the support they need [4]. No access or no possibility of rehabilitation could be due to a lack of health workers, high financial costs associated with rehabilitation, poor transportation possibilities, or geographical distance.

In addition, the lack of privacy in rehabilitation centres and the fear of stigmatization, through the access to healthcare, reduces the utilization of rehabilitation as well. Here, for example, you can think of an app that provides an exercise program for the client to perform at home. Another example is to send therapy reminders via text messaging to increase adherence and rehabilitation outcomes.

A further benefit of Digital Rehabilitation is the availability of information even outside the clinical settings. Technologies offer a variety and flexibility for using health information (websites, interactive applications, games, augmented and virtual reality, combinations of text, images, audio and video, social networking tools, animations, risk calculators) that can assist clients matching to their individual needs and preferences.

In addition, use of digital technologies enables individuals to exert more control over one's health and to have better access to own data, while remaining connected to the healthcare team [5–7]. Some digital tools (for example apps, portable devices with augmented reality) are rather appealing for the clients with entertaining and interactive elements, which capture clients' attention, engage them cognitively and emotionally. This may lead to increased participation and adherence to the therapy process [8].

Moreover, digital interventions often include peer support networks and online communities where clients can connect with others facing similar challenges. These peer support groups provide a safe space for clients to share their experiences, seek advice, and receive encouragement, reducing feelings of isolation and stigmatization.

Rehabilitation professional: The implementation of Digital Rehabilitation could facilitate the healthcare professional, for example to monitor client's behaviour, compliance, nutrition, digital health, symptom management, or to undertake quick adaptations of the treatment remotely [9].

Further, digitals solutions have the potential to improve the communication between the client and the healthcare professional, because they enable client-centred and personalized ways of providing information and treatment.

Healthcare provider: Digital technologies could support the management of the healthcare provider by outsourcing processes such as registration and/or billing. Think, for example, of a client who wants to make an appointment at a hospital or practice. The client could register via an online platform and, after adding their personal details, be allocated to an available appointment.

Health care system: Digital Rehabilitation has also the chance to reduce the costs for the client and health care system [10–12] when e.g. face-to-face sessions and travelling to the health care facilities could be reduced.

In addition, some studies showed that Digital Rehabilitation improves outcomes in clients with heart failure, diabetes, and respiratory disease. They also help clients to manage pain, increase their physical activity, and improve mental health, diet quality, and nutrition [13].
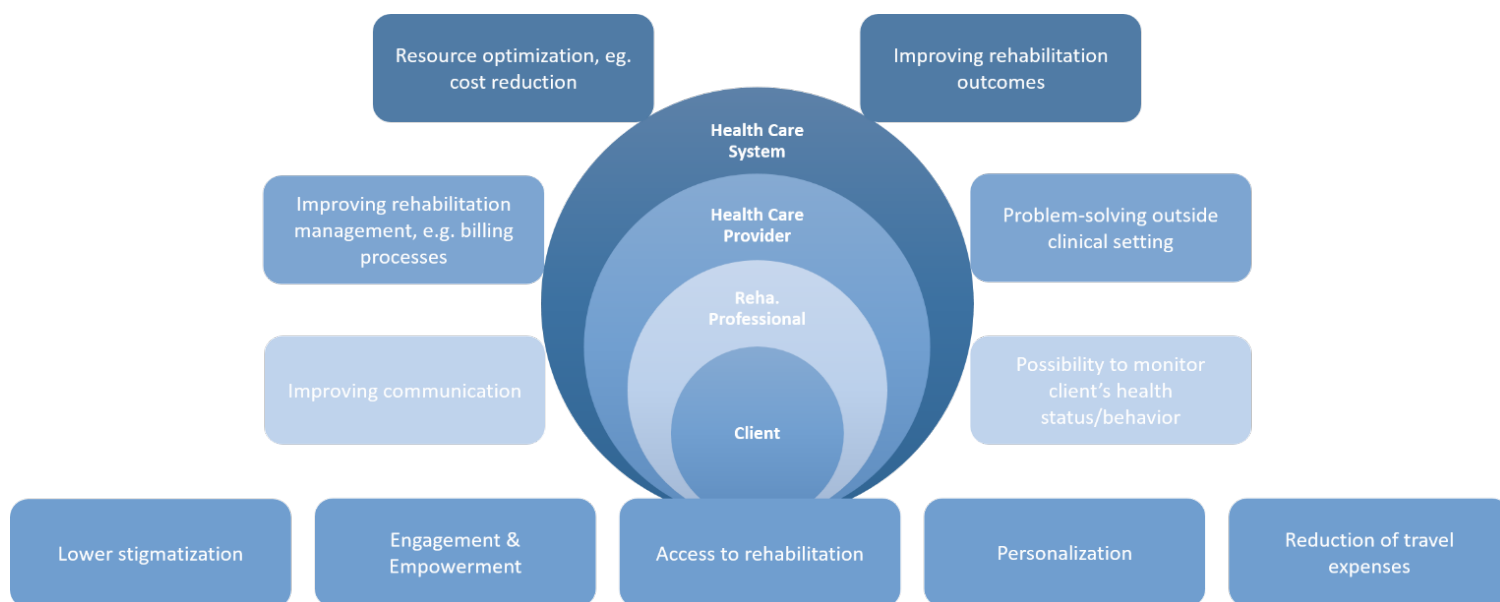

Figure 1: Potential of Digital Rehabilitation per stakeholder

1.5 Application in Sub-Saharan Africa (SSA)

In recent years, more and more technologies have appeared on the market that are intended for the healthcare and rehabilitation sectors. The types of technologies are limitless, as technology companies can develop technologies that meet almost any client need with a new or updated technology. In chapter 6, you will learn about the most used digital technologies in rehabilitation. The potential of digital technologies is very relevant for the provision of healthcare services - not only in a global context but also in low-income countries. Among other aspects, digital technologies can enable the provision of rehabilitation services to people living in rural and remote areas of developing countries. Digital technologies are not only important to improve health care but are also necessary for health systems to achieve the goals of universal health coverage defined by the WHO (see subchapter 1.2. for further potentials of Digital Rehabilitation).

It is reported that over 1000 mobile health services currently offer health content and diagnostic services in low-income countries [14]. Digital solutions have become increasingly popular as more and more people own a mobile phone. For example, 414.77 million people in sub-Saharan Africa (SSA) subscribed to a smartphone in 2022, up from 118.1 million people in 2015 [15]. In addition, internet coverage has improved. A mobile broadband network now covers most urban areas. In 2021, 83 % of SSA's population lived in an area covered by a mobile broadband network. This leads to 22 % of the total population in SSA using mobile internet at the end of 2021 (and 40 % of adults over 18 years) [16].

Although the benefits and conditions of Digital Rehabilitation are promising, the implementation of Digital Rehabilitation in SSA remains poor. A paper suggests that the majority of Digital Health initiatives within African countries remain a test bed [17]. Most of the research on Digital Rehabilitation in this region has been aimed at assessing the acceptance of clients, their families and healthcare providers for the use of digital technologies, while there is still a lack of guidance how to implement these services.

In this chapter, we provide an overview of the use of the most common technologies that are already in use in SSA. If you are interested in other technologies that are used in rehabilitation, switch to chapter 6 "Technologies". If you are more interested in the factors that drive or hamper the implementation of Digital Rehabilitation in the SSA context, please go to chapter 5.

Text messaging interventions display the most applied Digital Rehabilitation intervention in the sub-Saharan context. Text messaging could be used via an app like WhatsApp or via a mobile phone. Various text messaging interventions have been evaluated in Kenya, Nigeria, Uganda, Cameroon and South Africa [14,18–22]. In this context, text messaging was used as digital counselling and peer support for people with HIV [19], as a therapy reminder aiming at improving adherence to diabetes/depression therapy, as a motivator to promote physical activity [14,18,21], as a digitally supported intervention that targeted maladaptive cognitions in older people experiencing loneliness [20], and as a client education on the knowledge of the disease and glycaemic control [22]. While text messaging interventions seemed to be acceptable for the users and have proven to be successful and effective in improving health outcomes [18,20,22] some challenges were also identified. These challenges include technical issues, slow speed, lack of digital literacy of the clients, doubts about its effectiveness, and costs

[14,18–22]. Although these challenges were addressed in these studies, this suggests that even low-cost solutions could come with challenges. As such, when implementing simple digital solutions for healthcare purposes in African countries, technical issues, slow speed, lack of digital literacy, doubts about effectiveness, and cost should not be overlooked as these could hamper the effective use of digital solutions.

During the RADIC project, we conducted a scoping review to give an overview of already implemented Digital Rehabilitation practices in sub-Saharan Africa. As an additional methodological step, we included stakeholders to give more insight about that topic. During a meeting, we asked stakeholders to give their opinion about the most relevant technologies for Digital Rehabilitation practices in sub-Saharan Africa. The stakeholders were a Digital Rehabilitation specialist (n=1), an e-learning manager (n=1), educators for health sciences (n=2), rehabilitation professionals, a research assistant (n=1) and physiotherapists and occupational therapists as researchers (n=6). Seven stakeholders out of the eleven participants already had prior experience with Digital Rehabilitation. Most of the stakeholders believe that text messaging via SMS is a powerful tool, especially in rural areas, because it does not require an internet connection. In addition, these stakeholders emphasize that SMS is less dependent on literacy and therefore accessible and usable by more people.

Apps, web-based programs, and videoconference are also used for rehabilitation purposes in Ethiopia, Kenya, and South Africa. While these technologies are used to improve therapy adherence [23,24] and deliver peer support via group chats and digital platforms [25], they are also used to provide interventions for people with depression [26–28], with stroke [29] and for people with symptoms of stress and emotional exhaustion [30]. Users were overall satisfied with the interventions and motivated to use it, the digital services seem to be effective to improve the quality of life [24] depression [29] and produces minimal costs [24,28,31,32]. Besides all these positive results, there are also barriers, such as clients' low Internet skills and lack of access to functioning devices.

The stakeholders believe also that apps, web-based programs, and videoconference will be the most important technologies for rehabilitation in sub-Saharan Africa in the future. They think that mobile apps are very useful to increase the engagement in rehabilitation. Even though that research results show that videoconferencing is feasible and acceptable in the SSA countries, it is not implemented yet.

3D printing is not widely used in sub-Saharan Africa yet but compared to manufactured prosthetics this emerging technology could decrease the manufacturing time for prosthetic devices and thus reduce costs. One project carried out in Uganda, Tanzania, Cambodia [33] moved 3D printers to a rural area where prosthetics were directly printed for people with transtibial amputation almost without waiting time. Even though the effectiveness of 3D printed prostheses is comparable to conventionally manufactured prostheses and the usability of usual manufactured prostheses scores better, relevant interest groups consider 3D printing as important for rehabilitation, as it can reduce the cost of producing prostheses.

1.6 Prerequisites to apply Digital Rehabilitation

Overall, Digital Rehabilitation can be used for all clients in rehabilitation. However, as the examples above show, some aspects can hinder the implementation of Digital Rehabilitation. In this section we would like to point out the aspects that should be considered and serve as prerequisites for the implementation of Digital Rehabilitation.

Before we discuss the prerequisites that are influencing clients, rehabilitation professionals and societies, we would like to present some general aspects that are important when digital technologies are integrated in rehabilitation.

1.6.1 General Prerequisites

- One of the prerequisites for a successful rehabilitation process is tailoring services to meet the client's individual needs. This means that the implementation of Digital Rehabilitation must always be linked to the client's goal and the client's perspective must be included.
- In addition, face-to-face interventions are rarely replaced by purely digital components. This means that there is usually a blended therapy, which means face-to-face intervention mixed with digital components.
- The prerequisites that should be considered depends also on the different technologies that are used. We are not presenting the prerequisites per technology, but we will give you a general overview.
- The prerequisites below should not be considered alone but in combination with each other. They can rarely be separated from each other and should therefore be considered.

1.6.2 Prerequisites for clients

The following prerequisites should be discussed with the client before Digital Rehabilitation can be implemented. These aspects are intended to support the rehabilitation professional in setting up a personalized Digital Rehabilitation where face-to-face contact with a rehabilitation professional is integrated into a digital application that enables rehabilitation sessions digitally. Discussion of the items facilitates the determination of whether Digital Rehabilitation is appropriate for the individual client and promotes the achievement of their goals and if so, the determination of the appropriate level of therapeutic guidance alongside a digital application. All items are illustrated with examples. The following aspects are adapted from [34].

- **Motivation and consent of client**
  Example: Is the client open-minded to use Digital Rehabilitation? Consider client's attitude towards digital technologies, prior experiences with Digital Rehabilitation, beliefs about the benefits of digital technology.

- **Technology**
  Example: Does the client have access to the required technology to perform Digital Rehabilitation? Think of the access to the internet, a smartphone, tablet, or PC etc.

- **Space**

  Example: Does the client have enough space to perform Digital Rehabilitation? Consider whether a client has a quiet, private, calm place for rehabilitation, and consider that some digital technologies require some room.

- **Safety**

  Example: Is the safety of the client ensured when performing a part of the rehabilitation without the presence of the therapist? Consider physical and mental conditions or possible contraindications.

- **Computer skills**

  Example: Is it possible for the client to learn how to use the required digital technology? Consider the operation of the digital technology.

- **Digital (health) literacy**

  Example: Is the client able to interpret text, video, and/or audio files as presented in the digital technology? Consider the level of client's digital (health) literacy, language, and cognition.

1.6.3 Prerequisites for rehabilitation professionals

The following aspects should be reflected by the rehabilitation professional and then decided whether they are suitable to offer Digital Rehabilitation. Each requirement is explained with an example. The following aspects are based on [34,35].

- **Technology**

  Example: Does the rehabilitation professional have access to the required technology to perform Digital Rehabilitation? Consider access to the internet, a smartphone, tablet, or PC, and all software/programmes needed to deliver the service. Separate cameras and conference phone/headphones might be also needed to increase the quality of the video/audio transferred to the client.

- **Space**

  Example: Does the healthcare professional have appropriate space to deliver Digital Rehabilitation services? Consider that rehabilitation professionals need a quiet, private space for rehabilitation, and bear in mind that some digital technologies require a certain amount of space.

- **Computer skills**

  Example: Does the rehabilitation professional can operate with digital technologies? Consider the operation of the digital technology.

- **Organizational aspects**

  Example: Does Digital Rehabilitation fit into the rehabilitation professional's schedule? Consider time needed to prepare the Digital Rehabilitation intervention.

1.6.4. Prerequisites on system level

Apart from the prerequisites that must be met by the client and the rehabilitation professional, the use of Digital Rehabilitation also depends on political and societal infrastructure or/and legislation. The following aspects are based on [34,35]

- **Reimbursement for Digital Rehabilitation**
  Example: How could Digital Rehabilitation be reimbursed? Consider costs occurring for the client to purchase internet or the technology and of the legislation that are relevant in your country to perform Digital Rehabilitation.

- **Accessibility to Technologies/Internet**
  Example: Do the client and rehabilitation professional have access to the technology or internet connectivity required to use Digital Rehabilitation?

- **Usability of Technologies**
  Example: Is the technology designed to be user-friendly to facilitate the use of the technology?

- **Effectiveness of Digital Rehabilitation**
  Example: Does proof of effectiveness for the digital intervention exist?

1.7 Exercise

- Think about whether you already had contact with Digital Rehabilitation. If so, reflect in which context, in which function, with which technology and if applicable in which phase of rehabilitation it was used.
- Think about the benefits of Digital Rehabilitation/digitalization in the healthcare system in your country and discuss this with a friend or a colleague.

Summary

- Digital Rehabilitation is more than just adding technologies to rehabilitation. Digital Rehabilitation means that the whole rehabilitation process can be digitally driven.
- The biggest potential of Digital Rehabilitation in low-resource settings is to improve access to rehabilitation.
- Further advantages of Digital Rehabilitation are related to cost reduction and improved rehabilitation outcomes. From the client's perspective, the benefits may also include to lower stigmatization, reduced travel expenses, personalized rehabilitation, the possibility of peer-support and greater engagement in rehabilitation.
- The suitability of Digital Rehabilitation must be evaluated separately for each client based on the client's goals, needs and capability. Digital Rehabilitation can be used in many situations but there are no one fits all-solutions.

- Despite there are many advantages for clients, healthcare providers and the healthcare systems, the implementation of Digital Rehabilitation in the SSA remains low. To learn about the factors that are influencing the implementation of Digital Rehabilitation, go to chapter 5.
- Currently the most frequent used technologies in the SSA region are text messaging, apps, and web-based platforms.

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2 Best Practices

This chapter explores the successful methods and practices of Digital Rehabilitation in Sub-Saharan Africa. It highlights how organizations and professionals in the region have employed innovative technologies like mobile applications and telemedicine platforms to improve healthcare delivery and support individuals with diverse rehabilitation needs. In this chapter, we focus not only on East Africa, but also on the Sub-Saharan Africa region. As few Digital Rehabilitation interventions have currently been introduced in Africa in general, there are few examples from countries in East Africa. To provide a good overview of best practices, we have extended our search radius to the Sub-Saharan region. However, the conclusions we draw from the examples can also be applied to the East Africa region with slight limitations.

In recent scholarly discourse, Digital Rehabilitation in Sub-Saharan Africa has garnered significant attention in recent research. Studies have underscored the importance of rehabilitation interventions for various health conditions in the region. For example, Maddocks et al. [1] focused on rehabilitation approaches for children living with HIV in sub-Saharan Africa, emphasizing the need for strategies to enhance functioning and address disability-related barriers. Similarly, Bright et al. [2] discussed the limited access to rehabilitation services for individuals with disabilities in low- and middle-income countries, shedding light on the challenges encountered in providing such services.

Further compounding the issue, Bright et al. [2] illuminated the stark realities of limited access to rehabilitation services for individuals with disabilities in low- and middle-income countries, including those in Sub-Saharan Africa. thus, work sheds light on the formidable obstacles faced in delivering adequate rehabilitation services, thus underscoring a significant gap in healthcare provision. Similarly, Lombard et al. [3] investigated the rehabilitation experiences of women post-obstetric fistula repair, emphasizing the need for effective rehabilitation and reintegration strategies, which are crucial for restoring quality of life and dignity.

Parallel to these discussions, the role of digital health interventions has increasingly been recognized as a transformative element in healthcare delivery. Mwase et al. [4] and Karamagi et al. [5] respectively examined the deployment of digital health strategies in palliative care for HIV clients and the reinforcement of health systems in Sub-Saharan Africa. These studies collectively assert the transformative potential of digital technologies in enhancing healthcare outcomes and system efficiencies.

Furthermore, the exploration by Nguimkeu & Okou [6] into the application of digital technologies in the informal sector highlights the broader economic implications of digital solutions, suggesting their utility extends beyond healthcare into significant economic empowerment and development within the region.

Despite these advancements, the literature reveals a notable gap: the integration of digital technologies in rehabilitation services is not extensively studied within the context of its application to a wide range of disabilities and health conditions in Sub-Saharan Africa. This gap indicates a critical area for further research, where the effectiveness and scalability of Digital Rehabilitation solutions can be empirically tested and optimized for broader application across varied health scenarios in the region. This chapter seeks to provide a roadmap for

enhancing both health and economic outcomes through integrated digital solutions, reflecting a holistic approach to development challenges in Sub-Saharan Africa.

The aim of this chapter is to explain the following topics:

- Best practice examples from Uganda, Zambia, and Ethiopia
- Important points for the application of Digital Rehabilitation in Sub-Saharan Africa

To get an overview of chapter 2, look at the summary:

- Summary

2.1 Best practices from Uganda, Zambia, and Ethiopia

The partner institutions of the RADIC consortium are in Kenya, Tanzania, Zanzibar, and Rwanda. In these countries common health concerns are stroke, HIV, and tuberculosis (TB) [7]. Rehabilitation services are essential for addressing the physical, cognitive, and psychosocial needs of individuals living with stroke, HIV, and tuberculosis promoting their functional independence, and improving their overall well-being. In all three countries, the need for rehabilitation services for stroke, HIV and tuberculosis is exacerbated by numerous factors, including limited access to healthcare facilities, shortages of trained rehabilitation professionals, insufficient funding for rehabilitation programs, and social stigmatization of individuals with these conditions. Addressing these challenges and improving access to comprehensive rehabilitation services is crucial for reducing disability, promoting functional recovery, and enhancing the overall health outcomes of individuals affected by HIV, TB, and stroke in Kenya, Tanzania, Zanzibar, and Rwanda.

For this reason, we would like to present three best practice examples in which Digital Rehabilitation is used to build the bridge to increase access to rehabilitation, create a peer community without stigmatization, improve therapy adherence and lower the rehabilitation expanses.

Note: Digital Rehabilitation interventions can also be used in other areas than described in these examples. That means that Digital Rehabilitation interventions can also be applied for assessments, the diagnostic, as an intervention, to monitor the client's condition/symptoms and to evaluate the rehabilitation outcomes. See chapter 1 and/or 6 for more information.

Best Practice number 1:

The first best practice example is based on the publication from Teriö et al. and Kamwesiga et al. [8,9].

Mobile phone-based intervention helps to improve access to rehabilitation – A case example from Uganda

Challenge
The prevalence of stroke in Uganda is increasing. Despite the increased disease burden, the country has no national strategies or programs for the prevention or treatment of non-communicable diseases, including stroke. In Uganda, 72% of households live within five kilometers of a health facility. However, utilization of facilities is limited due to factors such as lack of transportation, poor infrastructure, lack of staff and lack of incentives for

staff. Medical care is provided at a specialized tertiary level by the National Referral Hospitals, such as Mulago Hospital in the capital Kampala, where people with strokes are admitted. Secondary care is provided by the Regional Referral Hospitals, which are less specialized. Primary care is provided by the health services in the communities, whereby the service capacity varies. The private healthcare sector is responsible for around 50% of healthcare services.

Opportunity

Digitalization is growing in sub-Saharan Africa. There are currently over 1000 mobile health services in low-income countries providing health content and diagnostic services. One goal of the Sustainable Development Goals introduced by the UN focuses on healthy living and promoting well-being for all. Against this backdrop, the use of mobile phones can increase quality, reduce costs, and extend the reach of healthcare to the benefit of millions of people. In East African countries, the use of mobile phones has been rapidly adopted. In sub-Saharan Africa, 444 million people had a mobile phone subscription in 2017. A mobile broadband network now covers most urban areas, meaning that infrastructure-related exclusion is greatest in rural areas. In Uganda, the use of mobile phones has gradually increased across the country since 1995 and in 2017, the number of mobile phone connections was 58 per 100 inhabitants.

This shows that there is potential for the successful use of mobile phones to improve accessibility of health services, especially due to the increasing societal demand for technologies use in daily activities. The potential of using digital technologies including cell phone solutions in stroke survivors has already been reported.

Solution

The F@ce intervention was implemented in Uganda in 2016 and aims to increase functioning in daily activities for persons living with the consequences of stroke, as well as participation in everyday life for persons with stroke and their family members.

Client's profile who could benefit from F@ce intervention
- Adults with stroke
- People living in a rural part of Uganda
- Access to and ability to use a mobile phone
- Willing family member or caregiver to support the client

F in the F@ce intervention stands for (Face-to-face between the Occupational Therapist (OT) and the client), @ for Assessment, C for Collaboration and E for Evaluation. In F@ce intervention, digital components are combined with face-to-face sessions. During the intervention, the three set activity targets were to be delivered to the client every morning and evening by short message service (SMS). The morning SMS was a reminder to perform the activities during the day. In the evening, the client was supposed to respond in three separate SMSs by scoring the performance of the activity between 0 (has not performed the activity) and 5 (did the activity well). If the clients had scored 0 or had not responded to the SMS, a red flag (a message that informed of a non-performed activity) was sent to the OT who should call the client the following morning to solve the problem. Additionally, the clients were to receive calls from the OT twice a week as a follow-up.

Technology reminding and monitoring

- The clients use a usual mobile phone to receive reminders, phone calls and sending text-messages
- Low internet literacy is needed to receive and send text-messages
- For the rehabilitation professional, the text-messages serves as a tool to monitor the rehabilitation and to identify performance gaps so they can help to close those gaps

Key characteristics of F@ce Intervention

- Blended intervention, mixing face-to-face session with online parts
- Intervention is tailored to the needs of the clients to improve the functioning of activities of daily living
- Involving family members or significant others
- Formulating three goals for the intervention in daily activities and transferable to the home-based environment
- Family members were informed about the client's target activities and the planned strategies for reaching these targets
- Use of a client reported outcome measure to monitor and evaluate the rehabilitation
- Enables change through setting goals and formulating strategies on the F@ce web-platform

Impact of F@ce intervention

- Intervention could increase accessibility, affordability, and continuity in the rehabilitation process after stroke but there is still a lack of research in this area
- F@ce seems to be acceptable for clients and family members
- Indications that the intervention increases functioning in daily living and self-efficacy

Challenges faced while implementation

- Lack of engagement among local colleagues or other medical personnel
- Non-compliance by clients and the family members
- Doubts on how beneficial the intervention is
- Unexpected server breakdown/technical problems
- Lack of knowledge about function of technology
- Lack of digital health literacy

Key message for implementation

- Services need to be carefully integrated into the local context
- Different responsibilities on various levels in the implementation are needed, thus enhancing the creation of supportive working culture
- Rehabilitation professionals and motivated clients acting as facilitators
- Empowering leadership → facilitators organized workshops characterized by open, non-hierarchical discussions
- Motivation of clients and rehabilitation professionals could be increased through monetary incentives

- Information about the benefits of the innovation should be given to the clients and family members before starting the intervention
- Further research with larger samples is needed to proof the effectiveness of the intervention

Best Practice number 2:

The second-best practice is based on the publication from Simpson et al. [10].

Creating a community with digital support groups for adolescent pregnant women living with HIV: A best practice example from Zambia

Challenge
Routine HIV testing during pregnancy is often the first-time young women learn their HIV status. While this has significantly improved antiretroviral treatment (ART) in southern Africa, pregnant adolescents face challenges accessing HIV services and are less likely to utilize them. Those diagnosed with HIV before or during pregnancy are more likely to be non-adherent to ART. Stigmatization during pregnancy, coupled with managing HIV alongside motherhood, can negatively affect maternal health and the baby's development. Concerns about HIV status and testing increase psychological distress in pregnant women.

Opportunity
Improving social support has been shown to have a positive impact on adherence to medication across a range of chronic illnesses for vulnerable populations. There is evidence to suggest that support groups and peer mentorship are effective interventions for delivering psychosocial support to pregnant women living with HIV. Where there are significant barriers to attending face-to-face counselling or support groups- technological interventions have a key place. Mobile phone-based interventions can overcome barriers that people must access critical social and psychosocial support. Mobile phones can be used as an educative tool, and toward their potential as a device for behavior change and psychosocial support for populations living with HIV.

Solution
A mobile phone-based virtual peer support group was introduced in Zambia in 2018. The aim of the support groups was to counteract the negative effects of social isolation and stigmatization on mental health that many people infected with HIV are exposed to.

Characteristics of setting in Zambia
- The healthcare needs in each community are serviced by one government clinic, which provides both in- and out-client services. The health facilities were initially designed for smaller populations, but due to rural-urban migrations and the formation of informal settlements, the populations and catchment areas served by the local government health facilities have grown.
- The average HIV prevalence in the communities where the intervention was introduced is 12%.

Client's profile who could benefit from intervention
- Pregnant women with HIV
- Access to and ability to use a mobile phone

- Women who want to access HIV services without the fear of stigmatization

Key characteristics of digital peer-support group
- A peer- support group consist of 6–8 clients and the support lasted for 4 months over the peri-partum and post-partum period
- Digital groups are formed via Rocket.Chat®
- Rocket.Chat® ensures privacy and anonymity for users
- Clients could freely communicate amongst themselves anonymously
- One trained moderator monitored the conversation
- The peer-support groups could be used via a smartphone (ITEL 1503 mobile devices, running the Android 4.4 KitKat® operating system)
- Topics discussed in the peer support group focused on social support and relationships, stigma, HIV knowledge and medication adherence
- Regularly digital sessions with a health professional were held to address specific medical questions from clients

Implementation

During a launch event, clients were given a mobile smart phone device with pre-loaded mobile data. They were asked to choose a nickname and remain anonymous during the intervention. They were encouraged to keep the content confidential and not to share their phone. The support groups used the open-source technology, Rocket.Chat®. This platform ensured clients could not share numbers, forward messages, take or send photo or video content. The team could administer the groups and monitor conversations.

Groups were facilitated by a trained Peer Mentor who delivered a curriculum of topics developed in consultation with the project team and key stakeholders. There were sessions where health professionals – a gynecologist, a nutritionist, and a general practitioner – were invited into the groups to run a session on a particular topic, where clients could ask specific medical questions. At the end of the groups, clients were asked to keep their phones, but the messaging platform was deleted from their phones to prevent ethical and information accuracy concerns surrounding conversations that were unmonitored or not facilitated.

Challenges while implementation
- Tensions with partners of woman over participation in the project.
- Poor reading and writing skills of the clients.
- Technical problems/repairs on the phone: clients were frustrated when "phones were delayed in coming back when they went for repairs".
- Not all groups had active facilitators, which resulted in topics remaining superficial.

Key message for implementation
- Clients were able to use the platform, even if their literacy levels or English language skills were poor. The speech-to-text and spell check functions facilitated such interaction.
- Anonymity of the intervention was a key aspect for using the peer-support group.

- The peer-led structure of the social support groups was a crucial factor in acceptability as it encouraged a democratic and unintimidating space for women.
- The design and user-friendliness of the phone make the intervention easy to use.
- Face-to-face services must be designed to complement digital provisioning such that those who are unable to participate in such interventions are still well served.
- The population is also at high risk of Intimate Partner Violence. In Zambia, 43% of women aged 15–49 years report lifetime experience of physical and/or sexual IPV (Intimate Partner Violence) and 27% of women reported physical and/or sexual IPV (Intimate Partner Violence) in the past 12 months. The introduction of the mobile phone into such a high-risk environment could lead to jealousy or suspicion, changing the power dynamics in the household. Hence, it is critical that a team of trained professionals can engage partners or other family members in the consent process to safeguard clients.

Best practice number 3:

The third best practice example is based on the publications from Manyazewal et al. [11–13].

Digital Medication event reminder results in lower costs for health care in people with Tuberculosis: A case example from Ethiopia

Challenge
TB is still mostly found in poor areas and affects people who do not have much money the most. The medicines used to treat TB work well, but they are expensive for clients and their families because they must go to special places to get the medicine. This makes it hard for them to stick to the treatment plan, and sometimes the treatment does not work, leading to the TB germs becoming resistant to the medicine. This can make the disease spread to other people. The current TB treatments last for a long time, at least six months for regular TB and even longer for drug-resistant TB. In many places, clients must go to a clinic every day to take their medicine under the supervision of a healthcare worker. This makes it difficult for clients and their families because they must spend a lot of money on transportation, food, and a place to stay near the clinic.

Opportunity
A digital medication reminder monitor (MERM) that monitors therapy in tuberculosis clients could address these issues. The MERM device (Wisepill Technologies) includes an electronic module and medication container to record adherence, store medication, provide audible alerts and color-coded visual light signals (i.e., green, yellow, and red) to remind clients to swallow and refill their medication, and allow physicians to digitally monitor adherence.

Solution
The 15-day TB medication supply (HRZE fixed-dose combination therapy of 15 doses) in an electronic pillbox device (evriMed500 digital medication monitoring and reminder device manufactured by Wisepill Technologies, South Africa) to self-administer, see picture below. The intervention was introduced in 2020 in Ethiopia to reduce travel expenses and to improve therapy adherence in clients with Tuberculosis.

Figure 1: evriMed500, medication reminder

Client's profile who could benefit from intervention
- People older than 18 years with Tuberculosis
- Out clinic status
- People not living close to a TB clinic
- Approved to follow the 2-month TB medication therapy recommended by the WHO (World Health Organization) [14].

Key characteristics of the intervention
- A digital medication reminder (MERM device, see picture 1) was given to the clients with 15 doses of medication in a TB clinic.
- Clients could return home for the next 15 days.
- The device has three indicator light-emitting diodes (LEDs) that are visible through the front of the container for the daily medication reminder (green LED), medication refill reminder, (yellow LED), and low-battery alerts (red LED). It also has a buzzer that is activated during the alarm sequences, and it emits a soft tone when the container is opened or closed.
- After 15 days, clients return to the TB clinic, where they counted any remaining tablets in the pillbox, download the pill-taking data from the device, evaluate the functionality of the device and troubleshoot as needed, and perform the urine isoniazid test.
- Clients could consult the healthcare provider in cases of medical illness or any adverse events outside of a scheduled visit before the next appointment.
- The phone number of the healthcare provider following their TB condition will be written at the backside of their appointment cards.

Implementation
- Clients were informed on how to use the device and given an instructional leaflet with client-friendly explanatory graphics prepared in the national language that outlined the procedures.
- Clients received a 15-day TB medication supply (HRZE fixed-dose combination therapy of 15 doses) in the MERM device to self-administer.
- Clients returned to the clinic every 15 days, at which point a clinician counted any remaining tablets in the pillbox and connected the MERM module with the computer.

- Along with the client, the clinician downloaded pill-taking data from the device to the computer and reviewed the event reports over the previous 15 days. Any missed event where no ingestion occurred over a particular prescribed ingestion period in the event report was evaluated against any remaining tablets in the pillbox and discussed further with the client for confirmation.

Key message for implementation
- The usability of the MERM device was high.
- Clients who used the MERM device visited the health care facility every 15 days and this significantly reduced vulnerability of clients to the underlying barriers including costs for travel, food, and accommodation for daily in-person visits.
- TB clinics in the study already had computers in use prior to the study. The MERM software was set up on computers that had already been in use in TB clinics or similar facilities.

2.2 Important points for application

When considering the application of Digital Rehabilitation in East or Sub-Saharan Africa, several important points should be considered to ensure successful implementation and effectiveness. These points include:

- The deployment of context-appropriate technologies such as wearable sensors and mHealth applications is essential to enhancing accessibility and effectiveness of rehabilitation services. These technologies provide cost-effective and scalable healthcare solutions [15].
- Addressing low digital literacy levels by providing user-friendly interfaces, clear instructions, and educational materials to support understanding and engagement with Digital Rehabilitation programs. Offer training and support to enhance digital literacy among users.
- Digital connectivity is vital for regional development, with the potential to accelerate progress in sectors including healthcare. Yet, the adoption of digital health technologies is hindered by challenges such as inadequate legal frameworks and ethical issues related to data ownership and privacy [16,17].
- Holistic and individualized approaches that respect spiritual and traditional beliefs are crucial for successful rehabilitation, particularly for conditions like strokes. This ensures cultural relevance and community acceptance [18].
- Digital preservation in academic libraries is crucial for sustaining digital resources, with cloud computing seen as a promising strategy. However, its adoption is low in places like South Africa, indicating a need for enhanced digital strategy implementation [19,20].
- With the healthcare focus shifting towards non-communicable diseases (NCDs) in Sub-Saharan Africa, accurate epidemiological data is essential. A coordinated political strategy that considers the uniqueness of each country is crucial to avoid implementation failures [21].
- A comprehensive approach that includes cultural sensitivity, technological innovation, improved digital connectivity, strong legal and ethical frameworks, and strategic political engagement is necessary for the success of Digital Rehabilitation in East and Sub-Saharan Africa. This strategy addresses current and future healthcare challenges in the region.

By considering these important points, stakeholders can ensure that Digital Rehabilitation initiatives in East and Sub-Saharan Africa are tailored to the needs of the population, culturally appropriate, accessible, and effective in improving rehabilitation outcomes and enhancing the well-being of individuals in the region. For more information on strategies to apply Digital Rehabilitation while overcoming this potential barrier, go to chapter 5.

Summary

- Digital Rehabilitation practices have several advantages for clients, rehabilitation professionals, society and the health care system, see chapter 1 for more information. Despite these advantages, digital interventions are not yet implemented widely in Sub-Saharan Africa.
- In this chapter, we presented three best practice examples from Uganda, Zambia, and Ethiopia to how Digital Rehabilitation was applied.
- In case example 1, we presented a digital intervention in Uganda for people with stroke consisted of a digital event reminder to increase access to rehabilitation.
- In case example 2, a digital peer support group was established for pregnant women with HIV from Zambia to improve therapy adherence.
- In case example 3, a digital technology was used to remind people with tuberculosis living in Ethiopia to take their medication to increase rehabilitation adherence and lower the costs.
- The most important key messages for the implementation of Digital Rehabilitation interventions based on all case examples are:
  - Digital Rehabilitation interventions need to be carefully adapted and integrated to the local context
  - Information about the benefits of the intervention should be given to the clients and family members before starting the intervention
  - Improving access to digital services when integrating technologies such as computers that are already in use in certain facilities such as schools, community centers and hospitals
  - Using technologies that are user-friendly and adapted to the client's digital literacy level
  - Combining digital interventions with face-to-face sessions that clients are not solely dependent on digital services
  - Being aware of the effect on the client's environment when implementing digital services
  - Further research with larger samples is needed to proof the effectiveness of the Digital Rehabilitation interventions

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3 Competencies in Digital Rehabilitation

In the dynamic landscape of healthcare, Digital Rehabilitation stands out as a promising avenue for delivering effective, accessible, and personalized health care to clients [1]. To perform Digital Rehabilitation effectively, competencies from the rehabilitation professional are needed.

This chapter presents the essential competencies required for rehabilitation professionals engaging in Digital Rehabilitation practices. Furthermore, we present approaches to evaluate the competencies for Digital Rehabilitation and give an overview of the skills and competencies of rehabilitation professionals in East Africa.

Thus, key topics covered in this chapter include:

- Competency Framework for Digital Rehabilitation in East Africa

- Approaches to evaluate competencies

- Current skills and competencies of rehabilitation professionals in East Africa

To get an overview of chapter 3, look at the summary:

- Summary

After you have gone through the content of chapter 3, you can work on the exercises to deepen the content:

- Exercises

3.1 Competency Framework

For effective Digital Rehabilitation services, the rehabilitation professional need a diverse set of competencies [2] to provide and support rehabilitation services, encompassing both **digital and non-digital components** throughout the entire rehabilitation process.

To show what competences are needed to perform Digital Rehabilitation, the Framework for Digital Rehabilitation Competences in East Africa (FDRC-East Africa) was created as a part of the RADIC project. The framework outlines the essential aspects of Digital Rehabilitation in the region, aiming to improve access to rehabilitation and to enhance quality of care. It covers the necessary competencies, digital activities, and behaviors required by the rehabilitation professionals to effectively provide and support rehabilitation services, encompassing both digital and non-digital components throughout the entire rehabilitation process.

The framework is organized around four dimensions: **health, education, livelihood & social and empowerment** and is linked to the Community-based Rehabilitation Indicator Manual [3]. The dimensions describe the outcomes for rehabilitation professionals to achieve successfully through Digital Rehabilitation interventions. To achieve the outcomes, the dimensions are linked to key competencies and digital tasks. For this purpose, four competence domains are defined and mapped to a behavior that the rehabilitation professional should demonstrate. For this, the competencies are complemented with activities and tasks rehabilitation professionals

should achieve in the rehabilitation process to successfully apply (digital) rehabilitation. This FDRC-East Africa is intended to guide teaching and practice.

The FDRC-East Africa is applicable to all rehabilitation disciplines and settings in East Africa, catering to clients of all ages receiving physical and mental rehabilitation. The framework was developed through an iterative process involving input from relevant stakeholders such as rehabilitation professionals, educators, and students, as well as the sources mentioned.

For the development of this framework, the following sources were used:

- Community-based Rehabilitation Indicator Manual [3]
- Rehabilitation Competency Framework [4]
- DigComp 2.2. - the Digital Competence Framework for Citizens [5]
- Needs assessment, a result of the RADIC-project
- Landscape analysis, a result of the RADIC-project (link is coming soon)

In table 1, we are presenting the **four dimensions** with the respective **competencies, key competencies** and **digital activities** required by the rehabilitation professional to successfully perform Digital Rehabilitation in East Africa. This table should serve as an overview. If you are interested in the complete framework, switch to the handbook for educators (coming soon).

Table 1: Dimensions, Definition of Competencies, Key Competencies and Digital Activities in Digital Rehabilitation in East Africa.

Dimension	Definitions Competencies	Key Competencies	Digital Activities
Health (digital service)	Practice: Competencies and activities related to (digital) interaction between rehabilitation professionals, the client and family. Competencies and (digital) activities include those necessary for establishing appropriate digital driven working relationships, assessment, planning, delivering and monitoring digital driven interventions. They use adequate decision-making and problem-solving for the entire Digital Rehabilitation process.	• Places the client and their family at the center of practice • Communicates effectively with the client, their family, and their health-care team • Adopts a rigorous approach to problem-solving and decision-making • Integrate evidence in practice • Works within scope of practice and competence	• Obtaining an environment for (digital) rehabilitation • Conducting (digital) rehabilitation assessments • Developing and adapting (digital) rehabilitation plans • Implementing (digital) rehabilitation interventions • Using evidence • Evaluating progress towards desired outcomes • Discharging and ensuring appropriate continuity of care
Education	Learning:	• Continues to learn and develop	• Supervising and teaching others

	Competencies and (digital) activities related to a digital driven development of the rehabilitation professional themselves and others. Competencies and activities within this domain involve continuous professional development, teaching, and learning.	• Supports the learning and development of others • Works to strengthen rehabilitation education and training	• Creatively using digital technologies • Integrating and re-elaborating digital content
Livelihood & Social	Professionalism: Competencies and (digital) activities related to professional integrity, collaboration, (digital) safety and privacy, and quality of care, that enable a digital-driven performance of the professional role.	• Demonstrates ethical conduct • Maintains professionalism • Works collaboratively • Manages professional responsibilities	• Managing risks and hazards • Interacting through digital technologies • Undertaking quality improvement initiatives • Participating in team forums • Advising on (digital) rehabilitation
Empowerment	Management & Leadership: Competencies and (digital) activities related to teamwork, strategic thinking, management, service development and evaluation, resource management and data protection.	• Works to enhance the performance of the rehabilitation team • Works to enhance the performance of rehabilitation service delivery • Acts as a rehabilitation advocate	• Managing digital approaches in a rehabilitation team • Managing rehabilitation (digital) service delivery • Identifying (digital) needs • Monitoring and evaluating (digital) rehabilitation service delivery • Protecting personal data and privacy • Protecting health and well-being

3.2 Approaches to evaluate competencies

Rehabilitation professionals may assess to determine how well they fulfill the competencies for Digital Rehabilitation. Similarly, governments and stakeholders have a duty to ensure that those who possess the requisite competencies in Digital Rehabilitation provide services. Following are considerations for evaluation.

- **Framework for evaluation** of digital competencies of rehabilitation professionals

- o Develop a specific assessment tool or questionnaires based on a competency framework. For example, look at the appendix. We have created a self-assessment that is based on the DigComp 2.2 framework.

- **Observational Assessment**
  - o Conduct observational assessments to observe how clients and professionals interact with Digital Rehabilitation tools in real-life settings. This approach allows for the direct observation of competency levels and can provide valuable insights into areas that may require further support or training.

- **Performance Metrics**
  - o Establish performance metrics to measure the effectiveness of Digital Rehabilitation interventions. These metrics can include measures such as task completion rates, user satisfaction scores, and improvement in functional outcomes. Analyzing these metrics can help identify areas of strength and areas needing improvement in digital competencies.

- **Feedback Mechanisms**
  - o Implement feedback mechanisms to gather input from clients and professionals regarding their experiences with Digital Rehabilitation tools. This feedback can be collected through surveys, interviews, or focus groups and can provide valuable insights into usability issues, training needs, and areas for enhancement.

- **Assessing against criteria**
  - o Develop criteria for evaluating rehabilitation professionals' digital competencies. You can think of the following:
    - ▪ Rehabilitation professionals must have provided services for a minimum of 1 year
    - ▪ Area of practice
    - ▪ Digital platform used
    - ▪ Duration of evaluation: Be completed within 6 months

3.3 Current skills and competencies of rehabilitation professionals in East Africa

To capture the Digital Rehabilitation skills and competencies of rehabilitation professionals working clinically in Kenya, Tanzania, and Rwanda, we created a self-assessment based on the European Digital Competence Framework for Citizens (DigComp 2.2) [5] as part of the landscape analysis in the RADIC project. In the following, we are explaining the self-assessment, give insights in the results and the derived recommendations to enhance the competencies. If you want to read the whole report of the landscape analysis, please follow the link (coming soon).

The self-assessment for rehabilitation professionals consisted of two parts:

Part 1: Demographic profile including sex, age, education level, working experience and the setting type (rural or urban).

Part 2: Digital competency questions adopted from the European Digital Competence Framework for Citizens (DigComp2.2) which has twenty-one items divided into five major components including information and data literacy, content creating, communication, safety, and problem solving. In the following, we are presenting the definitions of the five components. The DigComp is a descriptive, enabling framework designed to support the development of digital competence of individuals personally and professionally. All items were measured in 5-point Likert scale ranging from strongly disagree (score 0) to strongly agree (score 4). See for the complete self-assessment the appendix.

Information and data literacy:

Information and data literacy understand the competency level of participants focused majorly on individual's ability to search, find, appraise, sort, store and retrieve information using digital devices.

Digital content creation:

Digital content creation describes an individual's ability to create/delete/manipulate contents such as text and images in different application software such as Microsoft Word and Excel in digital devices. It also includes adjusting settings based on one's interest of use.

Communication and collaboration:

Communication and collaboration focus on an individual's capability to communicate, share, and interact with others using digital devices and network. It includes internet or local area connections.

Safety & Security:

Safety & Security assesses what people do to protect their devices from cyber/physical attack and the precautions they take on their own health.

Problem solving:

Problem solving focuses on assessing the skill of individual's potential in solving routine hardware and software problems encountered while using digital devices. Problem solving also evaluates where a person stops working when difficulties appear, or they look for digital solutions.

3.3.1. Analysis

The results of the participants were classified into various categories based on their overall scores. The DigComp 2.2 has 21 items (maximum score is 84). The Newcomer (A1) category is attributed to scores below 19, the Explorer category (A1) to scores between 19 and 32 (this upper limit corresponding to half of the items selected being "partial appropriation" and the other half "occasional use"); scores between 33 and 47 are mapped on the Integrator category; scores between 48 and 62 on the Expert (B2) category, thus splitting in equal halves the distance between the upper limit of the Explorer (A2) category and the lower limit of the Leader (C1) category.

Scores between 63 and 76 are attributed to the Leader (C1) level. Scores between 77 and 84 are attributed to the Pioneers (C2).

3.3.2. Results

The survey was carried out in 2024 in Tanzania, Rwanda, and Kenya. In total 174 rehabilitation professionals (physiotherapists, occupational therapists, speech therapists, psychologists, prosthetics, and orthotics) answered the survey. Most of the participants were physiotherapists (62,1%). In table 2, we present the overall results of the self-assessment per component of the DigComp 2.2.

Table 2: Overall results of the self-assessment per domain of the DigComp 2.2

Item	Mean
1. Information and data literacy (Maximum score: 12)	8.84
2. Communication and collaboration (Maximum score: 24)	16.60
3. Digital content creation (Maximum score: 16)	8.44
4. Safety (Maximum score: 16)	9.72
5. Problem solving (Maximum score: 16)	8.52
Total Score (Maximum score: 84)	**52.12**

Table 3 shows the scoring of participants per level.

Table 3: Frequencies of levels within the results of the self-assessment

Level	Frequency (n)	Percentage (%)
Newcomers (A1): < 19	5	2.9 %
Explorers (A2): 19-32	13	7.5 %
Integrators (B1): 33-47	42	24.1 %
Experts (B2): 48-62	71	40.8 %
Leaders (C1): 63-76	32	18.4 %
Pioneers (C2): 77-84	11	6.3 %

3.3.3. Discussion

The results indicate that a sizable portion of rehabilitation professionals, both in clinical or community settings, scored above the threshold considered to be indicative of expertise, leadership, or pioneering status in the field of digital competencies. In clinical or community settings, 65.5% of professionals scored above 47, with 40.8% categorized as experts, 18.4% as leaders, and 6.3% as pioneers. These findings suggest that a considerable proportion of rehabilitation professionals possess advanced knowledge and skills related to Digital Rehabilitation, regardless of whether they work in clinical/community or academic settings. The high percentages of experts and leaders in both settings suggest a solid foundation of expertise and leadership within

the field, which bodes well for the advancement and implementation of Digital Rehabilitation interventions in practice. However, it is worth noting that the digital competencies were self-reported.

Self-rating surveys, while valuable tools for gathering subjective data, have several limitations that should be considered while interpreting the survey results:

- Social desirability bias: Respondents may provide answers that they believe are socially acceptable or desirable, rather than reflecting their true opinions or behaviors. This can lead to inaccurate or biased results, particularly if respondents feel pressured to present themselves in a positive light.
- Lack of objectivity: Self-rating surveys rely on individuals' perceptions of themselves, which may not always align with objective reality. Factors such as self-esteem, mood, and cognitive biases can influence respondents' self-assessments, leading to inaccuracies or inconsistencies in the data.
- Limited insight into unconscious biases: Respondents may be unaware of their own biases or may underreport socially undesirable traits or behaviors. This can result in incomplete or misleading information, particularly when assessing sensitive topics or traits.
- Variability in interpretation: Self-rating scales may be interpreted differently by different individuals, leading to variability in responses. This can make it difficult to compare results across respondents or to draw meaningful conclusions from the data.
- Inability to capture complex behaviors or experiences: Self-rating surveys typically rely on simplified Likert scales or other rating systems, which may not fully capture the complexity of individuals' experiences, attitudes, or behaviors. This can limit the depth of insight gained from the data and may overlook important nuances or subtleties.
- Limited generalizability: Self-rating surveys are often based on convenience samples of respondents, which may

3.3.4. Recommendations

To enhance the digital competencies of rehabilitation professionals in East Africa, it is essential to involve key stakeholders and collaborate on strategic initiatives. Here are some recommendations tailored to different stakeholders:

Government Bodies and Regulatory Agencies:

- Develop policies and regulations that encourage the integration of digital technologies into rehabilitation practices.
- Invest in improving ICT (Information and Communication Technologies) infrastructure to ensure widespread access to digital tools and resources. This includes providing adequate internet connectivity, computers, and technical support services to facilitate seamless integration of technology in education.
- Provide funding and resources for training programs focused on digital competencies for rehabilitation professionals.
- Establish standards and accreditation processes for digital tools used in rehabilitation to ensure quality and safety.

Institutions of Higher Education (HEIs (higher Education Institutions)) in East Africa

- Enhanced Digital Literacy Programs: Institutions of Higher Education (HEIs) in East Africa should prioritize the development of digital literacy programs for both educators and students. These programs should focus on enhancing digital competence across various domains, including information literacy, communication skills, digital content creation, and safety.
- Update curricula to include courses on digital technologies relevant to rehabilitation practice, such as telehealth, electronic health records, and assistive technologies.
- Provide faculty development opportunities to ensure educators are equipped to teach digital competencies effectively.
- Offer hands-on training opportunities, such as clinical placements or internships, where students can apply their digital skills in real-world settings.

Professional Associations and Organizations:

- Offer continuing education programs and workshops specifically designed to enhance digital competencies.
- Facilitate networking opportunities for rehabilitation professionals to share best practices and learn from each other's experiences with digital technologies.
- Advocate for the inclusion of digital competency requirements in professional certification and licensure processes.

Technology Developers and Industry Partners:

- Collaborate with rehabilitation professionals to co-design and tailor digital tools to meet their specific needs and preferences.
- Provide training and technical support to ensure rehabilitation professionals can effectively use and integrate digital technologies into their practice.
- Offer affordable pricing models or subsidies for digital solutions to make them more accessible to rehabilitation facilities in East Africa.

Healthcare Facilities and Employers:

- Invest in infrastructure upgrades, such as reliable internet connectivity and secure data storage systems, to support the adoption of digital technologies.
- Provide incentives, such as bonuses or professional development opportunities, to encourage rehabilitation professionals to enhance their digital competencies.
- Foster a culture of innovation and continuous learning within the organization to promote the uptake of digital tools and practices.

Researchers

- Continuous monitoring and research efforts are essential to keep pace with the rapidly evolving digital landscape. Researchers should collaborate with policymakers to conduct longitudinal studies and evaluate the effectiveness of digital pedagogy initiatives in rehabilitation education.

3.4 Exercise

3.4.1 Objective

This practical exercise's objective is to enhance the digital competencies of rehabilitation professionals, enabling them to utilize effectively digital tools and technologies in their practice.

3.4.2 Exercise Steps

o   Reflecting on the importance of digital competencies in rehabilitation.
o   Perform the digital competence self-assessment questionnaire to identify areas for improvement.
o   Exploring digital tools relevant to specific areas of rehabilitation practice (e.g., physical therapy, occupational therapy, speech therapy).
o   Using digital tools to create treatment plans, track progress, or communicate with clients.
o   Reflection on own learning journey throughout the exercise, identifying areas of growth and areas for further improvement.

Summary

- Essential knowledge and competencies are required for the application of Digital Rehabilitation.
- The competencies cover practice, learning and development, professionalism, management, and leadership.
- To assess rehabilitation professionals' competencies regarding Digital Rehabilitation you can use a self-assessment that is based on a framework regarding Digital Rehabilitation, see for an example the appendix.
- According to the survey we conducted as part of the RADIC project, the skills of rehabilitation professionals in East Africa are good. However, some factors that may influence the results should be considered.
- Recommendations to enhance digital competencies could include the following: establishment of policies and regulations to support and enhance digital technologies in rehabilitation practices, the availability and decentralization of infrastructures such as internet connection, training for future rehabilitation professionals, and the enhancement of continuous professional training, follow-up of tools and practices. Further, digital literacy is recommended to improve competence in the use of Digital Rehabilitation tools. Furthermore, stakeholder collaboration between governments, researchers, higher education institutes, healthcare facilities, industries, and clients/end users are required.

Literature

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Appendix: *Questionnaire for rehabilitation professionals*

Part 1: Demographic Profile

1.1. What is your profession?
o occupational therapist
o physiotherapist
o prosthetist & orthotist
o speech therapist
o other, please specify: _____

1.2. What is your age category?
o Under 30 years
o 30-39 Years
o 40-49 Years
o 50-59 Years
o 60 or more
o I prefer not to answer

1.3 What is your sex?
o Male
o Female
o I prefer not to answer

1.4. What is your highest qualification?

o Diploma
o Bachelor
o Masters
o PhD

1.5. Years of working experience as a rehabilitation professional:

o Less than 5 Years
o 5-9 Years
o 10-14 Years
o 15-19 Years
o 20-24 Years
o 25 Years or more

1.6. What is the level of your health facility?
O Health centre
O District Hospital
O Provincial Hospital
O National Referral Hospital
O Other, Specify………………….

1.7. What is the area category of your workplace?
O Rural
O Semi-urban
O Urban

Part 2: Digital Competencies
Question: Are you able to do the following?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Information and data literacy					
1.1 Are you able to browse, search and filter data, information, and digital content?					
1.2 Are you able to evaluate data, information, and digital content?					

1.3 Are you able to manage data, information, and digital content?					
2. Communication and collaboration					
2.1 Are you able to interact through digital technologies?					
2.2 Are you able to share information through digital technologies?					
2.3 Are you able to engage in citizenship through digital technologies?					
2.4 Are you able to collaborate through digital technologies?					
2.5 Are you able to netiquette (communicate on the internet?					
2.6 Are you able to manage digital identity?					
3. Digital content creation					
3.1 Are you able to develop digital content?					
3.2 Are you able to integrate and re-elaborate digital content?					
3.3 Are you able to apply rules of copyright and licenses related to data, digital information, and content?					
3.4 Are you able to do programming?					
4. Safety					
4.1 Are you able to protect devices?					
4.2 Are you able to protect personal data and privacy?					
4.3 Are you able to protect health and well-being?					
4.4 Are you able to protect the environment?					
5. Problem solving					
5.1 Are you able to solve technical problems?					
5.2 Are you able to identify needs and technological responses?					
5.3 Are you able to creatively use digital technologies?					
5.4 Are you able to identify digital competence gaps?					

4 Accessibility in Digital Rehabilitation

Accessibility in Digital Rehabilitation is critical ensuring equitable health solutions in East Africa. This chapter explores the importance, challenges, and local opportunities in the region and provides a guide for creating digital content to support accessibility.

Accessibility goes beyond physical access and encompasses the inclusion of all abilities and backgrounds. However, East Africa faces challenges such as limited infrastructure and varying levels of digital literacy. Despite these challenges, local government and collaborative efforts are driving progress towards accessible Digital Rehabilitation services. Digital accessibility guidelines are also being provided to enable stakeholders to develop inclusive solutions.

This chapter explains the following points:

- Importance of accessibility globally
- Importance of accessibility in East Africa
- Challenges for accessibility in East Africa
- Digitalization in East Africa
- Guidance on digital accessibility

After you have gone through the content of chapter 4, you can work on the exercises to deepen the content:

- Exercises

To get an overview of chapter 4, look at the summary:

- Summary

4.1 Importance of accessibility globally

In recent years, the intersection between healthcare and technology has ushered in a transformative era for healthcare services. A key aspect of this development is the emphasis on accessibility in Digital Rehabilitation, which emphasizes the inclusion of people in need of rehabilitation.

Digital Rehabilitation accessibility is a concept that emphasizes the extent to which individuals with physical, cognitive, sensory or communication impairments can seamlessly and equally access and benefit from digital technologies developed for rehabilitation purposes.

Accessibility in Digital Rehabilitation goes beyond traditional physical access considerations, such as wheelchair ramps and barrier-free entrances. It is about the thoughtful design and delivery of rehabilitation programs, digital tools and virtual platforms that meet the diverse needs and abilities of all potential users. This means addressing challenges related to physical, sensory, cognitive and communication aspects that individuals may face.

The significance of accessibility becomes evident when considering that many clients in need of Digital Rehabilitation services may have physical limitations, sensory impairments, or cognitive deficits. By designing accessible rehabilitation programs and digital tools, developers and rehabilitation professionals empower individuals with disabilities to participate actively in their recovery journey. Additionally, it enables healthcare

providers to reach a broader and more diverse client population, thereby reducing disparities in healthcare access.

On a global scale, accessibility to Digital Rehabilitation is an evolving landscape marked by both opportunities and challenges. The state of accessibility varies across regions, and ongoing efforts aim to make Digital Rehabilitation universally accessible.

As the global community continues to navigate the evolving landscape of digital healthcare, accessibility remains a cornerstone in ensuring that the benefits of Digital Rehabilitation are accessible to all, fostering a more inclusive and equitable future for healthcare delivery.

4.2 Importance of accessibility in East Africa

Accessibility as described earlier endeavors to ensure that every individual has equitable opportunity to benefit from rehabilitation services, which should be possible regardless of one's literacy level, their physical or anatomical characteristics, their geographical location, financial ability. However, this may not be reflective of the current situations in our countries as developing nations and more specifically as the East African Community as we are still struggling with equitable access to healthcare [1,2].

Rehabilitation through digital technology is currently inevitable as there is a current upscale of technology all over [3,4]. It is every national government's mandate to ensure availability of timely, acceptable, and affordable health services to all persons [5], and this matter has currently been reinforced by the 2030 Sustainable Development Goals (SDGs) which aims to ensure that no one is left behind but be able to reduce inequalities and achieve good health and well-being for all [6]. The Eastern Africa countries therefore have no exception but be able to conform to these expectations. In addition, digital technology has more potential benefits for this region that will help curb the inadequate health personnel and reduce the geographical distance of acquiring healthcare services. With the variety of available user interface, it is therefore important to match the user with the most compatible form of technology (as described in chapter 6) that will suit their rehabilitation needs and enable the rehabilitation professionals to make informed decision based on the teleassessment or tele-evaluation that is needed. This can involve enhancing translation into a more appropriate language that is easily understood or involving caregivers which means one needs to identify the personnel that will be trained to assist them through the rehabilitation process.

Good and simple accessibility will thus promote compliance to rehabilitation services and hence important to see the reflection of the scenario within the Eastern African Countries.

4.3 Challenges for accessibility in East Africa

Ensuring accessibility in Digital Rehabilitation across East Africa requires addressing a range of factors to accommodate the diverse needs and challenges present in the region.

East Africa encompasses a wide range of settings, from urban centers with relatively strong digital infrastructure to rural areas with limited connectivity. Limited access to high-speed internet can hinder accessibility. Digital

Rehabilitation solutions must be designed to function across varying levels of internet access and technological infrastructure, including the use of offline capabilities where necessary.

Further, the cost of digital devices and internet access can be a significant barrier for individuals in economically disadvantaged regions. Solutions should be affordable and considerate of the economic realities of the region, potentially through subsidized programs, low-cost technologies, or leveraging existing resources like mobile phones.

Adapting Digital Rehabilitation content and interfaces to various languages and cultures is a complex challenge, where attention to cultural sensitivity and awareness is paramount to ensure that individuals from diverse backgrounds are not excluded from these valuable services. Apps, web-based programs, and other digital interfaces used in Digital Rehabilitation should be designed to be intuitive and easy to use, even for people with various levels of digital skills or disabilities. This may involve incorporating features like voice commands, simple visual cues, and text-to-speech capabilities to enhance accessibility for users with unique needs.

Additionally, healthcare workforce training is a crucial piece of the global accessibility puzzle. In many parts of the world, a lack of professionals with the necessary expertise in Digital Rehabilitation exists, making it imperative to develop training programs that equip healthcare providers to deliver these services effectively. Low digital literacy also presents a significant barrier to accessing and utilizing Digital Rehabilitation services. Without adequate digital literacy, individuals may struggle to navigate rehabilitation platforms, understand instructions, or effectively communicate with healthcare providers through digital mediums. Adequate training and support should be provided to both clients and rehabilitation professionals to ensure they can effectively utilize Digital Rehabilitation tools. This may involve the development of educational resources, remote assistance services, and capacity-building initiatives.

Moreover, navigating the intricate landscape of regulations and legal considerations presents a significant obstacle for Digital Rehabilitation services striving for global reach. Achieving accessibility requires strict compliance with local laws and healthcare standards to ensure both safety and efficacy. Furthermore, in various regions, clients may lack awareness of the existence and potential benefits of Digital Rehabilitation, or they may harbor reservations about embracing these services.

Global standards for data security and privacy can vary significantly, and it is important to address these concerns to facilitate international access to Digital Rehabilitation. Ensuring the protection of clients' sensitive information, regardless of their location, is vital for promotion of trust and widespread adoption.

Lastly, the differences in Digital Rehabilitation regulations and reimbursement policies from region to region present a remarkable challenge. In some areas, these policies may not be well-defined, which can hinder the expansion of Digital Rehabilitation. The cost coverage in services provided in the field of rehabilitation medicine through insurance schemes varies extensively in low and middle-income countries. Advocacy and policy changes are indispensable to create an enabling environment for global access.

Therefore, the journey toward accessibility to Digital Rehabilitation is ongoing, encompassing technological, cultural, economic, and regulatory considerations. Achieving a more equitable and inclusive healthcare landscape demands collaborative efforts from governments, healthcare organizations, technology providers, non-governmental organizations (NGOs), and international bodies. As Digital Rehabilitation continues to evolve,

it holds the potential to bridge healthcare disparities and elevate the quality of care for individuals worldwide. The path forward involves addressing these multifaceted challenges and creating an inclusive digital healthcare ecosystem that benefits individuals, regardless of their location or socioeconomic status.

4.4 Digitalization in East Africa

4.4.1. Digitalization in Kenya

Kenya has made significant strides in technological infrastructure. The Kenya National Digital Master Plan 2022-2032 is a blueprint for leveraging and deepening the contribution of ICT to accelerate economic growth. It provides a digital infrastructure for equitable access to service through a pervasive and ubiquitous national ICT infrastructure. In addition, it ensures digital skills for the development of a digitally skilled workforce and citizenry that is grounded on ethical practices and social cultural values. With this in place, Kenyan government has taken steps to promote telemedicine and digital healthcare services, which includes exploring the integration of Digital Rehabilitation into its healthcare system to improve accessibility and the quality of care. This initiative has accelerated the awareness and adoption of such services among healthcare providers and clients.

Likewise, the Kenya's growing economy has also enabled greater affordability and accessibility to digital devices, which can be instrumental in delivering Digital Rehabilitation solutions to a broader population.

The vibrant tech ecosystem has given rise to digital health startups and innovative solutions in healthcare, including Digital Rehabilitation platforms. This entrepreneurial spirit has the potential to drive accessibility. Additionally, collaboration with international healthcare organizations and NGOs can provide valuable expertise and resources to enhance the accessibility of Digital Rehabilitation in Kenya.

While internet and mobile phone penetration is steadily growing in Kenya, disparities in access remain, with urban areas enjoying better connectivity compared to rural and underserved regions. Moreover, there exists a significant variance in digital literacy and awareness of Digital Rehabilitation services among the Kenyan population.

Kenya is currently in the process of developing a regulatory framework for telemedicine and digital healthcare [7]. As the regulatory environment continues to grow, ensuring clarity and consistency in regulations becomes a vital consideration. A well-defined regulatory framework will substantially contribute to the safety and effectiveness of Digital Rehabilitation services, promoting confidence among providers and clients alike.

Training rehabilitation professionals to competently deliver Digital Rehabilitation services stands as an ongoing challenge. A lack of experts in this field may limit the availability and accessibility of these services. Addressing this gap necessitates investments in specialized training programs and capacity-building initiatives to cultivate a skilled workforce capable of delivering high-quality Digital Rehabilitation. Relatively excessive cost of data in Kenya can serve as a deterrent, preventing individuals from accessing Digital Rehabilitation services. To make these services more accessible, one effective strategy is reducing data costs or providing free access in specific contexts. This approach is instrumental in dismantling this data cost barrier and facilitating broad adoption.

In concert, addressing these multifaceted challenges is a collective effort, necessitating cooperation among government bodies, healthcare organizations, technology providers, and advocacy groups. By surmounting these

barriers, Kenya can lay the groundwork for a more inclusive and accessible digital healthcare ecosystem, enhancing the quality of care for individuals across the country.

4.4.2. Digitalization in Tanzania

Tanzania is making its mark in the field of IT, positioning itself as a significant player on the African continent. With an estimated GDP growth of 6.3% in 2024, the country is undergoing an ICT digital transformation that promises to drive further economic growth [8].

The expansion of network coverage, the introduction of high-speed internet services, and the establishment of a National ICT Broadband Backbone have laid a solid foundation for the country's digital future. The Ministry of Information and Technology in Tanzania, offers to make Tanzania a technological powerhouse in Africa.

Tanzania has undergone a digital transformation, reflected by the growing number of people connected to communications and internet services. This is having a profound impact on the country's social, cultural, and economic frameworks, through enhanced access to key services and improved productivity and efficiency across economic sectors.

Tanzania is currently finalizing its Digital Economy Strategic Framework 2023-2033, which is due for implementation in early 2024 [9]. A panel of digital experts has given permission to proceed with the suggestions and recommendations for the proposed national digital economy program. According to local media reports, the program will serve as a roadmap for the country's day-to-day economic activities, guiding the processing and management of electronic messages and documents.

Mobile technology is at the center of Tanzania's digital transformation. Mobile services today connect more people in the country than any other communications technology, with around 42% of the population subscribing to a mobile service in 2018. Mobile internet penetration has nearly quadrupled since 2010 to 18.5%, with more than 8 million new mobile internet subscribers added over that period [8].

With these advancement in digital technology Tanzania has improved payment system through mobile phones. The most popular payment option in Tanzania is now available for Payment wall merchants. Payment wall has added a new payment option in Tanzania. Customers in the country can now accept payments via mobile banking – the most popular financial service in Tanzania. Mobile banking services allow users to pay for online purchases using e-wallet accounts – like TigoPesa or Airtel Money. They can also use Mastercard QR-code payments via M-Pesa, TigoPesa, Airtel Money, HaloPesa, EzyPesa, or TTCLPesa (these are popular Tanzanian digital wallets). All payments, especially government payments, are done electronically including all public services. Locals frequently use mobile money to pay the bills, shopping, fees, transport, bank-to-wallet and wallet-to-bank transfers, POS, etc.

Tanzania through the Ministry of Health is committed to the effective application of digital technologies to improve population and individual health outcomes by facilitating evidence-based actions at all levels of the health system. The National Digital Health Strategy 2019–2024 outlines how Tanzania intends to leverage digital health technologies, build on the achievements, and experience from the implementation of the National eHealth Strategy 2013–2018 [10, 11]. This strategy outlines what needs to be done from 2019 to 2024, to fast-track progress towards attainment of universal health coverage and the health-specific sustainable development goals. The strategy will also address challenges encountered in the digitalization of the health sector in Tanzania.

Moreover, the government of Tanzania is striving to move the country to middle-income status and achieve the Sustainable Development Goals. Tanzania was able to achieve several health-related Millennium Development Goals (e.g., under-five mortality, measles-immunization coverage, incidence of HIV/AIDS, tuberculosis mortality), but others persist unattained (e.g., maternal mortality, antenatal coverage, births with a skilled birth attendant, family planning, antiretroviral-therapy coverage, malaria incidence).

To achieve these goals, the government is committed to expanding and improving the use of ICTs (Information and Communication Technologies) to strengthen the efficiency and effectiveness of its public health services. Trends in ICT availability, affordability, and usage are creating an increasingly promising context for expanding the use of ICTs (Information and Communication Technologies) for development in Tanzania. There are 39 million mobile connections (21.7 %), this number is growing as mobile service, and connectivity is expanding nationwide.

Tanzania is the landing point for East Africa fibre-optic cable. There are public and private investments in ICT infrastructure and increasing availability of hardware, including smartphones and tablets, at lower costs. More investments are required to leverage the ICT infrastructure for effective data systems and use for health impact.

Although an appetite for digital technology is growing in many countries, it seems to be particularly strong among Tanzanians. The publication of the country's new policy document demonstrates that, even in the poorer regions of the globe, digital approaches to health planning and provision are no longer a complete novelty. Equally encouraging is that Tanzania is now eager to adapt and deploy these technologies in the way that best suits them. Digital health and digital is firmly on the country's agenda.

The Tanzanian Act No. 9 of 2010 (12) for the health care, social support, accessibility, rehabilitation, education, vocational training, promotion of basic right for people with disability as outlined by the United Nation Convention on the Rights of Persons with Disabilities (UNCRPD) went even further in underlining under Part V, Para 26 (1) of the act that:

i.   Every person with disability shall have the right to enjoy the attainable standard of health care services without any discrimination.

ii. Every health facility whether public or private shall not deprive a person with disability the right to health care service and shall take all reasonable and necessary measures to ensure access for such person to health services.

Since such an act is in place then, the incorporation of Digital Rehabilitation services will be complementing the government initiatives of providing such services. In the process of the ongoing projections, the government needs to ensure that a policy of subsidizing/supporting these services is in place.

4.4.3. Digitalization in Rwanda

Rwanda's Health Sector Strategic Plan (HSSP 2018-2024) [13] aims at achieving Universal Health Coverage. However, Rwanda's hilly terrain and inefficient transport infrastructure makes it difficult to access health facilities especially for the rural population that constitutes more than 80% of the population [14]. The Rwandan government intends to use Information Communication Technologies (ICT) to transform the health sector to overcome this challenge. Rwanda's Digital Health Strategic plan 2018–2023 [15] set a decisive goal to improve health service delivery and accessibility through Digital Health. The Ministry of Health's strategic plan aligns with

the Smart Rwanda Masterplan under the Ministry of ICT in prioritizing the use of telemedicine technologies to increase accessibility to health services.

Rwanda is already a well-known tech hub in Africa and the Rwandan government has given priority to the health sector enabling innovative technology solutions such as robotics contact tracing, symptom surveillance, robot-monitoring and data visualization which were used in the management COVID-19. In addition, the government of Rwanda introduced AI-powered chatbots in health care to help Rwandans have easier access to consultations with doctors or nurses**.** Clients can complete consultations from any location in the country with just a mobile device. This is made possible due to increased mobile penetration in the country with over 10 million active mobile subscribers (14). Currently, there are over ten internet service providers, including MTN, TIGO, Altech Stream, Rwandatel, among others.

More Rwandan public services are also going digital for instance, "irembo" platform (Government's e-service portal) whereby, Rwandans can access government services online via mobile devices and/or PCs. In addition, there is digitalization of other services, including financial (mobile money, mobile banking services), agriculture (e-Soko) and health (Mobile e-Health) [14]. To enable smooth operations of digital services, the government has enacted laws to govern electronic messages, signatures, transactions, data protection, cyber-security, and ICT usage. It established the Rwanda Utilities and Regulatory Agency which adopted the International Telecommunications Union (ITU) ICT industry standards.

Sound ICT infrastructure is fundamental for an inclusive and accessible digital development which overcomes social, spatial, and economic gaps. A big challenge for telehealth solutions in Rwanda is the lack of access to digital infrastructure. Although majority of the population in Rwanda have access to electricity, progress in access to electricity remains far below the universal access target of 100% by 2024. Furthermore, disparities in access still exist with urban access being higher than rural areas. In addition, gender disparities persist, with more male headed households accessing electricity more than female headed households [16].

Internet penetration and digital literacy is still extremely low in Rwanda which is fundamental in the delivery of digital technologies. Another relevant challenge is the ability to source a skilled, local workforce. However, given the interest and advocacy from the government and the support of non-governmental organizations, Rwanda will make significant strides in establishing an accessible and more inclusive digital health care systems which will enable the delivery of Digital Rehabilitation possible.

4.5 Guidance on digital accessibility

Digital accessibility is the deliberate design of digital products and technologies to make it easier and more convenient for people with disabilities to use them in everyday life. Digital accessibility is important in relation to Digital Rehabilitation to ensure that Digital Rehabilitation services are inclusive, effective, and equal for all people, regardless of their abilities or disabilities.

It is guided by the following principles:

- Perceivability – Users should be able to easily process the content
- Operability – Users should have an easy time navigating the websites/digital products

- Robustness – The content must be accessible to individuals using a diverse mix of assistive technologies

- Understandable – The information should be clear and easy to comprehend

This is an essential pillar of rehabilitation as it ensures access to resources and facilities available to the rest of the population. For instance, individuals with visual impairments have trouble reading information presented on screens. In such cases, screen readers come in handy to ensure that they are not excluded from rehabilitation services provided on digital platforms. Similarly, accurate captions and transcripts for audio-visual information ensure access to information for people with hearing impairments. Additionally, a person with a tremor might not be able to operate a smartphone easily and therefore voice control might be beneficial.

Digital accessibility acknowledges that people living with disabilities use digital facilities as often as any other demographic. The primary objective of digital accessibility is operability. Digital content, services and technologies should be tailored to ensure that disability does not get in the way of their access. This can be achieved through;

- *Consultation to understand accessibility shortfalls* – Teams charged with digital accessibility must include people who understand the lived experiences of disability and the challenges associated with accessing digital resources.

- *Getting familiar with accessibility guidelines* – Digital accessibility design should align with existing web content guidelines such as the Web Content Accessibility Guidelines [17]. This ensures the design builds up on existing frameworks.

4.6.1. Universal design

All digital spaces must be built with universal design in mind.

"'Universal design' means designing or accommodating the main solution with respect to the physical conditions, including information and communications technology (ICT), such that the general functions of the undertaking can be used by as many people as possible, regardless of disability" [18].

Universal design is guided by the following principles:

- Equitable use – The design must be effective in use for everyone on the spectrum of ability.

- Flexibility in use – The design should accommodate the different preferences of the users [19]. For instance, a captioned audio-visual resource should have an option for the user to turn the captions on or off, increase the font size or change it.

- Simple and Intuitive Use – This means keeping the complexity of the design to a minimum [19]. It ensures that the user's experience and knowledge or lack thereof does not impede their interactions with the digital resources.

- Perceptible information – The design should communicate all the valuable information to the user regardless of the ambient environment or sensory abilities.

- Tolerance for Error: People living with disability may struggle with information input or with different technologies. The design should accommodate minor errors likely to occur without reducing their interactions with the systems.

- Low physical effort – Universal design should not be physically exacting or labor intensive to use.

- Appropriate Size and Space for Approach and Use – The design should allocate enough room for manipulation and use regardless of the user's size or mobility [19].

These are the universal design options:

- Providing alternatives – This is an important yet often overlooked aspect of accessibility in digital and offline spaces. In the digital spaces, this means text equivalent for non-textual content and alternative input methods.

- Captions and transcripts – In line with the alternative means of access, multimedia content must be accompanied with captions and transcripts [17].

- Simplified design – Assistive technologies in the digital space are not adequately advanced [20]. Thus, the design of digital resources should allow for clear and straightforward navigation.

- Logical content structure – Digital content should be outlined in a logical and consistent format with headings and other accessibility-oriented design decisions for easier navigation for people using assistive technologies.

- Regular updates – With continued research comes improvements in digital accessibility. All digital resources should incorporate these improvements through regular updates.

4.7 Exercise

- What are some of the factors that may hinder you from accessing Digital Rehabilitation?
- What do you think can be done in your setting to enable access to Digital Rehabilitation?

- **Case study 1**
  Situation: Strenuous task of lifting your elderly grandmother at home resulted in a disc bulge at your lower back. After visiting the closest health center, you were referred to a teaching and referral hospital for more treatment. The initial phase of management commenced at the physiotherapy department. Unfortunately, due to geographical constraints, attending daily physiotherapy sessions for the recommended 10 consecutive days, as advised by the therapist, became impractical. Considering these challenges, an agreement was reached with your therapist to pursue remote treatment through digital technology. This alternative approach ensures accessibility despite the physical distance, facilitating the seamless continuation of physiotherapy interventions.

  Exercise: Discuss how you will access and continue with your treatment.

- **Case study 2**
  Situation: You realize that your child was unable to sit at the age of one year. A visit to the doctor alluded that the child has delayed milestones and would require therapy to improve his milestones. You have attended therapy for several months and feel fatigued and exhausted. A discussion with the therapist suggests that you can do therapy remotely.

  <u>Exercise:</u> Discuss how you will actualize your son's treatment remotely.

Summary

- Accessibility in Digital Rehabilitation services seeks to ensure prevention of physical, social, cognitive, and geographical barriers.
- To ensure the accessibility in Digital Rehabilitation interventions in East Africa, several factors need to be considered to address the different needs and challenges in the region: inconsistent infrastructure and connectivity for digital interventions, cost of mobile devices, local languages and cultural aspects, user-friendly design of digital interventions, (digital) literacy, digital interventions need to comply with privacy and security regulations.
- Kenya's enactment of the digital bill enhances visibility and readiness for embracing Digital Rehabilitation.
- Mobile technology is fast upcoming in Tanzania as they look forward to implementing Digital Economy Strategic Framework 2023-2033.
- Rwanda's Digital Health Strategic plan 2018–2023 sets to improve health service delivery and accessibility through Digital Health.
- Digital literacy, especially in rural areas seems to be the impending challenge across all the three East African countries.
- Universal guidance principles will ensure equitable access to Digital Rehabilitation services in terms of flexibility, simplicity, perceptibility, tolerance for error and low physical effort amongst others.

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5 Potential barriers and strategies to overcome the barriers

As you have already learned in chapter 1, Digital Rehabilitation has several potential benefits for clients, rehabilitation professionals and the healthcare system globally and in East Africa. However, there may also be some obstacles, which could hinder its use.

In this chapter, we explain the potential barriers that can arise when applying Digital Rehabilitation, especially in the context of East Africa. We also show potential strategies to address these barriers to exploit the potential of Digital Rehabilitation.

Thus, the content of this chapter is:

- Potential barriers of Digital Rehabilitation
- Strategies to overcome these barriers

To get an overview of chapter 5, look at the summary:

- Summary

5.1 Potential barriers and strategies to overcome the barriers

As highlighted in chapter 1, the integration of digital technologies into rehabilitation presents distinct advantages for health care in East Africa, including the significant potential of Digital Rehabilitation. Despite the numerous advantages, there are barriers that may not be inherent but can arise in the use of digital technologies. This could lead that Digital Rehabilitation interventions cannot be performed, rehabilitation professionals/clients are less motivated to carry them out, which in turn can weaken adherence to rehabilitation and thus the effect.

The list of barriers does not claim to be exhaustive. If you use Digital Rehabilitation in practice, are planning to use/implement it or are already receiving it as a client, you may notice other barriers. The barriers listed are those most frequently mentioned in the literature in relation to Digital Rehabilitation in Sub-Saharan Africa. Most barriers presented in this chapter are based on a scoping review conducted as part of this project. You can view the registration of the paper via this link: https://osf.io/xyvmj [1]. The full paper is expected to be published by the end of 2024.

Note: The strategies listed below could be ways to overcome potential obstacles, but it will require collaboration between governments, healthcare providers, technology developers, and communities to develop sustainable and culturally appropriate solutions that overcome these challenges.

5.1.1. Access to internet

Since the invention of the internet and the development of the first website in 1990, it has developed enormously at a rapid pace. Now we cannot only make information accessible regardless of time and place, but we can also carry out banking transactions and offer rehabilitation services online.

Figure 1 shows the increase of internet users from the invention of the first website in 1991 until 2023 [2].

Figure 1: Internet users worldwide from 1990 until 2023

By 2023, the number of internet users stands at 5.158 million worldwide. However, there is also a discrepancy to the average use worldwide compared to the usage in East Africa. In figure 2 you can see internet adoption in 2023 worldwide [2].
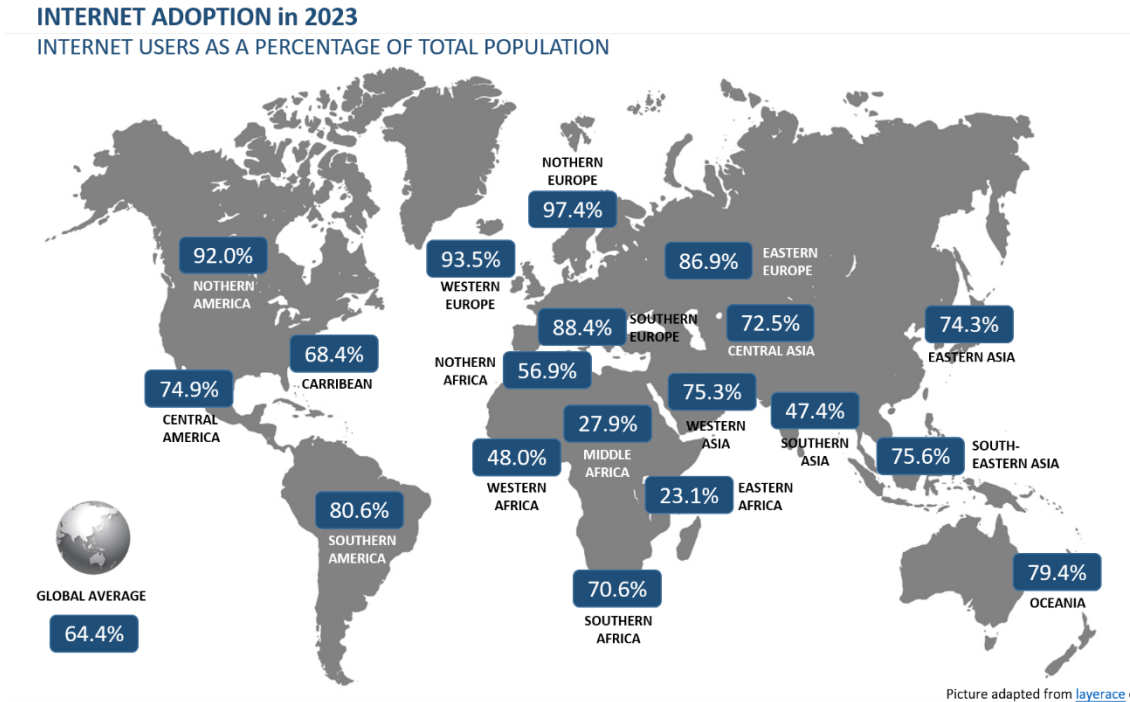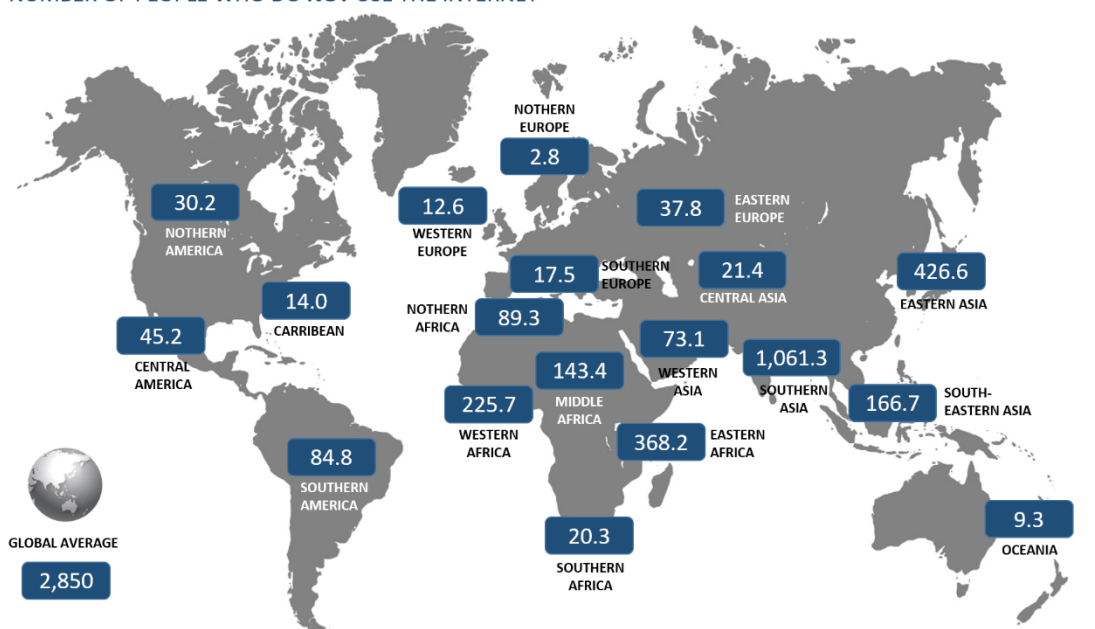

INTERNET ADOPTION in 2023
INTERNET USERS AS A PERCENTAGE OF TOTAL POPULATION

NOTHERN EUROPE 97.4%
NOTHERN AMERICA 92.0%
WESTERN EUROPE 93.5%
EASTERN EUROPE 86.9%
SOUTHERN EUROPE 88.4%
CENTRAL ASIA 72.5%
EASTERN ASIA 74.3%
CARRIBEAN 68.4%
NOTHERN AFRICA 56.9%
CENTRAL AMERICA 74.9%
MIDDLE AFRICA 27.9%
WESTERN ASIA 75.3%
SOUTHERN ASIA 47.4%
SOUTH-EASTERN ASIA 75.6%
WESTERN AFRICA 48.0%
EASTERN AFRICA 23.1%
SOUTHERN AMERICA 80.6%
OCEANIA 79.4%
GLOBAL AVERAGE 64.4%
SOUTHERN AFRICA 70.6%

Picture adapted from layerace on freepik

Figure 2: Internet adoption worldwide, picture adapted from layerace on freepik

The number of people who do not use the internet in East Africa is 328.9 million (figure 3) [2]. There are several reasons why many people in East Africa do not use the internet. On the one hand, many people do not have money to access the internet and on the other hand, the coverage of internet is not seamless in some regions in this area.

Figure 3: People who do not use the internet compared worldwide; picture adapted from *layerace* on *freepik*

As an internet connection and coverage is essential for synchronous access to Digital Rehabilitation services, this could limit usage. However, there are some ways to mitigate this challenge now and/or in the future:

Digital services without internet connection

Digital services that are possible without internet connection could be used to enable remote rehabilitation. For example, SMS could be used to provide information about a condition such as depression/diabetes and provide emotional support without the need for the affected person to visit an appropriate facility [3,4]. SMS could also be used to motivate clients to do their exercises at home and remind them of upcoming appointments [5]. Certainly, the functionality and customization potential of SMS services for rehabilitation are constrained. Therefore, an improved approach would involve expanding internet coverage.

Blended interventions

Another strategy could be to offer blended interventions, such as those suggested by Yusuhp et al. [6]. Blended interventions are interventions in which face-to-face sessions are offered in a rehabilitation center/hospital and these are mixed with digital sessions that can be conducted remotely [7]. This means that the client does not

have to rely exclusively on digital services if, for example, the client lives in a region where internet coverage is low.

Asynchronous interventions

If the client or rehabilitation professional does not have permanent access to the internet and therefore synchronous digital interventions such as video conferencing are not possible, another solution could be to offer asynchronous rehabilitation content digitally. This means that the rehabilitation provider does not have to be online at the same time as the client. In this way, content can be stored online and accessed by the client at another time remotely. In an example presented by Osborn et al. [8], high-school students with depressive symptoms living in Kenya were able to follow an intervention via a computer program that could be followed by the students in the school they attend. The intervention consisted of reading and writing activities about 3 concepts: growth mindset, gratitude, and value affirmation. The intervention produced a greater reduction in depression symptoms.

Investment in infrastructure

Governments, NGOs, and private sector entities can invest in improving internet connectivity and electricity access in underserved areas. This could involve expanding the reach of existing infrastructure or deploying alternative technologies such as solar power or satellite internet.

Supporting digitalization

Political initiatives that also promote digitalization in East African countries, such as the expansion of internet connectivity and/or the development of a digital infrastructure are essential to access digital services.

For example, Kenya's government has developed a digital masterplan [9] that intends to build a robust, secure, affordable, accessible, and reliable digital ecosystem, which benefits the public and private sector, and improve quality of life until 2032. This strategy outlines a comprehensive approach to enhance Kenya's digital ecosystem, including the expansion and improvement of digital infrastructure, services, products, and data management. It aims to bolster digital literacy across the population, offer support to enterprises and businesses, and develop legislation and regulations to facilitate digitalization throughout the country. The activities described are not only focused on the health care system but cover all sectors that are affected by digitalization. The plan has not yet been fully implemented and/or evaluated, but it shows that the government is supporting digitization and promoting projects that have the same goal.

Go to chapter 4, to learn more about the specific measures that Kenya, Tanzania and Rwanda take to improve the digital infrastrucutre in these countries.

5.1.2. Access to digital devices

Many Digital Rehabilitation services are offered as an app or as a web-based program. A suitable device is required to access these therapy and training programs. Smartphones are often used for this purpose, as they are portable and can therefore be used regardless of the location. This is a great advantage compared to a

computer or laptop. The number of smartphone users is increasing worldwide, as figure 4 shows [10]. According to forecasts, there will already be over 5 billion users by 2028.

SMARTPHONE USERS WORLDWIDE: TIMELINE
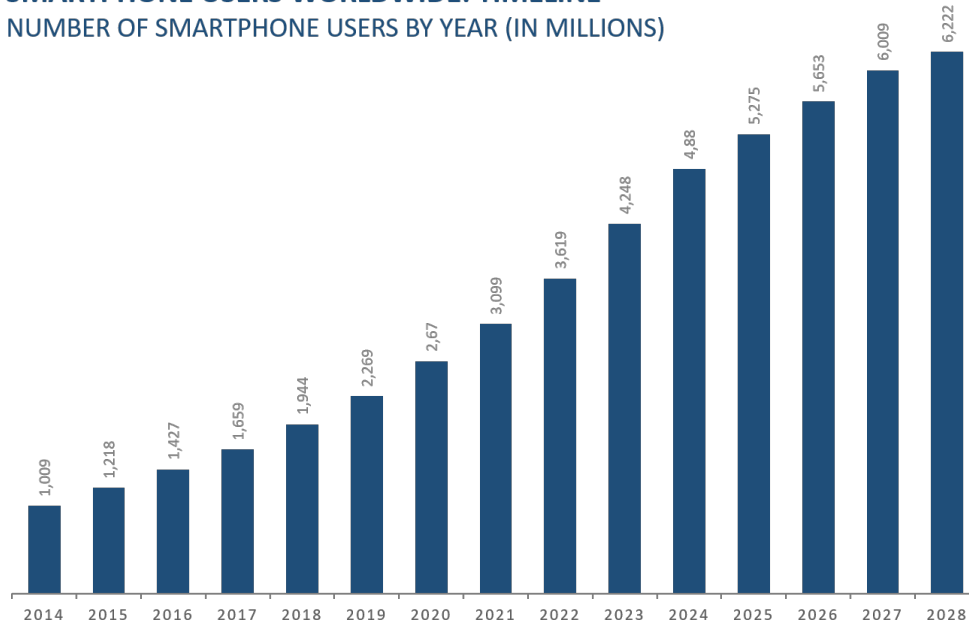NUMBER OF SMARTPHONE USERS BY YEAR (IN MILLIONS)

Year	Users
2014	1,009
2015	1,218
2016	1,427
2017	1,659
2018	1,944
2019	2,269
2020	2,67
2021	3,099
2022	3,619
2023	4,248
2024	4,88
2025	5,275
2026	5,653
2027	6,009
2028	6,222

Figure 4: Number of smartphone users worldwide from 2013 until 2028 (in millions)

There has also been an increase in smartphone users in the Sub-Saharan Africa region (figure 5), although the number is said to be only 688.89 million [11]. Even though the number of users has increased enormously in Sub-

SMARTPHONE USERS IN SUB-SAHARA AFRICA: TIMELINE
NUMBER OF SMARTPHONE USERS BY YEAR (IN MILLIONS)

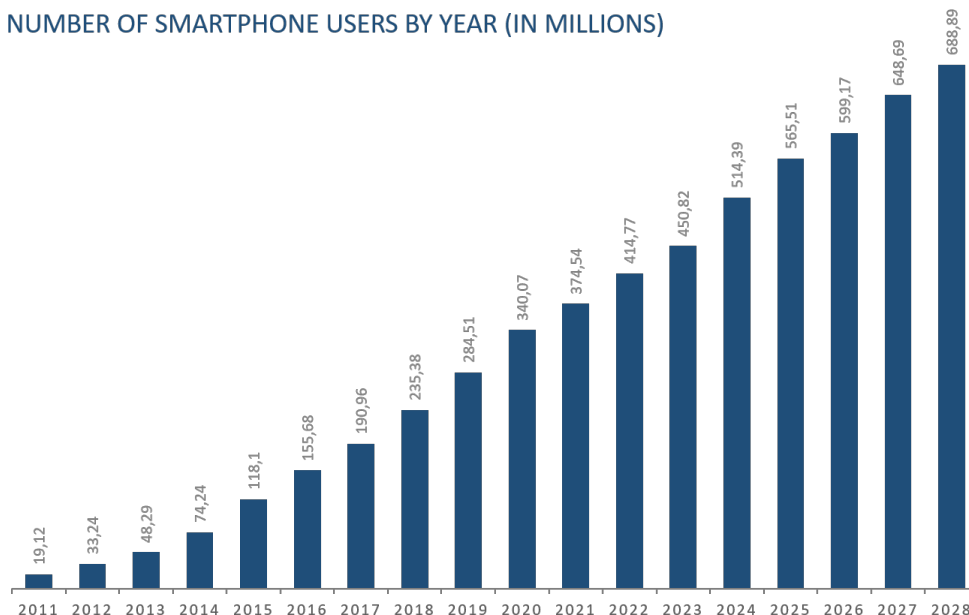| Year	Users
2011	19,12
2012	33,24
2013	48,29
2014	74,24
2015	118,1
2016	155,68
2017	190,96
2018	235,38
2019	284,51
2020	340,07
2021	374,54
2022	414,77
2023	450,82
2024	514,39
2025	565,51
2026	599,17
2027	648,69
2028	688,89

Figure 5:Number of smartphone users in Sub-Sahara Africa from 2011 until 2028 (in millions)

Saharan Africa, currently not everyone has a smartphone to access Digital Rehabilitation services and/or the money to buy bundles to access the internet.

Access via schools

For this potential hurdle, access to digital interventions could be created via laptops/computers that clients can access anyway. For example, it would be possible for students to carry out digital interventions on the computer of the school they attend, as described in the example by Osborn et al. [8]. This would allow clients to benefit from the advantages of digital interventions without owning a mobile device or having a laptop/computer at home.

Access via community

Another approach is to equip rehabilitation professionals with the necessary equipment (like a tablet) to bring digital interventions to the community. A social worker who is visiting the community on a regular basis could ask about the rehabilitation needs of the community beforehand. Even without permanent internet access, digital interventions could be stored on the social workers tablet and could be offered to the people living in this community. In this way, the interventions could not be individualized but could cover the greatest needs of the community.

5.1.3. Technical issues

Another barrier that can limit the use of Digital Rehabilitation services is technical problems with the internet or smartphones. For example, the smartphone could break down or repairs for the device could take longer, meaning that the client is no longer in possession of the smartphone. In addition, server breakdowns or electricity cut-offs are more common in sub-Saharan Africa, which can also affect usage negatively.

Low-tech options

In areas where server breakdowns and power cuts are more common, it would be beneficial to use low-tech options such as SMS-based platforms or interactive voice response systems that can be accessed with simple mobile phones. Look at the best practice example from Teriö et al. [12] in chapter 2, where the research group used SMS services as an intervention in Uganda to improve physical activity in people with stroke.

5.1.4. Digital (health) literacy

Among the 17 studies included in the scoping review conducted as part of the RADIC project, six assessed the barriers and facilitators for using Digital Rehabilitation services in Sub-Saharan Africa. All these studies identified low digital (health) literacy of clients and rehabilitation professionals as a significant barrier for using Digital Rehabilitation services.

Digital literacy is an individual's ability to find, evaluate, and communicate information using typing or digital media platforms. It is a combination of both technical and cognitive abilities in using information and communication technologies to create, evaluate, and share information. While digital literacy initially focused on digital skills and stand-alone computers, the advent of the internet and social media use has shifted some of

its focus on mobile devices. **Digital health literacy** refers to the ability to seek, find, understand, and appraise health information from electronic resources and apply such knowledge to addressing or solving a health problem [13].

With recent technologies and developments, e.g., in social media and mobile user devices, the requirements for digital skills are also constantly changing. This includes understanding how to use web browsers, features of mobile devices, search engines, email, word processing, wikis, blogs, graphics, videos, and presentation software. It also includes the ability to evaluate online resources for the trustworthiness of information. If digital (health) literacy in society is low, it is difficult to implement Digital Rehabilitation services, as the client and/or rehabilitation staff can only use the devices to a limited extent.

Technical support

Providing ongoing technical support to healthcare providers and users is essential for troubleshooting technical issues and ensuring smooth operation of Digital Rehabilitation platforms. This can be done through help desks, online forums, or dedicated support teams. However, this is only a short-term solution, and a more sustainable strategy would lead to better results.

Training

Providing training for healthcare workers and community members on how to use Digital Rehabilitation platforms can help overcome this barrier. This includes training on basic digital literacy as well as specific skills related to using the rehabilitation software such as receiving and sending text messages, searching for useful information on the internet and downloading updates to maintain the security of the device, etc. This would be valuable to the entire population, as digital devices can be used for many purposes. These programs can be delivered through community centers, schools, churches, and other local organizations.

Peer-support

Training community members could also serve as peer educators who can disseminate health information and provide support to their peers. Peer education programs can help foster trust and facilitate the sharing of information within communities.

5.1.6 Acceptance and awareness

There may be a lack of awareness among both healthcare providers and clients about the benefits of Digital Rehabilitation. Resistance to adopting new technologies or skepticism about their efficacy could impede their adoption and usage as described in the papers from Teriö et al. and Pandya et al. [12,14].

To overcome this potential barrier, a comprehensive strategy could include:

Training and Capacity Building

Offering training programs and capacity-building workshops for healthcare providers, community health workers, and rehabilitation professionals to enhance their understanding of Digital Rehabilitation technologies and their integration into practice. Providing hands-on experience and ongoing support to ensure confidence and competence.

Demonstration and Pilot Projects

Implementing pilot projects or demonstration programs in collaboration with local healthcare facilities to highlight the effectiveness and potential impact of Digital Rehabilitation. Collect data and testimonials from participants to demonstrate the benefits and build credibility within the community.

Partnerships with Key Stakeholder

Forge partnerships with government agencies, NGOs, academic institutions, and technology companies to leverage resources, expertise, and networks for promoting Digital Rehabilitation awareness and acceptance. Collaborate on advocacy campaigns and capacity-building initiatives to amplify efforts.

Tailored Messaging and Materials

Developing culturally appropriate educational materials, including brochures, posters, videos, and social media content, to communicate the importance of Digital Rehabilitation in local languages and formats accessible to diverse audiences. Highlight success stories and real-world examples to make the concept relatable and inspiring.

Policy Advocacy and Integration

Advocating for the integration of Digital Rehabilitation into national healthcare policies, strategies, and programs to institutionalize its importance and secure sustainable funding and support. Engaging policymakers and advocacy groups to prioritize digital healthcare initiatives and remove regulatory barriers.

5.1.6. Design of technology

Inadequate design of rehabilitation services, such as poorly designed apps, negatively affects the utilization of technology. This means, for example, if the handling is not intuitive, the user must spend some time familiarizing themselves with the content, and functions, which will have a negative impact on acceptance by both clients and rehabilitation professionals.

The design of e.g., an app should be tailored to people with physical disabilities. For example, many clients who need rehabilitation have visual impairments, which limits the handling of a smartphone/an app. This problem could be solved by using larger fonts and icons in the applications. There should also be a way for blind people to use an app by embedding an audio guide in the app. As an example: Since the tremor of people with Parkinson's disease are hindered to move their fingers purposefully to the buttons of a smartphone, voice control would help to use a smartphone even if they are limited in their function.

Collaboration

When companies, which are developing digital devices/rehabilitation services, would include clients and rehabilitation professionals in the development of these services they would get vital information about usability aspects. Based on the results, the device/program could then be further adapted, and our new functions could be integrated. Involving the target group is essential if we want people to benefit from Digital Rehabilitation.

Universal Design

Guidelines also exist to design digital solutions with respect to the physical conditions, such that as many people as possible, regardless of disability, can use the general functions of the intervention. Read chapter 4 to learn more about the "Universal Design" guiding principle, which aims to make digital content accessible to everyone despite physical challenges.

5.1.5. Policies and regulations

Furthermore, the absence of regulations pertaining to Digital Rehabilitation may create hurdles in its implementation. A case in point is the lack of clarity on billing procedures for such services—whether the client's insurance company is responsible for payment or if it falls to the clients themselves. This issue is further compounded in instances where clients lack insurance coverage, presenting an additional challenge.

The client may also injure themselves during exercises at home when he/she is not under supervision. There are also no regulations about who is responsible and bears the consequences.

New regulations

A policy is needed that precisely clarifies such issues and draws up regulations or passes laws accordingly so that there are realistically feasible approaches to implement Digital Rehabilitation nationwide.

Summary

- Some potential barriers exist to use or apply Digital Rehabilitation services.
- The main barriers are limited accessibility to the internet, a functioning digital device (smartphone or computer), limited digital literacy and/or lack of awareness and acceptability. A poor design and a lack of regulations and legislation are also challenges in the application of digital services.
- These barriers could have a negative effect on the accessibility of the service and/or on the motivation or adherence of the client/rehabilitation professional to use this service and thus on the effectiveness of the intervention.
- Strategies should be developed at a systemic level to break down these barriers, such as support for the expansion of nationwide internet coverage.

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6 Technologies

In today's rapidly evolving world, technology plays a crucial role in driving progress and change, particularly in East/Sub-Saharan Africa. Among the many technological advancements shaping the region, Digital Rehabilitation technology stands out as a cornerstone of innovation and disruption. Its influence extends across various sectors, reshaping healthcare delivery, redefining rehabilitation practices, and enhancing accessibility to rehabilitation services. In this chapter, we delve into the realm of Digital Rehabilitation technology, exploring its transformative power and ubiquitous presence and exploring its application in rehabilitation globally and in Sub-Saharan Africa.

The aim of this chapter is to explain the following topics:

- Definition of the term "technology"
- Technologies applied for rehabilitation in Sub-Saharan Africa
- (Technical) requirements to apply Digital Rehabilitaition

After you have gone through the content of chapter 6, you can carry out exercises to deepen the content:

- Exercises

To get an overview of chapter 6, look at the summary:

- Summary

6.1 What is technology?

For something name-checked so widely throughout our society, the precise meaning of the word "technology" is not that well-known. "Technology" is so frequently placed in conjunction with the word "science" that many think of the two as the same. Some equate technology purely with gadgetry while others think hazily of all the things that distinguish the present from the past.

In the current time the word "technology" means more the practical application of knowledge so that something entirely new can be done, or so that something can be done in a completely new way.

This may be a narrow scope though, as technology includes so many creative solutions to many everyday problems humans have faced all throughout history.

So what is technology?

The word technology is made up of two Greek words, which are translated as *techne* and *logos*. *Techne* means art, skill, craft or how something is achieved. *Logos* means word, the utterance with which the inner world is expressed. Thus, τεχνολογια (technologia) is the science and systematic treatment of (practical) arts [1].

Thus, technology can be also defined in five senses:

- Firstly, technology is the rational process of creating the means to transform matter, energy and information to achieve specific goals.

- Secondly, technology is the totality of means (tools, devices, systems, methods, procedures) created by the technological process.
- Thirdly, technology is the knowledge that makes the technological process possible. It consists of the facts and procedures necessary to organize matter, energy and information and the discovery of new means.
- Fourth, a technology is a subset of related technological objects and knowledge. Information and communication technologies and medical technologies are examples.
- Finally, technology is the system consisting of the technological process, the technological objects, the technological knowledge, the developers of technological objects, the users of technological objects, and the worldview (i.e., the beliefs about things and the value of things that shape one's view of the world) that has emerged from and drives the technological process.

There are many different types of technology, differing in historical invention and application, as well as by the type of problem they solve. Types of technology include mechanical technology, medical technology, communications technology, electronic technology, and industrial and manufacturing technologies. Though these different types of technology all serve different purposes, range in design, and are applied in different ways, they all have one thing in common: they all solve a problem.

In the sense of Digital Rehabilitation, we are using medical, information, and communication technology.

- Definition **medical technologies**: Medical technology is defined as the application of scientific principles to develop solutions to problems regarding health, prevent or delay the onset of disease, and promote the overall health of humans [2]. Medical technology is used to prevent, diagnose, treat, and monitor symptoms and diseases. This includes the use of X-rays, MRIs, and ultrasounds which are tools used to look in the body for ailments. Ventilators are another type of medical technology, and are used to assist people in breathing. Prostheses and orthoses are also medical technologies, such as advanced prostheses, orthopaedic implants and aids, as they help people with physical disabilities to regain their mobility and improve their quality of life.

- Definition **information and communications technologies**: Information and communication technology, abbreviated as ICT**,** covers all technical means used to handle information and aid communication. This includes both computer and network hardware, as well as their software. For example the internet is considered a communications technology, because it is a system that communicates information in infinite ways [3].

6.2 Technologies for Digital Rehabilitation

In the following, we explain the technologies that are used for Digital Rehabilitation in Sub-Saharan Africa. Furthermore, we show the fields of application and give examples of the application in Sub-Saharan Africa and globally.

During the RADIC project, we have conducted a scoping review to give an overview of already implemented Digital Rehabilitation practices in Sub-Saharan Africa. These results serve as a base for this section. As an additional methodological step, we included stakeholders to give more insights about the topic about the most relevant technologies for Digital Rehabilitation practices in Sub-Saharan Africa. The stakeholders were a Digital Rehabilitation specialist (n=1), an e-learning manager (n=1), educators for health sciences (n=2), rehabilitation professionals, a research assistant (n=1) and physiotherapists and occupational therapists as researchers (n=6). Seven stakeholders out of the eleven participants already had prior experience with Digital Rehabilitation. Thus, if we talk about stakeholders in this section, we are referring to the stakeholders we have interviewed in this context.

Note: All these listed technologies can be used alone but it is also common to use these in combination with each other. The decision depends on various aspects; see for more information chapter 1 "Prerequisities to apply Digital Reahbilitation" and section 6.3. "Technical requirements".

Technology	Definition	Application in rehabilitation	Application in Sub-Saharan Africa
Information and communication technology Mobile applications like apps, web-based programs, videoconferencing, and social media (Picture made by storyset on freepik.com)	Mobile applications (Apps) are software programs developed for and used via mobile operating systems or devices, such as smartphones, tablets, computers, or smartwatches. Mobile applications serve to provide users with similar services to those accessed on PCs or laptops (Adapted from [4]).	Mobile applications can be applied in various contexts for rehabilitation. Apps and web-based programs, for example, can be used to provide exercise and relevant information for the client. Furthermore, it can be applied to remind clients of their therapy appointment to improve therapy adherence. Videoconferencing is used to communicate with the rehabilitation professional and to get feedback on exercise performance. Users are overall satisfied with mobile phone delivered	Mobile applications are well known for rehabilitation by people living in Sub-Saharan Africa. Stakeholders from Rwanda have good experiences with apps in rehabilitation, especially for clients with low back pain. Stakeholders believe that apps are especially useful in increasing client engagement in rehabilitation. The stakeholders added also that videoconferencing is still in the piloting phase but has not been implemented in rehabilitation yet.

interventions and motivated to use it, the digital services seem to be effective to improve the quality of life [5], depression [6] and produces minimal costs [5,7–9]. Besides all these positive results, there are also barriers, such as clients' low Internet skills and lack of access to functional devices.

Apps, web-based programs, and videoconferencing are considered as the most important technologies for rehabilitation in Sub-Saharan Africa for the future.

Information and communication technology
Text messaging like SMS
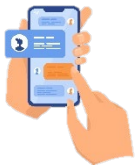
(Picture made by pch-vector on freepik.com)

Text messaging or texting, is the act of composing and sending electronic messages, typically consisting of alphabetic and numeric characters, between two or more users of mobile devices, laptops, or another type of compatible computer. Text messages may be sent over a cellular network or may also be sent via satellite or internet connection. The term originally referred to messages sent using the Short Message Service (SMS). It has grown beyond alphanumeric text to include multimedia messages using the Multimedia Messaging Service (MMS) and Rich Communication Services (RCS), which can contain digital images, videos, and sound content, as well as ideograms known as emoji (happy faces, sad faces, and other icons), and instant messenger applications (usually the

Text messaging can be used as a therapy reminder to improve therapy adherence, as a motivator to promote physical activity, as a digital supported intervention, and as client education on the knowledge of diseases.

While text messaging interventions were acceptable for the users and have proven to be successful and effective in improving health outcomes, some challenges were also identified. These challenges include technical issues, slow speed, lack of digital literacy of the clients, doubts about its effectiveness, and costs [10–12].

Text messaging rehabilitation interventions display the most digital applied rehabilitation intervention in Sub-Saharan Africa. Text messaging could be used via an app like WhatsApp or via a mobile phone.
Relevant stakeholders believe that SMS is a powerful tool, especially in rural areas, because it does not require an internet connection. In addition, participants emphasize that SMS is less dependent on literacy and therefore accessible and usable by more people. However, they also explained that the functions of SMS are limited and can therefore only be used to a limited extent.

term is used when on mobile devices).

TV & Radio

(Picture made by studiogstock on freepik.com)

Television is a method of recording moving images, transmitting them as a data stream and displaying or reproducing them simultaneously. Television (also abbreviated to TV, from the Greek Latin artificial word television) is conceived and produced as a mass medium and broadcasts live or after recording to a mass audience with a time delay.

Radio as an abbreviation for broadcast receiver refers to a device for receiving radio broadcasts. In conventional radios, these are transmitted from a broadcasting transmitter by terrestrial transmission (such as aerial television) via electromagnetic waves or high-frequency electrical signals via broadband cable (such as cable television).

TV and radio programs can be developed specifically to educate clients about their medical conditions, rehabilitation exercises, self-care techniques, and healthy lifestyle behaviors. These programs may feature expert interviews, testimonials from clients, instructional videos, and interactive content to enhance learning and comprehension. TV and radio programs can broadcast health-related content, including news segments, talk shows, and public service announcements, that address topics relevant to rehabilitation and chronic disease management. This information can raise awareness, promote preventive measures, and encourage clients to seek appropriate rehabilitation services. It can also incorporate motivational content, success stories, and encouragement to inspire clients to stay committed to their rehabilitation goals and overcome challenges. Hearing about the experiences of others who have successfully recovered or improved their health

Stakeholders from Sub-Saharan Africa consider TV & Radio as an important technology for rehabilitation in Sub-Saharan Africa. They explained that TV and radio are already used for public health campaigns and for prevention of specific health conditions. The coverage of TV and radio is good in Sub-Saharan Africa, and it has the possibility to reach many people without using another specific digital technology because most people own TV and/or radio.

can boost morale and motivation among patients.

Television and radio broadcasts ensure wide accessibility of rehabilitation content, reaching clients in remote or underserved areas where internet access or digital devices may be limited. This allows for equitable access to information and support for all clients, regardless of their technological capabilities.

Information and communication technology
Gamification like game consoles, video/computer games etc. examples are: "Nintendo Wii," "Xbox"

(Picture made by al17 on freepik.com)

Gamification is an umbrella term that refers to the application of game-typical elements to non-game contexts, such as rehabilitation or the work environment, to improve adherence, engagement, or productivity levels (Adapted from [13]).

Serious Games and Exergames are examples of Gamification. While Exergames are defined as any digital games that request physical movements and reactions (Adapted from [14], Serious Games are a goal-oriented application to adopt specific content or skills in an implicit way. The intention of a serious game is to combine serious aspects with the playful aspects of

Gamification elements are often applied for rehabilitation in the western world. The biggest advantage of that technology is that clients could be easily engaged and motivated in therapy. Serious games could also provide specific exercises based on clients' aims. The training process is monitored, and the training plan is adapted accordingly. On the downside are the excessive costs for the additional hard/software, that it requires certain skills for client and the rehabilitation professional to operate, that the healthcare professional should monitor the compliance with the prescribed tasks at a regular basis to make adaptions to the rehabilitation plan, and that the acceptance remains unclear.

Gamification is an emerging trend in some countries in Sub-Saharan Africa but is not yet used for rehabilitation in Rwanda and Ethiopia, reported relevant stakeholders. Due to the high costs of purchasing the needed technology (hardware and software) or because the application requires certain skills for the client and the therapist to operate.

digital games in a coherent and simultaneous way (..) (Adapted from [15,16]).

Medical technology
3D printing
An example is "3DPA device"
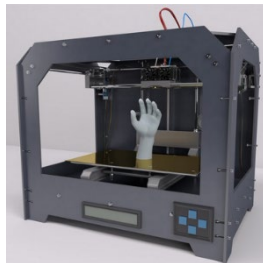
(Picture made by kfjpargeter on freepik.com)

3D printing is a process of making three-dimensional objects from a digital file. The creation of a 3D printed object is achieved using additive processes. In an additive process, an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced cross-section of the object.

3D printing can be used to manufacture individualized prostheses. Compared to conventionally manufactured prostheses, this innovative technology could shorten the manufacturing time and thus reduce costs. However, the cost of purchasing the 3D printer is extremely high.

This technology is not yet widespread in Sub-Saharan Africa.
However, there is one project carried out in Uganda, Tanzania, Cambodia [17] where 3-D printers moved to a rural area where prosthetics were directly printed for people with transtibial amputation without waiting time. Even though the effectiveness of 3D printed prostheses is comparable to conventionally manufactured prostheses and the usability of usual manufactured prostheses scores better, relevant interest groups, consider 3D printing as important for rehabilitation, as it can reduce the cost of producing prostheses.

Information and communication technology
Virtual reality/augmented reality examples are: "HTC Vive HMD," "Immersive Oculus Rift VR," "Immersive V8 VR HMD"

Virtual reality (VR) is an interface involving real-time stimulation and interactions of an embedded subject through multiple sensorial channels, based on a synthetic environment in which the subject feels their presence (e.g., a helmet with a screen inside, or gloves fitted with sensors) (Adapted from [18]).

VR and AR are used to improve physical functioning, fitness, balance, postural control, vestibular dysfunction, range of motion, gait, and anxiety. It is liked because it promotes engagement and motivation in rehabilitation. Nevertheless, it is in its infancy and requires further investigation with

Virtual reality/augmented reality is not well known for rehabilitation in Sub-Saharan countries and are not considered as important technologies for rehabilitation. In one project in Nigeria, people with chronic low back pain use a virtual reality headset to reduce costs. The

(Picture made by freepik on freepik.com)

Augmented Reality (AR) is a user interface that combines the real world with three-dimensional and interactive elements in real time. Suitable systems are designed to display AR as if it were part of the real world. An enhanced version of the physical world is achieved with digital visual elements, sounds, or other sensory stimuli delivered via technology (Adapted from [19]).

regard to its effectiveness. Dizziness and motion sickness may also occur during use and not all systems are commercially available and not at low costs.

findings suggest that the virtual reality intervention was cost saving for people with chronic low back pain [20].

Information and communication technology
Artificial Intelligence like chatbots, conversational agents, virtual humans, and machine learning algorithms

(Picture made by storyset on freepik.com)

Artificial Intelligence (AI) refers to systems that display intelligent behavior by analyzing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI is human-designed software that operates in digital and possible physical dimensions by collecting (e.g., via sensors) and evaluating data. Machine learning algorithms can be used in AI solutions, which focus on the use of data to imitate the way that humans learn, gradually improving its accuracy (Adapted from [21–23]).

AI and machine learning processes can be used as diagnostic and prognostic tools in rehabilitation. Abdohllai et al. [24] used for example a wearable system of sensors and machine learning processes to classify clients with nonspecific low back pain into subgroups according to quantitative kinematic data, for example, trunk motion– and balance-related measures. Based on this home assessment, a personalized rehabilitation plan can be created following practical guidelines.
Another example of the application of AI is a home-based monitoring system. For example, Chae et al. [25] developed a home-based rehabilitation system based on a smartwatch, as well as an app and AI processes that can recognize and record the type and frequency of

Ai is not well known in Sub-Saharan Africa, but important stakeholders think it is an emerging trend for rehabilitation. Currently it is more popular to use AI in education, however not implemented yet in rehabilitation in Rwanda and Ethiopia in this context.

rehabilitation exercises conducted by the client. This can facilitate participation in home training and improve the functional scores of patients with chronic stroke.

Chatbots and conversational agents are key technologies for AI and machine learning processes in rehabilitation. They could simulate and process human conversations. They enable communication via text or audio on websites, apps, or telephone and are used for psychoeducation and encouraging self-adherence by providing information and motivation.

AI can predict adherence and client conditions, but there are doubts that some decisions could be taken over from AI and machine learning algorithms or healthcare professionals could be replaced. In addition, more research is needed to prove its effectiveness.

Medical technology Sensors like smartwatches, inertial sensors, photosensors, GPS etc.	Sensors are devices capable of sensing and/or responding to a physical stimulus (e.g., heat, light, sound, pressure, magnetism, or a specific motion) and transmitting the resulting pulse (e.g., to measure or actuate a control). The sensor	Sensors are mostly used for diagnostic purposes to measure, assess, capture, or track movement and posture; some sensors can predict falls; and provide biofeedback. Sensors are highly represented for rehabilitation in the	Sensors are not commonly used technologies for rehabilitation in Sub-Saharan Africa.

(Picture by [marcovector](#) on [freepik.com](#))

usually consists of a transducer element, which responds directly to the measured parameter and produces a usable signal output, and its related electronics (Adapted from [26]).

western world. Kwon et al. [27] for example developed an app for clients with COPD (Chronic Obstructive Pulmonary Disease) and monitored their heart rates and blood oxygen saturation via sensors embedded in smartphones. An alarm function alerts the client regarding any critical health status during physical activity, such as when the values (SPO2 and heart rate) fall below certain thresholds. Thus, the client has the opportunity for self-monitoring, that is, to receive feedback on the correlation between physical activity and body reactions to adjust such behavior as needed. Healthcare professionals can also estimate these data using a dashboard where the data is collected. After 6 weeks, the application led to a significant reduction in symptoms associated with COPD (Chronic Obstructive Pulmonary Disease) compared with the control group. The intervention group's self-assessment of the impact of the disease also improved significantly.

6.3 Requirements to facilitate Digital Rehabilitation

In chapter 1, "Introduction to Digital Rehabilitation", we have already outlined the prerequisites you need to consider when using Digital Rehabilitation. Within these requirements, we have already mentioned aspects that belong to the technical requirements. In this section, we will now look closer at the prerequisites, particularly the technical requirements that must be observed when using Digital Rehabilitation.

Note: All requirements listed below may include, but are not limited to the requirements listed below. Also consider client needs in order to receive Digital Rehabilitation. You can find more information on this in chapter 1.

Technologies	(Technical) Requirements
Information and communication (ICT) technology Mobile applications like apps, web-based programs, and videoconferencing (Picture made by storyset on freepik.com)	- **Hardware**: Device like a smartphone, tablet, laptop, computer. - **Software**: Software like app to e.g., perform videoconferencing. - **Internet connectivity**: Internet connection to use the services/to get logged in to the app, web-based program, videoconference - **Training and support**: Training programs and technical support for rehabilitation professionals, clients, and caregivers to use ICT tools and platforms in rehabilitation settings effectively. - **User experience design**: User-friendly interfaces, intuitive navigation, and customizable settings to enhance the user experience and engagement with ICT platforms among clients and healthcare providers.
Information and communication technology Text messaging like SMS (Picture made by pch-vector on freepik.com)	- **Mobile phones**: Clients and healthcare providers need access to mobile phones capable of sending and receiving SMS messages. - **SMS gateway**: An SMS gateway is a telecommunications network that allows the exchange of SMS messages between mobile devices and computer systems. It acts as a bridge between the mobile network and the internet, enabling the transmission of SMS messages via software applications or platforms. - **Rehabilitation software or platform (optional)**: Integration of SMS functionality into rehabilitation software or platforms that enable healthcare providers to send automated SMS reminders, notifications, appointment confirmations, educational messages, and motivational content to clients. - **Client contacts**: The contact information (phone numbers) of clients participating in the rehabilitation program. The contact information should be securely managed and compliant with data protection regulations to ensure client privacy. - **Message templates (optional)**: Predefined message templates for common communication scenarios, such as appointment reminders, medication adherence reminders, exercise instructions,

and motivational messages. These templates can streamline communication and ensure consistency in messaging.

- **Scheduling and automation (optional)**: Scheduling tools and automation features to send SMS messages at predetermined times or in response to specific triggers, such as upcoming appointments, missed sessions, or progress milestones reached by clients.
- **Monitoring and reporting (optional)**: Monitoring tools to track the delivery and response rates of SMS messages, assess client engagement, and generate reports on communication effectiveness and outcomes in digital rehabilitation programs.

|	
TV & Radio (Picture made by studiogstock on freepik.com)	- **TV and radio equipment**: This includes televisions and radios capable of receiving and broadcasting content. - **Internet connectivity (optional)**: While traditional TV and radio broadcasts can be used, having access to internet connectivity can expand the range of content available. Streaming services, online radio stations, and on-demand programming can provide a wider variety of rehabilitation content.
Information and communication technology Gamification like game consoles, video/computer games etc. Examples are: "Nintendo Wii," "Xbox" (Picture made by al17 on freepik.com)	- **Gamified rehabilitation software or platforms**: Specialized software or platforms designed specifically for rehabilitation purposes, incorporating gamification elements such as game mechanics, rewards, challenges, and progress tracking features. - **User-friendly interface**: Intuitive and user-friendly interfaces that make it easy for clients to navigate and engage with gamified rehabilitation activities. Clear instructions, visual aids, and interactive elements can enhance usability and engagement. - **Rehabilitation content**: Gamified exercises, activities, and therapy programs tailored to the specific needs and goals of clients undergoing rehabilitation. These may include physical exercises, cognitive tasks, motor skill challenges, and activities targeting specific functional areas. - **Customization and personalization**: The ability to customize and personalize gamified rehabilitation programs according to individual client preferences, abilities, and rehabilitation objectives. This may involve adjusting difficulty levels, setting goals, and adapting gameplay based on client progress and feedback. - **Rehabilitation professional guidance**: Supervision and guidance from rehabilitation professionals to ensure that gamified rehabilitation programs are safe, effective, and aligned with client treatment plans.

Medical technology
3D Printing
An example is "3DPA device"
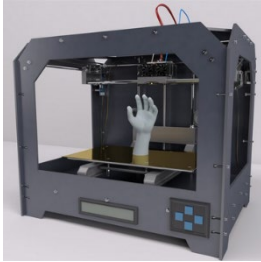
(Picture made by kfjpargeter on
freepik.com)

- **3D Printer**: A 3D printer capable of printing materials suitable for prosthetic devices. This includes printers with the ability to work with several types of filaments or resins, depending on the specific requirements of the prosthetic design.
- **Prosthetic design software**: Software that allows for the creation and customization of prosthetic designs. This may include computer-aided design software specifically tailored for prosthetics or other 3D modeling software capable of generating designs compatible with 3D printing.
- **Digital scanning equipment (optional)**: Digital scanning equipment such as 3D scanners or photogrammetry systems to capture precise measurements and anatomical data of the client's residual limb. This data can then be used to create custom-fit prosthetic designs.
- **Materials**: Suitable materials for 3D printing prosthetic devices. Depending on the specific requirements of the prosthetic, materials may include several types of plastics, metals, or flexible materials that provide durability, comfort, and functionality.
- **Knowledge and expertise**: Expertise in 3D printing technology, prosthetic design, and client-specific customization. This may involve training or experience in CAD software, familiarity with 3D printing processes and materials, and understanding of prosthetic anatomy and biomechanics.
- **Quality assurance**: Quality control measures to ensure that the printed prosthetic devices meet the necessary standards for safety, functionality, and comfort. This may involve post-printing processing, such as smoothing surfaces, assembly, and fitting adjustments to achieve the desired results

Information and communication technology
Virtual reality/augmented reality examples are: "HTC Vive HMD," "Immersive Oculus Rift VR," "Immersive V8 VR HMD"

(Picture made by freepik on
freepik.com)

- **VR/AR hardware**: This includes VR headsets, AR glasses, or other immersive devices capable of creating virtual environments or overlaying digital content onto the real world. These devices should be comfortable, easy to use, and provide high-quality visuals and tracking capabilities.
- **Rehabilitation software or applications**: Specialized software or applications designed for rehabilitation purposes, utilizing VR/AR technology to deliver immersive experiences, simulations, exercises, and therapies tailored to client needs. These applications may include VR environments for physical rehabilitation, AR overlays for cognitive training, or simulations for activities of daily living.
- **Motion tracking sensors (optional)**: Motion tracking sensors, cameras, or controllers to capture client movements and interactions within virtual or augmented environments. These sensors enable real-time tracking of client actions, feedback, and progress during rehabilitation activities.

- **Rehabilitation professional support:** Supervision and guidance from rehabilitation professionals to ensure the safe and effective use of VR/AR technology in rehabilitation settings. Rehabilitation professionals play a crucial role in prescribing appropriate VR/AR interventions, monitoring client progress, and adjusting treatment plans as needed.
- **Client training and support**: Training programs and support materials for clients to familiarize themselves with VR/AR technology and rehabilitation protocols. Clients should receive adequate instruction, guidance, and support to maximize engagement, adherence, and benefits from VR/AR-based rehabilitation programs.

Information and communication technology Artificial Intelligence like chatbots, conversational agents, virtual humans, and machine learning algorithms (Picture made by storyset on freepik.com)	- **AI Algorithms and models**: Development or utilization of AI algorithms and models tailored for specific rehabilitation tasks and objectives. These may include natural language processing (NLP) algorithms for chatbots and conversational agents, virtual human simulations for client interaction, and machine learning algorithms for predicting client outcomes or personalizing treatment plans. - **Data preprocessing and cleaning**: Preprocessing and cleaning of raw data to ensure its quality, consistency, and compatibility with AI algorithms. This may involve data normalization, feature engineering, outlier detection, and handling missing data. - **AI training infrastructure**: Access to computational resources, cloud computing platforms, and AI training infrastructure capable of handling large-scale datasets and training complex AI models efficiently. - **Model training and validation**: Training and validation of AI models using labeled datasets, cross-validation techniques, and performance metrics to assess model accuracy, reliability, and generalization capabilities. - **Interpretability and explainability**: Techniques and tools for interpreting and explaining AI-generated predictions, recommendations, and decisions to healthcare providers, clients, and caregivers. Explainable AI (XAI) methods help enhance trust, transparency, and understanding of AI-driven insights. - **Regulatory compliance and ethical considerations**: Compliance with regulatory requirements, ethical guidelines, and privacy regulations governing the use of AI in healthcare, such as HIPAA (in the United States) or GDPR (in the European Union). Client data privacy, confidentiality, and security must be safeguarded throughout the AI development and deployment process.
Medical technology	- **Sensor devices**: Access to sensor devices such as smartwatches, fitness trackers, inertial measurement units (IMUs), photosensors,

Sensors like smartwatches, inertial sensors, photosensors, GPS etc.

(Picture by marcovector on freepik.com)

GPS receivers, and other wearable or portable sensors capable of capturing relevant data related to client movements, activities, physiological parameters, and environmental conditions.

- **Sensor integration**: Integration of sensor devices with rehabilitation software, applications, or platforms to enable data collection, transmission, and analysis. This may involve establishing wireless connectivity (e.g., Bluetooth, Wi-Fi) between sensors and computing devices such as smartphones, tablets, or computers.
- **Data collection and processing**: Mechanisms for collecting, processing, and aggregating sensor data in real-time or asynchronously. This includes sensor data acquisition systems, data storage solutions, and data processing algorithms for cleaning, filtering, and analyzing sensor data to extract meaningful insights.
- **Placement and wearability**: Consideration of sensor placement and wearability factors to optimize data capture and minimize interference with client activities. Sensors should be positioned securely and comfortably on the body or within the environment to facilitate continuous monitoring and unobtrusive data collection.
- **Feedback and intervention (optional)**: Utilization of sensor data to provide real-time feedback, alerts, prompts, reminders, and interventions to clients and healthcare providers. This may involve adaptive algorithms, decision support systems, and automated responses based on sensor-derived insights and predefined rules.
- **Rehabilitation professional support**: Support by rehabilitation professionals, rehabilitation specialists, and interdisciplinary teams to interpret sensor data, integrate findings into clinical decision-making, and tailor rehabilitation plans based on client needs and goals.

6.4 Exercise

- Mention three technologies used in Digital Rehabilitation.
  - …………………
  - …………………
  - ………………….

- What technology involves video game interfaces for therapeutic purposes in Digital Rehabilitation?
  - Augmented Reality
  - Virtual reality
  - Artificial Intelligence
  - Internet of Things

- In Digital Rehabilitation, what is the purpose of using wearable sensors?
  - To monitor heart rate only

      ○   To track movement and progress
      ○   To measure blood pressure
      ○   To provide virtual coaching

- How does telemedicine contribute to Digital Rehabilitation?

- What is artificial intelligence and how will you distinguish it with machine learning systems?

You can find the answers after the literature.

Summary

- The word technology can be defined in five different senses. Overall, the word technology refers to methods, systems, and devices, which are the result of scientific knowledge being used for practical purposes.
- There are many types of technologies. In the context of rehabilitation we distinguish between two different categories: medical and information and communication technology (ICT).
- Medical technology is defined as the application of scientific principles to develop solutions to health problems, to prevent or delay the onset of disease and to promote general human health.
- Information and communication technology (ICT)**,** covers all technical means used to handle information and aid communication including computer and network hardware, as well as their software.
- Globally, mobile applications, text messaging, sensors, gamification, virtual reality, augmented reality, and technologies based on AI or machine learning principles are applied for various rehabilitation purposes.
- In Sub-Saharan Africa mobile applications and text messaging are already widely used for rehabilitation interventions. Relevant stakeholders consider apps, web-based programs, and videoconferencing systems as the most important technologies and virtual/augmented Reality as the least important technologies for rehabilitation in this region.

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Answers

- Virtual reality, robotics, wearable sensors
- Virtual reality
- to track movement and progress
- Enabling remote consultations and monitoring of the patients through telemedicine platforms. In these platforms healthcare practitioners can conduct virtual appointments with patients, treatment plans from a distance, real-time assessments and assess patient progress from distance. Telemedicine reduces the patient travels, making rehabilitation more convenient and cost-effective to the patient. (students can add more explanation about telemedicine to rehabilitation)
- Artificial Intelligence (AI) refers to the development of computer systems that can perform task a that typically require human-like intelligence. These tasks including learning, reasoning, problem-solving, perception, language understanding, and decision-making. On the other hand, Machine Learning (ML) is a subset of AI that focuses on the development of algorithms and statistical models that enable computers to learn from and make predictions or decisions based on data. This means that ML algorithms allow computers to learn patterns and insights from data without being explicitly programmed for each task.

7 Ethics, security, and the regulative framework in Digital Rehabilitation

This chapter describes the legislative framework relating to Digital Rehabilitation in East Africa. The relevant aspects covered include ethics, policies and regulations, and data security issues.

In brief, ethics is a branch of philosophy that describes moral principles and values. In the context of Digital Rehabilitation, ethical principles are applied in the design, development, evaluation, implementation, and provision of Digital Rehabilitation solutions. Regulations encompass the legal framework and guidelines set forth by governmental and regulatory bodies to safeguard the privacy, confidentiality, and integrity of data. Legislation forms the legal framework enacted by governing bodies to regulate the handling, processing, storage, and protection of data. Data security refers to the practice of protecting digital data from unauthorized access, disclosure, alteration, or destruction by implementing measures and safeguards to ensure the confidentiality, integrity, and availability of data throughout its life cycle.

Topics of this chapter include the following:

- Ethical considerations related to Digital Rehabilitation
- East African policies and regulations concerning the use of Digital Rehabilitation
- Cybersecurity and data protection aspects of Digital Rehabilitation

After you have gone through the chapter, you can do the following exercises:

- Exercises

To get an overview of chapter 7, look at the summary:

- Summary

7.1 Ethics in digital environments

Ethics is a branch of philosophy that describes moral principles and values, such as good and fair ways of living and acting in a world shared with others. Ethics guides people when making choices and helps evaluate actions and those of others. It also helps when examining the reasons behind those actions. Ethics does not provide ready-made solutions, but it does provide tools for reflection and consideration.

Ethics in Digital Rehabilitation involves the application of ethical principles to the design, development, evaluation, implementation and provision of Digital Rehabilitation technologies and services. Ignoring the ethical aspects can create unintended risk for clients and lead to reduced effectiveness, non-compliance, and harm, undermining the best intentions of service providers. Ethics is a complex construct that is applied when legislation and regulations allow freedom of decision.

When discussing ethics in Digital Rehabilitation, we may consider the topic in the context of health in general and view the common ethical practices for telemedicine [1]. In this chapter, we will discuss the five key principles of ethics originally presented in the context of telehealth, but carefully considered in the light of rehabilitation.

The key principles are autonomy, beneficence, non-maleficence, justice, and professional-patient relationships [2]. Note, that when discussing the last principle in this chapter, the term 'patient' is replaced by the term 'client'.'

7.1.1. Autonomy

The first principle, autonomy, is the predominant ethical principle which includes for example client's ability to make choices, have control, and exercise self-determination. When providing health-related services digitally, clients' autonomy can be improved by, for example, increasing their freedom to live an independent life in their own homes, promoting access to education and information, and receiving support at the level and time that are most suitable for the clients. However, the increased autonomy afforded by technology might potentially lead to heightened client isolation if they are left alone at home, relying solely on technological assistance, and lacking direct caregiver presence. Prioritizing the consideration of clients' individual needs and desires, including their preferred level of independence, is paramount whenever feasible. Thus, it is important to seek informed consent from clients when making decisions about the delivery of digital services, in other words, to ensure that clients grasp the nature of digitally provided services, including their limitations and potential risks. Where appropriate and possible, the client should have the option to choose between digital and traditional services. Questions about improving autonomy are not easy since they are often taken in complex and changing contexts.

7.1.2. Beneficence

The second principle, beneficence, refers to doing good or acting for the benefit of others. It means taking actions to promote clients' well-being, and it emphasises that professionals should act in the best interest of the clients and consider their welfare in service planning and delivery. Digital services have the potential to benefit people by providing assurance, increasing confidence in managing their health, reducing dependence on carers, improving access to quality healthcare, and allowing clients to be treated in familiar surroundings. The principle of beneficence can improve clients' opportunities to act in their own best interest and enable the provision of information that supports their well-being.

7.1.3. Nonmaleficence

The third ethical principle, nonmaleficence, stands for preventing harm. In the context of digital service delivery, there are possibilities such as using the video connection or other follow-up methods to check on the clients on a regular basis to ensure that no harm is occurring in the home environment. The possibility that professionals may choose to deliver remote services rather than services delivered in person in difficult or high needs cases may put clients at risk and impose them on the unwell. The use of digital services might also result in some clients being loaded with more responsibilities, which, on the other hand, might empower others.

7.1.4. Justice

Justice, the fourth ethical principle, stands for fairness concerning equal access to technology, taking into consideration the client's needs, and balancing those with the needs of the wider community. The key advantage of digital services, access to care for marginalised communities, can be unattainable for clients, communities, or localities with fewer financial resources or digital skills. For example, remote areas would need and benefit from digital services; however, those are likely to be least able to afford them, and in some cases, the clients might

not have the required skills to use the technology. It is crucial to consider equal access, fair distribution of technology, and the existence of a digital divide when implementing digital services to ensure justice in rehabilitation.

7.1.5. Professional–client relationship

The fifth ethical principle discusses the professional-client relationship. When designing and implementing digital services, it is important to consider the type and context of rehabilitation, as well as clients' preferences for the relationship with the professionals.

In the field of digital services, that relationship might be potentially disrupted. The lack of human touch is seen as a concern, although the importance of touch may vary between different disciplines, cultures, and individuals. Furthermore, the trust between the client and the professional might be undermined, particularly if the two have never met in person. There might also be scepticism generated by unfamiliar equipment, as well as reluctance to speak openly through the devices due to privacy or communication concerns.

On the other hand, some clients might find digital communication settings more secure and feel they are more likely to be listened to by professionals compared to face-to-face communication situations. Communicating through digital solutions may reduce loneliness in clients who otherwise would have only a few options for interaction.

7.1.6. Other ethical considerations

In addition to the five key principles of ethics in health care, protecting the privacy and confidentiality of client health information and ensuring the security of the technology used in service delivery are paramount aspects to take into consideration when discussing ethics. For example, an ethical issue related to data privacy might occur when clients are requested to fill out an online survey without being informed about the purpose of the survey and the usage of the collected data. Digital technology (for example, video conferencing solutions) also literally opens the door to private homes and personal spaces where family members might be present. In that case, the privacy issues and involvement in the rehabilitation process are stretched to encompass other individuals in addition to the clients.

Professionals involved in the delivery of Digital Rehabilitation services must be adequately trained to use the technology effectively and safely to provide high-quality care and ensure client safety. It is also recommended to ask the clients for feedback about, among others, the efficiency of the service, the relationship with the professional, the acceptability of the solutions and technology, and the methods used in rehabilitation to ensure the quality of the services. Furthermore, professionals must adhere to local, state, and federal laws, regulations, and policies governing digital services related to rehabilitation and/or health. Learn more about the Policies and Regulation in chapter 7.2. and about Cybersecurity and Data Protection in chapter 7.3.

7.2 Policies and Regulations

The implementation of Digital Rehabilitation in the East African region will be guided by the existing legal framework informed by country-specific policies and regulations governing the protection of data. Since there is lack of a harmonized sub-regional level legislation by the East African Community (EAC), each member state uses

the same data protection recommendations that are aligned to the global best practices and were adopted by the EAC [3]. Digital Rehabilitation interventions will therefore be guided by the national laws and policies of the respective member states that are participating in the project [4–6].

7.2.1. Policies

The existing country-level policies outline the minimum requirements principles and procedures governing the collection, collation, storage, processing, sharing and disposal of data by public and private organizations. The specific elements include:

a. **Data classification:** There should be a definite scheme in which data will be categorized based on its sensitivity level. The classification will help to determine the appropriate handling procedures and security controls for different types of data.
b. **Access controls:** Data should be accessible to authorized individuals only and hence user authentication measures should be put in place. Implementation of this will control and protect access to data for designated personnel. Some measures to be put in place include the use of strong passwords, multifactor authentication, and role/institution-based access control to limit data to a need-to-know basis.
c. **Data encryption:** It entails the use of encryption techniques to protect data stored or in transit.
d. **Data handling and disposal:** A guideline should be put in place to secure handling, storage, and disposal of data. This will include rules for data retention, secure deletion methods and proper disposal of physical media.
e. **Data backup and recovery:** Regular data backup procedures should be done to ensure data can be recovered in the event of data loss or system failures. Periodically the backup system should be checked and periodically the restoration process should also be tested to ensure data recoverability.

The existing policies are essential to ensure data is handled responsibly, ethically, and legally compliantly. They serve as a framework for promoting responsible data management, protecting individual privacy, and ensuring the integrity and security of organizational data.

7.2.2. Administrative Guidelines

Additionally, administrative guidelines are equally important and include a set of rules that provide a guidance on how best the responsible personnel can be equipped into becoming competent in data management, use and protection. These guidelines relate in particular to increasing knowledge and competencies by creating security awareness and providing training including regular trainings on data security among the authorized personnel on matters relating to network security, access by third party users, and compliance to laws and policies."

7.2.3. Regulations

The regulations of personal data protection in this project are aligned with article five of the General Data Protection Regulation (GDPR) [7], which sets out key principles that inform the general data protection regime universally. These principles include:

a. **Lawfulness, Fairness and Transparency**: Personal data must be processed lawfully, fairly and in a transparent manner.

b. **Purpose Limitation**: Personal data must be collected and processed for specified, explicit and legitimate purposes.

c. **Data Minimization**: Personal data should be limited to what is necessary for the specified, explicit, and legitimate purposes.

d. **Accuracy:** Personal data should be accurate and, where necessary, kept up to date.

e. **Storage Limitation**: Personal data should be stored for no longer than is necessary for the specified, explicit, and legitimate purposes.

f. **Accountability and Transparency**: The principle of accountability requires organizations to take responsibility for personal data and ensure individuals can exercise their rights, while transparency obligates organizations to provide clear information on data processing. Together, they ensure responsible data protection and understanding of data use.

g. **Integrity and Confidentiality**: Personal data should be secured and protected against unauthorized or unlawful processing and against accidental loss, destruction, or damage.

Within the East African sub-region, considering the lack of a harmonized legal framework, data protection regulations vary, however in all countries, the national Data Commission established by respective data protection act/law has the mandate and is responsible for ensuring compliance with data protection laws. As such, individuals have a right to secrecy and privacy of their personal data, and these data rights include the right to access, correct, and delete their personal information.

In all the three participating countries (Kenya, Tanzania and Rwanda), the laws provide for the following data subject rights: the right to access to personal data, the right to object to processing carried out for commercial advertising purposes, the right not to be subject to automatic decision making under some circumstances, the right to corrections, blocking and erasure of personal data.

In particular, the Rwanda's supervisory authority, the National Cybersecurity Authority (NCSA), provides several guidelines after the enactment of the Law No. 058/2021 of 13 October 2021 relating to the Protection of Personal Data and Privacy, 2021 [8]. The guidelines include registration of a data protection officer, privacy policies, right to object, right to portability, rectification and erasure, protection of children's data, key principles for processing personal data, and identifying the role as controller or processor.

7.3 Cybersecurity and Data Protection

In this part of the chapter, we will look closely at cybersecurity and data protection. Both are particularly important points to consider when planning the introduction and application of Digital Rehabilitation solutions in your work.

7.3.1 Cybersecurity

First, it is crucial to understand what *cyberspace* is. Cyberspace consists of three layers. The first layer is the national critical *infrastructure*, which contributes to the *cyber resilience* of the nation in question. The second layer consists of the *cybersecurity elements* of the people, processes, and technologies. The third layer consists of the cyberspace actors, which are citizens, business life and the public sector. Together these three layers ensure the existence of a secure cyber environment [9].

Another way of defining cyber environment is to divide it into five different layers. These are *physical layer, syntax layer, semantic layer, service layer and cognitive layer*. The physical layer includes all devices (e.g., computers, mobile phones) but also network connections (wired and wireless). Syntax layer is a bit more difficult to understand, but it contains all devices connected to the internet, system control programs and network protocols which ensure errorless functionality. Basic user is usually not able to interact with the syntax layer. Semantic layer is usually connected to "main users" of an institution. It includes information and data sets stored in servers and computers, and different user-administered functions, for instance, printer controls or program/system updates. Service layer is the area where a basic user usually acts. It consists of various kinds of digital services, web-based services that the public or private sector produces, and information and communication services. The last layer, cognitive layer entails the basic user's understanding of the digital information context, beliefs and assumptions and awareness of digital environment. So, it is the human factor affecting cyberspace [9].

For the user of Digital Rehabilitation services (e.g., rehabilitation professional, community health worker, client) the most important layer is the semantic layer. It consists of all the services and programs we use when applying Digital Rehabilitation solutions, but also it entails all the information we collect and store about our clients. Of course, all these layers are relevant when we want to provide safe and excellent quality Digital Rehabilitation services. If any of the layers are weak, the rehabilitation process is vulnerable to cyber threats. These vulnerabilities might be, for instance, inadequate protection of hardware, inadequate security software, weak backup systems, insufficient safety protocols and lack of competence and knowledge.

Cybersecurity is a broad term, an umbrella term. This means that it covers smaller entities, in this case: data security, network security, computer security and information technology security. It is also related to the reliability of various kinds of software and applications, robustness of global networks against maleficent attacks and safety of personal data in those networks. The main idea of cybersecurity is to protect the data, which is found in electronic form. Cybersecurity can be discussed in three different topics, and these are 1) threats, 2) protection and 3) privacy [10,11].

Information security means the protection of information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction. The aim of information security is to provide confidentiality, integrity, and availability [12]. Confidentiality means that the information in question is not accessible to outsiders, to people or processes who are not supposed to be using it. Integrity, however, means the information is trustworthy, which means it is not deliberately tampered with or accidentally modified. Term availability refers to the fact that the information is accessible and usable for the people or processes who are trusted with the right to handle it. Also, the term "quality" is good to be added to the list, when discussing information security in Digital Rehabilitation. Quality refers to the information being correct and not misleading.

When applying Digital Rehabilitation, the fact is that we are using different kinds of technologies, which often are connected to global networks. This means that from ethical and regulations perspective, cybersecurity and information security should be considered. In that case, how does Digital Rehabilitation fit in the big picture?

According to von Solms and van Niekerk [13] we can look at the entity through two-circle Venn-diagram (see figure 1 below). Cybersecurity and information security are partly overlapping concepts, and in this case Digital

Rehabilitation is situated in this overlapping area called "Information and communication technology security"." In practice this means that when a rehabilitation professional is working with a service-user using Digital Rehabilitation solutions (for instance with a client in Occupational Therapy), they are working together in both analog and digital world. The concept of Digital Rehabilitation also encompasses the use of phone calls or SMS-messages and if there is an electronic client record system in use, you are dealing with cybersecurity, even though the therapy itself would be in-person.
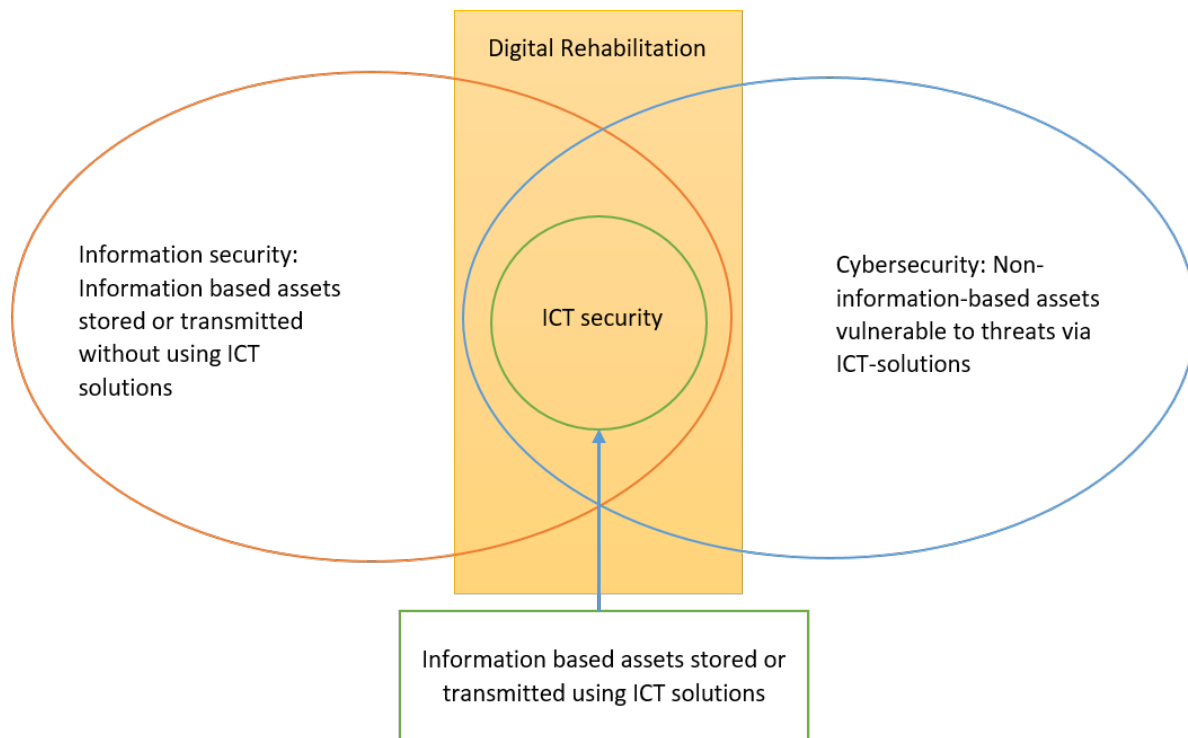

Figure 1: Digital Rehabilitation in the context of information- and cybersecurity (Adapted from von Solms and van Niekerk [13]).

In conclusion, cybersecurity is a crucial issue to consider in Digital Rehabilitation, because social and healthcare are very tempting targets for cyberattacks. Sensitive information and personal data are valuable, and for instance, malicious software, such as ransomware is often used to gain financial benefit by threatening to expose this information. Also, in hospital setting, people have even died due to cyberattacks directed to hospital infrastructure.

How can you, as basic user, prepare against cyberattacks when applying Digital Rehabilitation? [adapted from 10,11].

- Physical layer: Keep your gadgets safe, use strong passwords, do not use open Wi-Fi networks when handling client data or other sensitive information.
- Syntax level: Use only secure connections.
- Semantic layer: Keep your anti-virus software, computer security software and firewalls updated, use automatic backup. Discuss cybersecurity in your organization.
- Service level: Use only services which are reliable and secure, e.g., platforms designed for rehabilitation or health care needs.

- Cognitive level: Be vigilant, be sceptic. Keep your work files on your computer or on a secure cloud server. Do not share your username and password with anyone, not even with your colleague (user credentials are always personal). Learn more about cyberthreats and ask for proper training.

7.3.2 Data protection

Let us start by defining what data protection is. Data protection is the protection of any information related to identified or identifiable information of a living person. This includes names, birthdays, videos and photos, email addresses, and phone numbers. Also, IP addresses and communications content are also subject to data protection. This information is called *personal data* (see also figure 2). The purpose of data protection is to ensure that personal data is processed (that is collected, used, and stored) fairly by both the private and public sectors [16].

Personal Data	Special categories	Not personal data
- name - email address (name.surname@domain.com) - phone number - Internet Protocol (IP) address - home address - date of birth - social security number - occupation - appearance (photos, video) - voice - biometric identifiers	- criminal records - racial or ethnic origin - medical records - religious or philosophical beliefs - trade-union membership - blood type, genetic data - political views - sexual orientation	- a company registration number - a non-identifiable email address (e.g., info@company.com) - anonymized data - information about legal entities - data related to deceased person

Figure 2: Components of personal data

The need for data protection arises from people's right to privacy. Privacy is considered as a universal human right. The right to privacy and private life is embedded in the Universal Declaration of Human Rights (Article 12) [17]. Thus, data protection is instrumental in promoting and preserving fundamental rights and values, but also a way to support people in exercising other rights and freedoms, such as the right to assembly.

Data protection is usually ensured via national or international laws. For example, in Europe, the European Union (EU) has had high standards, of the data protection laws for decades and in April 2016 the EU adopted the General Data Protection Regulation (GDPR) which became fully applicable around the globe in May 2018. Even if the GDPR is a European law, it still may affect the people in East Africa. This is because it applies to companies and organizations who offer services or goods to individuals in the EU, or who monitor the behavior of the individuals in the EU area. Few examples from East African community: the Data Protection Act of Kenya came into force in November 2019 (please see https://www.odpc.go.ke/dpa-act/ for further information), The Personal Data Protection Act of Tanzania was commenced in June 2023 (please see https://oagmis.agctz.go.tz/portal/acts/237) and Data Protection Law of Rwanda came into effect in October 2021 (for more details, please visit https://www.risa.gov.rw/data-protection-and-privacy-law).

Data protection in social and health care is especially important because of the nature of personal data and is often sensitive due to the characteristics of the disciplines. If this data is accessed without consent it may cause distress, embarrassment, and suffering, but in addition, as discussed before, these kinds of security breaches may lead to financial losses or even decline in physical health and well-being [11,14]. Even though in the field of rehabilitation, the information we gather, and store of the client would not be that sensitive (for instance common knee rehabilitation), still we must remember that it is not only client records that are in threat but the personal identification data. If a maleficent attacker reaches the client database, the clients are exposed to identity thefts, financial loss and psychological suffering.

7.4 Exercise

- **Exercise 1:**
  Reflect on Digital Rehabilitation practices that you may have some experience with either as a professional and/or as a client. Based on your reflections, what ethical aspects must be taken into consideration when designing Digital Rehabilitation services? Write down for yourself at least three practical examples of problems that could arise if ethical principles are not considered when introducing and using Digital Rehabilitation services. After that, think how these problems could have been avoided or addressed.

- **Exercise 2:**
  Find out what are the national legislation and regulations related to data protection and privacy in the health or social sector in your own country. How do they influence the implementation and use of Digital Rehabilitation? In what way is the legislation and regulations related to ethical aspects?

- **Exercise 3:**
  Think of what kind of measures you as a rehabilitation professional and a civilian could do to ensure secure cyber environment and robust data protection?

Summary

- The application of ethical principles is crucial in the design, development, evaluation, implementation, and provision of Digital Rehabilitation technologies and services. Ignoring ethical aspects can lead to unintended risks for clients.
- The five key ethical principles that can be applied in Digital Rehabilitation are: autonomy, beneficence, non-maleficence, justice, and professional client relationships. These principles address concerns such as autonomy in decision-making, doing good for individuals, preventing harm, ensuring fairness in technology access, and maintaining the professional-client relationship in the digital context.
- The implementation of Digital Rehabilitation in the East African region is governed by country-specific legal frameworks, with each member state adhering to data protection recommendations aligned with global best practices. Key laws include Kenya's Data Protection Act 2019, Rwanda's NCSA law 2021, and Tanzania's Personal Data Protection Act 2022.

- The policies and regulations emphasize adherence to key principles of data protection, such as lawfulness, fairness, transparency, purpose limitation, data minimization, accuracy, storage limitation, integrity, and confidentiality, mirroring the core tenets of the General Data Protection Regulation (GDPR). These principles guide the collection, processing, and storage of personal data, ensuring the protection of individual privacy and the security of data against unauthorized access or loss.
- Understanding the layers of cyberspace is crucial when we want to provide safe and excellent quality Digital Rehabilitation services. Weak layers can be vulnerable to cyber threats.
- Data protection involves safeguarding personal information. Its importance in Digital Rehabilitation stems from the sensitivity of data and the potential consequences of breaches on individuals' privacy, highlighting the necessity for robust data protection measures in Digital rehabilitation practices.

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8 Frequently asked questions (FAQs) about Digital Rehabilitation in the context of East Africa

In this chapter we have compiled FAQs that clients, students and rehabilitation professionals might have on the subject of Digital Rehabilitation, especially in the context of East Africa. We have summarized the answers to some of the questions in a simplified form, but have added the respective chapter in the handbook where you can find more information about the specific topics.

1. **How does Digital Rehabilitation differ from traditional rehabilitation methods in East Africa?**

   - In East Africa, where access to healthcare facilities may be limited in remote areas, Digital Rehabilitation offers an alternative to traditional in-person therapy sessions. It allows clients to receive rehabilitation services without needing to travel long distances, thereby increasing accessibility to care. To learn more about the concept and potential of Digital Rehabilitation, go to chapter 1.

2. **What are the most important benefits of Digital Rehabilitation for clients in East Africa?**

   - **Accessibility**: Digital Rehabilitation increases access to rehabilitation services, particularly in remote or underserved areas where traditional healthcare infrastructure may be lacking. Clients in East Africa can access therapy sessions and support resources remotely, overcoming geographical barriers and reducing the need for travel to healthcare facilities.
   - **Lower stigmatization:** Digital Rehabilitation platforms offer clients in East Africa a level of privacy and confidentiality that may not be available in traditional in-person settings. Clients can access therapy sessions and support resources from the privacy of their own homes/communities, reducing the risk of being stigmatized or judged by others.
   - **Lower costs**: Digital Rehabilitation can be cost-effective for clients in East Africa, where traditional healthcare services may be limited or costly. Clients save time and money associated with travel to healthcare facilities, as well as expenses related to transportation, accommodation, and lost wages.
   - **Personalization**: Digital Rehabilitation platforms can be personalized to meet the unique needs, preferences, and cultural backgrounds of clients in East Africa. Therapy programs can be tailored to address specific conditions, language preferences, and socioeconomic factors, improving engagement and adherence to treatment.
   - **Engagement:** Digital Rehabilitation utilizes interactive technologies, gamification elements, and multimedia content to enhance client engagement and motivation. Clients are more likely to actively participate in therapy sessions, adhere to treatment plans, and achieve better outcomes as a result.
   - **Empowerment**: Digital Rehabilitation empowers clients in East Africa to take an active role in their own care and rehabilitation journey. Clients have access to educational resources, self-management tools, and peer support networks, empowering them to make informed decisions and manage their condition effectively.

- For more information about the benefits of Digital Rehabilitation for rehabilitation professionals, health care providers and the health care system, go to chapter 1.

3. **What technologies are commonly used in Digital Rehabilitation in East Africa?**

- In East Africa, Digital Rehabilitation may utilize text-messaging interventions, mobile applications, and web-based platforms. These technologies cater to the region's infrastructure and connectivity constraints. Switch to chapter 6 to learn more about other technologies used in Digital Rehabilitation.

4. **What role does Artificial Intelligence play in Digital Rehabilitation?**

- Artificial Intelligence can be utilized in Digital Rehabilitation to analyze client data, personalize treatment plans, and provide decision support to healthcare providers. AI-powered applications can help optimize resource allocation and improve the efficiency of rehabilitation programs in resource-constrained settings, see for more information in chapter 6.

5. **How effective is Digital Rehabilitation compared to traditional in-person rehabilitation?**

- While more research is needed, Digital Rehabilitation has the potential to be as effective as traditional in-person rehabilitation in East Africa. Its effectiveness may vary depending on factors such as the type of intervention, client engagement, and the availability of resources.

6. **What types of conditions are treated by using Digital Rehabilitation in East Africa?**

- **HIV**: Digital tools and platforms can be used to provide holistic support to individuals living with HIV in several ways: For example, digital applications can include medication reminder features to help individuals adhere to their antiretroviral therapy (ART) schedules. These reminders can be sent via SMS, mobile apps, or interactive voice response systems. Digital platforms can offer educational resources, counseling sessions, and peer support groups to empower individuals living with HIV to manage their condition effectively. This includes information on medication management, healthy living, stigma reduction, and coping strategies. Living with HIV can have significant psychological impacts. Digital Rehabilitation programs can provide mental health support through virtual counseling sessions, mindfulness exercises, and self-help tools to address depression, anxiety, and other mental health challenges.
- **Stroke**: Stroke survivors often require ongoing rehabilitation to regain mobility, strength, and function. Digital Rehabilitation tools can offer personalized exercise programs, virtual therapy sessions, and home-based support for stroke clients in East Africa.
- **Musculoskeletal Disorders**: Digital Rehabilitation platforms can provide exercises, instructional videos, and remote monitoring for individuals with musculoskeletal conditions such as low back pain.
- **Pediatric Disabilities**: Children with disabilities, such as cerebral palsy or developmental delays, can benefit from Digital Rehabilitation interventions tailored to their specific needs. These may include interactive games, assistive technologies, and teletherapy services.

- **Mental Health Disorders**: Digital Rehabilitation platforms may include mental health support services such as counseling, psychoeducation, and self-help tools for conditions like depression, anxiety, and post-traumatic stress disorder (PTSD).
- <u>Note:</u> The conditions mentioned above are examples of diseases that can be supported with Digital Rehabilitation in East Africa. The results are based on the experiences of relevant stakeholders from East Africa and published literature as part of a scoping review we conducted in this project; of course, other diseases could also be treated with the help of Digital Rehabilitation. Furthermore, the list above does not reflect the order of prevalence of the diseases in East Africa. In chapter 2, you will find best practice examples of how Digital Rehabilitation is used for clients with stroke, HIV, and tuberculosis.

7. What are the challenges to use Digital Rehabilitation in East Africa?

- **Limited Infrastructure:** Many regions in East Africa lack reliable internet connectivity and electricity, hindering access to Digital Rehabilitation services.
- **Low Digital Literacy:** A significant portion of the population may lack the necessary skills to navigate digital platforms effectively, limiting their ability to benefit from Digital Rehabilitation.
- **Financial Constraints:** High costs associated with internet access, smartphones, and digital devices can pose barriers to accessing Digital Rehabilitation services, particularly for low-income individuals.
- **Language and Cultural Barriers:** Digital Rehabilitation platforms may not be available in local languages or may not be culturally sensitive, making them less accessible to diverse populations in East Africa.
- **Healthcare Infrastructure:** Inadequate healthcare infrastructure and workforce shortages may limit the integration of Digital Rehabilitation into existing healthcare systems.
- For more information, look at chapter 4 and 5.

8. What might be strategies to overcome these challenges in East Africa?

- **Investment in Infrastructure:** Governments and private organizations can invest in improving internet connectivity and electricity access in underserved areas to ensure reliable access to Digital Rehabilitation services.
- **Digital Literacy Programs:** Implementing digital literacy training programs to empower individuals with the skills needed to navigate digital platforms effectively and participate in Digital Rehabilitation programs.
- **Subsidized Access:** Providing subsidized or low-cost internet access and digital devices to individuals with limited financial means to reduce barriers related to affordability.
- **Localization and Cultural Sensitivity:** Developing Digital Rehabilitation platforms in local languages and incorporating cultural considerations into design and content to ensure relevance and accessibility to diverse populations.
- **Capacity Building:** Investing in training healthcare professionals to effectively utilize Digital Rehabilitation tools and integrating Digital Rehabilitation into healthcare training curricula.

- **Partnerships and Collaboration:** Forming partnerships between governments, healthcare providers, technology companies, and non-profit organizations to leverage resources and expertise in expanding access to Digital Rehabilitation services.
- For more information, look at chapter 4 and 5.

9. What does digital accessibility mean?

- Digital accessibility refers to the practice of designing and developing digital content, websites, applications, and technologies in a way that ensures equal access and usability for people with disabilities. This includes individuals who may have visual, auditory, motor, cognitive, or other impairments that affect their ability to perceive, understand, navigate, and interact with digital content. Digital accessibility is important because it ensures that everyone, regardless of their abilities or disabilities, has equal access to information, services, and opportunities online. It promotes inclusivity, independence, and participation in the digital world, and it is supported by various laws, standards, and guidelines around the world. Digital accessibility is essential for ensuring that Digital Rehabilitation services are inclusive, effective, and equitable for all individuals, regardless of their abilities or disabilities. By prioritizing accessibility in the design and development of Digital Rehabilitation platforms, healthcare providers can maximize the potential benefits of technology-enabled rehabilitation for their clients.

10. What are key principles of digital accessibility?

- Key principles of digital accessibility include:

1. **Perceivable:** Digital content should be presented in ways that are perceivable to all users, regardless of their sensory abilities. This may involve providing alternatives for non-text content (such as images or videos), ensuring sufficient color contrast for readability, and offering text alternatives for audio content.
2. **Operable:** Users should be able to operate and interact with digital content using a variety of input methods, such as keyboards, mice, touchscreens, and assistive technologies like screen readers or voice recognition software. This requires ensuring that navigation is intuitive, controls are accessible, and functionality is operable through different input devices.
3. **Understandable:** Digital content should be presented in a clear and understandable manner to facilitate comprehension for all users. This may involve using plain language, organizing content logically, providing clear instructions and cues, and avoiding overly complex or confusing design elements.
4. **Robust:** Digital content should be developed using technologies that are robust and compatible with a wide range of user agents, assistive technologies, and platforms. This ensures that the content remains accessible as technology evolves and new devices and software are introduced.

11. Are there tools or software to help check for accessibility?

- Yes, there are various accessibility evaluation tools and software available. These tools can automatically test web pages, documents, and multimedia for accessibility issues and provide guidance on how to fix them.

  Automated Accessibility Testing Tools: These tools automatically scan web pages or digital documents to identify accessibility issues based on predefined criteria. Examples include:
    - **WAVE Web Accessibility Evaluation Tool:** A browser extension that provides visual feedback about the accessibility of web content.
    - **axe Browser Extensions:** Browser extensions that analyze web pages for accessibility issues and provide detailed reports.
    - **Accessibility Insights for Web:** A tool that helps developers identify and fix accessibility issues in web applications during development.

  Accessibility Checkers for Documents: These tools assess the accessibility of documents such as PDFs, Word documents, and PowerPoint presentations. Examples include:

    - **Adobe Acrobat Pro Accessibility Checker:** A feature of Adobe Acrobat Pro that checks PDF documents for accessibility issues and provides guidance on how to fix them.

    - **Microsoft Office Accessibility Checker:** Built-in accessibility checker in Microsoft Office applications (Word, PowerPoint, Excel) that identifies accessibility issues in documents and offers suggestions for improvement.

  Screen Reader Testing Tools: Screen readers simulate how individuals with visual impairments interact with digital content by converting text to speech or braille output. Examples include:

    - **NVDA (NonVisual Desktop Access):** A free, open-source screen reader for Windows that provides access to web content, documents, and applications.

    - **VoiceOver:** Built-in screen reader for macOS and iOS devices that provides spoken feedback and navigation assistance.

  Color Contrast Checkers: These tools assess the color contrast of text and background elements to ensure readability for users with low vision. Examples include:

    - **WebAIM Color Contrast Checker:** A tool that evaluates color combinations to determine if they meet WCAG color contrast requirements.

    - **Contrast Checker:** A feature available in some design tools and web development environments that allows users to check color contrast directly within their design or code.

12. **How do Digital Rehabilitation platforms ensure accessibility for clients with disabilities?**

- To ensure accessibility, Digital Rehabilitation platforms typically adhere to established web accessibility guidelines such as the Web Content Accessibility Guidelines (WCAG). They may offer features like screen reader support, alternative text for images, voice navigation, and adjustable font sizes. Developers also incorporate user feedback, especially from individuals with disabilities, to continuously improve accessibility.

13. **What are the primary ethical principles to consider in Digital Rehabilitation?**

- The primary ethical principles to consider in Digital Rehabilitation include autonomy, beneficence, non-maleficence, justice, and maintaining a professional-client relationship. Autonomy emphasizes the client's ability to make choices and exercise self-determination. Beneficence involves acting for the benefit of others to promote their well-being. Non-maleficence stands for preventing harm to the clients. Justice concerns ensuring fairness and equal access to technology. The professional-client relationship principal addresses maintaining trust and communication in digital settings.

14. **What are key aspects of data protection policies and regulations relevant to Digital Rehabilitation?**

- Key aspects include data classification, access controls, data encryption, handling and disposal of data, and data backup and recovery. These elements are critical for ensuring responsible, ethical, and legally compliant data management. Policies and regulations aim to protect individual privacy and ensure the integrity and security of organizational data, emphasizing lawfulness, fairness, transparency, purpose limitation, data minimization, accuracy, storage limitation, integrity, and confidentiality.