



**Mobility Assistive Technology Provision in Saudi Arabian
Healthcare: Identifying Barriers and Developing Implementation
Strategies**

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Abstract

Background: Mobility-related disabilities are the most prevalent in Saudi Arabia, significantly impacting quality of life. While mobility assistive technologies (MATs) help mitigate impairments, unmet needs persist in Saudi Arabia's healthcare system, with a critical knowledge gap regarding factors influencing their provision.

Aim: To investigate the factors influencing MAT provision in Saudi Arabia's healthcare system and recommend strategies to overcome the identified barriers to inform policy.

Methods: First, a scoping review was conducted to understand the barriers to MAT provision by summarising and synthesising theories, models and frameworks (TMF) and identifying key determinants and gaps (Chapter 2). Second, an online survey across three hospitals in two geographical regions assessed MAT availability in Saudi Arabia's healthcare system, with descriptive statistics used to summarise the findings (Chapter 3). Third, a qualitative embedded multiple-case study was conducted, involving 33 semi-structured interviews with healthcare professionals, managers and leaders, along with an analysis of six documents. The Consolidated Framework for Implementation Research (CFIR) guided data collection and analysis (Chapter 4). Finally, the findings from the previous chapters were triangulated, and the CFIR-Expert Recommendations for Implementing Change (ERIC) matching tool was used to develop strategies (Chapter 5).

Results: The scoping review synthesised 8 TMFs into nine propositions describing MAT provision barriers. The survey showed limited and inconsistent MAT provision across hospitals. The qualitative investigation identified barriers across the CFIR domains, with integration identifying six key barriers: healthcare system and policy, procurement and delivery, device-related, information and awareness, resource and infrastructure, and personal and environmental barriers. The CFIR-ERIC matching process identified priority strategies, including identifying and preparing champions, conducting educational meetings, assessing readiness, and conducting local consensus discussions.

Conclusion: This research provides the first comprehensive investigation of MAT provision barriers in Saudi Arabia and identifies strategies for improvement. Future research should evaluate these strategies within the Saudi context.

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List of abbreviations

MATs	Mobility assistive technologies
CFIR	Consolidated Framework for Implementation Research
ERIC	Expert Recommendations for Implementing Change
AT	Assistive technology
QoL	Quality of life
HCPs	Healthcare professionals
SCI	Spinal cord injury
PD	Parkinson's disease
MS	Multiple sclerosis
CP	Cerebral palsy
WHO	World Health Organization
CNS	Central nervous system
DALYs	Disability-adjusted life years
QALYs	Quality-adjusted life years
UNCRPD	United Nations Convention on the Rights of Persons with Disabilities
APD	Authority for the Care of People with Disabilities
UN	United Nations
APL	Priority Assistive Products List
ISO	International Organisation for Standardisation
AFOs	Ankle-foot orthoses
ICF	International Classification of Functioning, Disability and Health
MPT	Matching Person and Technology
SDM	Systemic Development Model
HAAT	Human Activity Assistive Technology
IMPACT2	The integrated multi-intervention paradigm for the assessment and application of concurrent treatments
TMFs	Theories, models and frameworks
BeHEMoTH	Behaviour of Interest, Health Context, Exclusion, Models, or Theories
GATE	Global Cooperation on Assistive Health Technology
MOH	Ministry of Health
MRC	Medical Research Council
TDF	Theoretical Domains Framework
PPI	Patient and Public Involvement
OTs	Occupational therapists
PTs	Physiotherapists

MHRSD	Ministry of Human Resources and Social Development
NUPCO	National Unified Procurement Company
NGOs	Non-governmental organisations
UNICEF	United Nations International Children's Emergency Fund
SCFHS	Saudi Commission for Health Specialties
PPPs	Public–private partnerships

Authorship statement

Chapter two of this thesis has been published in a peer-reviewed open access journal (BMJ Open) available under the CC BY-NC-ND 4.0 license (<https://creativecommons.org/licenses/by-nc/4.0/>). The reference for this paper and the authors' contributions can be found below.

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Student Contribution to the Paper

The PhD student conducted initial title and abstract screening, performed independent data extraction, conducted data synthesis and drafted the manuscript. These research activities were carried out in collaboration with the supervisory team – Professor Daniel Hind, Professor Simon Rushton and Dr Becky Field – who provided regular consultations. The supervisory team facilitated major manuscript revisions.

Chapter 1: Introduction

1.1 Introduction

Mobility-related disabilities are increasingly recognised as a global health challenge, significantly impacting people's quality of life (QoL) and imposing a burden on patients, caregivers, healthcare systems and society. Mobility assistive technologies (MATs) play a crucial role in addressing these challenges, yet their adoption faces numerous barriers. This introduction provides an overview of the subsequent chapters and describes the context of the thesis. This thesis pertains to a set of social science problems concerning the causes behind the failure to adopt MATs in practice. To achieve change, shifting from habit to inquiry and gaining knowledge about a specific element of reality are necessary (Morgan, 2014). Accordingly, this thesis investigates the barriers that hinder the adoption of clinically effective MATs within Saudi Arabia's healthcare system. Understanding these barriers is essential for designing interventions to facilitate their uptake (Cabana *et al.*, 1999).

This chapter starts by explaining how the burden of mobility disabilities caused by a range of conditions constitutes a significant societal problem (Section 1.2). A range of MATs have shown the potential to make an impact on that burden (Section 1.3). However, MATs are not routinely available and accessible in many countries, including Saudi Arabia (Section 1.4), with its unique healthcare system structure (Section 1.5). I argue that implementation science can provide a basis for determining how to adopt evidence-based practice (Section 1.6). Given the context-specific nature of this healthcare challenge, this research adopts pragmatism, which is oriented towards solving practical problems, as its philosophical foundation (Section 1.7). The chapter then addresses stakeholder selection (Section 1.8) and patient and public involvement (Section 1.9). I conclude that the main aim of this study should be an in-depth exploration of the factors influencing the provision of MATs for people with mobility-related disabilities, using a conceptual framework from implementation science, and to recommend to policymakers and clinicians strategies to overcome these barriers (Section 1.10).

Chapter 2 presents a scoping review that aims to identify publications that address the barriers to the provision of MATs using theories, models and frameworks. The findings of this scoping review assist in developing a qualitative study in Chapter 4. The survey in Chapter 3 is designed to provide an overview of the MATs available in Saudi Arabia's

healthcare system, as well as to assist in maximum variation sampling for the qualitative study in Chapter 4. Chapter 4 presents the qualitative study using semi-structured interviews and document analysis to investigate healthcare professionals' (HCPs), managers' and leaders' perceptions of the factors influencing the provision of MATs in Saudi Arabia. Chapter 5 presents strategies on how evidence can be adopted in practice to overcome the identified challenges for future research, policy and practice. This is based on the results from the scoping review (Chapter 2), survey (Chapter 3) and qualitative study (Chapter 4). Chapter 6 discusses the thesis's main findings and implications for Saudi Arabian healthcare and its relevance to the global context, as well as suggestions for further research and the strengths and limitations of the thesis. It also presents a plan for future research.

1.2 The health problem

1.2.1 Epidemiology

The mobility and functional capacity of individuals are affected by a wide range of conditions – in particular, neurological disorders, musculoskeletal disorders and ageing. Musculoskeletal disorders include many diseases that affect a person's musculoskeletal system, such as osteoarthritis, rheumatoid arthritis and osteoporosis. Cieza *et al.* (2020) report that 1.71 billion individuals worldwide are living with these conditions, which can lead to chronic pain and limited mobility. Amputation is another example of a musculoskeletal condition, which affected around 57.7 million people worldwide in 2017, and the lower extremities represent most amputations (McDonald *et al.*, 2020).

The impact of neurological disorders on global mortality and disability is increasingly acknowledged (Feigin *et al.*, 2020). Examples of neurological conditions that may affect mobility include but are not limited to spinal cord injury (SCI) (Wirz and van Hedel, 2018), Parkinson's disease (PD) (Bouça, Maetzler and Ferreira, 2018), multiple sclerosis (MS) (Motl 2013; Baird *et al.* 2018), cerebral palsy (CP) (Liang *et al.*, 2021), motor neurone disease (Dharmadasa *et al.*, 2018) and stroke (Mansfield, Inness and Mcilroy, 2018).

Millions of people experience a stroke annually, and the number of new cases reached over 13 million in 2016 (Johnson *et al.*, 2019; Virani *et al.*, 2020). In addition, approximately 27 million people worldwide are affected by SCI (James *et al.*, 2019); one of the highest SCI rates worldwide was reported in Saudi Arabia (Robert and Zamzami, 2013; Bakhsh, Aljuzair and Eldawood, 2020). Among the most common clinical problems associated with SCI is

the loss of motor function (James *et al.*, 2019). Furthermore, CP is the leading cause of physical disability among children worldwide (Korzeniewski *et al.*, 2018; Liang *et al.*, 2021), with an incidence of about two per 1,000 births (Oskoui *et al.*, 2013).

Both MS and PD are degenerative diseases that deteriorate with time. MS is the most common neuroinflammatory disease among young adults globally, accounting for more than two million cases worldwide in 2016 – an increase of over 10% since 1990 (Wallin *et al.*, 2019). This rise in MS prevalence was also recently reported in Saudi Arabia (Aljumah *et al.*, 2020). As Bishop *et al.* (2015) reported, 68.2% of MS participants in their cohort experienced mobility restrictions. While more than six million people worldwide are affected by PD (Dorsey *et al.*, 2018), more than 12 million cases are anticipated by 2050 (Rocca, 2018). PD is commonly characterised by gait and balance impairments (Nutt *et al.*, 2011), resulting in mobility impairment (Mancini *et al.*, 2018). Among the factors contributing to the rise in the prevalence of neurodegenerative diseases, such as PD, is ageing (Pang *et al.*, 2019). According to the World Health Organization (WHO) (2015), older adults will number two billion in 2050. Evidence shows that ageing is among the most significant contributors to physical disabilities that affect mobility (Grimmer *et al.*, 2019; Remillard, Fausset and Fain, 2019).

1.2.2 Aetiology and pathology

Musculoskeletal disorders, such as osteoarthritis, can be caused by a variety of factors, including genetics (Valdes and Spector, 2010), muscle weakness (Qiestad *et al.*, 2010) and joint trauma (O'Neill, McCabe and McBeth, 2018). Trauma is a leading cause of limb amputations (McDonald *et al.*, 2020). Additionally, diabetes is a risk factor for limb amputations; seven million people worldwide had limb amputations because of diabetes in 2015 (Vos *et al.*, 2016).

Neurological conditions, such as strokes, cause sudden declines in brain function due to blood flow disruptions (Grefkes and Fink, 2020). Hypertension has been thought to be a major risk factor for strokes (Virani *et al.*, 2020; Lavados *et al.*, 2021). The effects of a stroke are determined by the parts of the brain that have been damaged. For instance, if the middle cerebral artery is infarcted, the typical results include contralateral loss of sensory and motor function (Teasell and Hussein, 2013). In 80% of stroke patients, motor impairment is the most common complication (Grefkes and Fink, 2020). By contrast, CP is caused by abnormal

brain development or injury (Fleiss and Gressens, 2012). This results in motor impairments, including musculoskeletal, gait and balance issues that impair mobility and impact most CP patients (Fleiss and Gressens, 2012). Infection, preterm delivery and genetic factors can all impact the development of CP (Korzeniewski *et al.*, 2018).

Although the clinical symptoms of MS and PD differ, both are neurodegenerative diseases of the central nervous system (CNS). The CNS controls movement through complex interactions among different groups of neurons (Roeper, 2013). One such crucial group of neurons is found in the midbrain's substantia nigra (Roeper, 2013). In PD, dopamine neurons in the substantia nigra deteriorate; consequently, people with PD have poor balance and motor coordination, leading to mobility challenges (MacMahon *et al.*, 2021). The pathological basis for MS is the demyelination of nerve cells in the CNS (Baecher, Kaskow and Weiner, 2018). Subsequently, several regions of the CNS become dysfunctional, contributing to various deficits, including motor and sensory impairments (Baecher, Kaskow and Weiner, 2018). As a result of these impairments, along with vision and cognition impairments, as well as secondary factors, such as fatigue, MS patients' mobility is affected (Pearson *et al.*, 2004). The aetiology of the underlying cause of MS and PD remains unclear. However, genetic and environmental factors are thought to be influential and have been addressed in several studies (Ascherio and Schwarzschild, 2016; Baranzini and Oksenberg, 2017; Kouli, Torsney and Kuan, 2018; Pang *et al.*, 2019; Belbasis *et al.*, 2020).

SCI can be classified as either traumatic or non-traumatic. Traumatic SCI is generally caused by external physical trauma (Ahuja *et al.*, 2017). For example, falls and road accidents account for the most traumatic SCIs worldwide (James *et al.*, 2019), while tumours, infections and degenerative disc disease are among the causes of non-traumatic SCI (Ahuja *et al.*, 2017). Notably, the clinical symptoms of SCI are determined by the lesion's intensity and location (Ahuja *et al.*, 2017). The most affected spinal cord levels are thoracic and cervical, resulting in mobility limitations (Hachem, Ahuja and Fehlings, 2017).

1.2.3 Prognosis

People with musculoskeletal disorders experience marked declines in health (Minetto *et al.*, 2020). As an example, osteoarthritis of the knee can result in pain that can limit mobility (Cowan *et al.*, 2012), thereby causing difficulties with everyday activities and poor QoL (O'Neill, McCabe and McBeth, 2018; Minetto *et al.*, 2020). Majer *et al.* (2011) found that the

life expectancy of older people with mobility limitations is 10 years shorter than those without disabilities.

As mentioned, MS and PD are degenerative diseases and deteriorate with time. The disease trajectories have considerable variability, and effective treatments are few (Poewe *et al.*, 2017; Baecher, Kaskow and Weiner, 2018). The future disability milestones of an individual with MS and PD are difficult to predict (Galea *et al.*, 2013; Kouli, Torsney and Kuan, 2018), and both conditions lead to long-term disability (Jagadeesan *et al.*, 2017; Poewe *et al.*, 2017; Rotstein and Montalban, 2019; Van Schependom *et al.*, 2019).

Individuals living with Stroke, CP, or SCI often face long-term challenges with uncertain prognoses (Rodrigues, Moura and e Spohr, 2018; Blair *et al.*, 2019; Grefkes and Fink, 2020). A lack of evidence concerning stroke recovery persists (Grefkes and Fink, 2020). To date, the majority of stroke patients have disabilities with severe effects on functional mobility and long-term impairment (Bindawas and Vennu, 2018; Johnson *et al.*, 2019; Grefkes and Fink, 2020). As a result of impaired mobility, patients with disabilities resulting from SCI and strokes are at an increased risk for diabetes mellitus and cardiovascular disease (Cragg *et al.*, 2013; Wilby, 2019; Virani *et al.*, 2020).

1.2.4 The burden of disease

Many studies have been conducted to measure the QoL of individuals with MS (Wynia *et al.*, 2008; Alhazzani *et al.*, 2018), stroke (Ramos *et al.*, 2018; Alshahrani, 2020), SCI (Moshi *et al.*, 2021) and musculoskeletal disorders (Kim *et al.*, 2018; Cuervo *et al.*, 2020) and the elderly (Davis *et al.*, 2015; Shafrin *et al.*, 2017) for whom QoL is documented to be poor. Among the factors contributing to decreased QoL is limited mobility (An *et al.*, 2011; Riggins *et al.*, 2011; Davis *et al.*, 2015; Shafrin *et al.*, 2017; Bechtold, Stauder and Fieder, 2021). Likewise, in Saudi Arabia, CP patients' QoL is significantly impacted by their restricted motor ability (Chandra *et al.*, 2020). Mobility impairment leads to less social participation (WHO, 2011; Ahuja *et al.*, 2017; Alhazzani *et al.*, 2018; van Hees *et al.*, 2020), fewer employment opportunities (WHO, 2011; Ahuja *et al.*, 2017) and increased caregiver burden (Achilike *et al.*, 2020; Sit *et al.*, 2020). Individuals with physical disabilities, such as MS and SCI, have a higher rate of depression (Rosenberg *et al.*, 2013; Lewis *et al.*, 2017), and a greater suicide rate has been recorded among this population (Tulsky *et al.*, 2015; Lewis *et al.*, 2017; Milner *et al.*, 2019). Depression and anxiety also affect caregivers of

individuals with disabilities. In Saudi Arabia, for example, mothers of children with CP have a high prevalence of depression and anxiety (Soliman *et al.*, 2019).

As a result of neurological and musculoskeletal disorders, the rates of mortality and disability are greater, as well as economic burdens. These disorders are increasingly recognised as global health issues. In 2016, neurological disorders, such as stroke, MS, SCI and PD, were among the primary causes of disability-adjusted life years (DALYs) and deaths worldwide, with about 276 million DALYs lost due to neurological disorders (Feigin *et al.*, 2019).

Approximately 139 million DALYs were attributed to musculoskeletal disorders in 2017 (Kyu *et al.*, 2018).

These conditions have serious economic consequences for both governments and people. For example, \$380 billion was spent on musculoskeletal disorders in the United States (US) in 2016 (Dieleman *et al.*, 2020), and DeVivo *et al.* (2011) found that SCI significantly impacts healthcare costs in the US, with direct expenses reaching \$523,000 in the first year and \$80,000 in the years following SCI. Meanwhile, the average cost of post-stroke care in the US is \$4,850 per patient per month (Rajsic *et al.*, 2019). Nonetheless, when mobility is improved, as in the case of osteoarthritis patients, healthcare expenditures and nursing home utilisation are reduced (Kabiri *et al.*, 2018).

Neurological conditions, such as SCI and stroke, also significantly impact healthcare costs in Saudi Arabia (Robert and Zamzami, 2013; Basri *et al.*, 2021). The incidence of stroke is increasing rapidly, with projections indicating a growing challenge for the healthcare system (Basri *et al.*, 2021). Immobility is believed to be the direct cause of most secondary complications in SCI patients, such as pressure ulcers, which result in increased healthcare expenses (Miller and Herbert, 2016). Miller and Herbert (2016) claim that functional mobility and physical activity for SCI patients have the potential to considerably minimise the risk of medical consequences while also lowering annual direct expenses by around \$25,000 in the first year and \$4,000 per year after that.

In the United Kingdom (UK), MS has a substantial economic impact; it is estimated to cost £1.4 billion annually (Kobelt *et al.*, 2017). In Saudi Arabia, although precise cost data for MS is lacking, studies indicate a rising prevalence rate, with the majority of patients under the age of 40 (Aljumah *et al.*, 2020). This demographic trend suggests a significant economic burden on the Saudi healthcare system. A young patient population implies long-term costs and

productivity impacts, adding substantial strain on healthcare resources (Aljumah *et al.*, 2020). Several impairments, such as loss of mobility, may also contribute to the economic burden of MS (Pike *et al.*, 2012). Loss of mobility is a common problem in Germany's long-term care facilities and a key indicator for many other health conditions related to caring dependency (Lahmann *et al.*, 2015). By contrast, CP incurs most of its costs for home healthcare (Hoving, 2007). For instance, the average annual cost of CP in the Netherlands is \$46,677, with home care accounting for most of the spending at \$26,145 (Hoving, 2007).

1.2.5 Summary

In summary, long-term mobility limitations are increasingly recognised as a global health challenge. They are prevalent, arise for various reasons, negatively impact people's QoL and impose burdens on patients, caregivers, health systems and society. For this reason, research into support for mobility remains a priority.

1.3 Management of disabilities

1.3.1 Disability guidelines

Recent worldwide attention has been focused on disability as a global development and human rights issue. In 2006, the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) was adopted as an international human rights treaty. The UNCRPD aims to ensure that all people with disabilities can fully and equally enjoy all human rights (UN, 2006). To facilitate the implementation of the UNCRPD, the WHO has issued several recommendations aimed at enhancing the QoL of people with disabilities, including improving access to education and employment, as well as providing high-quality rehabilitation services that are timely, affordable and easily accessible (WHO, 2011). In accordance with the UNCRPD, nations have a legal responsibility to promote and protect the rights of people with disabilities. In the UK, for instance, the government has designated the UK Independent Mechanism as the body responsible for promoting, protecting and overseeing compliance with the UNCRPD across the country (UKIM, 2017).

Saudi Arabia ratified the UNCRPD in 2008. Although little research has been conducted on disabilities in Saudi Arabia (Al-Jadid, 2013), it is committed to protecting the rights of people with disabilities. Saudi Arabia has demonstrated commitment to disability support through various initiatives, notably establishing the Authority for the Care of People with Disabilities (APD) in 2018 and developing specialised rehabilitation centres. It is committed to ensuring

that people with disabilities can live fulfilling lives by improving healthcare facilities and rehabilitation centres and promoting equality in education and employment (United National Platform, 2022). This is also in line with WHO guidelines (WHO, 2011). People with disabilities' rights are also addressed in Saudi Vision 2030, which was launched in 2016. Saudi Vision 2030 intends to provide work and education opportunities for people with disabilities to improve their independence and integration into society (Saudi Vision 2030, 2016).

1.3.2 Mobility assistive technologies

Article 20 of the UNCRPD obliges nations to take appropriate actions to promote personal mobility with the most independence possible, including enabling access to MATs (UN, 2006). MATs refer to a range of assistive products and services designed to support mobility (WHO, 2022). According to the International Organisation for Standardisation (ISO) 9999 (2022), these assistive products include various devices, software and instruments that are either specially designed or commonly available to improve individual functioning. Their primary purpose is to support or replace mobility functions, enabling individuals to move between different locations. The range of MATs includes various devices, such as wheelchairs, walking frames, rollators and prosthetic and orthotic devices (ISO, 2022). The provision of MATs is essential, and the United Nations (UN) and WHO both endorse MATs as key to creating equitable opportunities for people with disabilities (UN, 2007; WHO, 2022). Indeed, states should also promote MAT availability, conduct research in this area and provide accessible information about it, as stated in Article 4 of the UNCRPD (UN, 2006). Furthermore, MATs should be available with comprehensive services, including assessment, fitting, training and maintenance (WHO, 2022). Thus, trained individuals must provide these services (WHO, 2022).

MAT devices are available in various types and are recommended based on an individual's specific needs and level of impairment. The WHO Priority Assistive Products List (APL) identifies 50 essential assistive products that are considered highly needed and an absolute necessity to maintain or improve an individual's functioning (WHO, 2016). Among these products, several are specifically designed for mobility: canes/sticks, crutches (axillary/elbow), orthoses, prostheses, rollators, tricycles, walking frames/walkers and wheelchairs (manual for active use, manual assistant-controlled and electrically powered) (WHO, 2016). Power wheelchairs, in particular, come in several varieties designed

to meet the needs of different kinds of disabilities. They can be classified based on such features as the control interface and seating system. In the basic power wheelchair, joysticks are most commonly used for controlling the wheelchair and require arm movement (Megalingam *et al.*, 2021). These can be used by individuals with stroke or SCI at the thoracic or lumbar level who have some hand function (Megalingam *et al.*, 2021). However, people with such disabilities as cervical SCI still face difficulties, resulting in reduced functional abilities in all extremities (Saboo, 2013; Patek and Stewart, 2020; Megalingam *et al.*, 2021). Thus, various power wheelchair control interfaces have been developed to enable wheelchair users to interact with the device using their remaining abilities, such as head movement (Pajkanović and Dokić, 2013; Winkler *et al.*, 2016). Seating systems also have different types depending on the user's requirements. Tilt-in-space and reclining powerchairs can address issues related to postural alignment in individuals with CP (Dicianno *et al.*, 2009; Rice *et al.*, 2021) or reduce seating pressure in individuals with SCI (Dicianno *et al.*, 2009; Jan *et al.*, 2013). In addition to power wheelchairs, mobility scooters with three or four wheels are recommended for older adults who have difficulty walking (Thoreau, 2015; Gitelman *et al.*, 2016).

Orthotic and prosthetic devices are also recommended interventions for enhancing mobility. The use of prostheses is particularly recommended for individuals with lower limb amputations (Pereira *et al.*, 2019; Vanicek *et al.*, 2021). As defined by the ISO (2022), a prosthesis is an externally positioned device that replaces an absent or deficient limb segment. Several types of prostheses have been developed to help with different needs and levels of amputations, such as bone-anchored prostheses (Leijendekkers *et al.*, 2019; Reetz *et al.*, 2020; Frossard *et al.*, 2021) and microprocessor-controlled prosthetics (Chen *et al.*, 2018). Meanwhile, orthotic devices are externally applied to alter the structure or function of the neuromuscular or skeletal system (ISO, 2022). In particular, ankle-foot orthoses (AFOs) are effective for the treatment of CP (Aboutorabi *et al.*, 2017), muscular dysfunction (Patzkowski *et al.*, 2012), stroke survivors (Tyson, Sadeghi-Demneh and Nester, 2013), and MS (Renfrew *et al.*, 2019). In recent years, orthotic devices have advanced, given 3D printing technology. The advantages of 3D-printed AFOs include rapid production, as they can be reproduced with the same quality at any time (Cha *et al.*, 2017; Xu *et al.*, 2019).

While wheelchairs remain a mobility option for individuals with severe disabilities, they lack the ability to provide upright walking (Esquenazi, Talaty and Jayaraman, 2017). Recently,

mobility technologies have developed considerably, including robotics and powered exoskeletons. Exoskeletons are motorised orthoses that attach to the limb and contain the same joint structure as a human to aid standing and walking (Miller, Zimmermann and Herbert, 2016; Xue *et al.*, 2022). Two types of exoskeletons, ReWalk and Indego, have been approved by the US Food and Drug Administration for personal use (Kandilakis and Sasso-Lance, 2021). Researchers have shown that these devices can improve the mobility of patients with SCI and MS at home and in the community (Miller, Zimmermann and Herbert, 2016; Kandilakis and Sasso-Lance, 2021; McGibbon *et al.*, 2021).

1.3.3 Mobility assistive technologies benefits

Several studies have documented the benefits of MATs in facilitating occupational performance (May and Rugg, 2010; Tefft, Guerette and Furumasu, 2011; Samuelsson and Wressle, 2014; Pettersson *et al.*, 2016), enhancing social participation (Rushton *et al.*, 2015; Carver *et al.*, 2016; Kemmis, Ashby and MacDonald, 2021; Laparidou *et al.*, 2021), reducing caregiver burden (Frank *et al.*, 2010; Rushton *et al.*, 2015), promoting access to education and employment (WHO, 2022) and consequently enhancing QoL (May and Rugg, 2010; Thoreau, 2015; Pettersson *et al.*, 2016; Pereira *et al.*, 2019; Sullivan, Handcock and Jackson, 2020).

Löfqvist *et al.* (2012) found that using powered wheelchairs and scooters leads to greater independence in outdoor and indoor activities. Bray *et al.* (2014) also reported that wheelchair interventions likely improve communication skills, personal-social development and cognition. Carver *et al.* (2016) conducted a mixed-methods study to analyse the impact of MATs on people with disabilities. They found that the participants were more active in their daily activities, as well as in society (Carver *et al.*, 2016), in agreement with previous studies (Löfqvist *et al.*, 2012; Bray *et al.*, 2014). Moreover, MATs have the potential to reduce healthcare expenditures by improving health outcomes and decreasing secondary health problems (WHO, 2022). A significant reduction in medical complications and costs associated with SCI can be achieved with MATs that improve functional mobility for patients with SCI (Miller and Herbert, 2016).

Prosthetics is often debated based on its cost rather than its medical benefits. Despite not being viewed as life-saving medical devices, prostheses can be life-changing for users (Boone, 2019). Individuals can quickly regain function with the provision of prostheses,

resulting in significant economic advantages (Boone, 2019).

Furthermore, the use of prostheses, power wheelchairs and orthotics has been demonstrated to be cost-effective in several studies (Samuelsson and Wressle, 2014; Hagberg *et al.*, 2017; Marchand and MacDougall, 2019). Andrich *et al.* (2015) found that powered wheelchair provision generated an average savings of €36,000 per person over five years in social costs. Similarly, Salatino *et al.* (2016) reported savings of approximately \$38,000 per person over five years, while Samuelsson and Wressle (2014) estimated societal savings of €6,227 per person annually. Furthermore, microprocessor-controlled prosthetics are known to be cost-effective. Chen *et al.* (2018) found that although microprocessor-controlled prosthetic knees (MPKs) have higher device acquisition and repair costs, they lead to lower direct healthcare costs and indirect costs, such as lost wages and caregiving expenses. This finding suggests that investing in advanced prosthetic technologies, such as MPKs, provides good value for money, as they result in improved health outcomes and long-term cost savings.

According to the International Classification of Functioning, Disability and Health (ICF) (WHO, 2002), an individual's level of functioning is determined by the interaction between their health condition, environment and personal characteristics. A person may experience disability due to a health condition, making it challenging to engage in activities or participate in work, school and leisure activities. Many factors, including personal and environmental factors, can improve participation. MAT devices are considered an ICF environmental factor (WHO, 2002) and can provide a supportive environment, increase participation and consequently improve the patient's health status. Figure 1.1 illustrates the ICF as it applies to an SCI patient.

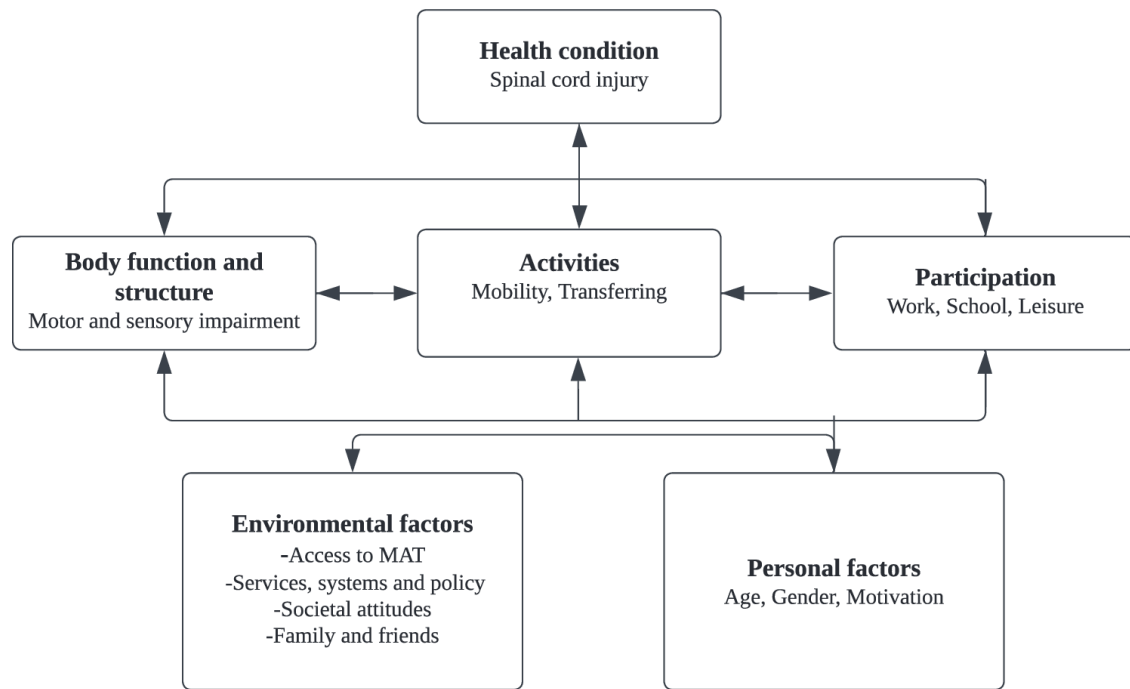


Figure 1.1 The disability of Spinal Cord Injury (SCI) as understood through the International Classification of Functioning, Disability and Health (ICF). Adapted from World Health Organisation (2002, p. 9)

1.3.4 Summary

Section 1.2 demonstrated that mobility impairment caused by a range of disabilities is a significant health and social care problem. Section 1.3 illustrated that various management strategies, especially the provision of MATs, can help mitigate the worst impacts of impairment and that governments, including the government of Saudi Arabia, have committed to the provision of MATs as part of their commitment to the UNCRPD. However, the next section shows that, in practice, the provision of MATs is, at best, uneven internationally and within the study setting.

1.4 Unmet need

1.4.1 Unmet needs internationally

According to the WHO (2022), two billion people will require assistive technology (AT) by 2050, with MAT devices being one of the most commonly needed categories. Even though MATs are a crucial component of ensuring equitable opportunities for people with disabilities and having access to them is a human right (UN, 2007; WHO, 2022), several impediments prevent people with disabilities from gaining access to available and affordable technologies (WHO, 2017). For example, approximately 70 million people require wheelchairs, yet only

5–15% have access to them (WHO, 2017). Furthermore, Danemayer *et al.* (2022) found a significant unmet need for MAT devices all over the world. Many countries, including China, Cameroon, India, South Africa, Namibia, Malawi, Sudan, Canada, Australia, Tajikistan, Nepal, India and Bangladesh, have reported unmet needs (Borg, Lindström and Larsson, 2011; Borg and Östergren, 2015; Steel and Layton, 2016; Visagie *et al.*, 2017; Ekman *et al.*, 2020; Boggs *et al.*, 2021; Gowran *et al.*, 2021; Karki *et al.*, 2021; Li *et al.*, 2021; Wang *et al.*, 2022).

Additionally, Visagie *et al.* (2017) investigated AT services across four African countries – South Africa, Namibia, Malawi and Sudan – and found that despite MAT devices being the most commonly provided devices at 46.3%, significant challenges existed in associated services, such as device training and maintenance, with most maintenance being performed by the users and their families. Similar findings were reported by Borg, Lindström and Larsson (2011). The problem is made worse by the fact that MATs are frequently given without considering the need for additional services. An inappropriately provided MAT device may be hazardous or useless, resulting in increased healthcare costs (WHO, 2022).

Therefore, providing MATs is extremely difficult, as it entails working with the government to set policies, regulations and funding, as well as obtaining a supply chain of high-quality MATs and competent staff to carry out these tasks. To respond to this unmet need, the WHO established the Global Cooperation on Assistive Health Technology (GATE) in 2014 to bridge the gap between the demand for and availability of ATs (Ebuenyi *et al.*, 2021). GATE's main aim is to promote worldwide access to affordable, high-quality ATs, with a heavy emphasis on research and development (WHO, 2017).

1.4.2 Unmet needs in Saudi Arabia

Despite Saudi Arabia's significant financial resources and explicit commitment to protecting the rights of people with disabilities through improved services, evidence suggests persistent inadequacies in disability service provision within the Saudi healthcare system (Al-Jadid, 2013). While functional mobility is identified as a top priority in Saudi rehabilitation settings (Al-Haidary, Qannam and Lam, 2015), the provision of MATs remains problematic (Alqahtani, Cooper and Cooper, 2021).

The development of specialised AT services in Saudi Arabia began in 1987 with the establishment of the Joint Research Centre for Prosthetics, Orthotics and Rehabilitation

Program. This initiative later expanded to include dedicated AT clinics, with the first one established at King Fahad Medical City's rehabilitation hospital in 2006 (Alqahtani, Cooper and Cooper, 2021). However, in the only comprehensive study examining the current state of ATs in Saudi Arabia, Alqahtani, Cooper and Cooper (2021) found that AT devices and services remain limited or non-existent despite governmental support and funding. Their research revealed that only 12 governmental and non-governmental specialised centres across the kingdom provide basic MAT devices and that the system faces significant challenges in meeting the increasing demand for specialised services, particularly in the provision of MATs. Furthermore, they emphasised the critical need for a deeper understanding of AT service delivery within Saudi Arabia's healthcare system and developing effective strategies to enhance service provision (Alqahtani, Cooper and Cooper, 2021).

The limited availability of AT services must be understood within the broader context of Saudi Arabia's size and geographic distribution. The country's population of over 32 million is spread across 13 administrative regions, yet only 12 specialised centres currently provide AT services (Alqahtani, Cooper and Cooper, 2021). This provision is inadequate to meet the needs of the estimated 1.3 million individuals with disabilities (Saudi General Authority for Statistics, 2022), particularly as the centres are concentrated in major urban areas such as Riyadh, Jeddah, and the Eastern Province (Alanazi *et al.*, 2023). This centralised distribution pattern has resulted in multiple regions experiencing a total absence of formalised AT services, creating geographical disparities that significantly impede access for individuals with mobility impairments who require specialist MAT evaluation and provision. As these services are delivered exclusively through tertiary and specialist rehabilitation hospitals (Asmri *et al.*, 2020), individuals often face long travel distances to obtain appropriate care, as detailed further in Section 1.5.2.

1.4.3 Reasons for unmet needs

These unmet needs can be explained by several factors, such as a lack of national policies in many countries, even those with high incomes (Wang *et al.*, 2022; WHO, 2022). In Canada, for example, many individuals who require MATs cannot obtain them because each provincial and territorial health system has its own set of rules and laws that define the conditions under which MATs will be funded (Wang *et al.*, 2022). Similarly, providers in Bangladesh target specific groups of the population (Borg and Östergren, 2015). Despite commitments to the UNCRPD, MAT provision continues to lack political

leadership. Accordingly, in 2020, the WHO announced the urgent need for political commitment (WHO, 2020).

High costs are another barrier to access (Borg and Östergren, 2015; Ekman *et al.*, 2020; WHO, 2020; Gowran *et al.*, 2021). As a result, these MAT devices are often not publicly funded, requiring users to cover significant out-of-pocket expenses (WHO, 2022). Researchers have noted a shortage of appropriately trained personnel (Borg, Lindström and Larsson, 2011; Borg and Östergren, 2015; Ekman *et al.*, 2020; Gowran *et al.*, 2021). Furthermore, users are largely unaware of their rights to and the availability of these services (Borg and Östergren, 2015; Karki *et al.*, 2021). This is also consistent with Quinby *et al.* (2021), who used an online survey to assess participant preferences and knowledge regarding MATs. The researchers noted a variety of gaps in the participants' awareness of emerging technologies. Consequently, individuals may not have access to MATs that can enhance their community participation (Quinby *et al.*, 2021).

Another reason is the lack of information and research. Many governments lack information about unmet MAT requirements, making it difficult to design programmes to address the problem (Danemayer *et al.*, 2022). Accordingly, the WHO prioritises the development of research in this field (WHO, 2017). Alqahtani *et al.* (2021) recommend further investigation to ensure the accessibility and affordability of MATs. This is reinforced by Feldner *et al.* (2022), who examined the research priorities related to MATs and highlighted the importance of identifying policy barriers and financing sources. As indicated by Best *et al.* (2021), improved knowledge translation is necessary to enhance clinical practice research; therefore, guiding future research in this field by using knowledge translation that includes key stakeholders will be beneficial. Likewise, Seymour, Geiger and Scheffler (2019) reported the importance of involving stakeholders in anticipating challenges and factors that may constrain access to wheelchairs.

However, Saudi Arabia is characterised by a lack of information on the barriers to the provision of MATs and unmet needs, as service provision varies significantly among countries (Alqahtani, Cooper and Cooper, 2021), with insufficient study in this field. As the need for MATs expands and the number of MAT users increases, Steel and Layton (2016) emphasise the need for more rigorous approaches to inform practice. In addition, Gowran *et al.* (2021) stress the importance of developing a strategy to enable global accessibility to appropriate wheelchairs and constructing suitable and sustainable wheelchair service-

providing systems.

1.4.4 Summary

In summary, unmet needs for MATs represent a significant healthcare challenge worldwide. While international evidence indicates that MAT provision is inadequate in many countries, the extent and nature of these unmet needs vary widely. In Saudi Arabia, understanding the barriers to MAT provision and the extent of unmet needs is limited. Given that service provision and user requirements differ substantially across healthcare systems, understanding the specific research context is essential for addressing these challenges effectively. The next section presents an overview of the Saudi Arabian healthcare context.

1.5 Research context

1.5.1 Saudi Arabian context

Saudi Arabia, the largest country in the Arabian Peninsula, is divided into 13 administrative regions, each with distinct geographical and demographic characteristics that influence healthcare service delivery and accessibility (Albejaidi, 2010; Saudi General Authority for Statistics, 2022). As of 2022, Saudi Arabia's population was approximately 32.2 million, with data indicating that around 5.9% (over 1.3 million people) have disabilities, mobility impairment being the most prevalent type (Saudi General Authority for Statistics, 2022). The country's robust economy, primarily driven by oil revenues, has enabled significant investment in healthcare infrastructure and services (Almalki, Fitzgerald and Clark, 2011).

1.5.2 Overview of the healthcare system

The Saudi healthcare system has undergone a remarkable transformation since the establishment of the Ministry of Health (MOH) in 1950 (Almalki, Fitzgerald and Clark, 2011). The current system operates through three main sectors: the MOH as the primary provider, other government agencies and the private sector. As of 2021, the healthcare infrastructure included 287 MOH hospitals supported by 2,121 primary healthcare centres (PHCs), 51 other government agency hospitals and 159 private sector hospitals (Saudi Ministry of Health, 2021). Figure 1.2 illustrates the structure of the Saudi healthcare system. The MOH serves as the primary healthcare provider, delivering approximately 60% of healthcare services, while other governmental agencies and the private sector provide the remaining 40% of services (Almalki, Fitzgerald and Clark, 2011).

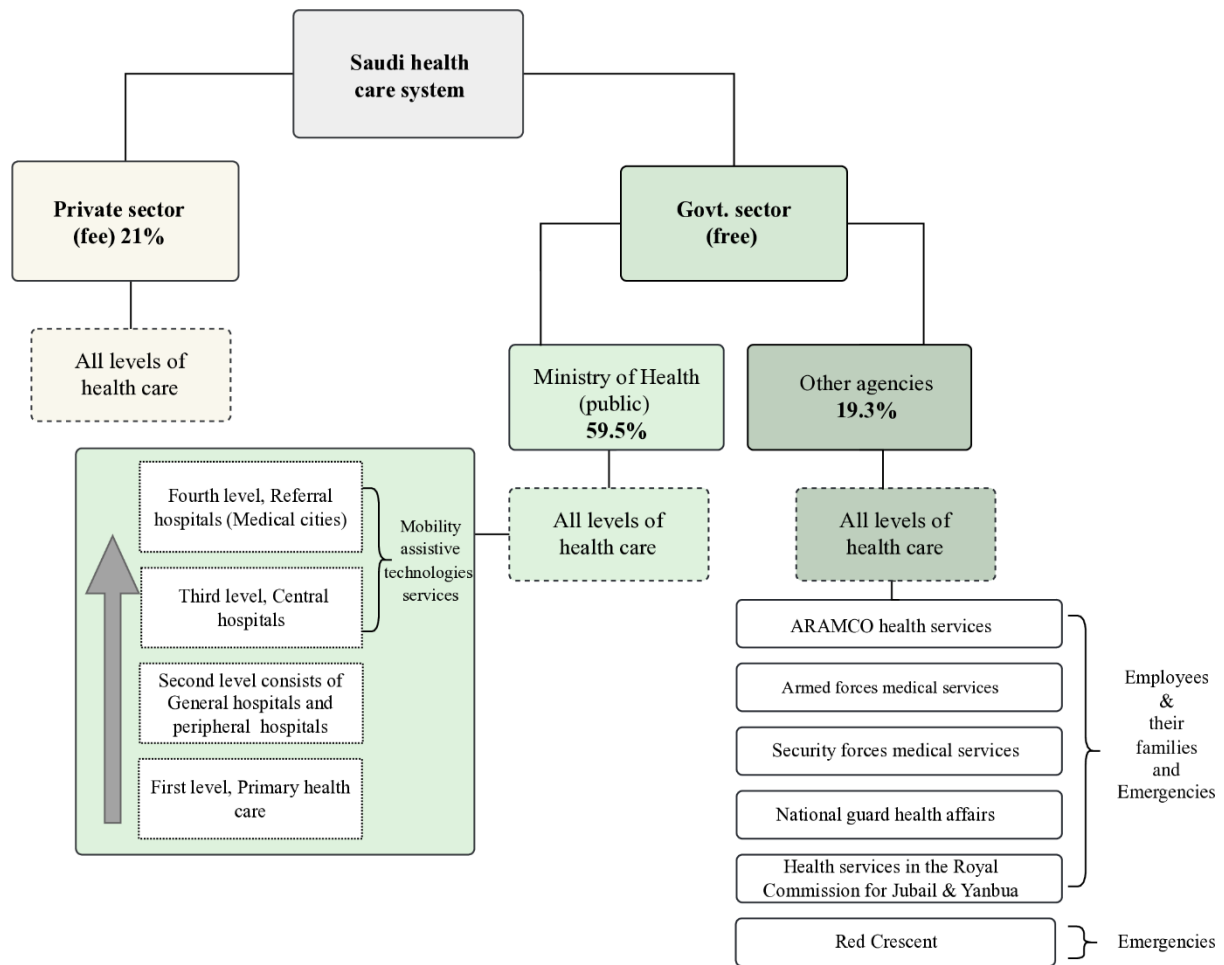


Figure 1.2 Structure of the Saudi healthcare system. Adapted from Almalki, Fitzgerald and Clark (2011) and Asmri *et al.* (2020)

The Saudi healthcare system operates through four distinct levels of care delivery, each serving specific functions and complexities of care (Asmri *et al.*, 2020). At the foundational level, PHCs serve as the initial point of contact, providing basic curative and preventive services to communities (Asmri *et al.*, 2020). The secondary level comprises general and community hospitals, which offer more comprehensive services, including diagnostic capabilities, emergency care and minor surgical procedures (Asmri *et al.*, 2020). Central hospitals constitute the tertiary level, delivering advanced diagnostic, surgical and rehabilitative services, including specialised rehabilitation programmes (Asmri *et al.*, 2020). The quaternary level, represented by referral hospitals and medical cities, provides the most sophisticated and specialised healthcare services while also functioning as research and teaching centres (Asmri *et al.*, 2020). This hierarchical structure enables a systematic approach to healthcare delivery, with cases being referred upwards through the system based

on complexity and specialised care requirements (Almalki, Fitzgerald and Clark, 2011). However, the distribution of these facilities varies significantly across regions, with higher-level facilities concentrated in major urban areas, which can affect accessibility to specialised services, particularly rehabilitation services (Alanazi *et al.*, 2023). MAT services are integrated within rehabilitation services provided in the tertiary and quaternary levels of the Saudi healthcare system. These services are delivered by multidisciplinary teams comprising occupational therapists, physical therapists, speech therapists and rehabilitation engineers (Alqahtani, Cooper and Cooper, 2021).

1.5.3 Summary

To review the argument, mobility impairment is an important societal problem (Section 1.2), but some cost- and clinically effective management strategies are available (Section 1.3). However, MAT provision is poor in many countries, including Saudi Arabia (Section 1.4), with its unique healthcare system structure (Section 1.5), meaning a considerable unmet need and unrelieved health burden exists. In philosophical terms, as a habitual mode of action does not achieve the desired results, a switch in the mode of inquiry is needed to reimagine the world. According to the policy literature (UN, 2006; WHO, 2011; UNP, 2022), these unmet needs present an ethical problem that must be overcome. The key uncertainty is around how to develop implementation strategies to adopt clinically effective MATs into routine practice in Saudi Arabia. The Medical Research Council (MRC) framework acknowledges that the uptake of interventions may be influenced by ‘context’ (Skivington *et al.*, 2021), a broad concept encompassing not only a setting but also ‘roles, interactions, and relationships’ (Pfadenhauer *et al.*, 2017). According to the MRC, programme theory should be established with a wide range of stakeholders, including those involved in the provision and receipt of interventions, to identify the contextual features that moderate MAT uptake and impacts (Skivington *et al.*, 2021). With the participation of stakeholders, interventions can be refined and guided by programme theory, resolving uncertainties about putting evidence-based interventions into practice. The next section shows how implementation science offers a basis for understanding how to uptake evidence-based practices.

1.6 Conceptual framework

1.6.1 Implementation science

The effectiveness and efficiency of healthcare can be enhanced through research, but only if

it is adopted by the healthcare system and practitioners (Eccles and Mittman, 2006). Findings from studies that are effective are not always adopted (Haines, Kuruvilla and Borchert, 2004), which can lead to inadequate care (Eccles and Mittman, 2006). Implementation science is intended as a bridge between research and practice, allowing for insights into how research findings can be implemented in practice (Olswang and Prelock, 2015). Eccles and Mittman (2006) define implementation science as the ‘scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of health services’ (Eccles and Mittman, 2006, p. 1). It involves studying the different elements influencing HCPs and organisational behaviour (Eccles and Mittman, 2006). In addition, implementation research includes the development of strategies that may be employed to increase the adoption of evidence (Powell *et al.*, 2019).

Understanding the context is necessary for implementation research (Eccles *et al.*, 2009). The social healthcare context may be conceived at multiple levels, including individuals – such as HCPs and patients – and organisations. According to Eccles *et al.* (2009), theories, models or frameworks are required to understand this multi-level context and the interaction of individuals participating in healthcare. In the field of implementation science, a wide variety of theories, models and frameworks have emerged (Nilsen, 2015). Frameworks provide structured approaches for organising concepts that enable understanding of phenomena (Nilsen, 2015; Press, Yon and Heyes, 2022). Models offer simplified representations of specific situations or populations, typically describing relationships between elements without providing deeper explanations (Fawcett, 1999a; Nilsen, 2015; Passey, 2020). Theories comprise interconnected abstract principles that explain and predict phenomena while considering broader implications beyond specific contexts (Fawcett, 1999a; Gregor, 2006; Nilsen, 2015; Press, Yon and Heyes, 2022). Nilsen (2015) identified five categories of theoretical approaches in implementation science, which serve three main purposes: to guide research translation into practice, to understand implementation influences and to assess implementation effectiveness. Table 1.1 presents these five categories with their key characteristics and examples. The identification and selection of relevant theoretical approaches should be guided by an understanding of their different aims and categories (Nilsen, 2015), and several tools and resources are available to help researchers make appropriate selections for their specific research (Damschroder, 2020).

Table 1.1 Categories of theoretical approaches in implementation science (Nilsen, 2015)

Category	Purpose	Example
Process models	Provide systematic approaches for translating research evidence into practice.	Ottawa Model
Determinant frameworks	Understand the factors influencing implementation outcomes.	Consolidated Framework for Implementation Research
Classic theories	Explain the aspects of implementation (originate from fields outside implementation science).	Theory of Diffusion
Implementation theories	Explain the aspects of implementation (developed specifically by implementation researchers).	Normalisation Process Theory
Evaluation frameworks	Guide the assessment of implementation efforts.	Proctor's Implementation Outcomes

1.6.2 Justification for the choice of a theoretical framework

The traditional selection criteria for scientific theories include ‘accuracy, consistency, scope, simplicity, and fruitfulness’ (Kuhn, 1977, p. 357). Philosopher of science Thomas Kuhn (1977) summarised his ideas on theory choice in a chapter of his book *Essential Tension*, titled ‘Objectivity, Value Judgement and Theory Choice’. He agrees with the conventional view that these five criteria provide a basis for deciding on a theory. However, he argues that issues in using these criteria remain, making theory selection complicated and challenging. The difficulties associated with using these criteria for selecting theories come from the fact that they are each imprecise and, when combined, contradict one another (Kuhn, 1977). Scientists may also come to different conclusions when using these criteria because they cannot distinguish sufficiently between competing theories (Kuhn, 1977). Kuhn (1977) maintains that further considerations, such as the characteristics of the researchers, must be included. For example, the researcher’s philosophical paradigm may influence the theory choice (Long, 2013).

The challenge of identifying which criteria should be used to select a theory persists. Strategies for choosing the best theory in implementation science are being developed (Birken *et al.*, 2017; Birken *et al.*, 2018). The Theory Comparison and Selection Tool (T-CaST) established by Birken *et al.* (2018) is one method for attempting to identify such

criteria. Determinant frameworks, such as the Theoretical Domains Framework (TDF) (Cane, O'Connor and Michie, 2012) and the Consolidated Framework for Implementation Research (CFIR) (Damschroder *et al.*, 2009), can help examine the facilitators and barriers to implementation and have been widely used in research (Birken *et al.*, 2018). Although CFIR and TDF appear to be similar (Birken *et al.*, 2017), some researchers claim that CFIR concentrates on the organisational level and takes a holistic approach, whereas TDF focuses on individual behaviour change and how implementation is affected by individual factors (Murphy *et al.*, 2014; Prior *et al.*, 2014).

This study employs CFIR as its theoretical framework for several reasons. First, CFIR, as a determinant framework, provides a comprehensive taxonomy of factors that may influence implementation, which aligns well with the research aims outlined in Section 1.10 (Damschroder *et al.*, 2022b). CFIR was initially developed by synthesising constructs from 19 implementation theories (Damschroder *et al.*, 2009) and has since become one of the most highly cited and accessed frameworks in implementation science (Damschroder *et al.*, 2022b). The framework was comprehensively updated in 2022 based on user feedback and now comprises 48 constructs organised across five domains (Damschroder *et al.*, 2022b). The framework's five categories are innovation domain, outer setting, inner setting, individual domain and implementation process (Figure 1.3).

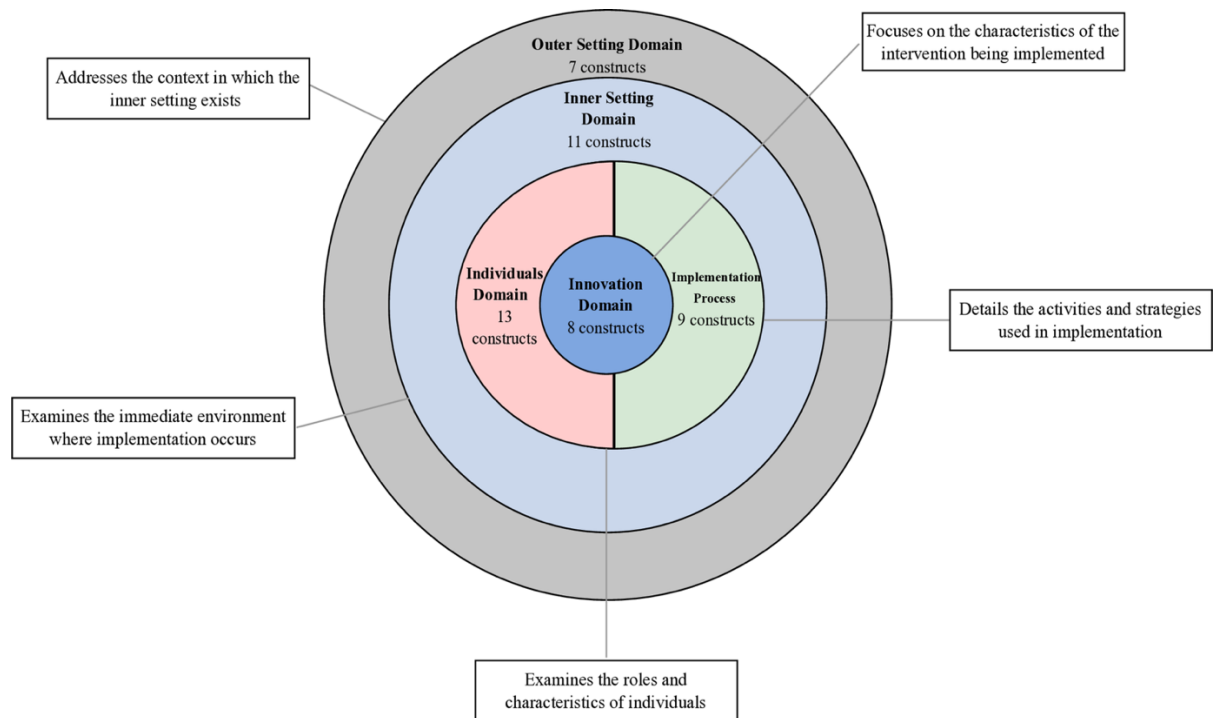


Figure 1.3 Domains of Consolidated Framework for Implementation Research and their definitions

CFIR is consistent with the theoretical evaluation measures of Birken *et al.* (2018) and the traditional selection criteria of ‘accuracy, consistency, scope, simplicity, and fruitfulness’ (Kuhn, 1977, p. 357). Although it includes a wide range of domains and constructs, it was developed as a simple and concise framework for implementation research. Furthermore, CFIR offers researchers a standardised framework of constructs, establishing a shared terminology for systematically describing implementation factors (Keith *et al.*, 2017; Damschroder, 2020).

Regarding testability, CFIR has been widely adopted and used in various health-related research (Kirk *et al.*, 2016) and in identifying the factors that facilitate or impede the implementation of services or interventions (Keith *et al.*, 2017). In addition, CFIR can guide the design of a data collection tool by providing a list of clearly defined constructs, as well as analysing and interpreting the collected data (www.cfirguide.org). CFIR has been applied in numerous settings and with multiple target populations (Means *et al.*, 2020). Moreover, it is likely to be acceptable and assist in refining new research while clarifying the best approach to assessing potential implementation challenges. Accordingly, this research is guided by CFIR, and its application in data collection and analysis is detailed in Chapter 4. The barriers identified through CFIR can be linked to specific implementation strategies using the Expert

Recommendations for Implementing Change (ERIC) matching tool (Waltz *et al.*, 2019). ERIC provides 73 evidence-based strategies developed through a modified Delphi process with implementation science experts (Powell *et al.*, 2015). This systematic approach enables the development of targeted solutions to mitigate identified barriers (Waltz *et al.*, 2019), detailed further in Chapter 5, Section 5.3.2.

1.6.3 Summary

This section illustrated how implementation science offers a basis for understanding how to uptake the evidence-based practices mentioned in Section 1.3 into practice to address the unmet needs discussed in Section 1.4. As no one-size-fits-all method for developing implementation strategies exists, key stakeholders are interviewed in this thesis to help establish a programme theory on how to overcome the barriers to accessing MATs in the context of the Saudi health system. The next section discusses the philosophical foundation of this research, where pragmatism is adopted, given its orientation towards solving practical problems and understanding context-specific challenges.

1.7 Research philosophy

1.7.1 Introduction

The term ‘paradigm’ is used to describe the researcher’s beliefs or philosophical assumptions that they use to direct their actions and shape their worldview (Lincoln and Guba, 2000). Examples of research paradigms include constructivism, positivism and pragmatism (Creswell and Poth, 2016). While constructivism focuses on the subjective co-creation of knowledge through individual and shared experiences, and positivism seeks objective truths through empirical observation (Creswell and Poth, 2016), pragmatism rejects such strict dichotomies. Instead, it views knowledge as provisional, contextual and oriented towards solving practical problems (Legg and Hookway, 2019; Wills and Lake, 2020). This thesis adopts pragmatism as its philosophical foundation, as it is a particularly well-suited perspective for healthcare research, where the focus is on achieving practical outcomes and understanding context-specific challenges. Pragmatism is especially relevant to healthcare research as interest grows among HCPs, including occupational therapists (Ikiugu and Schultz, 2016) and physiotherapists (Shaw, Connelly and Zecevic, 2010).

Pragmatism is characterised by a preference for fallibilism – the view that all beliefs are potentially wrong and subject to revision – and provisional knowledge over scepticism and a

priori knowledge, which are beliefs formed independently of experience (Legg and Hookway, 2019). This philosophical stance acknowledges that knowledge develops through research and experience rather than existing as absolute truths (Morgan, 2014). In the context of healthcare research, particularly when examining barriers to MAT provision, pragmatism supports the exploration of these challenges through the diverse perspectives of multiple stakeholders (Shaw, Connelly and Zecevic, 2010). It also rejects dichotomies between fact and value and between thought and experience and emphasises contextually specific thinking (Legg and Hookway, 2019; Wills and Lake, 2020). This is particularly relevant where multiple stakeholders' perspectives and experiences must be considered within specific cultural and systemic contexts. In addition, pragmatists consider the knowledge and experience of the practitioners in a field to have primacy over elite academic authority and insist that knowledge generation must be inclusive (Legg and Hookway, 2019; Wills and Lake, 2020). This principle supports this study's focus on gathering perspectives from various stakeholders who directly engage with MAT provision in Saudi hospitals.

1.7.2 Axiology

Axiology describes the significance of values in research (Creswell and Poth, 2016). The axiology of pragmatism is that knowledge is value-laden and practical (Allemang, Sitter and Dimitropoulos, 2022). It is value-laden in the sense that it does not believe in the distinction between fact and value (Wills and Lake, 2020), and its practical aspect stems from Peirce's pragmatic maxim, which holds that the value of ideas is determined by their effects or practical consequences (Wills and Lake, 2020). This consequentialist ethic implies that pragmatic research aims to maximise population health gain rather than identifying transcendental truths (Wills and Lake, 2020). This aligns with the research aim of investigating the barriers to MAT provision in Saudi Arabia, where understanding stakeholder values and practical consequences is crucial. Additionally, this pragmatic philosophy aligns with patient and public involvement (PPI) principles in healthcare research. PPI ensures that research design and outcomes reflect the needs and experiences of those who use healthcare services. This involvement of service users (see Section 1.9 and Chapter 4, Section 4.2.10) further supports the pragmatic aim of developing practical solutions.

I have identified a burden of mobility impairment (Section 1.2) that persists despite the availability of clinically effective MATs (Section 1.3.2). The values expressed by the WHO and professional bodies (Section 1.3.1) warrant the definition of the current situation as

problematic, given these shared values. As a guiding philosophy, pragmatism does not reject the concept of truth but focuses on practical solutions to real-world problems. To address these challenges, qualitative research methods (see Chapter 4) were important to explore the stakeholders' perspectives and examine whether current healthcare practices align with the principles established by professional bodies.

1.7.3 Epistemology

Epistemology relates to ideas about how we know the world and how knowledge is acquired (Creswell and Poth, 2016). In pragmatism, epistemology is seen as 'transactional realism' in which knowledge is constructed from humans' interactions with their environment (Allemang, Sitter and Dimitropoulos, 2022). Indeed, pragmatic research focuses on using diverse human experiences and values as the main source of knowledge construction rather than depending on absolute truths (Hildebrand, 2011). Realist philosophers tend to adopt a sceptical perspective and attempt to establish knowledge from firm foundations – *a priori* knowledge (Legg and Hookway, 2019; Risberg and Tersman, 2019). By contrast, philosophical pragmatists Peirce and Dewey suggest focusing on error-correcting methods instead of achieving certainty (Legg and Hookway, 2019). In other words, pragmatism proposes fallibilism, which states that all knowledge is provisional, never certain, always hypothetical and subject to correction (Wills and Lake, 2020).

Another important aspect of pragmatic epistemology is how to conduct inquiries in a productive manner (Legg and Hookway, 2019). Peirce and Dewey's pragmatic approach to inquiry, as summarised by Morgan (2014) and Wills and Lake (2020), involves the following: recognising a habitual situation as problematic (Chapter 1), considering the consequences of defining the problem in different ways (Chapter 2), developing possible lines of action (Chapters 3 and 4) and assessing the consequences of the proposed actions (Chapter 5). In Chapter 5, this assessment is limited to proposing strategies rather than fully assessing their potential outcomes. The final step, implementing actions thought to be effective in solving the problematic situation, lies outside the scope of this thesis.

1.7.4 Ontology

Ontology is a set of beliefs concerning the nature of reality (Creswell and Poth, 2016). Pragmatism's approach to ontology has been described as 'reality is renegotiated and interpreted based on usefulness in specific contexts' (Allemang, Sitter and Dimitropoulos,

2022, p. 40). Therefore, reality is constantly changing, based on human experience and oriented towards finding solutions to issues (Weaver, 2018). In addition, pragmatists, as fallibilists, continue to seek the truth and assume that they can learn from mistakes and progressively converge on the truth (Legg and Hookway, 2019). Thus, the frameworks I have selected for my inquiry are motivated by their perceived utility. Unlike scientific realists who claim absolute knowledge of which theories are best, pragmatists recognise that theories, models and frameworks serve as lenses through which to understand reality (Kochis, 2005). This perspective applies to this research's use of CFIR, as discussed in Section 1.6.2. While CFIR provides a structured approach to understanding the barriers to MAT provision, pragmatism acknowledges that different healthcare contexts may require diverse theoretical approaches to fully understand the complexities of implementation.

This ontological stance aligns with studying MAT provision in Saudi Arabia's healthcare system, where multiple stakeholders may hold different views of reality based on their roles, experiences and contexts. It allows for the recognition that the barriers to MAT provision may be understood differently across various hospitals and among several professional groups while still working towards practical solutions.

In light of these considerations, pragmatism was chosen as the philosophical foundation for this study because of its alignment with the research aim of identifying barriers to the provision of MATs and developing implementable strategies to overcome them. Its emphasis on problem-solving and achieving practical outcomes guided the development of actionable implementation strategies tailored to the specific context of Saudi Arabia's healthcare system. Pragmatism also supports methodological flexibility, which enabled the use of a multiple-methods approach—combining a survey, interviews, and document analysis—to capture different aspects of the problem (Creswell and Poth, 2016). Furthermore, its emphasis on human experience over abstract truths validated the inclusion of diverse stakeholder perspectives, ensuring that findings were grounded in real-world practice (Morgan, 2014; Wills and Lake, 2020).

1.7.5 Summary

In summary, this thesis adopts pragmatism as its philosophical foundation, as it is a perspective particularly well-suited for investigating the factors influencing MAT provision in Saudi Arabia's healthcare system. Pragmatism's emphasis on achieving practical outcomes

aligns with the research aim of identifying barriers to MAT provision and developing strategies to overcome them.

1.8 Stakeholder selection and research scope

This research focuses on stakeholders with a direct influence over MAT provision in Saudi healthcare settings. The implementation science literature suggests that when investigating barriers to implementation, data should be primarily collected from individuals with authority over implementation decisions (Damschroder *et al.*, 2022a). This approach is crucial in healthcare settings, where systemic changes require an understanding of complex organisational, financial and regulatory factors that affect service delivery (Nilsen *et al.*, 2020).

Although patient experiences are vital in healthcare research, implementation outcomes are typically informed by data gathering from decision-makers and those delivering the intervention, as they can provide insights into both system-level barriers and their perceptions of patient needs that affect implementation (Damschroder *et al.*, 2022a). Therefore, this study focuses on HCPs, managers and leaders who directly influence MAT provision practices and have the authority to implement systemic changes. Patient perspectives are valued and have been incorporated through PPI in research design and data interpretation (see Section 1.9).

1.9 Patient and public involvement

Stakeholder engagement in research is crucial in shaping the research process and ensuring that the research addresses issues that are important to patients and the public (Staniszewska *et al.*, 2017; Skivington *et al.*, 2021). In developing this research, I approached four experts at an early stage via the Saudi Occupational Therapy Association: two researchers interested in the field and two expert practitioners in the field of ATs in Saudi Arabia. The participants were invited to a short interview via Zoom regarding the planned research project. During these sessions, I presented the research, which was followed by an engaging dialogue with the participants. They contributed in three ways: by sharing their insights on the unmet needs of MATs for people with disabilities and the significance of the topic; by offering guidance on the study protocol, including whom to interview and where to recruit them; and by providing input on the use of interviews as a data collection tool. These consultations helped refine the research plan and confirmed the study's relevance.

Perspectives from patients were also sought. Two patients with mobility impairments who

used wheelchairs were engaged through the Adult Motor Disability Association in Riyadh. Adapting to the cultural perceptions of PPI in Saudi Arabia posed initial challenges due to misunderstandings of its benefits. In the Saudi Arabian healthcare and research context, a traditionally more hierarchical relationship between HCPs and patients exists, where patients are often viewed as recipients of care rather than active participants in research and service development (Alabdullah *et al.*, 2023; Alkhaibari, Smith-Merry and Forsyth, 2023). Additionally, the concept of formal patient involvement in research planning is relatively new in Saudi Arabia, as research has historically been driven primarily by academic and clinical experts. Despite these cultural challenges, I successfully clarified the purpose and importance of patient involvement by emphasising how their lived experiences could enhance the research quality and relevance to the local context. The details of these sessions are presented in Chapter 4, Section 4.2.10.

1.10 Aim and objectives

The aim of this research was to investigate the factors influencing MAT provision for people with mobility-related disabilities in Saudi Arabia's healthcare system and to recommend strategies to overcome the identified barriers and inform policy. To achieve this aim, the following objectives were established:

1. To understand the barriers to MAT provision through a scoping review that summarises and synthesises theories, models and frameworks, identifies key determinants and highlights knowledge gaps (Chapter 2). These findings informed the development of a qualitative study (Chapter 4).
2. To provide an overview of MAT availability in Saudi Arabia's healthcare system through an online stakeholder survey (Chapter 3). This survey facilitated participant recruitment for the qualitative study and enabled maximum variation sampling across various hospitals (Chapter 4).
3. To explore HCPs', managers' and leaders' perceptions of the factors influencing MAT provision in Saudi Arabia through semi-structured interviews and document analysis (Chapter 4).

4. To develop strategies using the CFIR-ERIC matching tool to overcome the identified challenges for future research, policy and practice (Chapter 5). These strategies were informed by the findings from the scoping review (Chapter 2), survey (Chapter 3) and qualitative study (Chapter 4).

1.11 Chapter summary

This chapter provided an overview of the unmet needs for MATs, highlighting their significance as a global healthcare challenge. It identified the knowledge gaps regarding the barriers to MAT provision within the Saudi healthcare system. The chapter established pragmatism as the philosophical stance and elaborated on the rationale for selecting CFIR to guide this research. Finally, it presented the research aims and objectives. The next chapter addresses the first objective of this thesis to understand the barriers to MAT provision through a scoping review that summarises and synthesises theories, models and frameworks, identifies key determinants and highlights knowledge gaps.

Chapter 2: Theories, Models and Frameworks to Understand the Barriers to the Provision of Mobility Assistive Technologies: A Scoping Review

2.1 Introduction

This chapter addresses the first objective of the thesis as outlined in Chapter 1, Section 1.10: to understand the barriers to MAT provision through a scoping review that summarises and synthesises theories, models and frameworks (TMFs), identifies key determinants and highlights knowledge gaps.

Chapter 1 provided an overview of the unmet needs for MATs, highlighting their significance as a global healthcare challenge and ethical imperative (UN, 2006; WHO, 2022). The reasons for the unmet need for MATs are poorly understood but include the absence of national policies, high costs, and insufficiently trained personnel (Chapter 1, Section 1.4.3). Several pre-existing TMFs have been used to understand the determinants of access and uptake, each with different conceptual coverage and terminology, which could help plan corrective actions (TMFs previously defined in Chapter 1, Section 1.6.1). When a research area is characterised by theoretical incoherence, researchers must choose between rigid empiricism, selecting theories based on their virtues, developing their own theory, and theoretical synthesis (Denzin, 2009). Theoretical synthesis can amalgamate propositions from different theories into a propositional network, enabling researchers to extend the coverage, content validity, and document points of convergence (Denzin, 2009). Scoping reviews are ideal for uncovering key concepts and informing future research designs (Khalil and Tricco, 2022). This chapter presents a scoping review method (Section 2.2) that summarises and synthesises the TMFs used to understand MAT access (Section 2.3.3), identifies the determinants of access (Section 2.3.2), and highlights the gaps in current knowledge (Section 2.3.4).

In this review, CFIR provides a systematic structure for categorising barriers. In subsequent chapters, CFIR will be used to systematically analyse the barriers to MAT provision in the Saudi Arabian context (Chapter 4) and guide the development of targeted implementation strategies (Chapter 5).

2.2 Method

We report a five-stage scoping review based on the approach outlined by Arksey and O'Malley (Arksey and O'Malley, 2005), in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR)

(Tricco *et al.*, 2018). This study did not meet the eligibility requirements for registration using PROSPERO. The research questions were as follows: What theories, models, and frameworks have been used to understand the barriers to the provision of MATs for people with mobility issues? What are the determinants of access to MATs for people with mobility issues? What are the current knowledge gaps in access to MATs for people with mobility issues?

2.2.1 Eligibility criteria

The Behaviour of Interest, Health Context, Exclusion, Models, or Theories (BeHEMoTH) framework (Booth and Carroll, 2015) was employed to formulate the search concepts (Table 2.1) and eligibility criteria (Table 2.2).

Table 2.1 Application of the BeHEMoTH framework to define search concepts

BeHEMoTH	Concept
Be – Behaviour of interest	Barriers to access or provision
H – Health context	People with mobility issues AND MATs
E – Exclusions	NA
MoTh – Models or Theories	Models or Theories or Frameworks

Table 2.2 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria	Rationale
Publications reporting on the barriers to the provision of MATs	Publication concentrates on aspects other than barriers to access, and there is no report on barriers	This review focuses on understanding barriers to the provision of MATs
Publications including at least a theory, model, or framework	Publications that did not employ a theory, model, or framework	To ensure that the articles concentrate on theory, model, or framework to understand the barriers
Publications in peer-reviewed journals	Other publications such as conference abstracts and theses	To ensure that studies had undergone rigorous evaluation
Publications published in the English language	Publications in other languages	Costs and time commitment associated with article translation
Publications between 2000 and 2024	Publication published before 2000	To ensure using the most relevant publications from the previous 24 years

2.2.2 Information sources and searches

Literature searches were performed by (AA) on MEDLINE (Ovid), EMBASE (Ovid), CINAHL (EBSCO), and SCOPUS databases for studies published between 1 January 2000 and 20 March 2024. To identify the appropriate publications relevant to the research issue, *a priori* search strategy was established in collaboration with the authors (AA and DH) and an information specialist (FZ). The search terms combined the concepts of ‘barriers to provision, mobility issues, AND ‘MATs’, and a theory/model/framework’. Free text terms, subject heading, use of the Boolean operators "AND" and "OR", and truncation were all used to ensure a successful search. The final search strategy was tested on MEDLINE via Ovid, and then translated into other databases. The full search strategy and results are presented in Appendix 1. We reviewed the reference lists of the included articles to identify additional relevant articles (Arksey and O’Malley, 2005) but restricted the eligibility to peer-reviewed studies, excluding grey literature.

2.2.3 Study selection

The Rayyan platform (<https://www.rayyan.ai>) was used for study selection. Initial title and abstract screening were conducted by (AA), where the primary aim was to assess studies for potential relevance based on predefined inclusion and exclusion criteria. Given the subjective nature of this assessment, any uncertainties regarding study eligibility encountered by AA were systematically discussed with the other reviewers (DH, SR, and BF). Full-text screening involved consistent discussions among (AA, DH, SR, and BF), and the full texts of eligible articles were subsequently retrieved for a more detailed assessment.

2.2.4 Data charting process

To facilitate consistent data presentation and synthesis, we charted general and study-specific information from the studies in Microsoft Excel spreadsheets. Data items included country of origin, study population, aims, sample size, study design, data collection tool, TMF used, a brief description of its purpose, research recommendations, and key findings related to barriers to the provision of MATs. We extracted theoretical propositions from the TMFs, as discussed in the articles included in our review. In instances in which these articles did not provide a comprehensive explanation of TMFs, such as Gibson's affordances theory, the integrated multi-intervention paradigm for the assessment and application of concurrent treatments (IMPACT²) model, and the Human Activity Assistive Technology (HAAT) model, we referred to the foundational sources. The sources cited within the included articles are original materials in which TMFs were first introduced or explained thoroughly. This ensured that our understanding and coverage of TMFs was comprehensive, especially when the application of these TMFs in the reviewed articles lacked depth. Although these foundational sources were not directly included in our review as they did not meet our inclusion criteria, they were consulted for additional insights. We mapped the reported barriers to one of the updated constructs of the CFIR, a synthetic framework of constructs used in 19 implementation theories (see Chapter 1, Section 1.6.2) (Damschroder *et al.*, 2009; Damschroder *et al.*, 2022b), using a codebook (<https://cfirguide.org/>). The CFIR provides a set of standardised constructs to guide researchers, creating a common language for explicitly and consistently describing aspects that may affect the provision (Keith *et al.*, 2017).

2.2.5 Synthesis of results

Tabular summaries and narrative syntheses were completed for the included articles and their

TMFs (Popay *et al.*, 2006). We conducted a theoretical synthesis to generate new insights that were unavailable for any TMF (Pound and Campbell, 2015). The synthesis was guided by Turner's (Turner, 1991) approach. In Step 1, the TMFs were summarised, and their shared themes were identified. We created a comprehensive matrix in Excel that documented each of the eight TMFs. For each TMF, we documented the original source, core concepts and primary focus areas. In Step 2, we identified aspects of each TMF that pertained to core concepts by extracting the phrases used, their definitions, and their explicit and implicit relationships. Our Excel matrix systematically documented key concepts and terminology from each TMF. For example, from the HAAT model, we extracted the proposition that "Activities are necessary to human existence" and "The activity is the process of doing something, and it represents the functional result of human performance."

In Step 3, we broke the TMFs into simple propositions that were tabulated. We reformulated the extracted theoretical elements into clear propositional statements. For example, concepts from HAAT about human skills and abilities (physical, cognitive, emotional) affecting activities were translated into the propositional statement "Human abilities directly impact activity performance". Our Excel matrix organised these propositions by framework, creating a systematic database of theoretical claims that could be directly compared.

In Step 4, we compared the TMFs and determined how they converged or diverged by combining similar elements. Using our propositional database, we systematically compared theoretical claims across TMFs, identifying areas of conceptual overlap and unique contributions. For instance, multiple frameworks converged on the concept that individual abilities can be enhanced through AT. For example, the HAAT model explicitly states that "Individual abilities are enhanced or augmented by the use of AT in order to complete a desired activity", whilst the ICF framework describes how external factors influence an individual's level of functioning. Despite using different terminology, both frameworks recognise AT as a key factor that bridges personal capabilities and activity performance, which contributed to our development of Proposition 3 ("Appropriate services influence mobility"). The matrix format facilitated visual identification of these patterns, with colour-coding used to highlight conceptual similarities across TMFs.

In Step 5, the convergent elements from the TMFs were combined into a single conceptual model that focuses on the relationships between concepts. For example, during this stage, we examined how concepts from these TMFs—such as cost, services, and activity (mobility)—

interacted and influenced each other within the synthesised theory to gain theoretical insight. By analysing these relationships across multiple theoretical perspectives, we developed nine integrated propositions that comprehensively explained the determinants of MAT access. Each integrated proposition synthesised conceptual elements from multiple TMFs. For example, Proposition 1 ("Mobility contributes to human flourishing") integrated concepts from HAAT "Activities are necessary to human existence" and IMPACT² "Activity is identified as participation and QoL".

In Step 6, we incorporated supporting evidence from the included studies to strengthen and validate the resulting conceptual model. For each synthesised proposition, we identified specific empirical evidence from the included studies that supported or illustrated the theoretical claim. The final product of this systematic synthesis process was a set of nine integrated propositions that comprehensively capture the determinants of MAT access.

2.2.6 Gaps analysis

To identify knowledge gaps and areas for future research, we reviewed papers and tabulated explicit recommendations, which is a core function of scoping reviews (Khalil and Tricco, 2022).

2.2.7 Patients and public involvement

No patients or public were involved in the study.

2.3 Results

2.3.1 Characteristics of the studies

The literature search yielded 306 citations after the removal of duplicates. A total of 246 citations were excluded after initial screening, and 60 potentially eligible articles were retrieved for full-text review. Of these, 45 were excluded because barriers were not reported ($n=10$), TMFs were not reported ($n=27$), and the citations were conference abstracts ($n=7$) or theses ($n=1$). Fifteen studies identified from the databases met all the eligibility criteria. After reviewing the reference lists and conducting manual searches, 25 additional studies were identified and examined for eligibility, and three studies were determined to be eligible (Figure 2.1) (Page *et al.*, 2021).

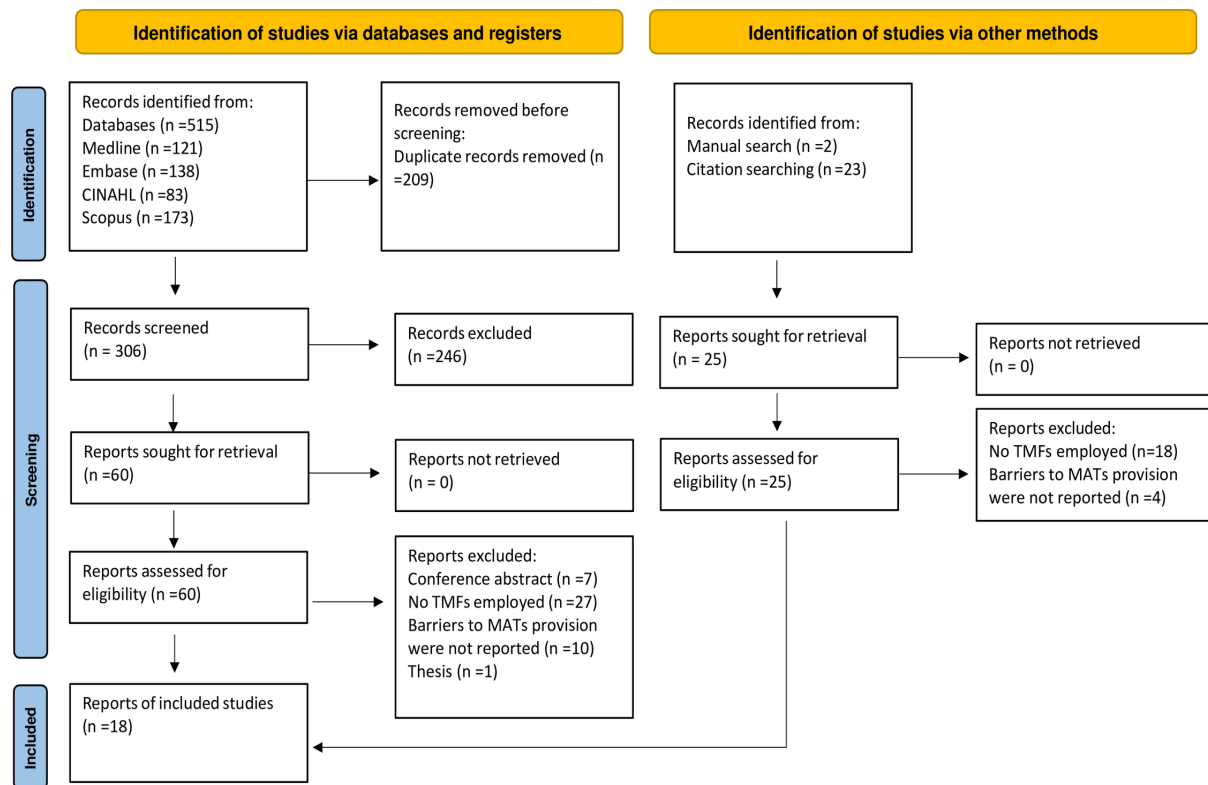


Figure 2.1 PRISMA flow diagram

The final synthesis included 18 articles (Appendix 2) (Oskar *et al.*, 2011; Layton, 2012; Hammel *et al.*, 2013; Dwyer and Mulligan, 2015; Steel and Layton, 2016; Smith, Sakakibara and Miller, 2016; Arthanat, Elsaesser and Bauer, 2017; Gonçalves, Knabben and Luz, 2017; Mairami *et al.*, 2017; Jindal *et al.*, 2018; Seymour, Geiger and Scheffler, 2019; Dorjbal *et al.*, 2020; Widehammar *et al.*, 2020; Gowran *et al.*, 2021; McIntyre, Cleland and Ramklass, 2021; Bhidayasiri *et al.*, 2022; Nabizadeh *et al.*, 2023; Serres-Lafontaine *et al.*, 2023). Eight studies addressed the challenges associated with the provision and use of MATs (Oskar *et al.*, 2011; Layton, 2012; Hammel *et al.*, 2013; Arthanat, Elsaesser and Bauer, 2017; Mairami *et al.*, 2017; Seymour, Geiger and Scheffler, 2019; Gowran *et al.*, 2021; McIntyre, Cleland and Ramklass, 2021; Bhidayasiri *et al.*, 2022; Nabizadeh *et al.*, 2023). Four studies examined environmental barriers to participation (Dwyer and Mulligan, 2015; Smith, Sakakibara and Miller, 2016; Dorjbal *et al.*, 2020; Widehammar *et al.*, 2020; Serres-Lafontaine *et al.*, 2023). Two studies explored the experiences of patients and caregivers and their rehabilitation needs (Gonçalves Junior, Knabben and Luz, 2017; Jindal *et al.*, 2018). One study drew attention to inconsistencies in AT provision schemes (Steel and Layton, 2016). There were (n=5) secondary studies and (n= 13) primary research studies conducted between 2012 and 2023 in South Africa (McIntyre, Cleland and Ramklass, 2021), Mongolia (Dorjbal *et al.*, 2020),

Canada, India (Jindal *et al.*, 2018), Australia (Layton, 2012; Steel and Layton, 2016), Malaysia (Mairami *et al.*, 2018), New Zealand (Dwyer and Mulligan, 2015), Uganda (Seymour, Geiger and Scheffler, 2019), Brazil (Gonçalves Junior, Knabben and Luz, 2017), United States (Arthanat, Elsaesser and Bauer, 2017), Iran (Nabizadeh *et al.*, 2023), Sweden (Oskar *et al.*, 2011; Widehammar *et al.*, 2020), Tanzania (Serres-Lafontaine *et al.*, 2023), Canada, and the United States (Hammel *et al.*, 2013). The primary studies contained between one and 318 participants.

Eight TMFs, representing various perspectives, were identified. Two were biopsychosocial in orientation: the ICF (WHO, 2001) and HAAT (Hussey and Cook, 1995), which focused on AT. Two other models that focus on AT are IMPACT² (Smith, 2011) and Matching Person and Technology (MPT) (Oskar *et al.*, 2011). Four other identified TMFs were applied to AT access: Penchansky and Thomas's framework (Nabizadeh *et al.*, 2023), Levesque's theoretical framework (Levesque, Harris and Russell, 2013), Gibson's affordances theory (Gibson, 2014), and the Systemic Development Model (SDM) (WEI, 2012). The most frequently used TMF was ICF (n = 12). All included studies applied one TMF, except for one (Steel and Layton, 2016), which used two in combination: ICF and IMPACT². There are three distinct applications of TMFs, as shown in Appendix 3. The majority were used as a basis for analysis and interpretation (n = 13) or as a guide for designing the surveys and interviews (n = 2). In addition, TMFs were used as a comprehensive framework to provide a context for reviewing the relevant literature (n = 3).

2.3.2 Barriers to MATs provision synthesised using CFIR

The key barriers in the innovation domain are cost concerns (Layton, 2012; Hammel *et al.*, 2013; Dwyer and Mulligan, 2015; Steel and Layton, 2016; Arthanat, Elsaesser and Bauer, 2017; Mairami *et al.*, 2017; Jindal *et al.*, 2018; Dorjbal *et al.*, 2020; Gowran *et al.*, 2021; McIntyre, Cleland and Ramklass, 2021; Nabizadeh *et al.*, 2023), intervention complexity (Hammel *et al.*, 2013; Seymour, Geiger and Scheffler, 2019; Widehammar *et al.*, 2020; Gowran *et al.*, 2021), inadequate evidence of effectiveness (Steel and Layton, 2016; Arthanat, Elsaesser and Bauer, 2017), product-related factors such as comfort, durability, and fit (Smith, Sakakibara and Miller, 2016); and limited models and colour choices available (Oskar *et al.*, 2011) (Figure 2.2). The outer-setting domain highlights societal attitudes toward AT (Oskar *et al.*, 2011; Smith, Sakakibara and Miller, 2016; Seymour, Geiger and Scheffler, 2019; Dorjbal *et al.*, 2020; Bhidayasiri *et al.*, 2022), geographic distance (Steel and

Layton, 2016; Gonçalves, Knabben and Luz, 2017; McIntyre, Cleland and Ramklass, 2021; Nabizadeh *et al.*, 2023), a lack of supportive legislation (Hammel *et al.*, 2013; Seymour, Geiger and Scheffler, 2019; Dorjbal *et al.*, 2020; Widehammar *et al.*, 2020; Gowran *et al.*, 2021; Bhidayasiri *et al.*, 2022; Nabizadeh *et al.*, 2023; Serres-Lafontaine *et al.*, 2023), and environmental barriers (Oskar *et al.*, 2011; Smith, Sakakibara and Miller, 2016). Within the inner-setting domain, resource constraints (Arthanat, Elsaesser and Bauer, 2017; Gonçalves, Knabben and Luz, 2017; Seymour, Geiger and Scheffler, 2019; Gowran *et al.*, 2021; McIntyre, Cleland and Ramklass, 2021), restricted knowledge, and information access hinder provision (Layton, 2012; Hammel *et al.*, 2013; Arthanat, Elsaesser and Bauer, 2017; Seymour, Geiger and Scheffler, 2019; Gowran *et al.*, 2021; Bhidayasiri *et al.*, 2022). The characteristics of the individuals' domains revealed knowledge about the intervention (Seymour, Geiger and Scheffler, 2019; Dorjbal *et al.*, 2020; Gowran *et al.*, 2021; Bhidayasiri *et al.*, 2022) and low self-efficacy among healthcare professionals (Arthanat, Elsaesser and Bauer, 2017; McIntyre, Cleland and Ramklass, 2021; Nabizadeh *et al.*, 2023) as barriers to its adoption. In addition, within the characteristics of individual domains, barriers include limited information access (Layton, 2012; Hammel *et al.*, 2013; Dwyer and Mulligan, 2015; Gonçalves Junior, Knabben and Luz, 2017; Widehammar *et al.*, 2020; McIntyre, Cleland and Ramklass, 2021; Nabizadeh *et al.*, 2023), such as a lack of access to training and instructions on the use and management of mobility products (Nabizadeh *et al.*, 2023). Furthermore, there is a lack of awareness among users (McIntyre, Cleland and Ramklass, 2021; Bhidayasiri *et al.*, 2022), and insufficient inclusion of user preferences in prescriptions (Oskar *et al.*, 2011). In the process domain, barriers include insufficient stakeholder engagement (Hammel *et al.*, 2013; Arthanat, Elsaesser and Bauer, 2017; Bhidayasiri *et al.*, 2022), absence of interdisciplinary standards (Arthanat, Elsaesser and Bauer, 2017), and limited strategic planning (Hammel *et al.*, 2013).

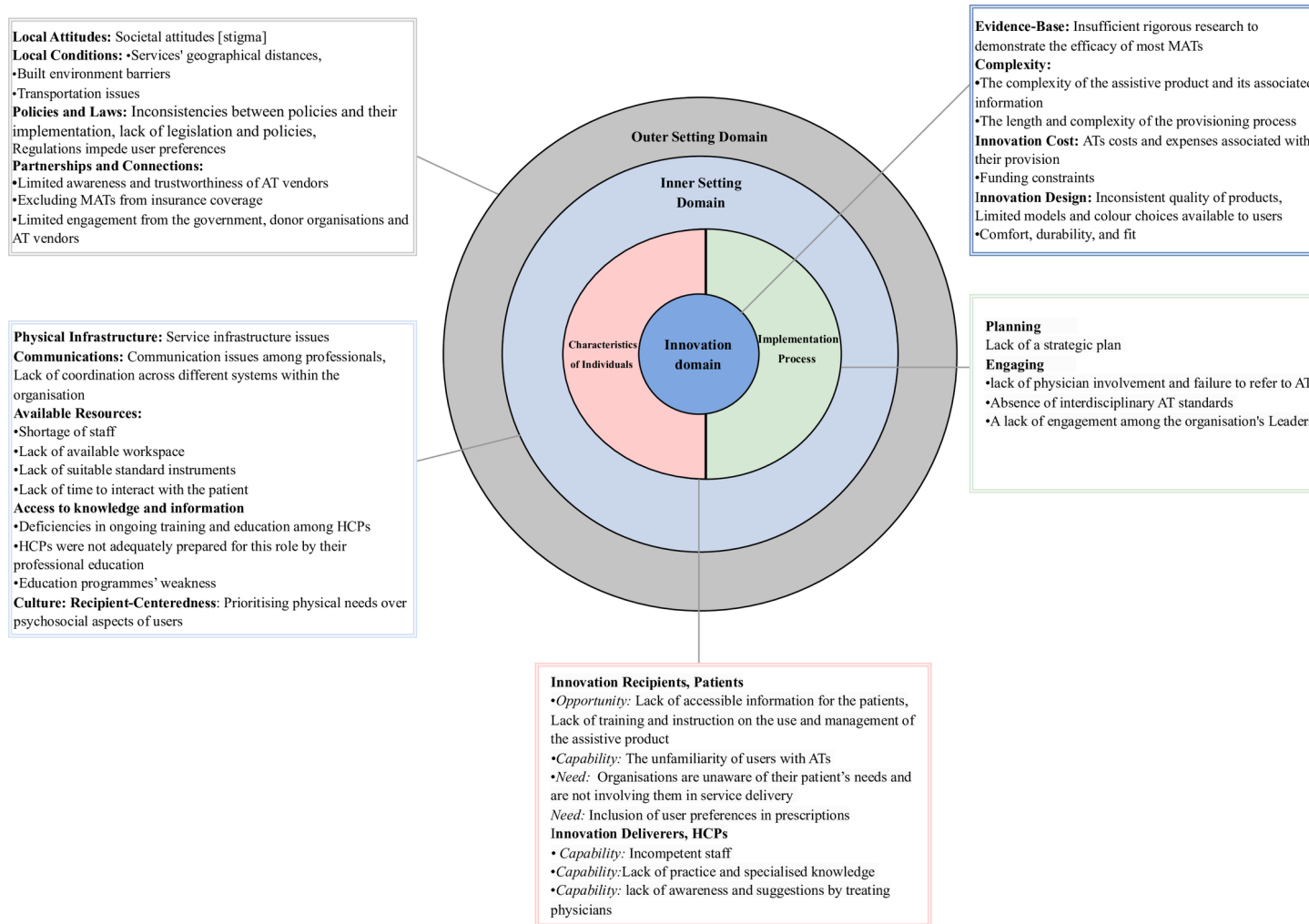


Figure 2.2 Barriers to the provision of mobility-assistive technologies (MATs) synthesised using the Consolidated Framework for Implementation Research

2.3.3 Theories, models and frameworks (TMF) synthesis

The propositions derived from the theories, models, and frameworks are described in Appendix 4, and the resulting synthetic model is presented in Figure 2.3.

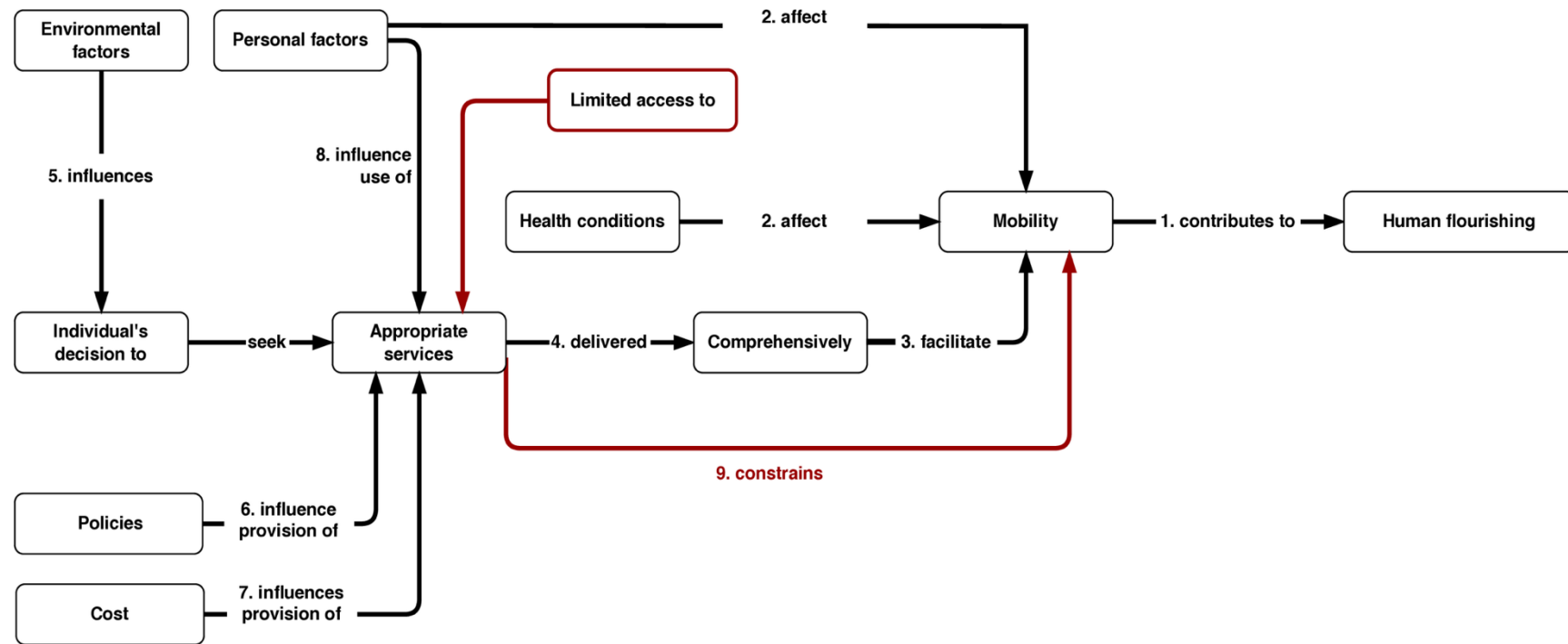


Figure 2.3 Synthetic model

2.3.3.1 Proposition 1: Mobility contributes to human flourishing

The ICF framework highlights activity as a key component of health, with disabilities resulting from restricted activities, such as mobility issues (WHO, 2001). This affects participation in everyday activities, such as work, socialisation, and healthcare access (WHO, 2001). The HAAT model explains a similar concept, describing the 'activity' as the action of performing a task that represents the functional outcome of human performance (Hussey and Cook, 1995). Building on these insights, 'mobility' is viewed as an individual's ability to perform tasks that enable meaningful participation. The HAAT model and IMPACT² emphasise the importance of participation in everyday activities, such as working and socialising, for overall health (Hussey and Cook, 1995; Smith, 2011), describing it as "necessary to human existence" (Hussey and Cook, 1995). According to the HAAT model, humans are defined based on their intrinsic physical, cognitive, and emotional abilities (Hussey and Cook, 1995). Accordingly, mobility is viewed more as a necessary means of meaningful participation than an end to the development of physical, cognitive, and psychosocial skills throughout life (Layton, 2012; Jindal *et al.*, 2018).

2.3.3.2 Proposition 2: health conditions and personal factors influence mobility

An individual's mobility is influenced by health and personal factors, which, in turn, affect their participation in social, work, and leisure activities. For example, the ICF framework clearly describes how health issues and personal factors can affect activities and participation (WHO, 2001) and describes health conditions as umbrella terms for diseases, disorders, injuries, or trauma (WHO, 2001). Similarly, the HAAT model highlights the impact of a person's physical and cognitive abilities and personal elements, such as emotional and psychological factors, on their ability to perform activities (Jindal *et al.*, 2018). Accordingly, 'personal factors' that encompass elements, such as psychological attributes, age, and coping style influence an individual's ability to perform activities (WHO, 2001). For example, Dwyer and Mulligan (Dwyer and Mulligan, 2015) highlighted how emotional changes caused by spinal cord injury (SCI) could impede participation in rehabilitation services and other areas of reintegration, such as employment and leisure activities.

2.3.3.3 Proposition 3: appropriate services influence mobility

The ICF and HAAT models explicitly describe the relationships between the activities and their environments. Both emphasise the importance of activities for participating in and

developing in life, and some interventions can improve a person's ability to engage in the desired activities (Hussey and Cook, 1995; WHO, 2001). For instance, in the ICF framework, AT services are considered to be an environmental factor, which is appropriate for helping individuals achieve their intended activities and participate in various situations (WHO, 2001). Similarly, the MPT model was developed considering the ICF framework and focusing on the relationship between individuals and AT (Lenker and Paquet, 2003). This suggests that AT is an essential means of bridging the gap between an individual's capabilities and the demands of tasks in their environment, thereby significantly enhancing their engagement in the desired activities (Oskar *et al.*, 2011). Levesque's framework, building upon the foundational work of Penchansky and Thomas, identifies that 'the appropriateness of a service' is determined by its alignment with the needs of the client, whereas the HAAT and MPT models emphasise that with AT, an individual's capabilities are increased (Hussey and Cook, 1995; Oskar *et al.*, 2011; Levesque, Harris and Russell, 2013; Nabizadeh *et al.*, 2023). Consequently, to meet individual needs and maximise capabilities, we define the appropriateness of services based on the extent to which they are tailored. This demonstrates that MATs are vital for people with disabilities and for older people who require them, thus enhancing their independence and participation in daily life (Layton, 2012; Jindal *et al.*, 2018).

2.3.3.4 Proposition 4: service delivery must be comprehensive to influence human mobility

Institutional factors significantly influence individual activities, as explained by the HAAT model (Hussey and Cook, 1995) and ICF frameworks (WHO, 2001). Levesque's framework emphasises the importance of how services are provided to meet client needs (Levesque, Harris and Russell, 2013), whereas Penchansky and Thomas highlight the necessity of adequate resources, including staff, to ensure that these needs are effectively met (Nabizadeh *et al.*, 2023). Similarly, the IMPACT² model is concerned with providing services and ensuring that outcomes are met, including QOL, participation, and satisfaction with the services provided (Smith, 2011). The MPT model demonstrates that user satisfaction with service provision can be achieved by considering key features of products such as usability, quality, weight, stability, and safety (Oskar *et al.*, 2011). Accordingly, the concept of 'comprehensive services' refers to providing clients with high-quality products and the necessary support services to meet their needs and achieve satisfaction. Providing comprehensive services encompassing assessment, training, and maintenance is crucial for

enhancing personal mobility (Hammel *et al.*, 2013; Gowran *et al.*, 2021). Effective delivery of AT services requires well-trained personnel (Gowran *et al.*, 2021). These are critical components of service delivery systems that help individuals enhance their mobility.

2.3.3.5 Proposition 5: environmental factors influence individuals' decision to seek appropriate health care services

Assistive products for mobility and participation are influenced by environmental factors such as social, cultural, and physical environments, which affect individuals' health and well-being. The ICF framework views disability as a health experience arising from context and not solely within an individual (WHO, 2001). It emphasises how society can create barriers such as inaccessible services or neglected facilitators, such as the lack of AT (WHO, 2001). Furthermore, an individual's level of functioning is determined by their relationships with family, people, and healthcare providers, all of which can influence their decision to seek healthcare (WHO, 2001). A similar concept of how society affects activities is highlighted by the HAAT model, which places particular emphasis on an individual's cultural context (Hussey and Cook, 1995). The MPT model also emphasises the role of sociocultural factors, acknowledging how a user's social setting and cultural attitudes towards disability can influence their perception of and adoption of mobility products. This includes consideration of product-related social implications and stigmas (Oskar *et al.*, 2011). For example, parents of children with disabilities oppose wheelchairs because of social stigma (Jindal *et al.*, 2018), and some older people perceive mobility products negatively because of stigmatising symbolism (Bhidayasiri *et al.*, 2022). This demonstrates the significant influence of sociocultural factors, such as support and relationships from family, health professionals, and community on MAT accessibility and acceptance. Furthermore, the MPT model emphasises the importance of the physical environment, which includes both the built environment within the user's home and the external surroundings, in affecting use and acceptance (Oskar *et al.*, 2011). For example, if a wheelchair does not fit the physical and psychosocial environment in which it is used, it is more likely to limit function rather than enhance it (Oskar *et al.*, 2011). Therefore, the success of MAT is not measured solely by its technical features but also by its ability to fit into the user's psychosocial context (Oskar *et al.*, 2011).

2.3.3.6 Proposition 6: policies influence the provision of services

The SDM framework highlights how organisational service delivery policies influence appropriate service provision (WEI, 2012), whereas the ICF explains how policies affect

participation and activities (WHO, 2001). As part of the ICF, the term 'policy' is commonly used within the environmental factor domain as an external factor that can impact an individual's health and function (WHO, 2001). This set of guidelines, rules, and regulations governs the range of services provided to individuals, including policies and standards that define the eligibility criteria for services (Widehammar *et al.*, 2020). For instance, prostheses are not considered to be life-saving medical devices or crucial components of the healthcare system (Gonçalves Junior, Knabben and Luz, 2017). However, they are life-changing for users and can quickly restore most functions (Gonçalves Junior, Knabben and Luz, 2017). Levesque's framework argues that the availability of health services should ensure those in need can access either the physical facilities or healthcare personnel (Levesque, Harris and Russell, 2013). However, barriers to access emerge when healthcare is unavailable in certain geographic areas or when individuals' insurance does not cover the necessary treatments (Levesque, Harris and Russell, 2013; Nabizadeh *et al.*, 2023). Penchansky and Thomas further emphasised the need for a well-organised supply of resources, including the integration of telephone or remote service consultations (Nabizadeh *et al.*, 2023). The lack of such accommodations can prevent individuals from obtaining the required healthcare, potentially leading to adverse health outcomes. Disparities between government and institutional policies can result in confusion among AT providers and decrease service utilisation (Seymour, Geiger and Scheffler, 2019; Gowran *et al.*, 2021).

2.3.3.7 Proposition 7: cost influences the provision of appropriate services

The SDM framework (WEI, 2012) highlights the significant influence of economic factors on service delivery and reinforces the idea that costs can significantly influence access to healthcare services. The term 'cost' refers to the expenses incurred by individuals and healthcare systems to provide services (Smith, 2011; Levesque, Harris and Russell, 2013). This comprises the direct prices of services such as consultation fees, product costs, and related expenses (Levesque, Harris and Russell, 2013). For instance, the IMPACT² model underlines the role of cost implications in selecting intervention approaches and demonstrating the cost effects at each stage of AT provision (Smith, 2011). Both Penchansky and Thomas (Nabizadeh *et al.*, 2023) and Levesque *et al.* (Levesque, Harris and Russell, 2013) emphasised the critical role of an individual's financial capacity, including income and willingness to pay, in accessing healthcare. Therefore, costs can significantly influence access to AT.

2.3.3.8 Proposition 8: personal factors influence healthcare utilisation

Healthcare utilisation is influenced by various 'personal factors' that represent an individual's internal aspects, such as psychological characteristics (WHO, 2001). This concept is explained using Levesque's framework. It highlights factors such as an individual's need for care, awareness of these needs, and desire for treatment (Levesque, Harris and Russell, 2013). Gibson's affordance theory suggests that an individual's perception of their environment is based on its potential to fulfil their needs, thereby shaping their decisions (Gibson, 2014). Therefore, the individual is responsible for unravelling the utility presented by affordance. For instance, the client in Mairami *et al.* (Mairami *et al.*, 2018) adapted a chair from a home to a wheelchair. This demonstrates how the client's perception of their environment shaped their recovery when an existing structure was found to have assistive potential. The ICF model explains the significance of environmental factors, such as the visibility of services, in determining an individual's level of functioning (WHO, 2001), which is related to Gibson's affordance theory, in which environmental cues trigger actions (Gibson, 2014). Consequently, the lack of service limits the activities that can be conducted. Personal factors not classified within the ICF are acknowledged to have a significant impact on healthcare access (WHO, 2001). The MPT model highlights that the choice of assistive products is deeply personal and shaped by individual aspirations, anticipated satisfaction of needs, and perceived personal value of these products (Oskar *et al.*, 2011). These elements play a crucial role in influencing the uptake of MATs, as they are associated with the context of users' lives (Oskar *et al.*, 2011).

2.3.3.9 Proposition 9: limited access to healthcare services creates disability

The ICF acknowledges the influence of environmental factors on disability development and emphasises the limitations it imposes on individuals' abilities to access healthcare services and engage in social activities (WHO, 2001). As defined by the ICF, disabilities include impairments, limitations in activity levels, and restrictions on participation (WHO, 2001). Consequently, restricted AT accessibility impairs body function, hinders participation, and contributes to disabilities. The SDM framework explains the significance of economic factors, particularly the "lack of economic means", which limit access to services such as MAT (WEI, 2012). Restricted access can trigger continuous cycles of disabilities and poverty (Gowran *et al.*, 2021). Persistent mobility constraints, whether due to inadequate MAT service support or diminished participation in daily life, have been identified as significant

factors leading to disability (Seymour, Geiger and Scheffler, 2019; Dorjbal *et al.*, 2020).

2.3.4 Gaps analysis

This review highlights key research areas in AT services that warrant further investigation (Appendix 5). Investigations should focus on AT access in remote regions (Layton, 2012; Jindal *et al.*, 2018; McIntyre, Cleland and Ramklass, 2021), examine gender disparities in service accessibility (Nabizadeh *et al.*, 2023), explore stakeholder perspectives on rehabilitation services and barriers to AT access (Seymour, Geiger and Scheffler, 2019; McIntyre, Cleland and Ramklass, 2021; Serres-Lafontaine *et al.*, 2023), and address challenges related to funding, policy, and legislation (Oskar *et al.*, 2011; Dwyer and Mulligan, 2015; Arthanat, Elsaesser and Bauer, 2017; Mairami *et al.*, 2017; Dorjbal *et al.*, 2020; Gowran *et al.*, 2021; Serres-Lafontaine *et al.*, 2023). Data collection and methodological enhancements are required, including standardised instruments for assessing functioning and disability (Gonçalves Junior, Knabben and Luz, 2017; Widehammar *et al.*, 2020), comparisons of user experiences with and without AT (Hammel *et al.*, 2013; Steel and Layton, 2016), and comprehensive evaluation tools combining objective and subjective measures (Hammel *et al.*, 2013; Steel and Layton, 2016). Emphasis should also be placed on understanding the in-country perspectives, inclusive solutions, and the impact of contextual factors on AT access (Gowran *et al.*, 2021). This involves evaluating how new products impact workplace settings and determining which types of AT are essential (Oskar *et al.*, 2011). Future studies should examine product compatibility, enhance user skills, and improve accessibility to the built environment (Smith, Sakakibara and Miller, 2016). Addressing these research gaps could contribute to the development of more effective, inclusive, and accessible AT services for individuals with disabilities.

2.4 Discussion

This scoping review offers a summary of the barriers to MAT provision and synthesis theories to guide future work based on 18 articles. The synthesised theory emphasises that mobility contributes to human flourishing (Proposition 1) and that certain health conditions may impose restrictions on mobility (Proposition 2). This impact can be ameliorated by two direct determinants: the provision of suitable services (Proposition 3) and their comprehensive provision (Proposition 4). Policies (Proposition 6) and costs (Proposition 7) indirectly influence these services. Furthermore, an individual's decision to access these services is determined by their environment (Proposition 5) and personal factors (Proposition

8). If these direct and indirect determinants are not effectively addressed, it could result in limited access to MATs and subsequent disability (Proposition 9). This synthesised theory integrates empirical and ethical dimensions and provides evidence-based approaches to solving problems (Fawcett, 1999a).

To the best of our knowledge, this is the first report on the synthesis of TMFs and the barriers to MAT provision. Although De Alves and Matsukura's (2016) literature review outlined the various theoretical models used in the AT literature, they did not attempt theoretical synthesis. TMFs organise concepts and thoughts to provide insights into different elements of practice and research (Nilsen, 2015). Lakatos proposes that scientific enquiry should appraise a series of theories rather than a single theory, noting that “the members of such series of theories are usually connected by a remarkable continuity which welds them into research programmes” (Lakatos, 1970). Lakatos advocated for a 'pluralistic model' of scientific theories, in which several theories, which are organised deductively to varying degrees, are brought together in a unified approach (Lakatos, 1970). Unlike Lakatos, we view this study as an enhancement of problem-solving effectiveness (Long, 2013). By combining propositions from different theories, we increased the coverage of the resulting syntheses of individual theories. It should predict the range of barriers encountered in MAT access and provision.

The theory covers a socially significant issue given that it addresses the current research priorities identified by expert panels organised by government agencies and clinical speciality organisations (Alqahtani *et al.*, 2021; Best *et al.*, 2021; Satpute *et al.*, 2021; WHO, 2022). It addresses the phenomenon of interest to rehabilitation scholars by filling the gaps in the existing TMFs. Although the MPT model does not explicitly discuss barriers to AT access, it provides valuable insights into the interactions between the personal, technological, and environmental factors that influence successful AT adoption (Oskar *et al.*, 2011). The MPT model, developed based on the ICF framework (Lenker and Paquet, 2003), highlights the importance of aligning assistive products with user needs, preferences, and contexts to optimise functionality and satisfaction. Future research should further explore how the MPT model can inform strategies to address barriers to access and provision of MAT.

When examining specific elements of the synthesised theory more critically, the framing of mobility in Proposition 1 as 'contributing to human flourishing' reflects careful consideration of diverse perspectives on disability and participation. While the ICF framework recognises

mobility-related activities as important components of participation (WHO, 2001), and the HAAT model emphasises that activities are necessary for human existence (Hussey and Cook, 1995), individuals with mobility limitations can and do achieve fulfilling lives through alternative means, adaptations, and supports (Shakespeare, 2013). This framing aligns with perspectives in disability studies that caution against deficit-based framings which position disability primarily as a limitation or lack, rather than recognising the role of social, environmental, and attitudinal barriers (Shakespeare, 2013). This framing recognises that whilst multiple pathways to flourishing exist, mobility remains a significant contributor to participation, independence, and QoL, thus emphasising the importance of MATs in facilitating these outcomes for individuals with mobility limitations.

An adequate specification was achieved by providing a clear and concise overview of the theoretical synthesis. In addition, we establish linkage adequacy by defining the concepts and their relationships (Fawcett, 1999b). The theory is testable because it contains observable concepts and propositions that can be operationalised and corroborated in empirical research. A limitation of the scoping review was the exclusion of non-English language studies, which could limit the applicability of the findings; research from other languages could have offered additional valuable insights (Stern and Kleijnen, 2020). Another limitation is that the review's focus on studies from 2000 to 2024 potentially omitted earlier relevant research on barriers and TMF. However, a broader historical scope may have reduced the relevance of the findings to contemporary decision-making in the provision of AT. The exclusion of grey literature, including government reports and policy documents, further narrowed the scope of the review. This exclusion may have resulted in the omission of relevant non-peer-reviewed TMFs. In addition, the processes of data extraction, coding using CFIR, and synthesis inherently involve subjectivity. Our search strategies and the databases selected may not have captured all relevant literature pertaining to other important TMFs that have been used to understand barriers to MAT access, such as the Student, Environment, Tasks, and Tools (SETT) (Zabala, 1995) and the Wisconsin Assistive Technology Initiative (WATI) (Wisconsin Assistive Technology Initiatives, 2003). Despite using SETT and WATI as search terms, these terms yielded no results in the databases we explored. This could indicate a lack in the literature where these frameworks are applied or reported in relation to barriers to MAT access, which requires further investigation. Search terms such as 'service delivery,' 'service*', 'deliver*,' and additional or alternative terms for older people, such as 'older person*' or 'older adult*,' may have identified additional studies.

Our review highlights several key knowledge gaps regarding MAT access and provision. These include the need for research on AT access in remote regions, stakeholder perspectives on barriers and enablers, funding and policy challenges, and the impact of contextual factors (Layton, 2012; Dwyer and Mulligan, 2015; Arthanat, Elsaesser and Bauer, 2017; Mairami *et al.*, 2017; Jindal *et al.*, 2018; Seymour, Geiger and Scheffler, 2019; Gowran *et al.*, 2021; McIntyre, Cleland and Ramklass, 2021; Serres-Lafontaine *et al.*, 2023). Methodological improvements such as the adoption of standardised instruments and the incorporation of user satisfaction measures are also needed to advance the field (Hammel *et al.*, 2013; Steel and Layton, 2016; Gonçalves, Knabben and Luz, 2017; Widehammar *et al.*, 2020). Importantly, the widely used ICF framework does not include personal factors that play a crucial role in MAT access (WHO, 2001). Future research should address these gaps to provide a more comprehensive understanding of the determinants of access to MAT. Figure 2.3 and Appendix 3 provide overviews of the identified barriers and the TMFs used in the included studies, respectively. Although no single model can fully capture the complexity of MAT access, researchers and practitioners should consider the strengths and limitations of each TMF and select the most appropriate one(s) based on specific research questions and contexts.

The insights from this review and the resulting integrated model have the potential to influence clinical practice and policymaking in line with the ethical imperatives outlined by the WHO and the UN (UN, 2007; WHO, 2022). These organisations have emphasised the necessity of AT to meet individual needs and enable equitable opportunities for people with disabilities. The synthesised theory aligns with the principles of access to AT as advocated by the WHO and UNICEF, highlighting the necessity for assistive products and services to be reachable, affordable, adaptable to individual needs and environments, culturally appropriate, and of high quality. By addressing the direct and indirect determinants of access, as identified in the theory, including service provision, policies, costs, personal preferences, and physical, social, and cultural factors, we can align better with these global principles (WHO, 2022). These factors are important and have also been linked to the abandonment or discontinuance of using mobility products (Lauer, Longenecker Rust and Smith, 2006; Emmel, Manzini and Mendes, 2016; Sugawara *et al.*, 2018). For example, difficult interactions between users and their products, as well as difficulties with the environment in which users live, could contribute to product discontinuance (Lauer, Longenecker Rust and Smith, 2006). Therefore, this review proposes a theoretical basis for reforming the existing system to align it with

international standards, thus addressing the pressing and unmet needs more equitably and personally to ensure successful access to and use of AT. To achieve this, future research must examine these determinants, understand the barriers to MAT provision, and plan and evaluate strategies to enhance its provision. Having a set of determinants organised around the CFIR (Damschroder *et al.*, 2022b) allows the creation of local implementation strategies to suit different policy jurisdictions.

There is a consensus (Powell *et al.*, 2015) and evidence-based approach (Powell *et al.*, 2019) to overcome the barriers to effective AT provision found in this review. The barriers identified by the CFIR can be linked to Expert Recommendations for Implementing Change (ERIC) strategies (Waltz *et al.*, 2019), which will be explored further in Chapter 6. These strategies guide the selection of implementation methods to mitigate barriers and include (1) activating local clinical leaders or champions, (2) providing educational materials, (3) organising meetings, and (4) implementing outreach or ongoing training. The implementation of these strategies can assist decision-makers in making informed choices regarding the selection of strategies for MAT provision.

2.5 Conclusion

The synthesised theory emphasises that mobility is a crucial aspect of human life and certain health conditions may restrict mobility. Providing comprehensive and appropriate services can reduce this impact; however, cost and policy decisions regarding these services affect their provision. Accessibility to these services is also affected by environmental and personal factors. This knowledge can be used to develop strategies to enhance provision.

2.6 Chapter summary

This scoping review fulfilled the first objective of the thesis. The review synthesised TMF, identified key determinants and highlighted knowledge gaps in the current literature. The findings informed the development of the qualitative study (Chapter 4), specifically in enhancing the interview guide that was designed based on the CFIR constructs, where the identified barriers, particularly the personal and cultural factors affecting MAT uptake, were incorporated as prompt questions under CFIR's innovation recipient characteristics domain (Chapter 4, Section 4.2.5.1). These CFIR-categorised barriers also provided a foundational structure for triangulating the findings, resulting in an overview of MAT provision barriers (Chapter 5, Section 5.3.1) and targeted ERIC implementation strategies (Chapter 5, Section

5.3.2). The next chapter addresses the second objective of this thesis by presenting a survey study that outlines MAT availability in Saudi Arabia's healthcare system. This survey facilitated participant recruitment and maximum variation sampling for the subsequent qualitative study (Chapter 4).

Chapter 3: A Survey Study of Mobility Assistive Technologies Provision in Saudi Healthcare Settings

3.1 Introduction

This chapter addresses the second objective of this thesis, as outlined in Chapter 1, Section 1.10. It presents a survey study designed to provide an overview of MAT availability in Saudi Arabia's healthcare system and facilitate participant recruitment for the subsequent qualitative study (Chapter 4). The scoping review in Chapter 2 provided a theoretical foundation for understanding barriers to MAT provision and its determinants, demonstrating a significant global unmet need for MATs. However, as detailed in Chapter 1, Section 1.4.2, Saudi Arabia is characterised by a lack of information on the barriers to the provision of MATs and unmet needs, as service provision varies significantly among countries. Therefore, this survey study examined MAT provision across three hospitals in two Saudi Arabian regions.

The chapter presents the survey methodology (Section 3.2), findings regarding MAT provision across hospitals and within individual hospitals (Sections 3.3.2 and 3.3.3), and their implications for MAT provision in Saudi Arabia (Section 3.4).

3.2 Method

3.2.1 Study design and setting

A descriptive cross-sectional online survey was conducted between January and July 2023. This study followed the Checklist for Reporting Results of Internet E-Surveys reporting guidelines (Eysenbach, 2004; Eysenbach, 2012). The study covers three government (public) hospitals in two main Saudi Arabian geographic regions: Riyadh (central region) and Dammam (eastern region). A comprehensive list of hospitals offering rehabilitation services across Saudi Arabia was identified from previously published studies (Al-Jadid, 2013; Al-Sobayel *et al.*, 2014). As outlined in Chapter 1, Section 1.5.2, MAT services are integrated within rehabilitation services provided at the Saudi healthcare system's tertiary and quaternary levels, which comprises three main sectors: the MOH as the primary provider, other government agencies and the private sector. Three hospitals were selected based on their governance type, service range and geographical location. The selection included two MOH hospitals – one in Riyadh and one in Dammam – and one operating under a different government agency located in Riyadh. This purposive selection approach was informed by the goal of maximising knowledge gained (Yin, 2018), with personal contacts and prior

knowledge contributing to identifying these hospitals as representative cases for the study.

Table 3.1 summarises the key characteristics and selection criteria for each hospital.

Hospitals are identified as hospitals A, B and C for confidentiality purposes. While MOH hospitals are identified as such due to the large number of MOH facilities, other government healthcare institutions are not specifically named to maintain institutional anonymity.

Table 3.1 Summary of hospital characteristics and selection criteria

Hospital ID	Hospital A	Hospital B	Hospital C
Governance Type	Ministry of Health (MOH)	Non- MOH Government Hospital	MOH
Funding Model	Government	Government	Government
Location	Riyadh	Riyadh	Dammam
Patient Types	All levels of healthcare.	All levels of healthcare. Eligibility: Employees, their families and emergencies.	All levels of healthcare.
Availability of Rehabilitation Unit	Rehabilitation hospitals provide comprehensive rehabilitation care.	The rehabilitation department covers basic rehabilitation needs.	The rehabilitation department covers basic rehabilitation needs.
Eligibility Concerning Mobility Assistive Technology (MAT)	The patient must be admitted as an inpatient on their first admission; otherwise, they need a referral to the Ministry of Human Resources and Social Development. Without that, patients must pay out-of-pocket.	Patients must be affiliated with the hospital to be eligible. Non-eligible and outpatients need a referral to the Ministry of Human Resources and Social Development. Patients must pay out-of-pocket if funding is unavailable.	Basic MAT devices such as canes, crutches and walkers are provided. Others, like wheelchairs, require assessment and referral to the Ministry of Human Resources and Social Development. Without that, patients must pay out-of-pocket.
Assistive Technology Unit Role	Facilitates provision through the hospital, Ministry of Social Services, or self-finance.	None	None

3.2.2 Participants and recruitment

The eligible participants were HCPs, managers and leaders involved in providing MAT services (Table 3.2). No exclusion criteria were applied. The scoping review findings (Chapter 2, Section 2.3.4), which highlighted the importance of understanding barriers from multiple perspectives, further supported the selection of diverse stakeholders across different settings. This approach ensured a comprehensive representation of key stakeholders involved in MAT provision.

Table 3.2 Roles and descriptions of the eligible participants

Roles	Descriptions
Healthcare Professionals (HCPs)	Individuals who provide mobility assistive technology (MAT) services. This includes occupational therapists (OTs), physiotherapists (PTs) and AT specialists.
Clinical Managers	Individuals who directly supervise HCPs involved in providing MAT services.
Administrative Managers	Individuals involved in budgeting, coordination and other administrative roles related to providing MAT.
Leaders	Individuals with higher levels of authority who are involved in decision-making processes related to providing MAT services.

The researcher approached rehabilitation management offices from each site, explained the study's purpose and asked permission to send eligible participants an invitation email, an information sheet and a link to the survey. The information sheet described the purpose of the survey, the estimated time for completion (five minutes), the data storage plan and the contact information. The researcher approached leaders and administrative managers individually, explained the purpose of the research and sent invitation emails containing the information sheet and the survey link. Leaders and administrative managers were asked if they were interested in voluntarily participating in the survey.

Answers to the survey were accessible only to the researcher. The recruitment period lasted over seven months (January–July 2023). Participants were not reimbursed for their participation in the survey. The survey was unadvertised. A follow-up call with hospital rehabilitation management offices was initiated two to four weeks after the initial e-mail was sent to request that they send a reminder email to potential participants.

3.2.3 Data collection

3.2.3.1 Survey

The online survey (Appendix 6) was administered with Qualtrics software (Qualtrics, Provo, UT) under the University of Sheffield licence. Because no previously validated tools were available for this purpose, the researcher developed the questionnaire based on the WHO Assistive Priority List (APL) and literature on MAT benefits (as discussed in Chapter 1, Section 1.3.2). The APL document provides a list of priority ATs that can improve QoL for people with disabilities (WHO, 2016). Drafts of the survey were piloted with an experienced UK physiotherapist before distributing the main survey. Response options were modified to enhance clarity. Specifically, items employing a 3-point Likert scale were refined by explicitly defining the Yes/No options ('Yes' = accessible, 'No' = not accessible), and an additional response category ('I don't know') was incorporated to address potential uncertainty in participant responses.

The survey was in the English language. A total of 10 questions were included in the survey, designed to take less than five minutes to complete. The survey was divided into four sections. The first section asked the participants to confirm their consent to participate in the survey. A ticked consent form was required to be completed by survey participants before they could access the survey. This ensured informed participation and reduced the possibility of human error. The participant was not able to complete the survey without giving their consent. The second section contained demographic information, such as age, gender, position, education, experience and healthcare setting (number of questions = 6). If the participant was an HCP, the following section focused on their specialisation and profession (number of questions = 2). The third section focused on the MATs list, rated on a 3-point Likert scale (accessible, not accessible, unaware). Section four asked if they consented to be contacted for a semi-structured interview (number of questions = 1). Survey questions included forced-choice questions with open-ended options and a Likert scale. The online survey displayed one question per page and allowed respondents to return and review previous responses. Considering the survey distribution and target audience, multiple entries from the same participant were considered unlikely. Participants were only asked for their email addresses if they indicated they would be willing to participate in a follow-up interview.

3.2.4 Data analysis

The survey results were analysed using descriptive statistics within Qualtrics software and calculated as frequency counts and percentages of participants who responded to that question. The data were cross-tabulated to investigate differences between hospitals and survey questions related to the availability of MATs. Data were exported using a simple statistical tool (Microsoft Excel 2022, Redmond, WA, US).

3.2.5 Ethical considerations

3.2.5.1 Ethical approval

Ethical approvals for this study were granted by each participating hospital (for further details, please refer to Confidential Appendix 7). The University of Sheffield's Research Ethics Committee validated these review procedures for robustness. The protocol's approval letter was subsequently uploaded to ScHARR's University Research Ethics Committee for an alternative application and received approval (Reference: 28-09-2022).

3.3 Results

3.3.1 Participants

A total of 75 participants from three hospitals participated in the survey. Sixty-seven participants completed the entire survey, resulting in an approximate completion rate of 89%. However, eight respondents completed between 0 and 14% of the survey. These participants did not complete the demographic questions and were excluded. Data from the 67 respondents who fully completed the survey is used in this study (Table 3.3). Most respondents were HCPs, comprising 70% ($n = 47$). Most were OTs and PTs, with a significant representation from the neurology speciality. Leaders and managers constituted 28.4% ($n = 19$) of the participants. There were 51% ($n = 34$) male and 49% ($n = 33$) female participants. Most respondents ($n = 32$; 48%) were aged 31 to 40 and had a bachelor's degree ($n = 44$; 66%). Over 80% ($n = 54$) of the participants were from Riyadh and 34% ($n = 23$) were from Dammam, representing three public hospitals.

Table 3.3 Demographic characteristics of respondents ($n = 67$)

	Sample size (n) Frequency (%)
Hospital Leaders	8 (12%)
Chairperson, Department of Prosthetics and Orthotics	1 (1%)

Chairperson, Department of Physical Therapy	2 (3%)
Chairperson, Department of Occupational Therapy	1 (1%)
Chairperson, Department of Rehabilitation Technology	1 (1%)
Chief Executive Officer, Rehabilitation Hospital	1 (1%)
Director of Rehabilitation Services	2 (3%)
Clinical and Administrative Managers	11 (16%)
Rehabilitation Services Coordinator	1 (1%)
Clinical Supervisors	7 (10%)
Medical Equipment Coordinator	1 (1%)
Director of Budget Administration	1 (1%)
Supply Chain Management	1 (1%)
Healthcare professionals	47 (70%)
Occupational Therapist	25 (37%)
Physical Therapist	19 (28%)
Speech and Language Therapists	2 (3%)
Assistive Technology Specialist	2 (3%)
Healthcare professionals Speciality	
Paediatrics	8 (12%)
Geriatrics	3 (4%)
Cardiovascular and Pulmonary	2 (3%)
Neurology	13 (19%)
Orthopaedics	5 (7%)
Adult Rehabilitation	2 (3%)
Lymphedema	2 (3%)
Musculoskeletal	1 (1%)
Acute Care	2 (3%)
Burn Unit	1 (1%)
Assistive Technology	1 (1%)
Amputation and Neurology	1 (1%)
Paediatrics and Orthopaedics	1 (1%)
No Specific Speciality	5 (7%)
Gender	
Male	34 (51%)
Female	33 (49%)
Age Group (in years)	

21–30	22 (33%)
31–40	32 (48%)
41–50	11 (16%)
51–60	2 (3%)
Years of Experience in the Hospital	
< 5	18 (27%)
5–10	23 (34%)
11–20	21 (31%)
> 20	5 (7%)
Academic Qualifications	
PhD	2 (3%)
Master's	21 (31%)
Bachelor's	44 (66%)
Geographical Area	
Riyadh	54 (80%)
Dammam	23 (34%)
Healthcare Setting	
Hospital A (central region)	19 (28%)
Hospital B (central region)	25 (37%)
Hospital C (eastern region)	23 (34%)

3.3.2 Provision of MATs across participant hospitals

Results demonstrate differences in accessibility between different MATs (Figure 3.1). Basic MATs are widely available to patients in all participating hospitals. This includes manual wheelchairs (85%; $n = 57$), ankle-foot orthoses (AFO) (87%, $n = 58$), canes/sticks (91%; $n = 61$), elbow and axillary crutches (93%; $n = 62$) and walkers (96%; $n = 64$). However, the availability of advanced or specialised devices to patients is slightly lower. Participants reported that electrically powered wheelchairs were accessible to patients in 61% of cases ($n = 41$). Seven per cent ($n = 5$) of participants reported that manual power-assisted wheelchairs were available to patients, while only 1% ($n = 1$) indicated that mobility scooters were accessible. Additionally, only 31% ($n = 21$) of participants reported that their patients have access to reclining power wheelchairs, and 25% ($n = 17$) indicated that customised manual wheelchairs are available to their patients. Traditional lower-limb prostheses were reported to be accessible to patients by 58% of participants ($n = 39$), and 13% ($n = 9$) reported that microprocessor-controlled lower-limb prostheses were available.

Several participants reported being unaware of the availability of different MAT devices in their hospitals (Figure 3.1). Specifically, 28% of respondents ($n = 19$) were uncertain about carbon fibre AFOs and microprocessor-controlled lower limb prostheses, 33% ($n = 22$) about wearable powered exoskeletons, 31% ($n = 21$) about manual power-assisted wheelchairs, and 18% ($n = 12$) about manual wheelchair with postural support.

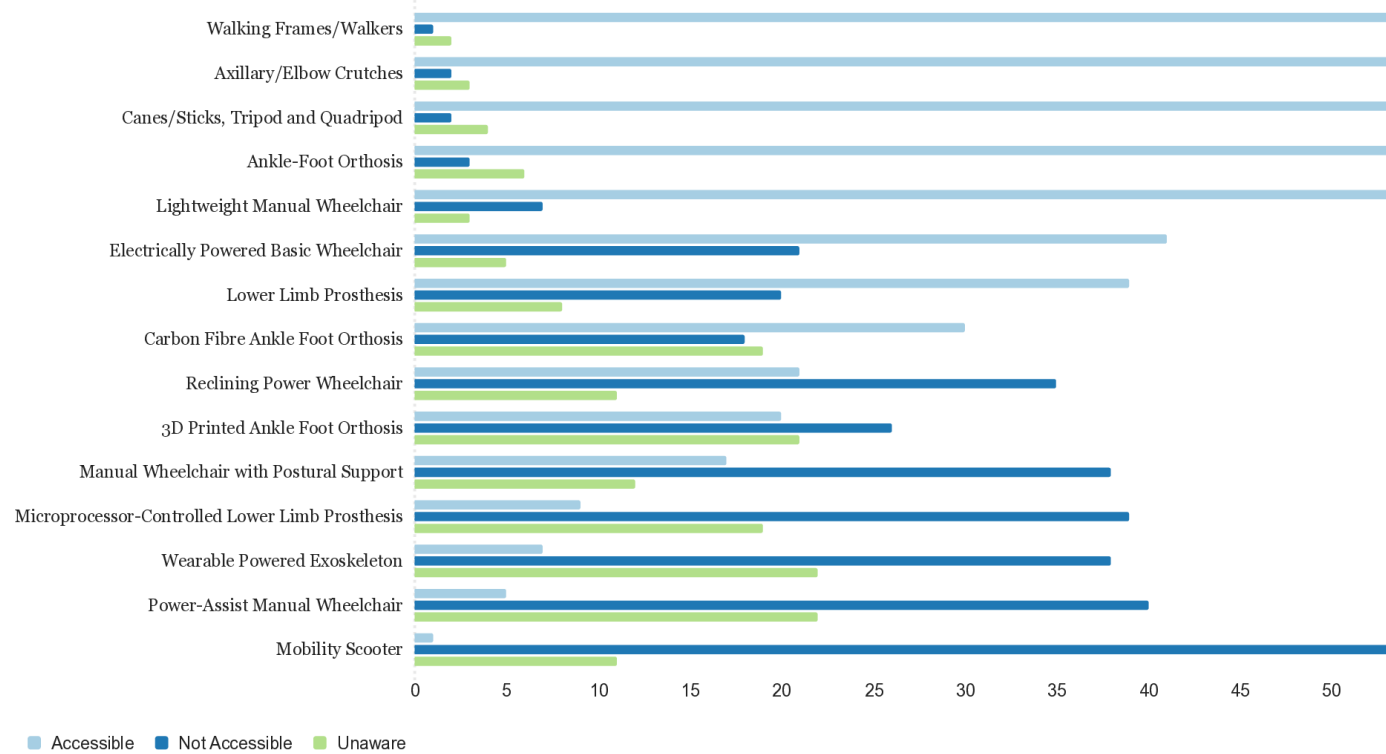


Figure 3.1 Accessibility to mobility assistive technologies (MATs) across participant hospitals

3.3.3 Provision of MATs in each hospital

MAT provision differs considerably between hospitals. The complete cross-tabulation results are provided in Appendix 8. This is particularly evident with devices such as electrically powered wheelchairs, lower limb prostheses, reclining power wheelchairs, carbon fibre AFOs and manual wheelchairs with postural support (Figure 3.2). Hospitals A and B in the central region demonstrated relatively high accessibility for electric wheelchairs, with 78.9% and 92%, respectively. The availability of the same device was notably lower in Hospital C (eastern region), at 13% (Figure 3.2 [a]). Additionally, the availability of traditional lower limb prostheses showed a noticeable difference. The accessibility rate for hospitals B and A in the central region was 80% and 84%, respectively. However, Hospital C (eastern region) reported a notably lower 13% accessibility (Figure 3.2 [b]).

Hospitals A and B in the central region have a high level of accessibility for carbon fibre AFO, with 68% and 48.0%, respectively. However, Hospital C in the eastern region has a lower accessibility level of 21% (Figure 3.2 [c]). The availability of reclining power wheelchairs is relatively high in hospitals A and B in the central region, at 36.8% and 48%, respectively. Hospital C in the eastern region has a notably lower availability rate of 8.7% (Figure 3.2 [d]).

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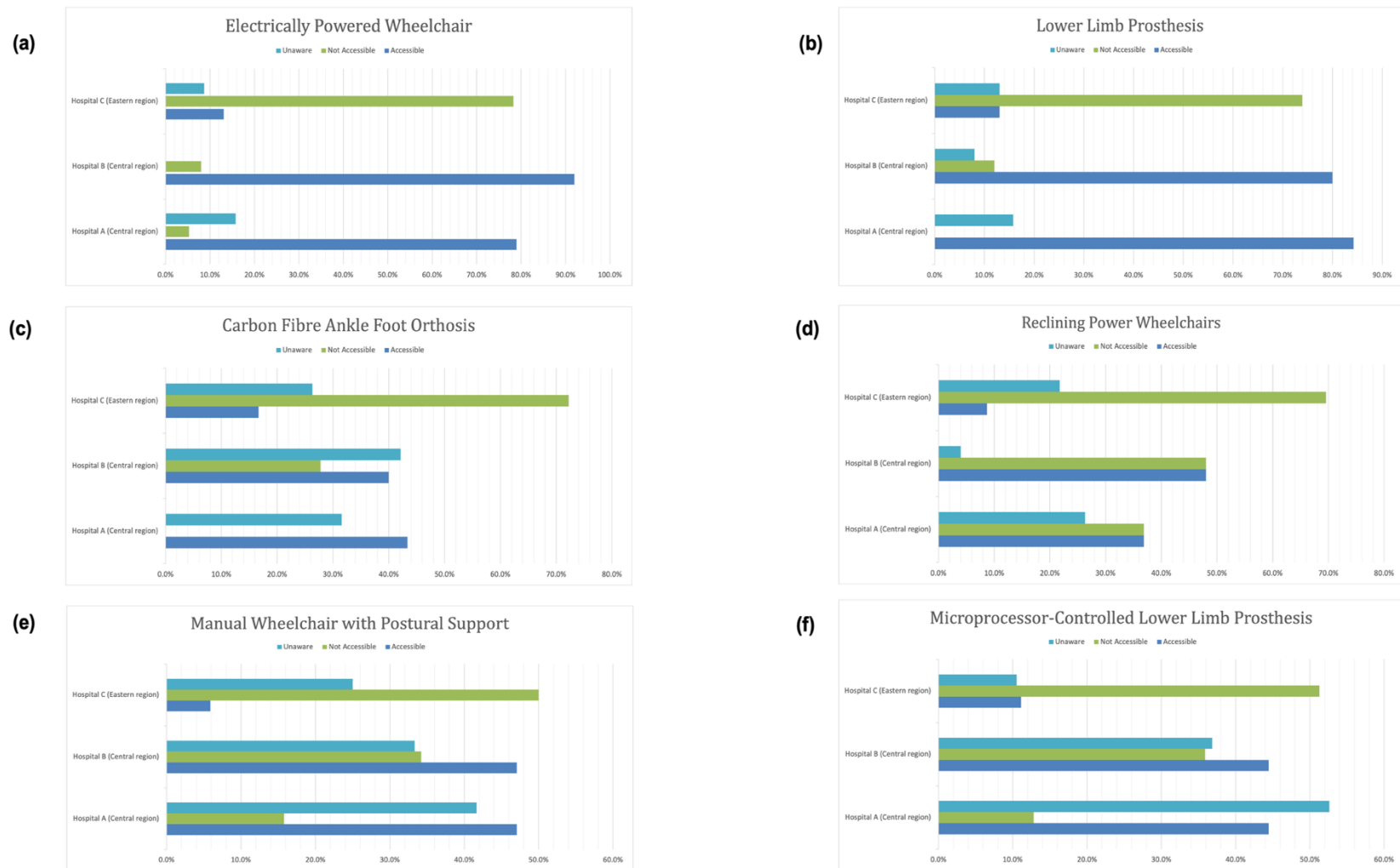


Figure 3.2 Accessibility to mobility assistive technologies (MATs) between participant hospitals

3.4 Discussion

This survey study provides insight into the current state of MAT provision in three government (public) hospitals located in two Saudi Arabian geographical regions. It is consistent with the WHO's recent attention to improving accessibility to MAT (WHO, 2022). Many basic MAT devices are readily accessible in all three hospitals studied, including lightweight manual wheelchairs, walkers, canes and crutches. There is, however, limited accessibility to advanced MATs, such as electric wheelchairs, lower limb prostheses and specialised wheelchairs, such as reclining power wheelchairs and wheelchairs with customisable postures. As discussed earlier (Chapter 1, Section 1.4.2), this limitation in access to advanced MATs is consistent with previous findings in Saudi Arabia, where services primarily focused on basic MAT devices. Similar patterns exist globally, where among individuals with mobility challenges, the adoption rates of electric wheelchairs and prosthetics remain notably low at less than 1%, while manual wheelchair utilisation reaches approximately 18% (Danemayer *et al.*, 2022).

Furthermore, a high percentage of respondents were unaware of the accessibility of certain MAT devices, including wheelchairs with customisable postures, microprocessor-controlled lower limb prostheses, carbon fibre AFOs, powered exoskeletons and manual power-assisted wheelchairs. This finding supports previous studies (Alqahtani, Cooper and Cooper, 2021) that have demonstrated that HCPs lack a comprehensive understanding of AT options, which impedes patients' ability to benefit fully from it. The lack of awareness observed in this survey may stem from multiple factors, including limited exposure to advanced MATs, insufficient training and lack of clear communication channels regarding available resources (Lee *et al.*, 2024; Mishra *et al.*, 2024). As Lee *et al.* (2024) highlighted, HCPs working in general clinical settings, which are less specialised rehabilitation settings, may have limited exposure to certain types of MATs, impacting their awareness and familiarity (explored further in Chapter 4).

3.4.1 Strengths and limitations

The main strength of this study is its inclusion of participants from diverse roles across three government (public) hospitals in two Saudi Arabian geographical regions. This diversity provides a broad perspective on MAT provision in the Saudi healthcare system, enabling insights from multiple stakeholder viewpoints and different institutional contexts.

However, several limitations should be considered when interpreting the findings. While two regions are represented, Saudi Arabia comprises 13 administrative regions with potentially unique healthcare landscapes and local policies. Therefore, findings may not represent practices throughout the country as a whole. A comprehensive discussion of these limitations is presented in Chapter 6, Section 6.4.

The study methodology presented additional limitations. The use of an online survey as the sole data collection method may introduce nonresponse bias (Wang and Cheng, 2020), where respondents and non-respondents may differ in key characteristics. This potential bias was combined by the inability to determine the exact number of participants who received the survey invitation, as distribution occurred through rehabilitation management offices. Without this baseline number, calculating a precise response rate was not possible, limiting the ability to assess the representativeness of the sample.

Furthermore, the survey was administered only in English, which is commonly used among HCPs in Saudi Arabia. However, this may have influenced participation or comprehension for respondents more comfortable in Arabic. The survey was piloted with a UK-based physiotherapist to assess clarity and structure, but no formal cultural adaptation process was undertaken. As a HCP familiar with the Saudi context, the researcher aimed to ensure the questions were contextually appropriate and aligned with local practices. Nonetheless, piloting the tool with Saudi-based practitioners may have helped identify culturally specific issues or interpretations, thereby improving its contextual relevance. Despite these limitations, the study has generated important insights and contributed new knowledge regarding MAT provision, which could inform HCPs and policymakers in designing interventions to improve MAT accessibility.

3.4.2 Implications for policy, practice and research

This study's findings aim to inform clinical practice and policymaking, potentially contributing to efforts aligned with WHO and UN ethical imperatives (UN, 2007; WHO, 2022). These organisations have stressed the importance of MAT in meeting individual needs and enabling persons with disabilities to have equal opportunities. While the results highlight areas for improvement, implementing changes would require action from healthcare and policy stakeholders. The survey findings suggest that policymakers should focus on increasing accessibility to a broad range of MATs, from basic to specialised, and promote

awareness of these resources. These changes could enhance clinical practice quality and ensure patient access to necessary mobility support. Future research should evaluate the challenges hospitals and clinicians face in providing these essential MATs and address the reasons for differences in service provision and awareness. A comprehensive discussion of these implications and detailed recommendations for clinical practice and policy development is presented in Chapter 6 (Section 6.2.2 and Section 6.5).

3.5 Conclusion

Basic MAT devices were found to be accessible in Saudi Arabian hospitals. There is, however, a reduction in accessibility to more advanced MATs, such as electrically powered wheelchairs, lower limb prostheses, customised manual wheelchairs, reclining power wheelchairs, microprocessor-controlled lower-limb prostheses and mobility scooters. There is also a noticeable difference in accessibility across hospitals. There is a need to improve advanced MATs' accessibility to better meet the needs of people with mobility-related disabilities. Future research should evaluate the challenges hospitals face in providing these essential services.

3.6 Chapter summary

This chapter addressed the second objective of this thesis by presenting the methods and results of a survey that targeted key stakeholders in MAT services within Saudi hospitals. The findings identified that basic MAT devices were generally accessible in Saudi Arabian hospitals. However, there is a notable reduction in accessibility to more advanced MATs. These results advocate for the need to enhance access to MATs and assess the challenges that hospitals experience in providing these services to better meet the needs of patients. This survey helped recruit participants for the qualitative study presented in Chapter 4. Additionally, based on the survey findings, the interview guide developed using CFIR was enhanced with prompt questions to explore reasons for low awareness (Chapter 4, Section 4.2.5.1). The next chapter addresses this thesis' third objective by exploring HCPs', managers' and leaders' perceptions of factors influencing MAT provision in Saudi Arabia through semi-structured interviews and document analysis.

Chapter 4: A Qualitative Study of Barriers to Mobility Assistive Technologies Provision in Saudi Healthcare Settings

4.1 Introduction

This chapter addresses the third objective of the thesis outlined in Chapter 1, Section 1.10, by presenting a qualitative study using semi-structured interviews with key stakeholders (HCPs, managers and leaders) and documentary analysis of reports, guidelines and policy documents related to MAT provision in Saudi healthcare settings.

Chapter 3 facilitated maximum variation sampling across different hospital types, professional roles and geographic locations for the semi-structured interviews. The survey findings (Sections 3.3.2 and 3.3.3) highlighted reduced accessibility to advanced MAT devices and service provision disparities among the surveyed hospitals. These findings align with previous evidence discussed in Chapter 1, Section 1.4.2, where MAT services in Saudi Arabia were predominantly limited to basic MAT devices. The significance of these findings is underscored by global policy frameworks and national initiatives previously addressed in Chapter 1, Section 1.3.1, including WHO and UN guidelines on MAT provision and Saudi Vision 2030's goals for healthcare accessibility (UN, 2007; Saudi Vision 2030, 2016; WHO, 2022).

Given these challenges in MAT provision and the need to develop evidence-based strategies to inform policy decisions, this qualitative study focused on understanding barriers from the perspectives of HCPs, managers and leaders, as these are key stakeholders who could influence provision, as detailed in Chapter 1, Section 1.8. The inclusion of diverse perspectives aligns with the pragmatic approach outlined in Chapter 1, Section 1.7 and is supported by the scoping review findings (Chapter 2, Section 2.3.4), which demonstrated the importance of understanding barriers from multiple stakeholder perspectives. The findings will establish a basis for identifying ERIC strategies to improve MAT provision (Powell *et al.*, 2015), which will be outlined in Chapter 5, Section 5.3.2. This chapter presents the qualitative study methodology (Section 4.2) along with findings regarding factors influencing MAT provision in Saudi Arabia (Section 4.3) and their implications (Section 4.4).

4.1.1 Study aim and objectives

This qualitative study aimed to investigate HCPs', managers' and leaders' perceptions of factors influencing MAT provision in Saudi Arabia through semi-structured interviews and document analysis. The key objectives of this study were as follows:

1. To describe the barriers influencing MAT provision in Saudi Arabia's public hospitals.
2. To compare the factors influencing the provision of MAT across three hospitals.
3. To compare the factors influencing the provision of MAT from the stakeholders' perspectives.

4.2 Methods

4.2.1 Study design

This qualitative study employed a multiple case study design with embedded units of analysis, consistent with Yin's (2012) principles (Figure 4.1). Case studies are particularly suitable when the phenomenon under investigation cannot be separated from its context (Yin, 2012), a broad concept encompassing not only a setting but also 'roles, interactions, and relationships' (Pfadenhauer *et al.*, 2017). This is relevant to the current study, where the factors affecting access to MAT can only be understood in terms of people's interactions, the organisations in which they are situated and the broader regulatory landscape in which they operate. A multiple case study design allows for the exploration of phenomena through comparison and contrast across different settings, yielding a comprehensive understanding by identifying both similarities and differences (Heale and Twycross, 2018; Yin, 2018).

In accordance with Yin's (2018) recommendation to employ more than one case to ensure robust findings, this study included three public hospitals in Saudi Arabia as individual cases. Within each case were three embedded units of analysis representing the stakeholder participants defined in Chapter 3, Section 3.2.2. These included frontline staff who provide MAT services, managers responsible for oversight and administration, and leaders with decision-making authority.

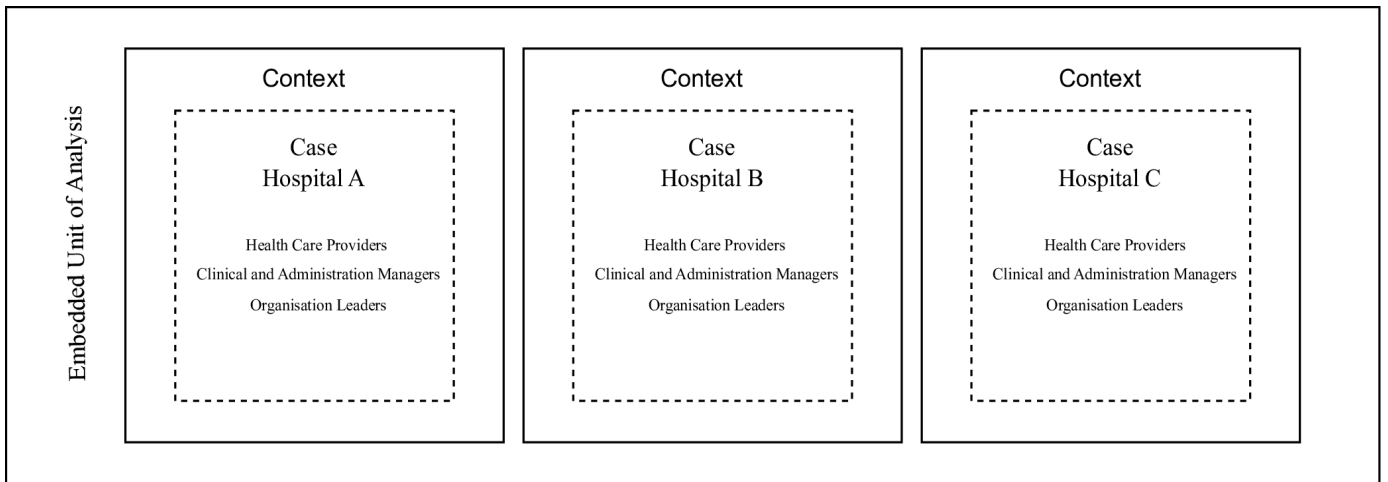


Figure 4.1 Multiple case designs with embedded units of analysis (adapted from Yin [2012])

A debate exists around whether adhering to a theoretical perspective could constrain the ability to make new discoveries (Yin, 2012). Nonetheless, theoretical frameworks often serve as invaluable tools, offering clear guidelines for data collection and analysis and shaping the research narrative (Yin, 2018). The CFIR, introduced as the guiding framework for this thesis in Chapter 1, Section 1.6.2, served as a comprehensive guide for both data collection and analysis in this qualitative study. This research work adhered to the Consolidated Criteria for Reporting Qualitative Research Checklist, which is a standardised guide to documenting qualitative research findings.

4.2.2 Study setting

As previously described in Chapter 3, Section 3.2.1, three hospitals were selected across two primary geographical regions in Saudi Arabia, as follows: Riyadh (central region) and Dammam (eastern region). The cases consist of two MOH hospitals – one in Riyadh and one in Dammam – and one hospital operating under a different government agency, also located in Riyadh. The rationale for selecting these hospitals, including considerations of governance type, service range and geographical location, is detailed in Chapter 3, Section 3.2.1.

4.2.3 Participant selection and recruitment

Of the 67 participants who completed the survey (Chapter 3, Section 3.3.1), 51 indicated their willingness to participate in follow-up interviews, while 16 declined to do so. To ensure diverse representation, the research employed maximum variation sampling, selecting participants across different roles, sites and characteristics. An invitation email was subsequently sent to these participants, offering a choice between face-to-face and online interviews according to their preference. Two reminder emails were subsequently sent to the participants at four-week intervals. To help identify additional suitable participants for the interview and to achieve data saturation, snowball sampling was employed. This method involved asking the interviewees to recommend other potential participants who could provide further insights into the study topic.

4.2.4 Sampling

Debate continues over the ideal sample size in qualitative research, which varies according to the study's overarching aim, objectives and questions. To address this, Saunders *et al.* (2018) identified four saturation models commonly used in qualitative research, as follows: theoretical saturation, data saturation, inductive thematic saturation and *a priori* thematic saturation. The current study's sampling aligned with the concept of data saturation, which involves continuing the interview process until no new information emerges, suggesting that the research's aims have been met (Saunders *et al.*, 2018). The concept of data saturation plays a key role in determining the sample size for qualitative research (Guest, Bunce and Johnson, 2006; Francis *et al.*, 2010). Some studies suggest that saturation can be achieved with as few as 6 to 12 interviews among homogeneous individuals (Guest, Bunce and Johnson, 2006), while others indicate a mean of 12–13 interviews is needed for saturation in such samples, with studies of a heterogeneous sample typically reaching saturation at 16 interviews (Hennink and Kaiser, 2022). Although this study's sample was more heterogeneous – involving HCPs, managers and leaders from three different hospitals – this diversity was deemed crucial. It allowed for the inclusion of unique perspectives and experiences from individuals in various roles, which is essential for the depth and breadth of the research findings.

In this study, data saturation was achieved by adhering to the principles outlined by Francis *et al.* (2010), who recommended starting with a sample of 10 participants for initial analysis and

applying a ‘stopping criterion’ after three additional interviews yield no new themes. Following this guideline, the current study began with 10 diverse participants and maintained a consistent approach to data reflection (Berger, 2013). After each interview, the researcher wrote a reflective memo to capture immediate thoughts and observations, which aided not only in determining saturation but also in refining subsequent interviews. After the initial 10 interviews were analysed, the stopping criterion was assessed after each subsequent interview. This process continued until no new material emerged in three consecutive interviews. In total, 33 interviews were conducted across three hospitals, ensuring the representation of at least six individuals from each subgroup (Guest, Bunce and Johnson, 2006). This sample size was consistent with that commonly reported in qualitative research literature (Mason, 2010).

Furthermore, based on the principle of informational power, a qualitative study aimed at a specific goal that involves participants with relevant characteristics, employs a theoretical framework (e.g. the CFIR), conducts high-quality interviews and chooses an appropriate analytical strategy can achieve robust results even with a small sample size (Malterud, Siersma and Guassora, 2016). Saturation was observed after the 29th interview. The last four interviews were critical in reinforcing and validating the existing themes, thus enhancing the trustworthiness of the research findings.

4.2.5 Data collection

To achieve a comprehensive understanding of the issue, this study drew on multiple perspectives and sources of evidence (Yin, 2018). It included semi-structured interviews and document analysis.

4.2.5.1 Semi-structured interviews

The interview guide (Appendix 9) contains open-ended questions developed using all of the CFIR’s constructs and domains. The scoping review findings (Chapter 2, Section 2.3.3.5, and Section 2.3.3.8) highlighted the significance of personal and cultural factors in MAT uptake, which were subsequently incorporated into the interview guide under innovation recipient characteristics as prompt questions. Additionally, the survey findings from Chapter 3, Section 3.3.2, which identified gaps in HCPs’ awareness of available MAT, informed the development of specific prompt questions within the individual characteristics domain, particularly under the

capability construct.

A pilot interview with a physiotherapist in the UK was conducted to refine the interview guide. Based on this pilot, the wording of several questions was modified to enhance clarity in the English version. For example, the original CFIR guiding question for Innovation Source was ‘What about the MAT device (e.g. wheelchairs) development? Who developed it?’ This was clarified with probing questions, such as ‘How are MATs sourced in your facility?’ The refined English version was then translated into Arabic by the researcher. The guide was structured into several sections, beginning with general questions about the interviewee’s current role in providing MAT. It then addressed issues of availability and access as indicated by their survey responses, inviting further discussion. Following this, the guide explored CFIR constructs to investigate specific issues more deeply. The interview concluded with open-ended questions, offering stakeholders the opportunity to share additional insights or ask their own questions. They were also asked to recommend other potential interview participants and to identify any documents that could provide further insight into the research questions. The same semi-structured interview guide was employed for all stakeholders to ensure consistency. Given the diverse backgrounds of the stakeholders, they were preliminarily asked about their specific knowledge pertaining to each section, allowing for assessment of the questions’ relevance to their experience.

Semi-structured interviews were chosen for their flexibility, which is crucial for eliciting comprehensive responses, thus making them an optimal method for this case study research (Yin, 2018). They also provided the researcher with the opportunity to ask more probing questions when necessary. The interviews were conducted in Arabic, the participants’ native language, to ensure they could fully express their experiences and perspectives without language barriers. This is essential in qualitative analysis, which aims to capture participants’ experiences meaningfully and best conveyed in their own language (van Nes *et al.*, 2010).

The interviews were conducted one-to-one, with only the researcher and participant present. Overall, 24 interviews were held face-to-face in quiet, private rooms within the participants’ hospitals, and 9 were conducted online using Google Meet. All interviews were recorded with an encrypted audio recorder and transcribed verbatim. The interviews ranged in duration from 38 to

57 minutes. Prior to conducting the semi-structured interviews, each participant completed the informed consent process. Throughout the data collection phase, field notes were systematically recorded during and immediately after each interview session, and these observational records were subsequently integrated into MAXQDA as analytical memos. These notes captured observational data (interview environment, non-verbal cues), initial analytical thoughts (emerging themes) and reflexive comments (initial interpretations).

4.2.5.2 Document analysis

To gain a comprehensive understanding of the barriers influencing the provision of MATs, an analysis of various documents – including reports, guidelines and policy documents related to the study – was conducted. Access to these documents was facilitated by the participants interviewed at each hospital. Following each interview, participants were asked to identify any relevant documents that could be included in the analysis. To ensure comprehensive coverage, an additional systematic online search was conducted through hospital websites, MOH portals and other governmental healthcare platforms; however, this search did not yield any additional relevant documents beyond those identified by the participants. The analysis of these documents served two primary purposes, as follows: first, to provide data on the context, aiding in the identification of issues that contribute to the barriers to the provision of MATs; and second, as a means to verify findings or corroborate evidence from interviews, thereby enhancing the credibility of the findings (Bowen, 2009).

4.2.6 Reflexivity in qualitative research

In qualitative research, the role of the researcher is crucial in shaping the study's outcomes and ensuring the credibility and validity of the findings (Pillow, 2003; Berger, 2013; Olmos-Vega *et al.*, 2023). Qualitative research processes are inherently influenced by the researcher's subjective viewpoints or 'biases' (Olmos-Vega *et al.*, 2023). Bias in qualitative research refers to any influence that affects the study's results (Galdas, 2017). This understanding emphasises the importance of reflexivity, which involves a conscious effort by researchers to examine how their perspectives, experiences and biases may influence every stage of the research process, from design to data collection, analysis and reporting (Olmos-Vega *et al.*, 2023). The active involvement of the researcher and the establishment of relationships with participants are crucial

for generating rich and comprehensive data (Berger, 2013). This section discusses the significant role of the researcher in this qualitative study, highlighting how reflexivity enhanced the integrity and depth of the research.

As a Saudi OT and academic, I am concerned about advancing rehabilitation services for people with disabilities. I bring a set of personal characteristics and professional interests that inherently influenced the research process. My familiarity with HCPs' challenges in delivering care positioned me uniquely within my study, placing me in an insider role. This offered three key advantages, as follows: easier access, a foundational understanding of the topic and a deeper understanding of participants' reactions (Berger, 2013). A researcher's personal familiarity with participants' experiences can profoundly impact all research stages, from participant recruitment and data collection to analysis and conclusion drawing (Berger, 2013). This familiarity may enhance the depth of understanding of participants' perceptions and interpretations of their lived experiences (Berger, 2013). However, I was aware during the research process that it was important to remain alert and to try and avoid projecting my personal experiences and biases onto the participants.

Furthermore, my role as an HCP was a significant asset in recruiting participants. They trusted that I could accurately convey their experiences, perhaps more comprehensively than a researcher from a different background might. Their willingness to contribute to my research goals, coupled with our shared professional understanding, fostered a sense of ease and facilitated rapport. Throughout the study, I maintained transparency regarding my background, which was essential to building trust and encouraging the open sharing of their experiences. Nonetheless, I consistently clarified that my focus was on understanding their unique perspectives rather than validating my own. Due to my position, I had an enhanced ability to understand implicit content, perceive the unsaid and probe effectively. However, I was aware of the risks familiarity brings, such as imposing my own values, beliefs and perceptions or projecting biases (Berger, 2013; Olmos-Vega *et al.*, 2023). I attempted to let interviewees describe their stories without directing them in specific directions, ensuring that I listened attentively to what was said.

Despite my experience with qualitative interviewing, there were moments when my status as an

early career researcher became evident in some interviews. My limited experience might have affected the depth of my probing questions and the overall richness of the interviews, as I was still developing my skills in handling sensitive topics and eliciting comprehensive qualitative data. However, my prior knowledge of qualitative research prepared me for this project with a solid foundation. My master's degree project enhanced my understanding of qualitative methodologies, including interviews and thematic analyses. This knowledge was further expanded during my PhD, which underscored the importance of reflexivity and encouraged me to engage in continual self-reflection on my biases and perspectives as they pertain to the research process. As a result of this understanding, I approached the current study with a critical and reflective mindset, ensuring that my findings were both trustworthy and deeply rooted in the experiences of the participants. Undertaking a course to understand the framework analysis approach and engaging in monthly supervision sessions helped ensure the validity and unbiased nature of my findings. Furthermore, I provided the interviewees with the opportunity to review a preliminary analysis of their interviews. This step was crucial for addressing any potential misunderstandings, thereby enhancing the overall credibility of the research findings.

4.2.7 Data analysis

4.2.7.1 Semi-structured interviews

Data were transcribed by the researcher following each interview. After the transcription was reviewed, the interviews were uploaded to the MAXQDA software (version 2022), a qualitative data analysis program, which was used to manage and analyse the data. Analysis began after the first interview and continued concurrently with data collection, enabling systematic assessment of data saturation.

The researcher analysed the Arabic data, allowing the context of the participants' answers to be accurately expressed (Al-Amer *et al.*, 2016). Translation of the quotations into English for the written report was conducted after the analysis was complete. The National Centre for Social Research's framework analysis approach was employed, following a five-step process: 1) familiarisation, 2) identifying a thematic framework, 3) indexing, 4) charting and 5) mapping and interpretation (Ritchie and Spencer, 1994). Initially, the researcher immersed herself in the transcripts to become familiar with the data, annotated the transcripts with notes, reviewed field

notes and subsequently created an overarching memo to capture observations (Step 1).

The second step involved establishing a thematic framework. Coding is an integral part of the framework identification stage (Ritchie and Spencer, 1994) (Step 2). Using the CFIR coding guidelines (<https://cfirguide.org/>), *a priori* codes were employed to assist with coding (Appendix 10). A framework was established after the initial coding of the first few transcripts (Step 3). Initially, the framework was organised by CFIR domains and constructs; then, it was re-framed to better reflect the descriptions provided by participants. Subsequently, during the interviews that followed, the researcher continuously refined the thematic framework, which was then applied to all study data.

Multiple Excel spreadsheets facilitated the establishment and management of the framework (Step 4). Initially, the data were organised using three spreadsheets (one per hospital), where each spreadsheet was structured to display identified themes across individual participants from that hospital. Text from the transcripts was inserted into relevant cells within the framework to understand stakeholders' perspectives on barriers and to compare and contrast charting patterns among different stakeholders within the same hospital. This was done while maintaining a link to the data set in MAXQDA, which facilitated returning to the data as necessary, as illustrated in Table 4.1. Two other sheets were created to compare perspectives between different stakeholder groups – managers, leaders and HCPs – and between hospitals. Then, a summary of the data was entered into the relevant cells in the sheets.

Table 4.1 Examples of data summaries from stage 4 of the framework analysis

Hospital B			
Inner Setting			
Domain			
Theme	Technological and Infrastructural Barriers		
Sub-Themes	Physical Infrastructure	Work Infrastructure	Information Technology Infrastructure
P11 HCP (OT), M, experience (5–	The intensive rehabilitation unit has a	A common misunderstanding is that	Errors stem from a lack of a barcode system

10) Speciality: Neurology	limited capacity of only 20 beds, which seems insufficient when compared to the volume of trauma cases that enter the hospital. (HCP interviews > 30-01-2023, P11, Text: 94–100)	after being prescribed a wheelchair by a doctor, patients believe they should immediately receive one without understanding the system. (HCP interviews > 30-01-2023, P11, Text: 14)	and the absence of a comprehensive, integrated system. (HCP interviews > 30-01-2023, P11, Text: 30)
P16 HCP (OT), M, experience (5–10) Speciality: Acute care	Have rehabilitation services and are well equipped in that area, but rehabilitation is not their primary focus. (HCP interviews > 21-03-2023, P16, Text: 174 and Text: 212)	The process of delivery is not clear. There is a distinction made between evaluating patient needs and the actual distribution of devices. (HCP interviews > 21-03-2023, P16, Text: 154)	No data
P17 HCP (OT), M, experience (<5) Specialty: Cardiovascular and pulmonary	Neurological rehabilitation unit within the hospital, where they work closely with rehabilitation doctors. They have a dedicated space with limited space, which is reserved for inpatient care only. (HCP interviews > 24-03-2023, P17, Text: 208)	OT should be responsible for managing the types of devices available in the warehouse. (HCP interviews > 24-03-2023, P17, Text: 34)	Technology within the facility is described as very basic, and there is a notable disparity in the availability of computers among the staff. (HCP interviews > 24-03-2023, P17, Text: 84)

In the final phase of the analysis, both within-case and cross-case (hospital) analyses were conducted to identify factors influencing the provision of MATs (Step 5; Appendix 11,12). The analysis was undertaken on two levels. First, the within-case analysis at the individual case level involved triangulating data from the three stakeholder groups (i.e. managers, leaders and HCPs) using joint display tables. This method was beneficial for identifying both convergences and divergences, thereby providing insights into the differences and similarities across the three

participant groups. The findings from this analysis were systematically compared across stakeholder groups, with the results organised in rows and the stakeholder groups in columns. Second, the cross-case analysis was conducted to uncover similarities and differences across the three hospital cases by combining the data to highlight convergent findings and underline the differences. This level of analysis also employed matrices for comparison, with results presented in rows and hospitals presented in columns. This process aimed to identify distinctive patterns across hospitals and participant groups regarding the factors influencing the provision of MATs.

4.2.7.2 Document analysis

The documents were reviewed and uploaded to the MAXQDA software (version 2022), where they were also annotated with notes. Relevant text elements in the documents were highlighted, and pertinent information was extracted and summarised using tables that included the type, source, date source was issued and source details and a summary of the documents. The documents were analysed using the same coding framework applied to the interview data, focusing on information related to MAT provision. This approach aligned with Bowen's (2009) recommendation to use predefined codes in document analysis, particularly when complementing other research methods within a study. Therefore, the researcher applied the same codes used in analysing the interview transcripts to the reviewed documents. This methodological consistency allowed for the integration of data from diverse sources, enhancing the robustness of the analysis (Bowen, 2009). This integrated data analysis proved valuable in identifying the barriers to the provision of MATs, illustrating the value of combining various data sources to achieve a more comprehensive understanding of the research issue.

4.2.8 Trustworthiness in qualitative research

Trustworthiness in qualitative research may be viewed with scepticism, particularly from a positivist perspective. This scepticism arises from concerns that traditional measures of validity and reliability cannot be directly applied within the naturalistic paradigms of qualitative inquiry (Shenton, 2004). However, Nowell *et al.* (2017) suggested that the criteria for trustworthiness represent pragmatic choices made by researchers to ensure the acceptability and usefulness of their research to a diverse range of stakeholders. In this study, the criteria developed by Lincoln and Guba (1985) to demonstrate trustworthiness were adopted. Their criteria, which emphasise

credibility, transferability, dependability and confirmability, provide a comprehensive approach to validating qualitative research. This framework has gained wide acceptance in qualitative research for demonstrating the trustworthiness of studies (Lincoln and Guba, 1985; Shenton, 2004; Nowell *et al.*, 2017).

4.2.8.1 Credibility

Credibility in qualitative research is defined as researchers' efforts to accurately represent the phenomenon under investigation (Lincoln and Guba, 1985). Adopting a robust research methodology is crucial in enhancing data credibility (Shenton, 2004). In the context of this study, every aspect of the research process – from the selection of the research design to the formulation of the data collection tool – was theoretically underpinned by the CFIR. The credibility of the research was further enhanced through regular debriefing sessions between the researcher and her supervisors (Shenton, 2004; Houghton *et al.*, 2013). These sessions helped in sharing research insights and refining the study's focus and methodology based on the supervisors' experience. Moreover, the study employed member checking as a strategy to ensure that participants' interpretations were accurately captured and not influenced by the researchers' bias (Birt *et al.*, 2016).

Member checking can include a variety of activities, such as returning transcripts to participants and providing them with summaries of the analysis (Birt *et al.*, 2016). In this research, the member checking process involved providing each participant with a summary of the researcher's interpretation of their interview, inviting them to confirm the accuracy of these summaries or to suggest additions (Doyle, 2007; Harvey, 2015). This approach was selected to accommodate participants' time constraints. All participants agreed to be contacted for the process of member checking; however, only 15 responded to the interview follow-ups. Among the feedback received, a few participants highlighted crucial aspects that had initially not received enough attention. For example, one participant specifically pointed out deficiencies in training and information regarding MAT. Further feedback emphasised that these deficiencies stemmed from inadequate funding and shortcomings in local education programmes.

The research also employed triangulation of data sources to strengthen credibility. According to Yin (2018), triangulation, which is the convergence of evidence from different sources,

constitutes a core strength of case study research. This was demonstrated in two forms within this study, as follows: first, through the collection of data via multiple methods, specifically the integration of findings from both documents and interviews; and second, through interviewing a diversity of individuals from different locations to compare and contrast their experiences (Shenton, 2004). Lastly, the credibility of research can also be enhanced by the background, qualifications and experiential knowledge of the investigator. In qualitative research, the researcher is frequently regarded as an element of the research instrument (Patton, 2014). The current researcher is an OT and academic with experience in the AT field, details of which are explained in Section 4.2.6.

4.2.8.2 Transferability

Transferability refers to the degree to which the findings of a study can be applied to other contexts (Lincoln and Guba, 1985). Qualitative studies are inherently specific to their particular environments and individuals, which limits their direct applicability to other situations (Shenton, 2004). Nonetheless, providing detailed and comprehensive descriptions allows readers to judge the potential of transferring findings to alternative settings (Shenton, 2004; Houghton *et al.*, 2013; Nowell *et al.*, 2017). Such descriptions should include the characteristics of the participating organisations, the participant demographics, the data collection strategies and the duration of data collection (Shenton, 2004). In this study, the researcher facilitated assessment by transparently detailing the data collection methodologies, the sample's diversity, the number of organisations included and the relationship of the findings to the existing literature. This transparency helped to build a foundational understanding of potential barriers to the provision of MATs, which may be applicable to other hospitals in Saudi Arabia with similar regulatory bodies and cultural attributes.

4.2.8.3 Dependability

Dependability refers to the consistency of study findings and their potential for repeatability under similar conditions (Lincoln and Guba, 1985). Lincoln and Guba (1985) stressed the need for detailed documentation – including an audit trail consisting of raw data, analysis notes and decision-making processes – to ensure a study's dependability. This study improved the research's dependability by keeping a detailed record of decisions made during the data

collection and analysis. The use of analytical software such as MAXQDA further enhanced the dependability, providing a systematic and organised approach to data analysis. Additionally, by detailing the research methods employed, from the initial aims to the final findings, the study has allowed for detailed replication and will enable other researchers to validate the findings.

4.2.8.4 Confirmability

Confirmability ensures that a research study's findings are derived from the participants' experiences and views rather than the researcher's biases (Shenton, 2004). In this study, confirmability was achieved through triangulation – which assisted in the mitigation of investigator bias by incorporating interviews from various hospitals and with diverse stakeholders – as well as document analysis. It was further reinforced not just by an individual's perception but through a consensus among multiple participants, demonstrating that a significant number of participants shared the same viewpoint. This indicated that the conclusions were based on the data, not on the subjective interpretation of the researcher. Reflexivity also enhanced the confirmability, with the researcher engaging in critical self-reflection on their role and potential biases, as detailed in Section 4.2.6 (Shenton, 2004; Houghton *et al.*, 2013).

4.2.9 Ethical considerations

4.2.9.1 Ethical approval

As detailed in Chapter 3, Section 3.2.5.1, ethical approvals were obtained from all participating hospitals (Confidential Appendix 7).

4.2.9.2 Data protection, anonymity and confidentiality

All collected documents, informed consent forms, audio recordings and anonymised transcripts were securely stored in the university's filestore (X: drive). The researcher was able to access the X: drive on- and off-campus using the virtual private network of the University of Sheffield. For the face-to-face interviews, the informed consent forms were scanned and converted into digital format (PDF) immediately after the interviews. Subsequently, the original paper versions were shredded. Both direct identifiers (e.g. names) and indirect identifiers (e.g. references to geographical locations that could be used to identify participants) were removed from the transcripts before they were uploaded to the X: drive. Each transcript was assigned a unique

identifier known only to the researcher, ensuring confidentiality. After the transcripts were confirmed to be free from any errors, the corresponding audio was deleted from the recording device. To enhance data security, a codebook containing identifiable information, such as email addresses, was stored in a separate location within the University of Sheffield's Google Drive. This information was utilised to arrange interviews with the participants and was deleted after the analysis was completed.

4.2.9.3 Informed consent

All participants who agreed to be contacted for interviews as part of the survey (Chapter 3) were sent an invitation email containing a participant information sheet and an informed consent form. The researcher offered participants the chance to decide whether to participate in the interview. Participants were encouraged to ask questions about the interview process before giving their final consent to participate. Signed informed consent was obtained from each participant before the interviews were conducted. Participants were informed that they had the right to withdraw from the research at any time, without any consequences or need for justification, and that they also had the right to skip any questions without providing a reason. They were assured that their participation would be kept confidential and that their names would not be disclosed in any reports, journal articles or presentations.

4.2.10 Patient and public involvement

Building upon the PPI activities described in Chapter 1, Section 1.9, this section focused on patient involvement specific to this qualitative study. The aim of this PPI engagement was to ensure the research design's relevance to user needs and to validate the findings through the lived experience lens of MAT users, ensuring that the identified barriers resonated with real-world user experiences in the Saudi Arabian healthcare context.

Two individuals with mobility-related disabilities who used wheelchairs were recruited via the Adult Motor Disability Association in Riyadh. Given the cultural context of traditional decision-making hierarchies in Saudi Arabia (as described in Chapter 1, Section 1.9), considerable effort was made to reduce hierarchical structures and power imbalances to facilitate learning from PPI members. Two sessions were conducted. The initial session (24 January 2023) utilised social media platforms, combining messaging and voice communication, chosen to facilitate

comfortable and accessible participation. This approach aligned with recent research suggesting that social media platforms can facilitate effective PPI through their flexibility (Fedorowicz *et al.*, 2022). Discussions focused on personal MAT service experiences, with the primary aim of ensuring the research design's relevance to user needs. The follow-up session (21 February 2024) was conducted via Zoom, where preliminary findings were discussed. Prior to this meeting, the preliminary findings were translated into Arabic and distributed to participants as simplified tables of the identified barriers.

The PPI engagement provided important validation of the study findings. Participants confirmed key systemic barriers identified in the research, particularly regarding administrative processes between hospitals and the MHRSD. Their experiences highlighted three crucial gaps in service delivery: timely provision of appropriate devices, maintenance services, and geographical accessibility challenges. Participants described their experiences with lengthy waiting times due to administrative partnerships between agencies, limited access to MAT services, and difficulties navigating between different healthcare departments. These real-world examples reinforced the barriers identified through interviews with HCPs, managers, and leaders, and provided valuable context from the user perspective.

Although formal ethical approval is not typically required for PPI activities—as they constitute consultation rather than research participation (Health Research Authority, 2016)—implementing PPI in the Saudi Arabian context presented several challenges. Formal structures and expectations around PPI are still emerging in Saudi Arabia's research environment, which made it difficult to identify and access appropriate patient representatives for this study. Cultural perceptions of traditional healthcare hierarchies, as noted in Chapter 1 (Section 1.9), also required careful navigation to establish meaningful engagement. Additionally, institutional unfamiliarity with PPI as a formal research practice required additional time to explain its purpose and value to stakeholders.

These contextual challenges were reflected in the PPI process used in this study, which had several limitations. These included the small number of participants ($n = 2$), a geographic focus limited to Riyadh, and a long gap between the initial and follow-up sessions. Furthermore, this represented the researcher's first experience with patient partnership, highlighting the emerging

nature of PPI practice in Saudi Arabia. Nonetheless, the process provided valuable learning opportunities and highlighted the importance of incorporating earlier and more structured patient engagement in future research.

4.3 Results

The participant and document characteristics will be presented first, followed by the interview and document findings organised by CFIR domain and construct. The findings also highlight key themes, differences and similarities in perspectives among participants and show variations across the three hospitals, illustrating how organisational structures and processes impact MAT provision. This approach provides a comprehensive view of the barriers at both the individual and institutional levels. These barriers, covering all five CFIR domains, are illustrated with representative quotations from the interviews and documents. An example of a detailed comparison between sites and participants' views is provided in Appendix 11.

4.3.1 Participant characteristics

Overall, 33 participants were interviewed, including 6 leaders, 10 clinical and administrative managers, and 17 HCPs, with the majority ($n = 16$) holding a master's degree (Table 4.2). Among these HCPs, 12 were OTs. The participant group comprised 22 males and 11 females. A significant number of the participants ($n = 24$) were from the Riyadh region. The age group most represented among the participants was 31–40 years.

Table 4.2 Participant characteristics ($n = 33$)

Participant Type	Number of Participants
Hospital Leaders	6
Chairperson, Department of Physical Therapy	1
Chairperson, Department of Occupational Therapy	1
Chairperson, Department of Prosthetics and Orthotics	1
Chairperson, Department of Rehabilitation Technology	1
Chief Executive Officer, Rehabilitation	1
Director of Rehabilitation Services	1
Clinical and Administrative Managers	10
Rehabilitation Services Coordinator	1

Clinical Supervisors	6
Medical Equipment Coordinator	1
Director of Budget Administration	1
Supply Chain Management	1
Healthcare Professionals (HCPs)	17
Occupational Therapist	12
Physical Therapist	3
Assistive Technology Specialist	2
HCP Speciality	
Paediatrics	1
Geriatrics	1
Cardiovascular and Pulmonary	1
Neurology	6
Orthopaedics	3
Acute Care	2
Assistive Technology	2
No Specific Speciality	1
Gender	
Male	22
Female	11
Age Group (in years)	
21–30	10
31–40	18
41–50	4
51–60	1
Years of Experience in the Site	
<5	7
5–10	10
11–20	13
>20	3
Academic Qualifications	
PhD	2
Master's	16

Bachelor's	15
Geographical Area	
Riyadh	24
Dammam	9
Healthcare Setting	
Site A (central region)	10
Site B (central region)	14
Site C (eastern region)	9

4.3.2 Document characteristics

The documentation included three documents representing guidelines from each hospital involved in the study and three general government documents (Table 4.3). The documents associated with each hospital serve as guidelines for providing medical devices to patients. Site A has a comprehensive policy detailing eligibility for MAT (Document 2). Site B has developed informal guidelines through its HCP staff (Document 1). In contrast, Site C lacks clear guidelines (Document 3). The three general government documents offer an extensive overview of the policies and regulations governing the provision of MAT in Saudi Arabia. Document 4 outlines the process through which patients can receive financial support for assistive devices. Document 5 discusses the legal and financial frameworks for government procurement, which influence how government organisations acquire and fund these technologies. Lastly, Document 6 highlights the Saudi government's initiatives to integrate AT for individuals with disabilities, emphasising the importance of training and awareness to foster technology adoption and effective utilisation. These data from the documents were used in conjunction with the interview data to identify barriers to the provision of MAT. A summarised table of the documentary analysis findings is available in Appendix 13.

Table 4.3 Type of documents

Identifier	Title	Type	Source	Date of Source Issuing	Specific to Site	Source Details
D1	Guidelines for Prescribing Equipment for Patients	Guideline Document	Hospital A	2021	A	Interview participants referred to this document and provided me with a copy.
D2	Assistive Devices and Durable Medical Equipment Provisions for Rehabilitation Hospital Inpatients	Medical Policies and Procedures	Hospital B	25 December 2019	B	Interview participants referred to this document and provided me with a copy.
D3	Wheelchair Seating and Mobility Assessment	Guideline Document	Hospital C	Not specified	C	Interview participants referred to this document and provided me with a copy.
D4	Financial Assistance Procedures for Medical Devices	Guideline Document	Ministry of Human Resources and Social Development	1 January 2019	NA	Interview participants referred to this document; Ministry of Human Resources and Social Development website.
D5	The Implementing Regulations of the Competition and Government	Government Procurement Regulations	Ministry of Finance	5 April 2020	NA	Interview participants referred to this document; Ministry of Finance website.

	Procurement System					
D6	Assistive Technologies and Their Employment for Individuals with Disabilities in Saudi Arabia	Policy Report	The Authority for the Care of People with Disabilities	12 September 2021	NA	Interview participants referred to this document; the Authority for the Care of People with Disabilities website.

4.3.3 Factors influencing the provision of MATs in Saudi Arabia

The following sections describe the factors influencing the provision of MAT. To reduce repetition, the findings of the cross-case analysis and documents are integrated throughout the results section. For details of this integration, see Appendix 14. Throughout the findings, CFIR constructs are indicated in square brackets to show how the identified factors align with the theoretical framework. Figure 4.2 provides a visual synthesis of all barriers to MAT provision identified in this qualitative study, organised according to the five CFIR domains.

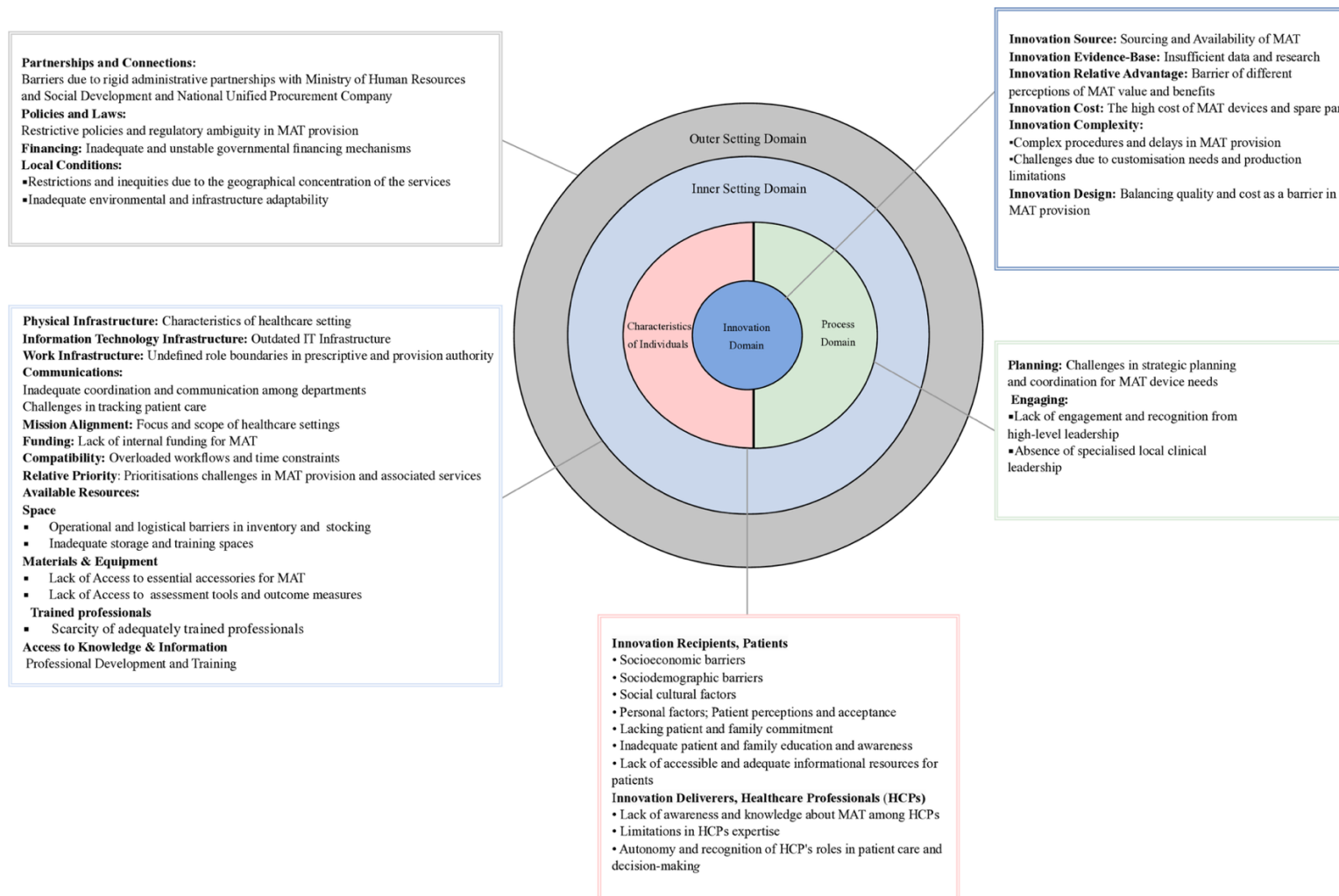


Figure 4.2 Barriers to the provision of mobility assistive technologies (MATs) in Saudi Arabia synthesised using the Consolidated Framework for Implementation Research

4.3.3.1 Innovation domain

The Innovation domain in the CFIR focuses on the thing being implemented, highlighting its key features, such as its design, cost and evidence (Damschroder *et al.*, 2022b). The Innovation domain for this study was MAT, which is defined as assistive devices for mobility and related services. Most participants in the study indicated a significant reliance on imported devices due to a lack of local manufacturing, raising concerns about the sustainability and reliability of supply chains [Innovation Source] (Table 4.4). Many also reported that the financial implications of acquiring devices are significant; the cost of these devices and their components often exceeds healthcare organisations' allocated budgets [Innovation Cost]. Further financial pressure is caused by import duties and logistics, which leads to the purchase of alternatives that may be less expensive but of lower quality. There was consensus among the participants that the perceived low quality of MAT devices in the local market could be attributed to economic challenges and a lack of product standardisation as a means of controlling quality [Innovation Design]. The HCPs emphasised the importance of access to high-quality devices; they asserted that if a device is substandard, it will be neither safe nor durable. However, the leaders and administrative managers stressed the importance of balancing quality and cost; faced with high prices for premium options, they often chose more affordable options, even if some features might be compromised, particularly under the strict government procurement rules highlighted in Document 5 (Table 4.5). Thus, regulatory complexity and strict procedures challenge the procurement process, hindering timely access to MAT. Participants also agreed that devices need to be customised for patient-specific needs; the process of customising advanced devices to meet individual needs is complex, time-consuming and resource intensive, hindering MAT's rapid and efficient provision [Innovation Complexity].

It is essential that all stakeholders fully recognise the benefits of MAT before its successful uptake can be achieved; however, divergent views on these benefits create a barrier. Although the HCPs and clinical managers interviewed supported the MAT use, emphasising its importance to patient recovery and QoL, the administrative managers focused on financial implications [Innovation Relative Advantage]. They consider the economic benefits of MAT, such as reduced hospital stays and facilitated discharges, which do not necessarily align with clinical priorities. According to participants, there is a lack of contextual data in Saudi Arabia, particularly

regarding comparative studies between MAT users and non-users, the prevalence of MAT use and cost-effectiveness analyses of MAT provision [Innovation Evidence Based]. Producing solid evidence of MAT's impact on patient outcomes, functional independence and QoL is essential for validating its benefits to clinical practices and healthcare systems, informing policymakers and supporting the development of effective policies and programmes.

Table 4.4 Illustrative quotes for the themes and sub-themes under the innovation domain

CFIR Construct Under the Innovation Domain	Themes Identified	Sub-Themes	Representative Quotes	Identified at Site
Innovation Source	Sourcing and Availability of MAT Devices	Dependence on Foreign Suppliers	‘These are Saudi companies that don’t manufacture but only import. The company that I mentioned... is an importer’. (P3, HCP) ‘And the primary reason I mentioned is that there is no provider of this type of device’. (P7, Leader) ‘Most of them are foreign... Most are not locally available; the companies order them from abroad. We mostly deal with a German company... and a Swiss company’. (P24, Manager)	A, B, C
		Lack of Reliable Local Providers	‘This is something I tell you from experience. I’ve lived it. It happens. Patients seek our assistance after they have been unable to find trustworthy providers’. (P1, HCP)	A, B, C
Innovation Evidence Base	Insufficient Data and Research	Data Needed to Guide Decisions in MAT	‘Because we need to be evidence based, and because if you have research, we can make an argument and say, “Look at these results... These are not our problems; it’s at the level of the country”’. (P4, HCP) ‘But what I’m saying is that when we want to go and buy something, you really need sufficient data to see that, yes, it is what it says. Okay, so this will create some reluctance, and that’s why I would like to see a lot of data on it’. (P9, Leader)	A, B
		Data Accessibility and National-Level Statistics	‘Yes, it’s possible at a national level. I always look for general numbers. For example, how many people use a wheelchair regularly? I don’t know, honestly; I’ve searched everywhere. There isn’t [any information]. For example, the extent of governmental bodies’ commitment to accessibility. I don’t see, I mean...’. (P11, HCP)	

Innovation Relative Advantage	Different Perceived Value and Benefits of MAT		‘There is something they call “operation cost”. This, which comes every day, for example, food delivered to the room, a nurse attending to the room, aside from the liquids administered daily. So, these costs add up over four or five days, sometimes exceeding the value of the devices provided to the patient. So, as expenses go, budget-wise, it preserves the budget... They have many advantages for the facility itself, like the discharge turnover for the beds’. (P23, Administrative Manager) ‘Of course, it makes the person more functionally independent and can facilitate their quality of life. It’s highly needed; it’s a priority’. (P29, Clinical Manager) ‘It’s important to make sure that the devices are available to minimize the patient’s return to the clinic’. (P20, Leader)	B, C
Innovation Cost	High Cost of Devices and Spare Parts		‘I mean, you see, we’re talking about a wheelchair that costs a hundred thousand riyals. I mean, a hundred thousand riyals for just one person definitely requires several people to approve it. It incurs a very high budget on the department. Because the budget for the devices is very high, there is reservation from the department about the entire matter’. (P20, Leader) ‘The good wheelchairs that I know of cost above 7,000, and when I give this information to families, they hesitate. They tell me..., the price is very expensive; the seating system alone costs 10,000 and above’. (P4, HCP)	A, B, C
Innovation Complexity	Customisation and Production Constraints		‘Yes, but wheelchairs or, for example, some devices now need customisation, which I expect takes a long time. Hmm, because now you need a long time to prepare the device to be suitable for the patient’. (P6, Leader) ‘Of course, because the artificial limb or prosthesis is custom-made, it’s not ready-made. We don’t have ready-made prostheses, so it’s custom-made and tailored for the patient himself’. (P11, HCP)	A, B, C

			‘Some cases are complicated and must be custom-made. I mean, yes, what is not available in this form, always the things that are provided through [NUPCO] and such, which are ready-made, usually in specific measurements or sizes. Typically, wheelchairs can be custom-made’. (P32, Clinical Manager)	
	Complex Procedures and Delays in MAT Provision		‘The process takes a very long time because there are codes, approval steps and several parties involved in the matter’. (P2, HCP) ‘Logistically, when you order a device, you don’t just order it randomly; it goes through a recommendation process by the OT and the doctor themselves. Then, it goes through channels in the Medical Equipment Committee, where they review and approve it. When the device is available – like always – anything involving financial budgets takes time. Devices usually operate on contracts, tenders and such. They have a chain of command, a supply chain and a specific purchasing process’. (P23, Administrative Manager) ‘You wish that when the patient receives this thing, it’s done in an easy way, not in a complicated way’. (P3, HCP)	A, B, C
Innovation Design	Quality–Cost Balance in MAT Provision		‘There was a problem on the patient side, of course, from what the patients themselves say: they give us the wheelchair, but it doesn’t match the specifications and sizes written in the description’. (P5, HCP) ‘Quality matters, but it’s more important to balance it with cost to really understand its value. It’s not just about having the best quality; it’s about meeting what’s needed in a way that’s affordable and works well’. (P10, Administrative Manager)	A, B, C

Table 4.5 Illustrative examples from documents organised by Consolidated Framework for Implementation Research domains and constructs

CFIR Domains	CFIR Constructs	Themes Identified	Illustrations from Documents
Innovation Domain	Innovation Complexity	Procurement Regulations	‘Contracting for works and purchases is not permissible without confirming the availability of funds or financial credits. The entity must consider the annual cash flows of contracts to align with budget planning activities. When there is an urgent need to expedite competitive procedures, the governmental entity must state in the competition documents that the competition will not be open for offer submissions before the necessary financial credits have been obtained’. (D5, p. 14)
		Product Specification Constraints	‘Article Twenty-Two: The government entity must adhere to the conditions and specifications stated in Article Twenty-Two of the system. This adherence includes the following requirement: not to refer specifically to the type, description, category, or number mentioned in the suppliers’ lists’. (D5, p. 13) ‘Article Twenty-Four: Specifications should not specify a particular brand unless they apply only to a specific product’. (D5, p. 13)
Inner Setting Domain	Funding	Budgetary Constraints	‘It is not permissible to contract for works and purchases except after ensuring the availability of costs or credits’. (D5, p. 14)
		Dependency on External Funding	‘For all other inpatients, assistive devices and durable medical equipment will be provided by the rehabilitation hospital for in-house training purposes only, or until sponsorship from other sources is granted (i.e. provided the sponsorship is granted before the patient is discharged)’. (D2, p. 2) ‘Communicate with the Ministry of Social Affairs or [hospital name]’s self-finance fund to facilitate the provision of the required equipment’. (D2, p. 3) ‘The method of applying for financial aid for assistive medical devices involves the Ministry of Human Resources and Social Development’. (D4, p. 1)

			‘For Class B and C, an estimated cost and information on where the device can be obtained should be shared with the patient and/or their family’. (D2, p. 3)
	Mission Alignment	Commitment to Inclusive and Equitable Development for Persons with Disabilities	‘The Quality-of-Life Program, part of the 2030 Vision, focuses on the well-being of all individuals in the Kingdom without discrimination or exception’. (D6, p. 4) ‘The system of care for the disabled, established by Royal Decree No. M/37 dated 23/9/1421H (corresponding to 19/12/2000), ensures the protection and enhancement of the rights of persons with disabilities. Furthermore, the Kingdom became a party to the Convention on the Rights of Persons with Disabilities and its Optional Protocol in 2008, which ranks among the principal United Nations human rights treaties. Article (2) of the Royal Decree, governing the protection of the rights of persons with disabilities, provides a general framework for all the services that the state must offer to these people, including the following areas: health, education, employment, cultural and sports domains, and supplementary areas’. (D6, p. 21)
	Work Infrastructure	Role and Boundaries in MAT Provision	‘The Wheelchair Seating and Mobility Assessment Form is within physical medicine’. (D3 p. 1)
Outer Setting Domain	Policies and Laws	Restrictive Policies and Regulatory Ambiguity in MAT Provision	‘Assistive devices and durable medical equipment will be provided and sponsored by the Rehabilitation Hospital for patients admitted for a comprehensive rehabilitation programme for the first time following an injury/illness (i.e. their first experience)’. (D2, p. 2) ‘A power wheelchair is not considered medically necessary when the patient is capable of ambulating within the home but requires a powered wheelchair for movement outside the home’. (D1, p. 7) ‘This guide defines and provides the clinical guidelines for Occupational Therapists at [hospital name] when prescribing device for eligible patients’. (D1, p. 1)

	Local Conditions	Environmental Accessibility and Suitability for MAT	‘Requirements for prescription: The patient’s living environment must provide adequate access between rooms, manoeuvring space, and surfaces suitable for the use of the power wheelchair’. (D1, p. 7)
	Partnerships and Connections	Collaboration Across Sectors	‘The AT Unit will facilitate the provision of the required device either through the Ministry of Social Affairs or through [hospital name]’s self-finance fund’. (D2, p. 2)
	Financing	Financial and Feasibility Constraints	‘The governmental entity shall present a study of feasibility and cost in cases where the preliminary cost of works and purchases exceeds twenty-five million Riyals’. (D5, p. 4)
Process Domain	Planning	Procurement Planning	‘Article Three: According to paragraph (1) of Article Two (10) - The entity’s plan for its works and purchases shall be published, including the following information during the first quarter of each financial year as per the system’. (D5, p. 2)
Individual Domain	Innovation Recipients, Patients (Opportunity)	Financial Burden on Patients	‘Procedure 6.3: Fill out the Assistive Devices Prescription Form, and for Class C, include the estimated cost and information on where the patient can find it’. (D2, p. 3)
	Innovation Recipients, Patients (Motivation)	Patient Autonomy and Consent	‘The patient has not expressed any unwillingness to use a power wheelchair in the home’. (D1, p. 7) ‘The patient will use it regularly’. (D1, p. 5) ‘Class C = Optional: This category refers to device that could improve the quality of life; however, such device is not required for enabling task performance. As such, it will be the patient’s choice and responsibility to obtain this device (i.e. it will not be provided by the hospital)’. (D2, p. 2)

4.3.3.2 Outer setting domain

The CFIR's Outer Setting domain focuses on the broader contexts encompassing healthcare institutions [Inner Setting]. This includes a variety of environments or levels, such as hospital systems and communities (Damschroder *et al.*, 2022b). The current study's outer setting encompassed the hospital system and the broader community. This also included the sociocultural and economic environments that influence the provision and accessibility of MATs (Table 4.6). Most participants reported strict and complicated dealings with the National Unified Procurement Company (NUPCO) [Partnerships and Connections]. They pointed out that the NUPCO requires hospitals to submit procurement requests through an accredited platform, which limits purchases to preapproved devices; introducing new devices is a complex process requiring thorough evaluation. Also, the participants noted that strict rules complicate direct purchases, leading to delays due to the complexity of logistical processes and the need for detailed expert assessments. This challenge is also evidenced in Document 5, which governs all government purchases. The document highlights how healthcare systems must adhere to structured procurement plans. However, participants reported that these rigid procurement policies create challenges when acquiring MATs, as these devices often require customisation and vary based on individual patient needs.

Furthermore, the participants reported issues related to collaboration with the MHRSD [Partnerships and Connections]. A partnership with the ministry aims to provide assistive devices to patients who cannot afford them. However, this often leads to delays and the provision of generic devices that do not meet the needs of patients, which is further exacerbated by the lack of direct communication between hospitals and patients. The same points were reported for the Document 1 and 2 guidelines; if a patient cannot pay the out-of-pocket costs, they are referred to the MHRSD. One participant raised a concern regarding the sustainability of this process, as it could lead to a discontinuity in care when a patient moves from the hospital to the community setting. Participants also reported inconsistent policies and procedures between inpatient and outpatient services, which led to confusion and access issues [Policies and Laws]. In terms of patient eligibility, there is a notable 'red line' (P11 HCP), where patients without employment or insurance affiliations are excluded from services. The HCPs expressed concerns that they could not refer ineligible patients to affordable alternatives due to potential conflicts of interest within

the hospital system [Policies and Laws]. There was consensus among the participants in all hospitals that a lack of clear policies and regulations regarding MAT provision, maintenance and follow-up severely compromises its comprehensive delivery [Policies and Laws].

Many participants outlined financial constraints, with the Ministry of Finance responsible for budget approvals [Financing]. This complicated process can result in delays in procuring essential MAT. Participants also expressed concerns about the lack of access to MAT, particularly in rural areas, forcing patients to travel to major hospitals for specialised treatment and causing additional stress on the healthcare system in cities [Local Conditions]. Lastly, HCPs noted the inadequacy of environmental and infrastructure adaptability, which often results in patients refusing useful devices since their living conditions do not allow them to use the technology [Local Conditions]. This is also mentioned in the guidelines for prescriptions (Document 1), which emphasise the importance of having accessible and navigable spaces that can accommodate the specific requirements of the device. This includes adequate room for manoeuvring, barrier-free access between different areas and surfaces that are compatible with such devices.

Table 4.6 Illustrative quotes for the themes and sub-themes under the outer setting domain

CFIR Construct Under the Outer Setting Domain	Themes Identified	Sub-Themes	Illustrative Quotations	Identified at Site
Partnerships and Connections	Challenges in Rigid Administrative Partnerships		‘NUPCO is like a mediator or a unified purchasing company for all government entities. Based on competition, it needs time until it’s put forward by procurement, until the offers are presented, until they are... inspected. The offer inspection committee meets to determine the appropriate offer. All these processes take about six months to a year until the competition is approved. Only after that, when I issue the authorisation, does the company start to supply’. (P8, Administrative Manager) ‘The sources of devices have become different. It might be from the Ministry of Social Services, or through our central warehouse, or through charitable associations. So, with different sources, the devices vary. Imagine now a patient comes to you, and you dispense something to them, not from your department but from another ministry’. (P30, Clinical Manager) ‘The issue has become that introducing a new product into NUPCO is very difficult. They conduct comparisons and look at several companies that provide devices and see if there is a local alternative available. Several things they have to do in order to be able to request a new product’. (P20, Leader)	A, B, C
Policies and Laws	Restrictive Policies and Regulatory Ambiguity in Mobility Assistive Technology Provision	Restrictive and Inflexible Policies	‘We can’t always ensure that the patient receives the device that they should receive. This policy comes from the hospital according to the budget capabilities’. (P5, HCP) ‘We use a form in our prescription that the patient uses; they buy it with their money. I mean, usually, it’s the patient themselves who looks for it. We don’t provide anything. Some patients use simple things; they go and get simple pillows, a sheet they roll up to adjust the car. Honestly, this is what’s happening; even if I referred it and knew what needs to be provided, in the end, they might not be able to buy it. The barrier is always there’. (P32, Clinical Manager)	A, B, C

			‘The non-eligible patients who come from outside, and there are many – maybe we’re talking about 30% of the admissions are non-eligible. Yes, we prescribe requirements, and they have to go to the Social Service Department at the MOH, put their names there and wait until their requirements come. So, the requirements at our place in [hospital name] are only for the eligible, those who are appointed by [hospital name]’. (P12, HCP)	
		Absence of Clear System and Regulation on Device Provision	‘There is no protocol or clear system. Sometimes, the delay in providing the device delays the patient’s discharge. So typically, sometimes, we are not accurate with the sizes and that’s why we give them what is available... There is no protocol for follow-up or training’. (P12, HCP) ‘Look, devices like walkers and canes, any patient with a referral is eligible, so we give them what we have, no problem. The bigger problem, I think, is for our colleagues in OT, which is wheelchairs. In providing them in the right size, there is no clear mechanism for it, and often, they are referred to Social Services’. (P22, Clinical Manager) ‘Actually, the idea came from the fact that we have a number of patients who stay in the hospital for long periods for medical treatment. The doctor doesn’t have any other solution in the medical plan, so they say, “This patient is ready to go home.” Most families ask, “How do they go home? Do they just go home like that? Or should they be prepared for something?” Of course, they go home, but how? Just like that? Or should they be prepared for something so they can go home? Then, this idea came along, and the devices came, and we started doing discharges for the patients’. (P23, Administrative Manager)	B, C
Financing	Inadequate and Unstable Governmental Financing Mechanisms		‘Generally speaking, we are talking about the second health cluster and a budget from the cluster’s budget, which may not be sufficient’. (P7, Leader) ‘The Ministry of Finance is the one that will provide; it is the funder that will approve the budget for you and provide the amounts we need. We submit a request to the MOH, through the MOH to the Ministry of Finance, so that they approve financial allocations for our tenders at the beginning of the fiscal year. Usually, it’s not necessarily that the allocation covers one fiscal year – it could be allocated for three years. The duration of the competition is usually three to	A, B, C

			five years and sometimes just one year, so they might request their needs for the next year or maybe for the next three years. All government entities, whether health-related or otherwise, this requirement is called the preparation of the fiscal year budget project'. (P8, Administrative Manager)	
Local Conditions	Restrictions and Inequities due to Geographical Concentration		'Most of the patients are from outside Riyadh. Usually here, the relatives come, take the prescription and leave'. (P17, HCP) 'Yes, some patients are transferred to major cities to receive appropriate treatment because the major rehabilitation hospitals are located in the main cities and patients often prefer them'. (P31, Clinical Manager) 'For most patients, when the cases become difficult, they immediately make a referral to Riyadh, either to [hospital name] or [another hospital name]'. (P33, Leader)	A, B, C
	Inadequate Environmental and Infrastructure Adaptability		'We face this a lot. Some patients come and say that there is a device that helps with mobility and so on, but they say, "My home itself is not prepared. The basics at my home are not ready. If the basics are adjusted, maybe I can think about the devices. If I brought it to my house in such-and-such village, I wouldn't benefit from it at all. I don't have a car or a car big enough to fit it, so it becomes an obstacle for me. It's better for someone to push me, to have a caregiver with me to help, because of the area and so on". But actually, the device would benefit them, but because of the surrounding obstacles and problems, it made them decide that "No, currently I don't need it"'. (P1, HCP)	A

4.3.3.3 Inner setting domain

The Inner Setting domain of the CFIR focuses on the context in which innovations are implemented (Damschroder *et al.*, 2022b). The inner setting for this study was defined as specific units within the hospital system, which included rehabilitation, occupational therapy, physiotherapy and AT units where the assessment and provision of MATs occur (Table 4.7). The participants indicated that the type of healthcare environment, whether acute or rehabilitative, plays a crucial role in the provision of MATs, specifically highlighted by Sites B and C. Furthermore, the level of hospital classification (primary, secondary, tertiary, advanced) and its characteristics, such as location and size, directly influence the range of services provided [Physical Infrastructure]. An important issue raised by the clinical and administrative managers was the absence of an effective management system [Information Technology Infrastructure]. The reliance on manual processes, such as the use of Excel spreadsheets, hinders efficient tracking and increases errors in inventory management. Participants highlighted the issue of role clarity and boundaries; in specific sites, particularly B and C, there was uncertainty regarding who was responsible for assessing a patient's needs and authorising the provision of a device [Work Infrastructure]. For instance, while OTs assess patients, the provision of devices such as wheelchairs is managed by a separate administrative department. This division could result in miscommunications and delays, impacting patient care quality. There was concern among the HCPs that devices provided to patients may not always be an appropriate fit; they reported being unaware of the quality of devices purchased or provided to patients [Communications].

Healthcare leaders described the differing focuses of their institutions, with some serving as rehabilitation facilities and others providing a broader range of healthcare services [Mission Alignment]. Such differences often result in an uneven resource allocation. For example, as highlighted by participants from Site C, there tends to be a higher priority placed on oncology and acute care, which can overshadow the needs of other departments [Relative Priority]. The HCPs argued that the current focus on resource allocation may not align well with the broader objectives of Saudi Arabia's Vision 2030, which emphasises preventive medicine. They stressed the importance of prioritising prevention, particularly in light of the high rates of patient readmissions due to falls or complications from pressure sores. These issues are often linked to delays in the provision of inappropriate assistive devices. This concern is explicitly mentioned in

Document 6, which offers an in-depth view of the Saudi Arabian government's initiatives and strategic direction in developing innovation to support individuals with disabilities, aligning with the overarching goals of Vision 2030 [Mission Alignment].

A significant challenge identified by participants concerned the availability of resources. The participants expressed concern about insufficient internal funds for MAT, such as electric wheelchairs [Available Resources; Funding]. If the healthcare system or patients cannot afford specific devices for financial reasons, one of the guidelines mentioned by participants and reported in Document 2 and Document 4 is to refer them to a social worker. Additionally, this situation often necessitates seeking sponsorship from external sources to bridge the funding gap, particularly through charitable organisations or government assistance programmes such as the MHRSD. Space constraints and competing departmental needs also hinder MAT provision [Available Resources; Space]. The clinical and administrative managers discussed the need for dedicated storage and training areas for MAT. They also expressed concern about inventory management issues, emphasising the need to maintain specific storage conditions in warehouses to preserve items such as silicone liners, which are commonly utilised in specific prosthetics and require controlled humidity levels and protection to remain effective [Available Resources, Space].

The HCPs noted that the provision of a wheelchair is inadequate without the addressing of additional needs, such as pressure sore prevention cushions [Available Resources; Materials and Equipment]. Additionally, the lack of standardised assessment tools affects the ability to accurately prescribe MATs that align with patients' needs [Available Resources; Materials and Equipment]. There is also a notable shortage of MAT specialists, and an educational and training gap was reported by most participants [Available Resources; Specialist Shortage]. Several participants expressed concerns about insufficient training opportunities for MAT provision. Specifically, they highlighted limited funding for workshops on patient assessment techniques and practical training in prescribing appropriate MATs [Access to Knowledge and Information]. The HCPs also mentioned that the workload in healthcare settings leaves little time for meaningful patient interactions, thereby affecting device provision [Compatibility].

Table 4.7 Illustrative quotes for the themes and sub-themes under the inner setting domain

CFIR Construct Under the Inner Setting Domain	Themes Identified	Sub-Themes	Illustrative Quotations	Identified at Sites
Physical Infrastructure	Characteristics of Healthcare Setting	Type of Healthcare Facility	‘Maybe because we are not a centre – I mean a large rehabilitation centre – but as a hospital, we provide services in the acute stage for patients, and then, the follow-up happens in our outpatient department only. We are focused on many things; honestly, there are more than one department, and the hospital is trying to cover them’. (P15, HCP) ‘The type of hospital affects the services it offers and what it provides. If it’s a hospital serving primary healthcare, for example, it’s not considered a hospital, it’s considered a clinic or perhaps secondary care. And how many beds it serves, these things have an impact, plus the location of the hospital’. (P23, Administrative Manager)	B, C
		Patient Admission Criteria	‘The hospital services are based on the patient flow. Traffic accidents, as well as the presence of salvage limb, are among the reasons that allow a patient to enter our hospital. If it’s a threatening limb or life-threatening, it is accepted automatically, which has facilitated procedures for us. The frequency of traffic accidents and, in the end, the most common cases we have are diabetic foot, which are amputations due to diabetic foot. We have a large number of diabetic patients in the kingdom, and despite education and awareness, it is still the major source of patients’. (P24, Leader)	
Information Technology Infrastructure	Outdated IT Infrastructure		‘First of all, of course, we need to use technology. There must be a system. You see, we are working with PT and doing a lot of work, we’re doing a lot of Excel sheets, but you have to keep the tracking. And in the end, things still turn out wrong because maybe someone will make an entry, there’s no barcode, there are no things, there’s no system synchronising things together. So, it needs a real system’. (P33, Leader)	B, C

			‘Instead of writing a paper and giving it to someone to come and upload it to the system and then raise it to us and then we review it. So now, I’m connecting the [name of the system] with the [another system] so that both of them can share and serve each other, and no one gets tired, and even the doctor doesn’t get tired; it becomes a double list. Most of the papers will stop; signatures will be electronic requests, all of them will be electronic. We are now mostly electronic, but there are papers that must be signed by the doctor; these are not electronic. So now, we are systemising these things, and the big obstacle was that there was no loop, no operation between these systems’. (P23, Administrative Managers)	
Work Infrastructure	Undefined Role Boundaries in Prescriptive Authority		‘Another problem is that they don’t have the medical background. The social services, I mean, don’t know what we are talking about, right? And we come to say, honestly, we need a specific measurement for a patient. Okay, they will ask me, “Why do you give this to the patient who is already bedridden?” No, she is not bedridden; she is bedridden because there is no assistive device that can help her to get out of the bed. So, maybe the medical background they have can be a barrier. I say the first problem is that the accommodation, the service itself, is supposed to not be under bed management. It is supposed to be under rehabilitation, let’s say occupational therapy’. (P12, HCP) ‘Okay, of course, in terms of the prescription, we don’t have the authority to prescribe, although we tried since 2013. But, for example, when the patient is transferred, let’s say to physical therapy, occupational therapy, we do an assessment, we give recommendations, but then the matter is transferred to physical medicine. They are the ones who can issue [the prescription]. Sometimes, the physiatrists do it, and sometimes, the social workers get involved, and they bring devices that are donations from associations, even when they don’t fit the patient properly. Sometimes, our OTs do measurements and put recommendations, and we place things, but they don’t come 100% perfect unfortunately. Even the form that comes to us from the physiatrists is just to fill the measurements, and we send it all together’. (P31, Clinical Managers)	B, C

Communications	Inadequate Coordination and Communication Among Departments		‘The reasons, I expect, are miscommunication between the departments’. (P33, Leader) ‘We need integration in the matter of multidisciplinary team’. (P30, Clinical Managers)	C
	Challenges in Tracking Patient Care		‘So we don’t always know what type of quality they received’. (P5, HCP)	A, B, C
Mission Alignment	Focus and Scope of Healthcare Settings		‘I don’t blame them; they deal with the patient (acute medical bed), and we deal with rehabilitation. We want to return maximum independence, meaning he manages on his own, they don’t, right? If you have a fracture, it gets fixed, medical optimisation, there is no infection, no... no problems, then discharge. We are a trauma centre; it’s customary that it treats trauma cases. They don’t skimp on the requests, but the devices, up until now, it’s difficult for them to be as abundant as we would like them to be... Currently in the 2030 vision, we are working on prevention more than treatment, and prevention means a high quality of life. When we talk about quality of life, we talk about how to make the patient live his life appropriately. In prosthetics, maybe at some point it was a rare thing, but I think now it has become a necessity, especially in amputations. It’s supposed to be provided in all sectors and hospitals’. (P11, HCP) ‘The whole approach that the hospital is now heading towards is that the patient doesn’t always stay in the hospital. We’ve emphasised its importance a lot. Every time we get the response, “We are not a rehabilitation hospital”. The goals of the hospital and its mission are to try to take care of [patients] in an environment other than the hospital environment, whether they rely on outpatient care, home healthcare, telecare, virtual clinics, or preventive medicine’. (P20, Leader)	B, C
Funding	Availability of Internal Funding for MAT		‘You know, the department has a certain budget, and there are pre-required things during the year. So, in case they are not available and we can’t provide them to the patient, we always advise the patient to look for them elsewhere. I believe, yes, the management here is limited by budget, and based on it, they request what they need’. (P13, HCP)	A, B, C

			‘And then also you need to make sure where the funding comes from’. (P9, Leader)	
Compatibility	Overloaded Workflows and Time Constraints		‘There isn’t enough time, “so they can’t take training”. I can’t train them because I have limited time. “I don’t have in my hospital, in my clinic, a wheelchair for training.” So, mostly I just do education, show them’. (P19, HCP)	A, B
Relative Priority	Prioritisation Challenges in MAT Delivery and Associated Services		‘There might be a priority, and I return to say that the priority is not rehabilitation at the moment, possibly because the budget they have is specific and limited to essential things. So, they serve the basic [needs], and that [rehabilitation] is not considered basic for them. They serve things related to emergencies and urgent surgeries, but they don’t serve what is related to the final stage of rehabilitation because their budget is limited’. (P3, HCP) ‘Even if there is a budget, it’s not a priority; it’s not on the priority list that the matter needs because, indeed, the issue is significant and costly for the department’. (P20, Leader) ‘Like I told you, they calculate based on cost-effectiveness. I mean, they look at what the majority needs, you know, logistic things, they think a lot about it. It’s possible to pay a high cost for features that are not essential. I believe we haven’t reached such a level of perfection yet that we think about preferred things. They are accessories, I think they view assistive devices this way’. (P22, Clinical Manager)	A, B, C
Available Resources	Scarcity of Adequately Trained Professionals		‘So, I think that we have few assistive specialists, so no one knows exactly what we are talking about. Right, this is related to employment, meaning the specialists themselves, even those in prosthetics, are few and they want more’. (P1, HCP) ‘For example, we had a shortage in the staff, and it all ended in rejection because of the budget’. (P32, Clinical Manager) ‘Currently, we have a shortage of manpower in Saudi Arabia’. (P24, Leader)	A, B, C

Available Resources, Space	Operational and Logistical Barriers in Inventory and Stocking		‘There is an issue with organisation in that they have to produce a barcode for this thing, for the device, let’s say the wheelchair, for example. But our problem – not really a problem, it’s just the nature of the work – that this chair will be dispensed to the patient and they will leave with it outside the hospital; it won’t be returned. I think it was like this, I mean. But it’s an internal matter. I don’t know exactly how, I mean this topic’. (P2, HCP) ‘They refer the patient to us, and the patient comes saying it’s not available, so it’s a long journey for the patients and it’s a headache. In the end, there is no system to indicate whether it’s available or not available, which means to simplify the life of the patient’. (P33, Leader) ‘I always ask companies why they don’t have a local warehouse to provide simple parts. I mean, don’t stock large quantities; just provide me one or two pieces of each thing, so even if I order them, they are delivered quickly, and I don’t have to wait for so long. But they always had this excuse that most of it is difficult to store or requires a specific environment for storage, so they don’t store it in Saudi Arabia. It’s more convenient for them to order it online. If we had a warehouse, I could store these things at a certain level of storage. For example, a silicone liner, I can’t just store it anywhere, right? It needs a certain level of humidity and a specific place away from dust or anything, so I can use it for a long period’. (P21, Administrative Managers)	A, B, C
	Inadequate Storage and Training Spaces		‘A small room, you might say its size is three by five meters, rectangular, and it does not have many cabinets. There is actually no place for devices, just storing boxes and a bit of chaos’. (P14, HCP) ‘No, the storeroom is small. We have two storerooms. We also have a space problem. In the hospital, we have these two storerooms and a large one. Sometimes, they go to bring [items] from there too’. (P29, Clinical Manager) ‘Currently, the workshop we have is a small one due to space limitations. We don’t have enough space currently, and there will be [more] because the	A, B, C

			workshop doesn't rely only on small parts. It needs an oven; it needs many things. So, this is among the issues we have, which is the space, and also...'. (P24, Leader)	
Available Resources, Materials and Equipment	Access to Materials and Equipment	Access to Essential Accessories for MAT	'Most of them don't have an adapted car, nor do they have a prepared place. The chairs need a good cushion, like the Roho'. (P26, HCP)	A, B, C
		Assessment Tools and Outcome Measures	'The standard, we usually take three important things: width, depth, height. These are the main things, and then, we put the external things that might be needed, like whether the handrest is removable or not. Yes, of course, we include all of these in the clicks. We don't have a follow-up, so we don't have an official form to see the outcome and the satisfaction. It's just prescriptions only'. (P5, HCP)	A, B, C
Access to Knowledge and Information	Professional Development and Training	Poorly Designed Educational Programmes	'I believe that training and other things, no, I was not trained on them. For example, sport wheelchairs, lightweight wheelchairs, specific measurements and these things, no, I was not trained on them at the university, only through experience'. (P19, HCP) 'We have a lack of educational outputs. We only have one Saudi university, which is Taibah University, that graduates specialists in prosthetics. Some educational institutions, I think, had a level of technician, and they graduate [students]. One of the recommendations is that universities should start looking into this field'. (P24, Leader)	A, B, C
		Training Deficiencies	'I have encountered this a lot. I used to wish that I could do something; the idea is welcome. That's why, when I come to tell you about it, honestly, my management is receptive because they understand that this is needed. They might give you educational leave, but in the end, I might end up paying for it myself, you know? Then, I go back and reconsider: does this thing deserve that I pay such an amount? I mean, for me, how much of an investment is it when I put something in and get something out of it in the end? Of course, it's worth it or not? So, it didn't happen, I mean, the matter'. (P27, HCP)	A, B, C

			'Most of the specialists are not certified, they just have experience'. (P22, Clinical Manager)	
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4.3.3.4 Implementation process domain

The CFIR's Implementation Process domain includes strategies that can significantly impact innovation success (Table 4.8) (Damschroder *et al.*, 2022b). Several leaders stressed the importance of annually estimating device needs based on historical data and patient demographics, emphasising its critical role in effective planning [Planning]. In accordance with this approach, each department is required to submit preliminary plans for device procurement. In compliance with regulation Document 5, each healthcare facility must submit a comprehensive plan for operations and acquisitions, including these details, in the first quarter of each financial year. However, there is a divergence in perspectives between HCPs' needs and management's decisions. In this study, the HCPs criticised a one-size-fits-all approach, especially for devices such as wheelchairs, as the approach needs to meet individual patient needs [Assessing Needs; Innovation Deliverers; Innovation Receipt]. Several HCPs highlighted limitations in the range of device options the NUPCO offers as well as challenges associated with accurately predicting future needs [Planning]. In addition, a few participants reported that, despite various complaints and attempts to raise the matter, no concrete solutions had been implemented, particularly in Site C [Assessing Needs; Innovation Deliverers]. Several participants reported that proposals for specialised clinics, such as a wheelchair clinic with a dedicated budget and comprehensive planning, are not always considered or implemented, especially in Site C. In addition, while some informal feedback is sought regarding the need for various devices, a formal process for collecting and acting upon this feedback is absent.

The participants reported a notable lack of engagement both at the hospital leadership level and in national healthcare administration in Saudi Arabia, marked by uncertainties in decision-making processes and unclear directives from upper management [Engaging]. This was particularly evident in the field of rehabilitation, which many participants noted was frequently neglected and lacked adequate support and representation in decision-making [Engaging; Innovation Deliverers]. The lack of local clinical leaders or specialists in advanced rehabilitation devices was also reported as a contributing factor [Engaging].

Table 4.8 Illustrative quotes for the themes and sub-themes under the process domain

CFIR Construct Under the Process Domain	Themes Identified	Illustrative Quotations	Identified at Site
Planning	Challenges in Strategic Planning and Coordination for Device Needs	‘Yes, not every year, but almost every quarter; this is for basic mobility devices like canes and walkers. But we have regular usage patterns, and every year, we determine [our needs] based on the need we had the previous year. For example, last year, we had so-and-so; we always make our reserves, honestly’. (P22, Clinical Manager) ‘In terms of the facility, you have many things that are divided into two main categories: planning and budget. In terms of planning, when the hospital plans properly for the demand for these devices, the planning won’t be effective without the presence of a budget. So, I have a database, and I know my needs, how much is required. Therefore, I can make a plan for the assets for the next four years. The demand is usually not going to decrease’. (P23, Administrative Manager)	A, B
Engaging	Lack of Engagement and Recognition from High-Level Leadership	‘For higher management and decision-makers, you can make a proposal and raise it to them, saying, “I see that this device serves a large segment of people, this is within your scope because you actually see that this device serves this segment of people.” It’s not a decision-maker, it’s a committee, so they can process your medical device needs upon the total budget. They have a higher insight into the entire hospital, not just your areas. Right? So, the decisions, the choices like, say, the mechanical ventilator in the ICU, the nursing, they want things, you know’. (P21, Administrative Manager) ‘In reality, it will end up in the higher management. I feel, no, they are not interested – but if they knew the importance of assistive devices, they would definitely provide them’. (P18, HCP)	A, B, C
	Absence of Specialised Local Clinical Leadership	‘As staff, sometimes, I mean, they ask us, but there is nothing official, like “not a committee”, as you said. No, they don’t gather here and such, but they send us an email, for example, asking whether we use a certain device or not.	A, B, C

		If we don't use it, we tell them we don't use it. They save money and allocate it for something else instead of it sitting in the store not being used. It ends up not being ordered again. So, these are some of the things that we participate in'. (P13, HCP) 'It's a very important step that there are people concerned with assistive devices matters'. (P6, Leader)	
Assessing Needs; Innovation Deliverers	Lack of Effective Response to Feedback and Complaints	'The wheelchairs available in the hospital, which the patients need, are almost expired and pose a safety risk to the patients. So, when a patient comes, for example, in a wheelchair that needs a hip replacement, coming from the car to the clinic, for example, there are no breaks. Even what is currently available is not safe. So, if the physicians, for example, started to advocate for us to have a seating clinic, and we insisted on it, and we raised a proposal and requested to have a wheelchair clinic and set a budget for it and did a full study – but it's gone with the wind'. (P33, Leader)	C

4.3.3.5 Individual domain

The domain of individuals within the CFIR emphasises the significance of the roles and personal attributes of those associated with implementing, delivering and/or receiving the innovation (Table 4.9).

4.3.3.5.1 Innovation recipients: patients

In the CFIR, innovation recipients are defined as those who directly or indirectly benefit from an innovation (Damschroder *et al.*, 2022b). The HCPs recognised that the complexity of a patient's health condition correlates with their adoption of MAT, necessitating more targeted interventions [Need]. In addition, they noted that cultural norms could influence MAT acceptance by patients and their families. Specifically, they stated that elderly patients and their families often prefer family-based care over technological solutions that promote independence. This cultural preference for family dependence, particularly among older adults, can affect the adoption of MAT, even when the technology could enhance mobility [Motivation]. Document 1 and Document 2 guidelines emphasise this point, where consent and autonomy are required to provide the device to the patient. The HCPs also reported on the importance of patient awareness and understanding of their needs as well as the potential benefits of MAT [Capability]. However, complex healthcare systems often impede the use of such devices; several HCPs reported that the process can be so complicated that patients 'get lost', leading to suboptimal care and financial pressures [Opportunity]. To avoid lengthy delays and regulatory restrictions, many patients choose to buy such devices independently. This issue is further emphasised in the Document 2 procedure, which highlights the healthcare system's responsibility to provide patients with an estimated cost and guide them on sourcing these essential resources.

4.3.3.5.2 Innovation deliverers: health professionals

The CFIR framework identifies innovation deliverers as those individuals who directly or indirectly deliver the innovation (Damschroder *et al.*, 2022b). The HCPs expressed concerns about limited autonomy and inadequate recognition of their roles, noting that their responsibilities often seemed to terminate after the documentation of their assessments was completed (Opportunity). Additionally, they pointed out that they lacked knowledge about the various MAT devices available within hospitals, remaining unaware of these resources unless

they undertook specific investigations or inquiries [Capability]. They were also concerned about inadequate training for HCPs specialising in AT and the need for additional funding for educational programmes to address this issue [Capability]. Furthermore, participants noted that the limited number of academic programmes specialising in AT exacerbates these challenges, as most HCPs in this field rely on practical experience rather than formal certification. They also reported the need for a standardised evaluation approach, as the current prescription process for devices is often inconsistent, leading to mismatches between patients' specific needs and the devices they receive [Need].

4.3.3.5.3 Other implementation support: administrative and clinical managers

Administrative and clinical managers play a crucial role in supporting implementation leads in integrating new practices within the healthcare environment (Damschroder *et al.*, 2022b). These managers are instrumental in this process, addressing logistical challenges, facilitating communication between departments, ensuring compliance with regulations and managing resources effectively. In the current study, the administrative managers emphasised the importance of strategic planning to avoid service delays and prevent product shortages, underlining the necessity of these practical measures for maintaining high-quality patient care and operational efficiency [Need]. Additionally, they advocated establishing local warehouses for important devices and materials, driven by a strong commitment to enhancing service delivery and operational processes [Motivation]. The concern arose from a reported unawareness of MAT benefits, highlighting a significant gap in the effective utilisation of these devices to enhance the QoL of individuals with disabilities [Capability]. The clinical managers raised concerns that suggestions for improvements, such as the initiation of a seating clinic, had been unfortunately overlooked at Sites B and C [Opportunity]. This oversight suggested a systemic problem where the potential of MAT was not fully recognised or integrated into care plans, further exacerbating disparities in access to necessary support.

4.3.3.5.4 High-level leaders

In the CFIR framework, individuals with significant authority, such as key decision-makers, executive leaders or directors, are vital to guiding innovations within the healthcare system (Damschroder *et al.*, 2022b). In this study, the high-level leaders identified the need for diverse

expertise across Saudi Arabia, emphasising the importance of having specialised representatives in areas such as wheelchair procurement to inform the tendering process [Need]. Motivation for change was driven by the recognition of areas for improvement within the healthcare system. For instance, some leaders expressed frustration over the lack of attention paid to proposals for enhancing services and the disparities in the influence of rehabilitation services across regions [Motivation]. This situation highlighted the lack of knowledge and understanding of the potential benefits of MAT within the healthcare systems and community [Capability]. One leader noted that the primary issue in rehabilitation services is their lack of complete autonomy as department leaders, which severely hinders their ability to fully manage and innovate in the process of patient care [Opportunity]. This pointed to a systemic issue where the healthcare system's current hierarchical and administrative structure restricts the potential for innovation and improvement in health services. A summary of the barriers is presented in Table 4.10.

Table 4.9 Illustrative quotes for the themes and sub-themes under the individual domain

CFIR Construct Under the Individual Domain	Characteristic Subdomain	Themes	Illustrative Quotations
Innovation Recipients, Patients	Need	Type of Functional Difficulty	‘When the patient entered, I found her weighing 150 kg, very overweight, and there were many overweight patients. And she is conscious, GCS 15 out of 15, she talks to you, everything, but she has a problem with mobility out of the bed; definitely she needs a power wheelchair. Okay, when we come to take her measurements according to her size and we put specific criteria in the power wheelchair, it’s going to be very hard to provide. Even if we give it to the case manager, they won’t be able to provide it’. (P12, HCP)
	Motivation	Cultural and Social Influences on MAT Acceptance	‘There is a stigma around it in society; patients want to appear to be normal, and hence, they have high expectations with regard to rehabilitation to be able to walk again. Yes, I think society still does. There is still a stigma around patients with wheelchairs’. (P5, HCP)
		Patient Perceptions and Acceptance of MAT	‘Some patients don’t accept it at all. If you tell them that they will receive devices, they think it means they can no longer write, walk or do anything anymore! Some patients simply don’t accept it; they have basic needs that they need to fulfil at home first’. (P1, HCP)
		Lacking Patient and Family Commitment	‘But unfortunately, the compliance was very low from the patients and their families regarding these matters’. (P26, HCP) ‘Some patients take the financial support money to buy devices and purchase other things they might need instead... A patient might buy something that is not required but takes the payment and does not buy what is recommended for them. They might have other priorities’. (P31, Clinical Manager)
	Capability	Inadequate Patient and	‘I mean, most of the patients and their families are not well educated. So, when they are informed, yes, some parents come to you and discuss, saying,

		Family Education and Awareness	“I saw this, I saw that”, but they are rare; you can count them on your fingers. However, the majority shows little interest in this matter’. (P27, HCP) ‘Some patients take the financial support money to buy devices and purchase other things they might need instead. There are also reported cases where the caregiver buys other devices for the patient without consulting the patient. So, it’s almost like a cycle around these reasons. A patient might buy something that is not required but takes the payment and does not buy what is recommended for them. They might have other priorities. It could be that the patient’s awareness of these devices is low, or the patient might request something that’s not suitable for them even though they were given education – or maybe they weren’t given enough education. Or they need the devices, but they arrive too late, and the patient has developed complications and can’t use them. I mean, the hospital should be responsible for discharging the patient with the devices. This would greatly help many families’. (P31, Clinical Manager)
	Opportunity	Lack of Accessible and Adequate Informational Resources for Patients	‘A patient who is referred to us gets enough education about the available devices or alternatives if they exist with us; this is the only way. We don’t have access even to the website. We have the intention to do it, and one of the ideas proposed is to put it on the rehabilitation page on the website’. (P22, Clinical Supervisor) ‘Indeed, the patient gets lost between the departments, between home care, social services, or rehabilitation. Those who come asking, we try to help. We go and tell them that you have alternatives, you have solutions one, two, three... If you’re buying from outside or if someone is buying for you, I tell them you have to take this type. Some might go, like in the past, to the social services’ warehouses, and they give them something that is not their size. This has happened a lot’. (P1, HCP)

		Socioeconomic Barriers	‘Some families, some of them don’t want to wait because the provision of devices takes a long time, so they say they prefer to buy it themselves. So, we help them. We look, they come to us, they show us; even with pictures, they show us. We all help them on this journey until they get the right wheelchair. But some patients say they can’t afford a wheelchair, even if it costs 2,000 riyals’. (P4, HCP) ‘There is a big gap, especially if we want to provide the best solution for the patient. And it’s hard for some families to cover the remaining amount’. (P30, Clinical Supervisor) ‘We use a form we have for prescriptions that the patient uses, and it’s possible for them to get it dispensed from outside. But they buy it with their own money. And what I was going to say is that the more advanced and more expensive things, we don’t bring them at all. Usually, it’s up to the patient themselves to look for and find them, or they don’t know exactly where to go. Or if they go and find [it], they say it’s expensive. So, they end up using simple things; they go buy simple pillows, sheets that they wrap into a roll. Honestly, this is what works more with patients, especially in paediatrics; it turns into a sort of creativeness. Even if I transferred it and knew what needs to be provided, in the end, they won’t be able to buy it, always an obstacle. So, some of them, even... I remember one of my patients took a long-sleeved t-shirt, an old cotton one, cut it and stuffed it with cotton and used it as a cuff, like that. This is what happens, especially among people with medium or low income’. (P33, Leader)
Innovation Deliverers, Health Professionals	Capability	Awareness and Knowledge about MAT among HCPs	‘Difficult cases that have core mobility issues, those I don’t know how to work with or those with spine problems, they become difficult for me to do an assessment for them, to do the assessment and to choose devices suitable. So, I book an appointment for them and call the company, arrange with the company. They send two people from the company, including OTs. They have to do the assessment with me... Based on their assessment, we make a request’. (P18, HCP)

		Limitations in HCP Expertise	‘I know the basics, but for complex cases and so on, everyone [has their limitations]’. (P25, HCP)
	Opportunity	Autonomy and Recognition of HCP’s Roles in Patient Care and Decision-Making	‘Like I told you, my role ends after I do the device prescription only, but the decision-making is done by the higher management’. (P17, HCP)
Other Implementation Support, Administrative, Clinical Managers	Need	Strategic Planning and Staff Expertise	‘Here, the delay sometimes is due to planning, that the requests were not made early enough. The solution, as we said, is early planning. There must be early planning. When we send, we need them to provide us with the orders they need. This is the first step. So, always the requesting department or administration should ideally present their preliminary plans based on which future shortages in any required device can be avoided’. (P8, Administrative Manager) ‘We need the staff to be competent; we need competency to be applied to them’. (P22, Clinical Manager)
	Motivation	Logistics and Resource Management in MAT Provision	‘Why don’t you have a local warehouse that provides simple parts? I mean, don’t store large quantities – just provide me with one or two pieces of everything, so that even if I order them, they are delivered quickly and I don’t have to wait this long’. (P21, Administrative Manager) ‘Because not providing the necessary device, unfortunately, will increase the cost, whether for the ministry or any fund, since the patient will keep going around in the same circle. But if we provide the devices, we will move on to the next stage, which is safer for the patient, offers better function for them and, also, it’s cost saving’. (P31, Clinical Manager)

	Capability	Advocacy and Awareness	‘No, they don’t feel aware; I mean, they don’t feel it’s important. If the physicians, for example, were to advocate for having a seating clinic and we provide [wheelchairs]’. (P32, Clinical Manager)
	Opportunity	Expanding Opportunities in Patient Support	‘We face many difficulties with the families, and unfortunately, I don’t have solutions that I can offer them. I don’t have the ability to refer them to another service, nor do I have the authority’. (P30, Clinical Manager)
High-Level Leaders	Need	Building Expert Networks for Enhanced MAT Services	‘Yes, we need experts from all over the kingdom, representatives of course. If the tenders are related to chairs, they request experts specialised in chairs from all sides that have the desire to purchase, and there should be a representative’. (P7, Leader)
	Opportunity	Empowering Rehabilitation with Autonomy for Improved Patient Care	‘The reason is that rehabilitation does not have full autonomy for this entire process. Autonomy is the main issue; we don’t have complete autonomy for the whole process’. (P20, Leader)

Table 4.10 Summary of barriers identified in this study mapped to the Consolidated Framework for Implementation Research constructs (CFIR)

CFIR Domains	Barriers Identified and Mapped to CFIR Constructs
1. Innovation Domain	1. Innovation Source <i>1.1 Sourcing and Availability of MAT</i> ▪ Barriers caused by a high level of dependence on foreign suppliers ▪ Lack of reliable local providers 2. Innovation Evidence Base <i>2.1 Insufficient Data and Research</i> ▪ Lack of data accessibility and national-level statistics ▪ Lack of data to guide decisions in MAT 3. Innovation Relative Advantage ▪ Barrier of different perceptions of MAT value and benefits 4. Innovation Cost ▪ The high cost of devices and spare parts 5. Innovation Complexity ▪ Complex procedures and delays in MAT provision ▪ Challenges due to customisation needs and production limitations 6. Innovation Design ▪ Balancing quality and cost as a barrier in MAT provision
2. Inner Setting Domain	1. Physical Infrastructure <i>1.1 Characteristics of Healthcare Setting</i> ▪ Type of healthcare facility ▪ Patient admission criteria 2. Information Technology Infrastructure ▪ Outdated IT infrastructure 3. Work Infrastructure ▪ Undefined role boundaries in prescriptive and provision authority 4. Communications ▪ Inadequate coordination and communication among departments ▪ Challenges in tracking patient care 5. Mission Alignment

	▪ Focus and scope of healthcare settings 6. Funding ▪ Lack of internal funding for MAT 7. Compatibility ▪ Overloaded workflows and time constraints 8. Relative Priority ▪ Prioritisation challenges in MAT provision and associated services 9. Available Resources <i>9.1 Space</i> ▪ Operational and logistical barriers in inventory and stocking ▪ Inadequate storage and training spaces <i>9.2 Materials and Equipment</i> ▪ Lack of access to essential accessories for MAT ▪ Lack of access to assessment tools and outcome measures <i>9.3 Trained Professionals</i> ▪ Scarcity of adequately trained professionals 10 Access to Knowledge and Information <i>10.1 Professional Development and Training</i> ▪ Poorly designed educational programmes ▪ Training deficiencies
3. Outer Setting Domain	1. Partnerships and Connections ▪ Barriers due to rigid administrative partnerships with NUPCO and the MHRSD 2. Policies and Laws <i>2.1 Restrictive Policies and Regulatory Ambiguity in MAT Provision</i> ▪ Restrictive and inflexible hospital policies ▪ Absence of clear system and regulation on device provision 3. Financing ▪ Inadequate and unstable governmental financing mechanisms 4. Local Conditions ▪ Restrictions and inequities due to geographical concentration of the services ▪ Inadequate environmental and infrastructure adaptability

4. Process Domain	1. Planning ▪ Challenges in strategic planning and coordination for device needs 2. Engaging ▪ Lack of engagement and recognition from high-level leadership ▪ Absence of specialised local clinical leadership
5. Individual Domain	1. Innovation Recipients, Patients ▪ Socioeconomic barriers ▪ Sociodemographic barriers ▪ Social cultural barriers ▪ Personal factors; patient perceptions and acceptance ▪ Lacking patient and family commitment ▪ Inadequate patient and family education and awareness ▪ Lack of accessible and adequate informational resources for patients 2. Innovation Deliverers, HCPs ▪ Lack of awareness and knowledge about MAT among HCPs ▪ Limitations in HCPs' expertise ▪ Autonomy and recognition of HCPs' roles in patient care and decision-making 3. Other Implementation Support, Administrative and Clinical Managers ▪ Strategic planning and staff expertise ▪ Logistics and resource management in MAT provision ▪ Advocacy and awareness ▪ Expanding opportunities in patient support 4. High-Level Leaders, Leaders ▪ Building expert networks for enhanced MAT services ▪ The need for empowerment and recognition of HCP in MAT provision ▪ Empowering rehabilitation with autonomy for improved patient care

4.4 Discussion

This qualitative study aimed to identify barriers to MAT provision in Saudi Arabia by interviewing 33 stakeholders and analysing six documents. A total of 52 factors were identified across the five domains of the CFIR that have the potential to influence the provision of MAT within the Saudi health system. These challenges encompass difficulties in sourcing and ensuring device availability as well as economic factors that hinder the provision of consistent, high-quality MAT. Furthermore, there is a lack of awareness among stakeholders and insufficient data and research to inform effective decision-making processes for improving access [Innovation]. Infrastructural challenges, resource allocation issues and communication barriers are exacerbated by the unclear roles of HCPs and inadequate training, impacting the prioritisation of MAT provision and associated services [Inner Setting]. Restricted policies, regulatory ambiguities and uneven government funding alongside local service concentrations negatively impact accessibility and equality [Outer Setting]. The Process domain is affected by inadequate strategic planning and clinical leadership, demonstrated by poor coordination for product needs, limited engagement from senior leaders and a deficiency in localised clinical leadership. Socioeconomic and sociodemographic factors, along with personal, cultural, social and physical barriers, emerged as key limitations affecting patients' access to and acceptance of MAT. Additionally, HCPs' limited awareness and expertise impede their autonomy and the recognition of their roles [Individual].

To the best of the researcher's knowledge, this is the first study to explore barriers to MAT provision in Saudi Arabia. The research aligns with the domains and constructs of the CFIR and supports the findings from recent global reports by authoritative bodies such as the WHO and UNICEF (2022) as well as the recent scoping review by Mishra *et al.* (2024). Several similar barriers to MAT access have been consistently identified by these sources, including a lack of awareness, high costs, a limited product range, procurement and delivery challenges, gaps in workforce capacity, insufficient policy and legislation, lack of funding, market failures, fragmentation of the sector and socio-demographic factors. This study highlighted additional critical challenges within the Saudi Arabian healthcare system, most notably the dependence on imported MAT. This reliance arises from a weak local manufacturing sector, leading to potential deficiencies in the supply chain and accessibility of these essential devices. This dependence leads to further financial pressure through import duties and logistics, leading the healthcare system to select alternatives that may be of lower quality.

The perceived low quality of locally available devices can be attributed to these economic challenges and a lack of knowledge of the benefits of MAT.

The integration of documentary and interview data provided complementary insights into MAT provision barriers in Saudi healthcare settings. The documentary analysis highlighted formal structures, including procurement procedures (Document 5) and eligibility criteria (Documents 1–3), while the interviews uncovered the practical challenges in implementing these requirements. Both data sources identified consistent challenges, particularly around procurement processes, with the documents highlighting lengthy regulations and participants describing significant delays due to multiple approval layers and diverse stakeholders. This consistency between documented standards and participant experiences strengthened the evidence base for the identified barriers.

When examining specific healthcare settings, the barriers identified by participants and documented sources were largely consistent, yet some distinctions were observed in the Inner Setting domain across different sites. Specifically, Sites B and C encountered barriers related to physical infrastructure, including healthcare facility characteristics, and information technology infrastructure. Additionally, they faced challenges in prescriptive authority due to undefined role boundaries [Work Infrastructure] and issues with the focus and scope of healthcare settings affecting prioritising MAT [Mission Alignment]. These factors were not reported by participants from Site A, suggesting that differences may stem from the varied scopes, infrastructures and geographical locations of healthcare settings, as distinct agencies regulate each site. Furthermore, Site C interviewees reported issues with inadequate coordination and communication among departments – problems not identified at Sites A and B. Additionally, Sites A and B faced challenges related to overloaded workflows, time constraints and compatibility issues arising from geographical disparities in the distribution of MAT services and the concentration of these services within these sites. This analysis indicated that the differences in reported barriers could be attributed to the distinct operational frameworks and regulatory environments of the healthcare facilities involved.

Across all participant groups, there was consensus that MAT provision varies significantly depending on whether the devices are provided by governments, nongovernmental organisations (including charities) or the local private sector, which is consistent with international findings (Rey-Matias, Bundoc and Montes, 2019; WHO, 2022). When appropriate MAT devices are not available or delayed, most participants reported that

patients and their families rely on out-of-pocket payments to purchase them. There were also differences in the perceptions of MAT benefits among the various types of participants. For example, the HCPs stressed the necessity of high-quality MAT for safety and durability, highlighting its critical role in patient recovery and QoL. In contrast, the administrative managers and leaders, often constrained by budget limitations, were sometimes forced to balance cost against quality. This issue led to a preference for more cost-effective devices, even if they might not meet the highest standards of quality or address clinical priorities effectively. These concerns align with international observations indicating that the market price of MAT devices can be unaffordable (WHO, 2022). Consequently, managers might choose lower-quality, cheaper alternatives rather than a more costly but suitable option. In addition, a significant discrepancy existed between the needs of HCPs and management decisions, particularly concerning the procurement and customisation of MAT devices such as wheelchairs. The HCPs criticised the ‘one-size-fits-all’ approach, which fails to accommodate the unique needs of individual patients, alongside difficulties in predicting future requirements and pre-planning for device needs. These challenges are caused by policy-related barriers encountered by the NUPCO, highlighting the need for more flexible procurement policies that can better align with the diverse needs of patients and the recommendations of HCPs.

The barriers identified parallel the universal MAT access challenges discussed in Chapter 1, Section 1.4, emphasising the need for comprehensive solutions. The study's findings advocate for sustainable MAT policies that align with WHO's (2022) six fundamental principles of healthcare provision. These principles - accessibility, affordability, availability, adaptability, acceptability, and quality - are crucial for ensuring MAT services effectively meet users' needs.

4.4.1 Strengths and limitations

The study's sample comprised 33 participants. The data collection was concluded when saturation was reached, ensuring that no new themes emerged from subsequent interviews. A major strength of this study is the diversity of stakeholders interviewed, encompassing managers, HCPs and leaders. The inclusion of participants with a wide range of characteristics in terms of clinical experience, speciality, site and education level enhances the study's robustness by mitigating selection bias and enhancing the analysis with varied perspectives. In addition, the triangulation of data sources and member checking enhance the

trustworthiness of the findings. The comparative analysis conducted across three sites and the perspectives of various participants contribute to robust conclusions about the factors creating barriers to MAT provision in different environments. While the results are specific to the hospitals studied, the standardised methodology employed in this research supports the transferability of the findings to similar healthcare contexts within Saudi Arabia and could aid in the planning of strategies to improve access at other sites. Details on the transferability limitations are discussed in Chapter 6, Section 6.4.2.

Despite these strengths, several methodological limitations should be acknowledged. The study employed both face-to-face (n=24) and online (n=9) interviews based on participants' preferences. Face-to-face interviews, conducted at participants' workplaces, may have been affected by time constraints or interruptions, potentially limiting the depth of responses. Online participants may have had more flexibility and provided more detailed input, though these interviews lacked non-verbal cues and the opportunity to build in-person rapport. Despite these differences, the consistency of themes across both formats suggests the data collection method did not substantially affect the core findings.

Another methodological limitation was the use of single coding, as all interview data was analysed and coded by a single researcher. While this approach ensured consistency in the application of the analytical framework, it lacked the additional validation that multiple independent coders might provide, as credibility is enhanced when data are analysed by more than one researcher (Nowell *et al.*, 2017). To mitigate this limitation, regular supervisory discussions, the use of CFIR's established coding framework, member checking with participants, and triangulation with documentary data were employed to strengthen the trustworthiness of the findings.

4.4.2 Implications for policy, practice and research

Building on the global healthcare priorities for MAT provision (discussed in Chapter 1, Section 1.3), this study offers significant implications for clinical practice and policymaking. By mapping factors to a standardised set of constructs in the CFIR, this research provides stakeholders with a systematic approach to identifying, assessing and addressing key barriers to MAT uptake. The identification of these barriers through the CFIR enables their linkage to ERIC strategies for improving MAT provision, which will be presented in Chapter 5, Section 5.3.2, while comprehensive recommendations for practice and policy will be discussed in

Chapter 6, Section 6.5.1.

Future research should focus on identifying barriers within diverse settings and specifically investigating the challenges of accessing MAT in other regions of Saudi Arabia, especially in remote areas. Furthermore, it is necessary to examine the funding and policy-related barriers, specifically the challenges faced by the NUPCO and MHRSD in providing MAT. These organisations face unique challenges in the procurement and distribution processes, necessitating innovative solutions to enhance service delivery.

4.5 Conclusion

This qualitative study comprehensively presented the factors influencing MAT provision and directly addressed the chapter objective of exploring HCPs', managers' and leaders' perceptions through semi-structured interviews and document analysis. It offered new insights into the barriers encountered across three hospitals in two regions of Saudi Arabia, identifying both shared concerns and divergences among different participants, including HCPs, clinical and administrative managers, and leaders in healthcare settings. Structuring the barriers around the CFIR aided in identifying the multi-level factors affecting access to MAT, including issues such as local shortages and economic constraints affecting the consistent quality of MAT devices [Innovation]; infrastructural and resource allocation problems, communication barriers, and unclear roles and training for HCPs [Inner Setting]; restrictive policies, funding disparities and service concentration that hinder MAT accessibility and equity [Outer Setting]; a lack of strategic planning and clinical leadership, which impairs engagement in MAT implementation [Process]; and socioeconomic, sociodemographic and personal factors, along with HCPs' awareness and expertise, that influence patient access to and acceptance of MAT [Individual]. The findings from this qualitative study will be of practical utility for researchers and policymakers, aligning with the pragmatic axiological principle that knowledge should lead to practical consequences (Chapter 1, Section 1.7.2). They provide a foundation for identifying and designing contextually relevant implementation strategies to improve MAT access.

4.6 Chapter summary

This chapter addressed the third research objective of this thesis. It presented the methods and results of semi-structured interviews and a documentary analysis involving key stakeholders in MAT services within Saudi hospitals. It identified a number of barriers to MAT provision

across three hospitals in two regions of Saudi Arabia, emphasising the urgent need for a comprehensive approach to address the complexity of these barriers. The findings advocate for the development of policies and practices that support the sustainable delivery of MAT devices. The findings could inform the development of ERIC strategies for improving MAT service provision in Saudi Arabia, which will be discussed in the next chapter (Chapter 5).

Chapter 5: Triangulation of Findings and Strategies for Enhancing the Provision of Mobility Assistive Technology

5.1 Introduction

This chapter addresses the fourth objective of this thesis outlined in Chapter 1, Section 1.10: to develop strategies using the CFIR-ERIC matching tool to overcome identified challenges for future research, policy and practice. These strategies are informed by findings from the scoping review (Chapter 2), survey (Chapter 3) and qualitative study (Chapter 4).

The qualitative study in Chapter 4, which included interviews with 33 stakeholders and an analysis of six documents across three hospitals in two regions of Saudi Arabia, identified several barriers across CFIR domains to MAT provision (Chapter 4, Section 4.3.3). These barriers, identified through diverse stakeholder perspectives (HCPs, managers and leaders), highlighted the need for comprehensive solutions. The CFIR-ERIC matching tool detailed in Section 5.2.2 combines framework constructs with expert-recommended strategies, offering 73 implementation strategies ranked by their relevance to specific barriers (Powell *et al.*, 2015; Waltz *et al.*, 2019). This systematic approach enables the development of targeted solutions to mitigate identified barriers.

The chapter presents the methodology for data triangulation (Section 5.2.1) and strategy identification using the CFIR-ERIC matching tool (Section 5.2.2), followed by triangulation findings (Section 5.3.1), identified strategies (Section 5.3.2) and their implications for MAT provision in Saudi Arabia (Section 5.4).

5.2 Method

This chapter was guided by the CFIR-ERIC matching tool to identify strategies to address barriers to MAT provision identified in the previously conducted chapters. The methodological processes undertaken in this chapter are to triangulate the data from Chapters 2, 3 and 4 and then map them to ERIC (Figure 5.1). The methods for each step are explained in more detail below.

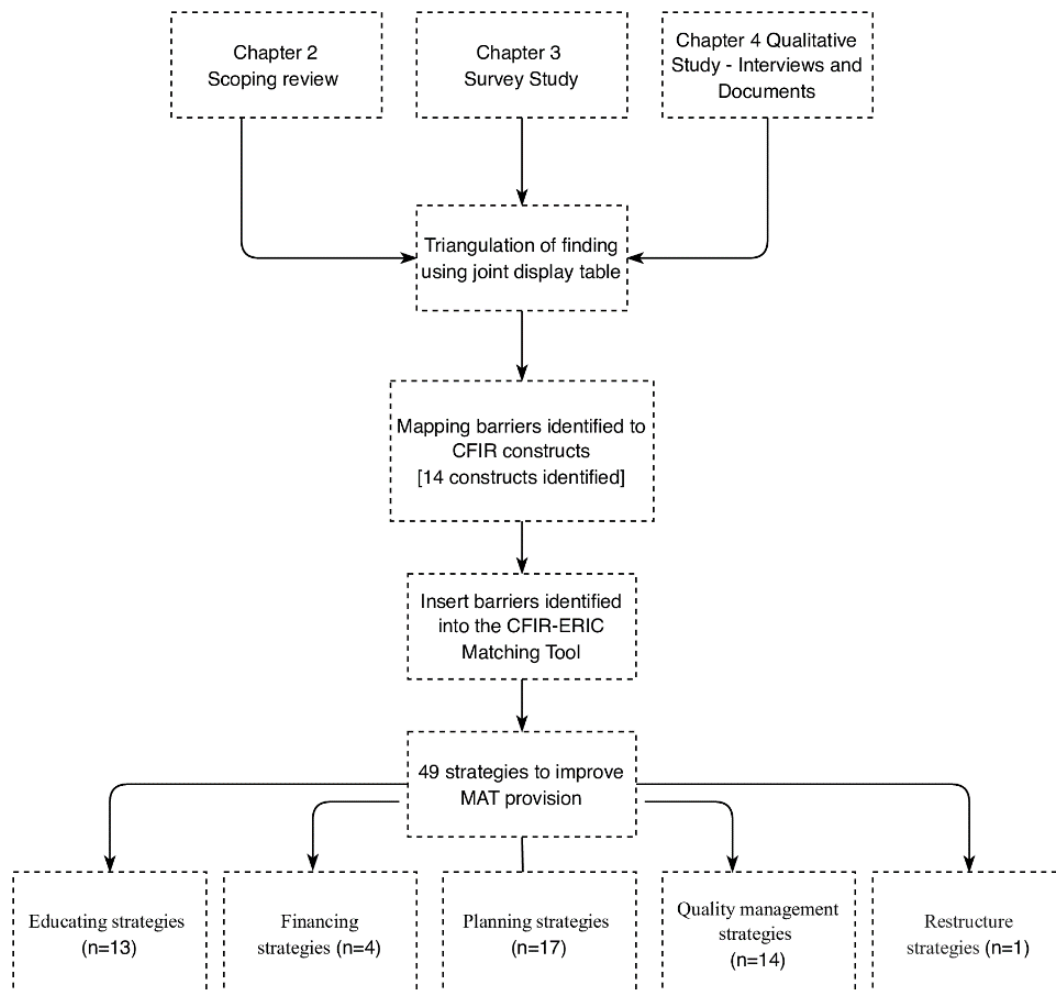


Figure 5.1 The methodological processes undertaken in this chapter

5.2.1 Identification of barriers to MAT provision: triangulation of findings

The triangulation protocol method was used in this chapter to integrate the findings from the different chapters to gain a better understanding of barriers to MAT provision (Farmer *et al.*, 2006; O’Cathain, Murphy and Nicholl, 2010). This approach follows the six-step process developed by Farmer *et al.* (2006), as outlined in Table 5.1. This method can improve the validity of the findings by determining whether data agreement, partial agreement, dissonance and silence indicate a key finding that is identified from one component but not from another (Farmer *et al.*, 2006). The data sources triangulated in this chapter include findings from the scoping review, survey, semi-structured interviews and document analysis presented throughout this thesis. The guiding research question for this analysis is the following: What are the factors

influencing MAT provision?

Table 5.1 The six steps of a triangulation protocol (Farmer *et al.*, 2006)

Step	Description
Step 1: Sorting	Organise the data from each data source into specific categories designed to address the research question.
Step 2: Convergence Coding	Identify and compare themes to determine the level of agreement or disagreement across data sources.
Step 3: Convergence Assessment	Review categorised segments to evaluate overall convergence or divergence in the findings.
Step 4: Completeness Assessment	Compare data sources to ensure comprehensive coverage and highlight any gaps or differences.
Step 5: Researcher Comparison	Compare and discuss findings with the research team.
Step 6: Feedback	Present and review the triangulated results with the research team or stakeholders.

5.2.1.1 Sorting

First, all the results and themes from each data source presented in this thesis – including the scoping review, survey, semi-structured interviews and documents regarding factors influencing MAT provision – were reviewed and organised in an Excel sheet. These findings were then categorised by theme, with data from different sources related to the same themes grouped to present an overview of the barriers to MAT provision.

5.2.1.2 Convergence coding

The identified themes formed the rows of a convergence coding matrix, which was used to summarise the similarities and differences between the data sets. This matrix facilitated the evaluation of how the findings showed agreement, whether there was partial agreement or dissonance from one another and whether there were any themes without a common finding across components (Table 5.2).

Table 5.2 Convergence coding scheme (Farmer *et al.*, 2006)

Coding Label	Definition
Agreement	Full agreement across all data sources.
Partial Agreement	Agreement on some but not all components across data sources.
Dissonance	Disagreement between data sources.
Silence	Theme present in one source, absent in the other.

5.2.1.3 Convergence assessment

The overall alignment of all themes across the data sources was then reviewed. This assessment applied the coding scheme from Table 5.2 to evaluate the consistency of themes across data sources. The convergence coding matrix was analysed to determine the overall level of agreement among the themes. This analysis provided a comprehensive overview of where themes showed agreement, partial agreement, silence or dissonance, thereby highlighting the consistency and discrepancies among the data sources.

5.2.1.4 Completeness assessment

A completeness comparison was conducted to evaluate the unique contribution of each data source to answering the research question guiding this triangulation analysis about barriers to MAT provision in Saudi Arabia. This assessment examined how each data source added depth, breadth or new insights to the understanding of the barriers. The scoping review provided a global context from existing literature. The survey revealed service inconsistencies across Saudi hospitals. Semi-structured interviews offered qualitative insights into barriers from different key stakeholder perspectives. Documents provided contextual and policy-related information. This approach highlights how different data sources complement each other, providing a holistic view of the research question. The assessment demonstrated that while individual data sets offered partial views, their combination enabled a more thorough understanding of the barriers to MAT provision in Saudi Arabia.

5.2.1.5 Researcher comparison

In this step, the assessments of convergence or dissonance of the findings were compared across multiple researchers (Farmer *et al.*, 2006). However, although one researcher conducted the triangulation protocol in this chapter, the process and findings were regularly discussed with her

supervisors.

5.2.1.6 Feedback

Following the initial triangulation and convergence assessment, the results were shared with supervisors for feedback and comments.

5.2.2 Identification of strategies using the CFIR-ERIC matching tool

The CFIR consists of constructs drawn from 19 theories of implementation science and can serve as a tool for identifying barriers and developing implementation strategies, as described in Chapter 1, Section 1.6.2 (Damschroder *et al.*, 2022b). The ERIC recommendations provide 73 strategies for overcoming implementation barriers, which were developed through a modified Delphi process with experts in implementation science and clinical practice (Powell *et al.*, 2015). The CFIR-ERIC matching tool was created to support tailored implementation planning by aligning ERIC strategies with CFIR constructs (Waltz *et al.*, 2019). Experts ranked the seven most effective ERIC strategies for each CFIR construct to address barriers (Waltz *et al.*, 2019). Strategies recommended by $\geq 50\%$ of experts for a construct are considered ‘Level 1’ and those recommended by 20%–49.9% are considered ‘Level 2’ (Waltz *et al.*, 2019). The output of this work, the CFIR-ERIC matching tool, is freely available (www.cfirguide.com/eric), and it matches CFIR constructs with ERIC strategies.

The CFIR-ERIC matching tool was used to select strategies for addressing barriers identified in previous chapters. The tool allowed the user to rate the relevance of each CFIR construct to these barriers by checking ‘0’ or ‘1’, with the output presented in a table. This table matches the CFIR constructs with the ERIC strategies while also indicating the proportion of expert endorsements (Waltz *et al.*, 2019). Since the researcher utilised the updated constructs of CFIR while the matching tool employed older constructs, the researcher linked the new constructs to the old ones. This process followed the guidance provided by Damschroder *et al.* (2022b), who detailed the changes in construct names – detailed in Appendix 15.

5.3 Results

5.3.1 Barriers to MAT provision: triangulation of findings

The integration grids presented in Tables 5.3–5.8 triangulate the findings from Chapters 2, 3 and

4 regarding barriers to MAT provision, which provide a clearer understanding of these barriers within Saudi Arabia. The MAT provision was determined to be influenced by 14 constructs across the five CFIR domains – innovation, process, individual, inner setting and outer setting. These constructs are innovation complexity, cost, design, source, evidence base, engaging, planning, innovation recipients, available resources, structural characteristics, mission alignment, access to knowledge and information, policies, laws and partnerships connections (Figure 5.2). After constructing the table, the types of barriers were considered and the findings were summarised into six main categories: 1) Healthcare Systems and Policy Barriers, 2) Procurement and Delivery Challenges, 3) MAT Devices-related Barriers, 4) Information and Awareness Barriers, 5) Resources and Infrastructure Barriers and 6) Personal and Environmental Barriers. These categories are presented and discussed below.

In this convergence assessment, 100% of the themes showed either partial or full agreement across the data sources. Specifically, there was full agreement on seven themes (50%) and partial agreement on seven themes (50%). It is important to note that the survey employed in this thesis had a specific focus; its objective was to provide an overview of MAT in Saudi Arabia and to facilitate participant recruitment (Chapter 3). Consequently, certain aspects explored in other data sources were outside the scope of this survey.

Table 5.3 Integrated factors influencing mobility-assistive technology (MAT) provision – healthcare systems and policy barriers

	Chapter 2	Chapter 3	Chapter 4				
Factors	Scoping Review	Survey	Semi-Structured Interviews	Documents	CFIR Domain and Constructs	Convergence Code	Integration
Barriers in administrative and collaborative partnerships.	Limited engagement from the government, donor organisations and MAT vendors in supporting and promoting the implementation and provision of MAT.	Not applicable.	Partnership with government facilities, such as the National Unified Procurement Company, complicates direct purchasing. Collaboration with the Ministry of Social Services often leads to the supply of generic MAT devices that do not meet patients' specific needs.	Highlighted collaboration across sectors (D2).	Outer setting domain, partnerships and connections.	Partial agreement.	The semi-structured interviews complement the findings from the scoping review and documents by providing detailed examples of how these partnerships' challenges are noticeable.
Absence of clear system and regulation on MAT device provision.	Policy and law issues, such as inconsistencies between policies and their	Accessibility to MAT varied significantly among hospitals,	Hospitals lack comprehensive policies governing MAT provision, maintenance and equitable	Regulatory ambiguity in MAT provision is shown. Site A has a comprehensive	Outer setting domain, policies and laws.	Agreement.	The survey results complement the observations made in the scoping review and the semi-structured

	implementation and lack of legislation and policies. Theory, model or framework synthesis shows that policies influence the provision of services.	with facilities in the central region (Sites A and B) showing greater accessibility than those in the eastern region (Site C).	distribution. No structured follow-up procedures and limitations on MAT device eligibility. Criteria for eligibility for receiving MAT include factors such as medical needs and financial status. Consensus among all participant groups that MAT provision varied greatly, influenced by whether MAT devices were supplied by governmental bodies, non-governmental organisations (including charities) or the local private sector.	policy detailing eligibility for MAT (D2). Site B has developed informal guidelines through its healthcare professionals (HCP) staff (D1). In contrast, Site C lacks clear guidelines (D3).			interviews about regulatory ambiguity and the absence of clear guidelines.
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Leadership engagement deficit.	Lack of physician involvement and failure to refer to MAT service, the absence of interdisciplinary MAT standards and a lack of engagement among the organisation's leaders.	Not applicable.	Lack of engagement and recognition from high-level leadership, specifically the limited acknowledgement of the rehabilitation role and HCP autonomy in decision-making.	Not addressed.	Process domain, engaging.	Partial agreement.	Challenges of insufficient engagement and recognition from leadership.
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Note: 'Not applicable' indicates areas where the survey was not designed to generate data, as the survey was mainly designed to provide an overview of MAT provision and assist in participant recruitment. 'Not addressed' indicates topics that were not covered in the source.

Table 5.4 Integrated factors influencing mobility-assistive technology (MAT) provision – procurement and delivery challenges

	Chapter 2	Chapter 3	Chapter 4				
Factors	Scoping Review	Survey	Semi-Structured Interviews	Documents	CFIR Domain and Constructs	Convergence Code	Integration
Sourcing and availability of MAT devices.	Limited trustworthiness of MAT vendors.	Not applicable.	Challenges in finding suppliers for certain types of MAT devices [prostheses and specialised wheelchairs]. Few local options or companies are available for servicing and maintaining equipment.	Not addressed.	Innovation domain, innovation source.	Partial agreement.	Challenges related to the trustworthiness and accessibility of MAT device vendors and suppliers. Silence in documents.
Procurement and delivery challenges.	The length and complexity of the provisioning process.	Not applicable.	Inconsistent both across and within hospitals, lacking a coherent strategy for purchasing MAT devices. Complex procedures and delays in meeting patient needs. Hospital managers frequently face	Highlighted procurement regulations and the long process that requires planning the need in advance (D5).	Innovation domain, complexity; process domain, planning.	Partial agreement.	Procurement and delivery challenges from multiple angles, such as accessibility issues, regulatory frameworks and planning challenges.

			difficulties in planning for MAT device needs. Healthcare professionals (HCPs) face challenges in submitting device pre-planning; many MAT devices require customisation to meet individual patient requirements.				
Logistical challenges.	Not addressed.	Not applicable.	Absence of clear information systems for inventory and tracking, alongside poor management of supply warehouses. Need for clearly defined roles regarding prescription authority.	The documents highlighted issues with roles and boundaries in MAT provision, where patients receive MAT devices from the warehouse/ Ministry of Human Resources and Development that may not match what the HCP prescribed (D1, D2, D3).	Inner setting domain, structural characteristics.	Partial agreement.	The semi-structured interviews and document analysis provide complementary insights into these challenges.

			Some managers believe these responsibilities should be divided between different departments to optimise patient discharge preparations, which contrasts with the views expressed by other HCPs who see the current arrangement as problematic.				
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Notes: See Table 5.3 for explanations of 'Not applicable' and 'Not addressed'

Table 5.5 Integrated factors influencing mobility-assistive technology (MAT) provision – devices-related barriers

	Chapter 2	Chapter 3	Chapter 4				
Factors	Scoping Review	Survey	Semi-Structured Interviews	Documents	CFIR Domain and Constructs	Convergence Code	Integration
The high cost of MAT devices and spare parts.	Provides evidence that MAT devices are associated with high initial costs and ongoing maintenance expenses. Theory, model or framework (TMF) synthesis shows that cost influences the provision of appropriate services.	The survey did not explicitly address this issue. Still, the results highlight reduced accessibility to more advanced MAT devices, such as electric wheelchairs, lower limb prostheses and specialised wheelchairs, such as reclining power wheelchairs	Challenges and the high cost of MAT devices, noting that organisational budgets are limited, making it difficult to afford them. Leaders and administrative managers acknowledge balancing quality and cost is challenging. The high price of the MAT devices often leads them to choose less expensive options that compromise some features.	Documents detail how the cost affects the provision and specify that higher-cost MAT devices are only provided for certain cases; they also include information on how patients can purchase or obtain these MAT devices (D1, D2, D3 D4, D5).	Innovation domain, innovation cost.	Agreement.	High cost of MAT devices a significant barrier to the provision of MAT. The documents offer further insight into provision constraints and alternatives available to patients for acquiring MAT devices due to the high costs.

		and wheelchairs with customisable postures.					
Challenges in MAT device standardisation and quality assurance.	Highlights inconsistent quality of MAT devices, limited models and colour choices available to users. Emphasises issues with comfort, durability and fit. According to the TMF synthesis, ‘comprehensive services’ refer to providing clients with high-quality products as well as essential support	Not applicable.	Main challenge: providing correct sizes; limited standard sizes from some companies; equipment of low quality due to market shortages; limited range and quantity; challenges in sourcing reliable equipment; some deemed unsafe and poor suitability to patients. Healthcare professionals recognise that high-quality MAT devices are essential for safety and durability.	Documents emphasise that when setting criteria for MAT device specifications, it is important to avoid directly referencing specific details from suppliers, such as the exact type, description, category or catalogue number. Instead, the focus should be on broader criteria that are not tied to any particular supplier’s offerings (D5).	Innovation domain, innovation design.	Partial agreement.	The scoping review and semi-structured interviews highlighted quality problems. Document analysis further shows how MAT device specifications, including the constraints of avoiding direct references to specific supplier details, may contribute to these quality issues.

	services to suit their needs.		Leaders and administrative managers acknowledge that balancing quality and cost is challenging.				
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Notes: See Table 5.3 for explanations of 'Not applicable' and 'Not addressed'

Table 5.6 Integrated factors influencing mobility-assistive technology (MAT) provision – information and awareness barriers

	Chapter 2	Chapter 3	Chapter 4				
Factors	Scoping Review	Survey	Semi-Structured Interviews	Documents	CFIR Domain and Constructs	Convergence Code	Integration
Data needed to guide decisions in MAT provision.	Insufficient rigorous research to demonstrate the efficacy of most MAT devices.	Not applicable.	Need for comprehensive data on the effectiveness of MAT devices, especially concerning the performance and durability of some MAT devices. Lack of national statistics on MAT use and governmental commitment to accessibility.	Not addressed.	Innovation domain, innovation evidence base.	Partial agreement	There is agreement on the need for comprehensive, context-specific data on MAT device effectiveness.
Lack of awareness and information.	Deficiencies in ongoing training and education among healthcare professionals (HCPs), stating that they were	Several participants reported being unaware of different MAT in their hospitals.	Lack of knowledge about available MAT devices that can be provided to patients and express concerns about the limited number of educational institutions	Not addressed.	Inner setting domain access to knowledge and information.	Agreement.	The findings from three sources complement each other by providing a fuller picture of the issue from different angles. There is a lack of awareness and knowledge about

	not adequately prepared by their professional education and highlighting weaknesses in education programmes.		producing graduates in MAT. HCPs felt underprepared by their professional education, particularly in relation to MAT, as they were primarily trained as general OTs or PTs. HCPs suggest that administrative managers and leaders may have a limited understanding of the advantages of MAT in patient care. Administrative managers and leaders may potentially prioritise financial outcomes over clinical ones.				MAT, with discrepancies in priorities between HCPs, administrative managers and leaders and silence from the documents.
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Notes: See Table 5.3 for explanations of 'Not applicable' and 'Not addressed'

Table 5.7 Integrated factors influencing mobility-assistive technology (MAT) provision – resources and infrastructure barriers

Factors	Chapter 2	Chapter 3	Chapter 4		CFIR Domain and Constructs	Convergence Code	Integration
	Scoping Review	Survey	Semi-Structured Interviews	Documents			
Characteristics of healthcare setting.	Indicates issues with service infrastructure.	The survey highlights variation in the provision of MAT devices between hospitals, with a high variation noted in Site A.	Type of healthcare facility and admission criteria affect the services provided. Also, the focus and scope of healthcare settings affect the services' prioritisation.	Hospitals that primarily focus on acute care have not documented formal guidelines for MAT provision (D1, D3).	Inner setting domain, structural characteristics and mission alignment.	Agreement.	All chapters acknowledge issues with the physical infrastructure in healthcare settings that affect the provision of MAT.
Availability of resources, such as funding, space, trained professionals and materials.	Limited funding, staff shortages, lack of workspace, insufficient time for patient interaction and the absence of suitable assessment tools to evaluate patient needs properly.	Not applicable	There is no allocated budget for MAT provision, a limited number of specialists are familiar with MAT, there is limited time to train the patients and there are limitations in stocking and	Budgetary constraints are highlighted (D2, D4, D5).	Inner setting domain, available resources.	Agreement.	Agreement across different chapters acknowledges the challenge of resource availability.

	The theory, model or framework synthesis illustrates the need for adequate resources, including staff, to effectively meet the needs of the patients.		training spaces, as well as in MAT assessment tools and outcome measures.				
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Notes: See Table 5.3 for explanations of 'Not applicable' and 'Not addressed'

Table 5.8 Integrated factors influencing mobility-assistive technology (MAT) provision – personal and environmental barriers

	Chapter 2	Chapter 3	Chapter 4				
Factors	Scoping Review	Survey	Semi-Structured Interviews	Documents	CFIR Domain and Constructs	Convergence Code	Integration
Environmental barriers include physical, social and cultural.	Highlighted the geographical distances of services and built environment barriers. Theory, model or framework (TMF) synthesis indicates that environmental factors, such as societal attitudes, transportation issues, geographical distances and policy inconsistencies, significantly influence an	A significant difference in accessibility was noted across hospitals, with those in the central region showing higher accessibility.	Patients are often referred to facilities in the central region for specialised medical conditions. Cultural norms suggest a preference or acceptance of dependence on family. Challenges in adapting MAT at home due to infrastructure deficits. In public spaces, there is an absence of accessible areas to accommodate	Highlighted the requirements for prescriptions, such as environmental accessibility and suitability for assistive technology (D1, D2).	Individuals' domain and outer setting domain, innovation recipients, policies, laws.	Agreement.	Environmental barriers significantly impact the accessibility and use of MAT.

	individual's decision to seek appropriate healthcare.		assistive technologies.				
Personal factors, such as individual preferences and educational background, and sociodemographic factors.	The unfamiliarity of users with MAT and their preferences in prescriptions. TMF synthesis shows personal factors influence healthcare utilisation.	Not applicable.	Highlighted how the type of functional ability affects accessibility and how family education and awareness, along with socioeconomic factors, influence accessibility.	Highlighted the requirements for prescriptions, such as patient autonomy and consent, and emphasised the classification system that determines where patients need to purchase these MAT devices (D1, D2).	Characteristics of individuals, innovation recipients.	Agreement.	Personal factors significantly impact the use and accessibility of MAT.

Notes: See Table 5.3 for explanations of 'Not applicable' and 'Not addressed'

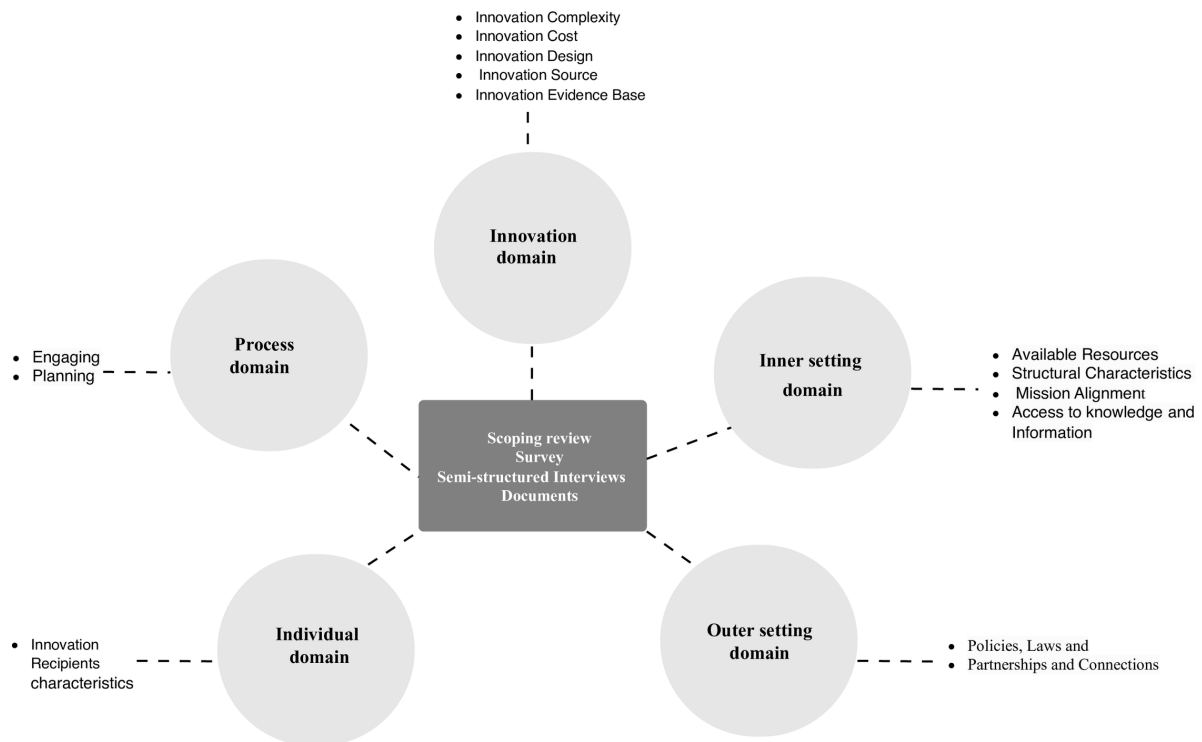


Figure 5.2 Constructs identified from triangulation as relevant determinants of mobility assistive technology provision

5.3.1.1 Healthcare systems and policy barriers

Integrating findings has contributed to a deeper understanding of the challenges associated with MAT provision, highlighting comprehensive issues in the healthcare system and policy framework, such as the absence of a clear system and regulation on MAT device provision (outer setting domain, policies and laws), a leadership engagement deficit (process domain, engaging) and barriers in collaborative partnerships (outer setting domain, partnerships and connections). This integration confirmed a lack of clear systems and regulations across various data sources. Interviews and reviewed documents indicated an inconsistent provision of MAT in the three hospitals. Although the survey primarily aided participant recruitment, its results further emphasised the observations from the scoping review and interviews and documents regarding regulatory ambiguity and inconsistencies in MAT provision (Hammel *et al.*, 2013; Seymour, Geiger and Scheffler, 2019; Dorjbal *et al.*, 2020; Widehammar *et al.*, 2020; Gowran *et al.*, 2021; Bhidayasiri *et al.*, 2022; Nabizadeh *et al.*, 2023; Serres-Lafontaine *et al.*, 2023). Notably, accessibility to MAT varied significantly among the three hospitals, with the two hospitals in the

central region showing greater accessibility compared with the one in the eastern region.

There was a consensus among all participant groups in the interviews that MAT provision varied greatly, influenced by whether MAT devices were supplied by governmental bodies such as the hospitals where the patients were treated or the MHRSD, non-governmental organisations (NGOs), such as charities, or the local private sector, including medical device companies. For example, patients assessed in hospitals face challenges in receiving necessary MAT devices, often being referred to other sectors, such as the MHRSD or other private rehabilitation centres, for provision. This issue stems from several systemic problems, as MAT is not adequately prioritised, and existing legislation fails to address the needs of individuals with various functional difficulties comprehensively. Furthermore, the criteria for eligibility and the range of MAT devices and services covered are both inadequate and inconsistent, which complicates the provision of necessary MAT. Further complicating the situation is the insufficient engagement and recognition from key leadership figures, such as hospital leaders, government health officials and directors of relevant government bodies, such as the MHRSD and the local private sector, all of whom are essential for driving policy changes and creating a supportive environment for MAT provision.

Additionally, HCPs frequently report a perceived lack of autonomy in critical decision-making processes. Many HCPs express frustration at their limited authority to establish prescribing guidelines or influence policies that could improve access to MAT. This constraint on professional autonomy represents a significant barrier to optimising patient care and MAT provision. Data from three chapters of this thesis consistently demonstrate that barriers to collaborative partnerships within healthcare settings may impact the provision of MAT. The semi-structured interviews complement the findings from the scoping review and document analysis by providing detailed examples of these partnership challenges. For instance, interview participants reported difficulties in partnering with government facilities, such as the National NUPCO and the MHRSD. The central role of NUPCO introduces bureaucracy, complicates direct purchasing due to rigid regulations and causes delays through complex logistics and mandatory expert reviews, where specialists assess the necessity and suitability of the procurement item. Additionally, collaboration with the MHRSD often results in the supply of generic aids that do not meet patients' specific needs.

5.3.1.2 Procurement and delivery challenges

The findings from this integration provide a complex picture of the challenges involved in the procurement and delivery of MAT and highlight multiple aspects, such as planning (process domain, planning), sourcing (innovation domain, innovation source) and logistics challenges (inner setting domain, structural characteristics). The findings show that procurement processes for MAT devices vary significantly among healthcare facilities and even within individual hospitals. There is a notable absence of standardised approaches in the acquisition of MAT devices, which highlights the need for a more uniform and strategic purchasing framework. Interviews with hospital managers show they frequently face difficulties in planning for MAT device needs. There is also an evident issue with departments, such as occupational therapy and physical therapy, submitting their MAT device needs late, which complicates the timely acquisition of these devices.

Additionally, governmental regulations on purchasing medical devices impose further barriers, as observed from the review of regulatory documents. These factors, such as extended approval times, multiple levels of bureaucratic oversight and mandatory expert reviews, contribute to the prolonged duration required to procure the necessary MAT devices. On the other hand, HCPs also face challenges in submitting MAT device pre-planning because patient needs can be unpredictable, and many MAT devices require customisation to meet individual patient requirements. These issues contribute to delays in MAT device delivery, which not only exacerbate logistical complications but may also worsen patients' health outcomes, such as increased risk of falls, extended hospital stays, deterioration in physical condition and increased dependency. Thus, integrating these data sources offers a deeper understanding of the complex issues surrounding the procurement process.

Integrating findings also highlighted challenges related to sourcing MAT devices, spare parts and accessories. Pricing issues, complex contractual arrangements with buyers and suppliers and delays further reduce patients' access to MAT. These MAT devices, including spare parts, are often imported due to limited local manufacturing capacity and a narrow range of available MAT devices. The scarcity of repair services further exacerbates these challenges. In the interviews, participants noted difficulties in finding suppliers for certain types of MAT devices, such as prostheses and specialised wheelchairs. Due to these limitations, they often rely on original

sellers or manufacturers for these MAT devices. There is an apparent lack of data in the reviewed documents, which suggests a potential gap in formal documentation or policies concerning the sourcing and availability of MAT devices. This area may require further investigation or action.

The semi-structured interviews and document analysis provide complementary insights into the logistical challenges faced in the distribution of MAT devices. Participants highlighted the absence of clear information systems for inventory and tracking, alongside poor management of supply warehouses. They also emphasised the need for clearly defined roles regarding prescription and provision authority. They highlighted confusion over who is authorised to issue MAT – whether it should be doctors, physiotherapists, occupational therapists or administrators responsible for facilitating discharge. This ambiguity contributes to issues with role clarity and boundaries in MAT provision. Some HCPs reported that their involvement ends after prescribing MAT devices, leaving them uninformed about what patients ultimately receive. Others only discover that a requested MAT device is unavailable when the patient receives a different one – for instance, in a different size. Some HCPs noted that when such discrepancies occur, there is often limited communication with patients, and the process for resolving these issues remains unclear. This lack of effective information systems and inadequate delivery infrastructure significantly contributes to logistical challenges, impeding the timely delivery of MAT devices to patients.

5.3.1.3 MAT device-related barriers

This integration identified several challenges related to MAT devices, such as their high cost (innovation domain, innovation cost) and concerns over device quality (innovation domain, innovation design). Although the survey did not ask explicitly about MAT device costs, the survey results highlighted limited accessibility to more advanced MAT devices, such as electric wheelchairs, lower limb prostheses and specialised wheelchairs, such as reclining power wheelchairs and those with customisable postures. Interview participants further supported these findings, with a consensus that the high cost of MAT devices significantly impedes the provision of MAT. The documents offer further insight into provision constraints and the alternatives available to patients for acquiring MAT devices due to the high costs. They detail the possibilities of either purchasing through personal funds or obtaining support from NGOs, such

as charities, and government facilities, such as the MHRSD.

Financial pressures caused by import duties and logistics lead to purchasing alternatives that may be cheaper but are often of lower quality. The consensus among interview participants was that these economic challenges, along with a lack of standardisation of MAT devices, directly contribute to the lower quality of MAT devices. HCPs recognise the importance of ensuring that MAT devices meet safety and performance requirements. Specifically, HCPs reported MAT device quality concerns, including inadequate durability, poor fit due to limited size options and functionality issues stemming from the restricted range of available MAT devices. Leaders and administrative managers acknowledge the challenge of balancing quality and cost; the high price of MAT devices often leads to the selection of less expensive options that may compromise essential features, especially under government procurement rules governing contracting procedures, financial approvals and budget considerations. These rules significantly influence how healthcare settings procure and provide MAT. The problem stems from legal and financial frameworks that sometimes prioritise cost over quality. This is exacerbated by a lack of awareness among managers, administrators and procurement officials regarding the need for adequate standards to ensure the safety and effectiveness of MAT devices.

These findings are supported by Document 5, which outlines criteria for MAT device specifications. The document advises against specifying particular brands, models or unique features exclusive to certain MAT devices. While aiming to provide general guidelines for broader procurement criteria, this approach could potentially contribute to quality issues by not addressing the specific requirements of individual MAT devices. These findings also align with international observations from the scoping review, which highlighted issues such as inconsistent MAT device quality, concerns about comfort, fit and durability and restricted model and colour options from vendors (Oskar *et al.*, 2011; Smith, Sakakibara and Miller, 2016).

5.3.1.4 Information and awareness barriers

This integration identified several challenges related to awareness and information, such as the need for data to guide decision-making in MAT provision (innovation domain, innovation evidence base) and concerns over a lack of awareness and access to information (inner setting domain, access to knowledge and information). Several survey participants were unaware of the

different MAT devices available in their hospitals. This finding is backed up by interview results, where participants pointed out their limited awareness of the range of MAT devices available and noted a significant knowledge gap. Another challenge highlighted in the interviews is the lack of accessible and adequate information for both patients and HCPs. They often do not know how to access MAT, what solutions are available or where to find reliable sources of information. Furthermore, HCPs point out deficiencies in ongoing training and education, stating that their professional education did not adequately prepare them. There were also delays in administrative responses concerning educational support.

Despite the potential benefits of MAT in improving patients' QoL and their role in increasing participation in daily activities, work and leisure when provided in a timely manner, significant barriers remain. One notable obstacle is the limited understanding among administrative managers and leaders of the clinical advantages these MAT devices offer. This knowledge gap often results in a prioritisation of short-term financial outcomes over long-term clinical benefits. For instance, there is a tendency to advocate early discharge and reduced clinic visits without sufficient focus on providing quality MAT devices and necessary patient training. This perspective, as reported by HCPs, highlights a disconnect between clinical priorities and administrative decision-making. Additionally, some managers acknowledged the importance of MAT devices in facilitating early patient discharge, highlighting the complex balance between clinical needs and financial constraints.

Another challenge identified by interviewees is the need for comprehensive, national-level data on the effectiveness of these MAT devices. This issue was not addressed in the survey, which primarily aimed to provide an overview of MAT within Saudi Arabia's healthcare system and to recruit participants for the qualitative study (as detailed in Chapter 3), nor was it covered in the document analysis. Participants emphasised the necessity for detailed information on several aspects: the number of MAT users across Saudi Arabia, user satisfaction with the MAT devices and measures of effectiveness, such as improvements in mobility, independence and social participation. Furthermore, they stressed the importance of understanding how MAT influences discharge times and costs of services. Interviewees emphasised that robust evidence demonstrating the impact of MAT is crucial for validating their benefits, informing clinical practices, guiding policymakers and shaping the development of relevant policies and

programmes.

5.3.1.5 Resources and infrastructure barriers

This integration identified challenges linked to infrastructure (inner setting domain, structural characteristics and mission alignment) and available resources (inner setting domain, available resources) that influence MAT provision. The data from various chapters of this thesis consistently demonstrate that issues related to the physical infrastructure in healthcare settings may impact the provision of MAT. Interview participants acknowledged that the type of healthcare facility, such as an acute care hospital or a rehabilitation centre, significantly influences the services provided. They noted that acute care facilities tend to focus more on immediate medical needs and urgent interventions, while rehabilitation centres may prioritise long-term recovery and functional improvement. Additionally, the admission criteria of these facilities, including the severity of patient conditions and the types of services covered, affect how and which MAT is provided. This distinction highlights how the focus and scope of different healthcare settings can determine whether or not certain services are prioritised. The document analysis further corroborated these findings, demonstrating that hospitals primarily focused on acute care, such as Sites B and C, often lack formal guidelines for MAT provision and do not prioritise it within their settings.

Another significant challenge highlighted is the availability of resources, such as funding, space, trained professionals and materials. Interview participants agreed on several barriers: the absence of an allocated budget, a limited number of specialists familiar with the relevant MAT and constraints on stocking and training spaces, as well as assessment tools and outcome measures. Healthcare leaders further described the varying focuses of their institutions, with some serving as rehabilitation facilities and others offering a broader range of healthcare services. These differences often result in uneven resource allocation between hospitals. Another challenge reported by HCPs is the burden of tasks and time constraints, which limits their ability to train patients on the MAT devices. The HCPs also mentioned that the workload in healthcare settings leaves little time for meaningful patient interactions, thereby affecting MAT device provision.

Interviewees expressed concerns about the lack of standardised assessment tools, which leads to inconsistent prescriptions that may not align with patients' needs. This issue is exacerbated by

HCPs' limited access to a consistent range of MAT devices – for example, varying sizes – making it challenging to find the optimal fit for individual patients. The absence of standardised protocols for assessing patients' needs results in varied approaches, which may not always align with best practices, potentially compromising the quality and appropriateness of MAT provision. This problem is exacerbated by the lack of outcome measures to evaluate the effectiveness of MAT over time from both patient and service perspectives. Without these measures, it becomes difficult to assess whether these MAT devices are meeting their intended goals, hindering the ability to refine and improve MAT provision using evidence-based outcomes.

Space constraints were also highlighted, with clinical and administrative managers discussing the need for dedicated storage and training areas for MAT. These challenges align with findings from the scoping review, which noted similar issues related to funding, staff shortages and lack of available workspace (Arthanat, Elsaesser and Bauer, 2017; Gonçalves, Knabben and Luz, 2017; Seymour, Geiger and Scheffler, 2019; Gowran *et al.*, 2021; McIntyre, Cleland and Ramklass, 2021). Document analysis further supports these findings, indicating that budgetary constraints significantly impact resource availability.

5.3.1.6 Personal and environmental barriers

5.3.1.6.1 Environmental factors

This integration identified challenges linked to environmental factors, such as social, cultural and physical contexts, which affect MAT provision. Physical factors, including access to the built environment and geographical limitations, often make MAT inaccessible to potential users. The data collected from various chapters of this thesis consistently demonstrate that environmental barriers substantially hinder access to MAT services and the use of MAT devices. The scoping review showed findings from the literature indicating that geographical distances and barriers in the built environment hinder access (Steel and Layton, 2016; Gonçalves, Knabben and Luz, 2017; McIntyre, Cleland and Ramklass, 2021; Nabizadeh *et al.*, 2023). Although this was not explicitly addressed in the survey, the results indicated marked disparities in accessibility across hospitals, with those in the central region showing higher accessibility. Interviews with participants provided deeper insights; they noted that patients from rural or remote areas are often referred to facilities in the central region for specialised medical treatments due to the

absence of necessary specialisations in their local areas.

The results further highlighted challenges in adapting MAT devices due to infrastructure deficits. Public spaces in Saudi Arabia often lack accessible areas that accommodate these MAT devices, limiting their effective use. Document analysis provided further insight into this issue and the eligibility criteria for these MAT devices. Specifically, Documents 1 and 2 indicate that environmental accessibility and suitability for the MAT device are prerequisites for prescription eligibility. Participants in the interviews also reported that the inadequacy of environmental and infrastructure adaptability often leads patients to refuse useful MAT devices since their living conditions are not suited to their use.

Cultural factors can also significantly influence and contribute to accessibility issues. Interview participants reported that cultural norms, such as the perception of MAT as a sign of weakness or dependency, and stigma associated with physical or mobility impairments can substantially affect MAT acceptance by patients and their families. While cultural factors were not addressed in the survey or within the analysed documents, these insights provide valuable context for understanding environmental barriers. These findings align with the results of the scoping review (Oskar *et al.*, 2011; Smith, Sakakibara and Miller, 2016).

5.3.1.6.2 Personal factors

This integration identified several challenges related to personal factors, such as health conditions, individual preferences, educational backgrounds and sociodemographic characteristics, which affect the provision of MAT. Data collected from three chapters of the thesis consistently acknowledge that personal factors significantly impact the use of and accessibility to MAT. These chapters provide complementary insights, offering a broader understanding of the issue. Interviews highlighted how the type and severity of functional impairment affect accessibility to MAT, with individuals experiencing more severe mobility limitations or higher levels of dependency facing greater challenges. Additionally, lower levels of family education and awareness, as well as socioeconomic factors, such as reduced income, influence accessibility, creating more barriers for these individuals. These insights are further supported by findings from the document analysis, which emphasise that prescription requirements, such as patient autonomy and consent, are crucial determinants of access to MAT.

These findings align with the scoping review, which highlighted users' unfamiliarity with MAT and the failure to include patient preferences in prescriptions, both of which have been reported to influence access (Oskar *et al.*, 2011; McIntyre, Cleland and Ramklass, 2021; Bhidayasiri *et al.*, 2022).

5.3.2 ERIC strategies

Based on the CFIR-ERIC matching tool, 49 strategies were identified as being effective in addressing the determinants of MAT provision identified in this thesis. Table 5.9 presents the strategies ordered by cumulative percent, with the top-listed strategies having the highest cumulative level of endorsement across all identified CFIR barriers. Detailed information on Level-1 strategies for each CFIR barrier is also included. These strategies are grouped according to Powell *et al.*'s (2012) categories: planning, educating, financing, quality management and restructuring strategies (Table 5.10).

Table 5.9 Expert recommendations for implementing change (ERIC) strategies to improve the provision of mobility-assistive technology, including cumulative percentages and level-1 strategies for each Consolidated Framework for Implementation Research construct

ERIC Strategies	Cumulative Percent	Innovation Source	Innovation Evidence Base	Complexity	Innovation Design	Cost	Innovation Recipients	Partnerships and Connections	Policies, Laws	Structural Characteristics	Mission Alignment	Available Resources	Access to knowledge & information	Planning	Engaging
Top strategies based on cumulative percent to address more than one barrier identified															
Identify and prepare champions	332%	31%	41%	30%	15%	12%	5%	15%	22%	27%	12%	4%	24%	31%	63%
Conduct educational meetings	291%	27%	47%	13%	22%	12%	10%	12%	15%	5%	21%	0%	79%	8%	21%
Assess for readiness and identify barriers and facilitators	272%	12%	13%	30%	7%	16%	33%	15%	4%	36%	6%	13%	7%	42%	38%
Conduct local consensus discussions	270%	19%	41%	7%	26%	4%	29%	15%	22%	14%	18%	0%	10%	23%	42%
Capture and share local knowledge	268%	23%	25%	27%	15%	4%	10%	23%	26%	23%	12%	22%	31%	15%	13%
Create a learning collaborative	246%	12%	16%	33%	7%	8%	0%	31%	15%	18%	12%	9%	45%	8%	33%
Develop a formal implementation blueprint	242%	0%	0%	43%	15%	8%	5%	4%	7%	18%	42%	4%	14%	73%	8%
Build a coalition	242%	31%	6%	0%	0%	4%	14%	62%	33%	27%	15%	17%	3%	4%	25%
Inform local opinion leaders	214%	27%	38%	13%	19%	12%	0%	15%	22%	14%	18%	0%	7%	0%	29%
Promote adaptability	212%	31%	3%	40%	48%	16%	14%	0%	0%	23%	9%	4%	7%	0%	17%
Conduct local needs assessment	211%	12%	3%	3%	15%	4%	57%	12%	7%	18%	6%	0%	3%	50%	21%
Access new funding	191%	0%	3%	3%	4%	72%	0%	4%	7%	5%	3%	78%	0%	8%	4%
Use advisory boards	190%	23%	9%	0%	19%	0%	29%	35%	15%	5%	12%	4%	0%	15%	25%
Develop educational materials	187%	12%	28%	13%	33%	0%	10%	4%	4%	0%	9%	4%	59%	8%	4%
Alter incentive structures	187%	4%	3%	7%	0%	44%	10%	0%	41%	18%	15%	17%	0%	12%	17%
Obtain and use patients and family feedback	173%	27%	6%	0%	30%	4%	76%	0%	0%	5%	9%	0%	0%	4%	13%

Chapter 5: Triangulation of Findings and Strategies

Involve patients and family members	171%	15%	13%	0%	19%	0%	71%	4%	11%	9%	9%	0%	3%	4%	13%
Conduct educational visits	167%	19%	34%	7%	15%	4%	5%	23%	0%	0%	12%	0%	28%	8%	13%
Involve executive boards	166%	12%	6%	0%	4%	20%	5%	23%	41%	14%	0%	17%	0%	0%	25%
Tailor strategies	156%	15%	6%	27%	15%	12%	14%	0%	11%	18%	0%	9%	0%	12%	17%
Identify early adopters	155%	19%	22%	20%	11%	8%	0%	4%	7%	23%	6%	0%	10%	12%	13%
Develop academic partnerships	152%	15%	25%	0%	4%	4%	5%	50%	11%	5%	3%	4%	10%	8%	8%
Facilitation	144%	12%	0%	20%	7%	8%	0%	12%	4%	9%	18%	4%	10%	23%	17%
Visit other sites	143%	23%	13%	3%	4%	16%	0%	38%	7%	5%	0%	9%	14%	8%	4%
Conduct cyclical small tests of change	142%	8%	3%	37%	11%	8%	10%	0%	4%	23%	3%	13%	3%	12%	8%
Conduct ongoing training	141%	8%	6%	37%	4%	0%	0%	0%	4%	0%	9%	9%	38%	23%	4%
Distribute educational materials	136%	12%	31%	3%	19%	0%	5%	0%	0%	0%	3%	0%	55%	4%	4%
Develop and implement tools for quality monitoring	135%	0%	6%	7%	30%	0%	14%	0%	11%	5%	27%	0%	0%	31%	4%
Promote network weaving	129%	4%	0%	0%	0%	0%	0%	50%	11%	23%	6%	9%	10%	4%	13%
Organize clinician implementation team meetings	127%	8%	3%	20%	4%	0%	0%	0%	0%	14%	36%	9%	14%	15%	4%
Use an implementation adviser	122%	8%	6%	10%	15%	4%	5%	8%	4%	5%	12%	13%	14%	15%	4%
Provide local technical assistance	118%	0%	3%	17%	4%	4%	5%	4%	7%	18%	12%	0%	24%	15%	4%
Purposely reexamine the implementation	117%	12%	6%	17%	22%	0%	5%	4%	11%	0%	12%	4%	0%	15%	8%
Fund and contract for clinical innovation	114%	0%	0%	3%	4%	28%	0%	0%	15%	14%	0%	39%	3%	0%	8%
Model and simulate change	114%	0%	3%	27%	11%	20%	0%	8%	4%	14%	9%	0%	7%	4%	8%
Recruit, designate and train for leadership	113%	15%	3%	7%	0%	4%	0%	15%	0%	18%	18%	4%	3%	12%	13%
Audit and provide feedback	113%	8%	13%	3%	4%	8%	5%	0%	0%	5%	61%	0%	3%	0%	4%
Provide ongoing consultation	111%	15%	9%	20%	7%	0%	5%	0%	0%	9%	15%	0%	17%	4%	8%
Develop resource sharing agreements	105%	0%	0%	0%	0%	32%	0%	31%	0%	5%	0%	26%	3%	4%	4%
Facilitate relay of clinical data to providers	100%	12%	6%	3%	7%	0%	10%	0%	4%	0%	36%	0%	10%	8%	4%

Chapter 5: Triangulation of Findings and Strategies

Stage implementations scale up	94%	0%	3%	30%	4%	8%	0%	0%	4%	14%	0%	13%	3%	15%	0%
Work with educational institutions	89%	15%	16%	0%	11%	4%	0%	19%	4%	5%	0%	4%	7%	0%	4%
Develop and organize quality monitoring systems	84%	0%	3%	10%	0%	4%	0%	0%	15%	5%	24%	0%	0%	15%	8%
Obtain formal commitments	80%	4%	0%	0%	0%	0%	0%	19%	15%	9%	12%	13%	0%	4%	4%
Prepare patients/consumers to be active participants	67%	4%	0%	0%	0%	0%	48%	0%	0%	0%	3%	0%	0%	0%	13%
Intervene with patients to enhance uptake & adherence	65%	12%	3%	3%	7%	4%	24%	0%	4%	0%	0%	0%	0%	4%	4%
Alter patient/consumer fees	53%	4%	0%	0%	0%	20%	0%	0%	7%	0%	0%	22%	0%	0%	0%
Develop an implementation glossary	51%	0%	0%	3%	4%	4%	0%	4%	4%	9%	9%	0%	7%	8%	0%
Shadow other experts	50%	8%	3%	7%	4%	0%	0%	4%	0%	5%	0%	0%	21%	0%	0%

Note: Level-1 strategies, endorsed by $\geq 50\%$ of the experts, are highlighted in green. Level-2 strategies, endorsed by 20%–49.9% of the experts, are highlighted in yellow.

Table 5.10 Expert recommendations for implementing change strategies identified in this thesis categorised using Powell *et al.* (2012)

Strategy Category	Strategies Identified
Planning strategies	1) Identify and prepare champions; 2) conduct local consensus discussions; 3) assess readiness and identify barriers and facilitators; 4) develop a formal implementation blueprint; 5) build a coalition; 6) conduct local needs assessment; 7) develop academic partnerships; 8) involve patients and family members; 9) involve executive boards; 10) tailor strategies; 11) identify early adopters; 12) visit other sites; 13) model and simulate change; 14) recruit, designate and train for leadership; 15) develop resource-sharing agreements; 16) stage implementation scale-up; 17) obtain formal commitments.
Educating strategies	1) Develop educational materials; 2) distribute educational materials; 3) conduct educational meetings; 4) inform local opinion leaders; 5) create a learning collaborative; 6) conduct educational outreach visits; 7) conduct ongoing training; 8) work with educational institutions; 9) prepare patients to be active participants; 10) shadow other experts; 11) develop an implementation glossary; 12) provide ongoing consultation; 13) provide local technical assistance.
Financing strategies	1) Access new funding; 2) fund and contract for clinical innovation; 3) alter patient fees; 4) alter incentive structures.
Quality management strategies	1) Obtain and use patient and family feedback; 2) audit and provide feedback; 3) promote network weaving; 4) capture and share local knowledge; 5) use advisory boards and workgroups; 6) facilitation; 7) conduct cyclical small tests of change; 8) develop and implement tools for quality monitoring; 9) organise clinician implementation team meetings; 10) use an implementation adviser; 11) purposely reexamine the implementation; 12) develop and organise quality monitoring systems; 13) intervene with patients to enhance uptake and adherence; 14) promote adaptability.
Restructure strategies	1) Facilitate relay of clinical data to providers.

The majority of the strategies with the highest cumulative degree of endorsement are in the planning category, with ‘identify and prepare champions’ ranking first. Implementing this strategy provides the greatest opportunity to address various aspects of multiple barriers. Following this are ‘assess for readiness and identify barriers and facilitators’, ‘conduct local consensus discussions’, ‘develop a formal implementation blueprint’ and ‘build a coalition’. The top strategies with the highest cumulative percentage in educational categories are ‘conduct educational meetings’, ‘create a learning collaborative’ and ‘inform local opinion

leaders'. Two other strategies belong to quality management: 'capture and share local knowledge' and 'promote adaptability'.

Another nine strategies do not appear as top strategies with a high cumulative percentage but are endorsed as Level-1 for particular CFIR constructs. These strategies, which may seem less relevant to overall barriers but could still significantly impact a particular construct, include 'conducting local needs assessments', 'accessing new funding', 'developing educational materials', 'obtaining and using patient and family feedback', 'involving patient and family members', 'developing academic partnerships', 'distributing educational materials', 'promoting 'network weaving' and 'auditing and providing feedback'. Table 5.11 provides a summary of the ERIC strategies that specifically address each main barrier to the provision of MAT. All of the above ERIC top strategies for CFIR barriers by cumulative percentage and Level-1 ERIC strategies for specific CFIR barriers are discussed further below. More details on all the strategies identified and their definitions are provided in Appendix 16.

Table 5.11 Barrier-specific implementation strategies

Barrier	Consolidated Framework for Implementation Research (CFIR) domain	CFIR constructs	Expert Recommendations for Implementing Change-endorsed Implementation Strategies
Sourcing and availability of mobility-assistive technology (MAT) devices	Innovation domain	Innovation source	Identify and prepare champions; build a coalition; promote adaptability; inform local opinion leaders; conduct educational meetings.
Data needed to guide decisions in MAT provision	Innovation domain	Innovation evidence base	Conduct educational meetings; identify and prepare champions; conduct local consensus discussions; inform local opinion leaders.
Procurement and delivery challenges	Innovation domain	Complexity	Develop a formal implementation blueprint; promote adaptability; conduct cyclical small tests of change; conduct ongoing training.

	Process domain	Planning	Develop a formal implementation blueprint; conduct local needs assessment; assess for readiness and identify barriers and facilitators.
Challenges in MAT device standardisation and quality assurance	Innovation domain	Innovation design	Develop educational materials; promote adaptability; obtain and use patients and family feedback; develop and implement tools for quality monitoring.
High cost of MAT devices and spare parts	Innovation domain	Cost	Access new funding; alter incentive/allowance structures; develop resource-sharing agreements.
Personal factors, such as individual preferences and educational background, and sociodemographic factors. Environmental barriers include physical, social and cultural	Individuals' domain and outer setting domain	Innovation recipients, policies, laws	Conduct local needs assessment; obtain and use patients and family feedback; involve patients/consumers and family members; prepare patients to be active participants.
Barriers in administrative and collaborative partnerships	Outer setting domain	Partnerships and connections	Build a coalition; develop academic partnerships; promote network weaving.
Absence of clear system and regulation on MAT provision	Outer setting domain	Policies, laws	Alter incentive/allowance structures; involve executive boards; build a coalition.
Characteristics of healthcare setting and logistical challenges	Inner setting domain	Structural characteristics	Assess for readiness and identify barriers and facilitators; change physical structure and equipment; identify and prepare champions; build a coalition.
MAT has no priority at the healthcare settings	Inner setting domain	Mission alignment	Audit and provide feedback; develop a formal implementation blueprint; organise clinician implementation team meetings.

Availability of resources, such as funding, space, trained professionals and materials	Inner setting domain	Available resources	Access new funding; change physical structure and equipment; fund and contract for clinical innovation.
Lack of awareness and information	Inner setting domain	Access to knowledge and information	Conduct educational meetings; develop educational materials; distribute educational materials, create a learning collaborative.
Leadership engagement deficit	Process domain	Engaging	Identify and prepare champions; assess for readiness and identify barriers and facilitators; conduct local consensus discussions.

5.3.2.1 Planning strategies

Priority strategies related to planning have been identified: 1) identify and prepare champions; 2) conduct local consensus discussions; 3) conduct local needs assessment; 4) assess readiness and identify barriers and facilitators; 5) develop a formal implementation blueprint; 6) build a coalition; 7) develop academic partnerships; 8) involve patients and family members; and 9) promote adaptability.

5.3.2.1.1 Identify and prepare champions

Champions serve as key strategic resources that can market and promote innovation and advance advocacy for its necessity and benefits (Powell *et al.*, 2015). An expert endorses this strategy as one of the Level-1 strategies to address the identified barriers associated with ‘engaging’. In particular, this strategy is recommended to address the leadership engagement deficit concern identified in the triangulation results (Section 5.3.1.1). It provides a localised solution to bridge the gap between administrative decision-making and clinical priorities, ensuring that the benefits of MAT are fully recognised and integrated into practices.

5.3.2.1.2 Conduct local consensus discussions

Local consensus discussions involve engaging HCPs and other stakeholders in discussions to build understanding and agreement about the importance of addressing specific healthcare challenges (Powell *et al.*, 2015). This strategy was endorsed as a key approach to address barriers related to ‘data needed to guide decisions in MAT provision’ and ‘leadership

engagement deficit’ identified in the triangulation results. By engaging HCPs, managers and other key stakeholders in discussions about MAT accessibility and its significance, this strategy can enhance stakeholder awareness and commitment to improving MAT services. Furthermore, these discussions can support the implementation of other identified strategies, such as conducting needs assessments and building coalitions, thereby creating a more comprehensive approach to MAT service improvement.

5.3.2.1.3 Conduct a local needs assessment

This strategy involves collecting and analysing information related to the need for MAT (Powell *et al.*, 2015). The assessment should focus on describing the current state and identifying gaps between existing practices and evidence-based practices (Powell *et al.*, 2015). It should also gather opinions from local stakeholders on the necessity of the service and any special considerations for implementing MAT (Powell *et al.*, 2015). These assessments help objectively evaluate MAT’s current state and create urgency for change by highlighting how stakeholders perceive the importance of improving MAT provision. This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘innovation recipients’ and ‘planning’. Specifically, it addresses the issues related to procurement and delivery challenges identified in the triangulation results. It also tackles challenges related to personal factors, which affect the provision of MAT.

5.3.2.1.4 Assess for readiness and identify barriers and facilitators

Assessing readiness involves evaluating various aspects of healthcare facilities to determine their preparedness for improving MAT services, identifying potential implementation challenges and recognising existing strengths that can support service enhancement (Powell *et al.*, 2015). This strategy was endorsed to address barriers within the ‘inner setting domain’, particularly relating to ‘characteristics of healthcare setting’ and ‘leadership engagement’ identified in the triangulation results. The assessment encompasses multiple critical areas: organisational culture and its alignment with MAT provision goals, staff competencies and training needs, existing infrastructure capacity, financial readiness, resource allocation and regulatory considerations (Powell *et al.*, 2015). This comprehensive evaluation approach directly addresses the concerns highlighted in the triangulation results regarding the variability in MAT provision readiness across different healthcare settings in Saudi Arabia.

5.3.2.1.5 Develop a formal implementation blueprint

A formal implementation blueprint is crucial for the successful adoption of MAT within the healthcare system. The blueprint should describe the purpose and implications of MAT provision enhancement, define the scope of the change and identify the hospital units affected (Powell *et al.*, 2015). The plan should include a comprehensive timeframe with milestones and appropriate measures for measuring progress and performance (Powell *et al.*, 2015). It serves as a clear roadmap for all stakeholders, helping them understand their roles and responsibilities regarding MAT provision enhancement. This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘planning’. Specifically, it targets the procurement and delivery challenges highlighted in the triangulation (Section 5.3.1.2).

5.3.2.1.6 Build a coalition

A key component of this strategy is the development of relationships with various stakeholders involved in MAT provision (Powell *et al.*, 2015). These collaborations involve stakeholders, such as HCPs, managers of healthcare organisations, policymakers, disability associations, influential community figures, academic institutions and other local organisations, such as NUPCO and the MHRSD. This broad coalition can help in advocating systemic changes and garnering public support. This coalition can work towards standardising MAT protocols across different healthcare settings, addressing the inconsistencies in provision highlighted in the triangulation results. Additionally, building these relationships can assist in identifying champions who can promote and support the adoption of MAT. This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘partnerships and connections’. Specifically, it targets the barriers in administrative and collaborative partnerships highlighted in Section 5.3.1.1.

5.3.2.1.7 Develop academic partnerships

This involves collaborating with universities or academic departments and aims to combine efforts in training and integrating research skills into practical applications to enhance the uptake of MAT (Powell *et al.*, 2015). These collaborations can focus on developing MAT-specific modules within existing healthcare curricula, conducting research on MAT effectiveness and creating continuing education programmes for HCPs. They can also contribute to the development of Arabic-language resources and culturally appropriate assessment tools for MAT. This partnership allows for greater knowledge exchange and improvement in healthcare training programmes for providers, which can lead to better

access and adoption of MAT. This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘partnerships and connections’. It directly addresses the barriers in administrative and collaborative partnerships highlighted in Section 5.3.1.1.

5.3.2.1.8 Involve patients and family members

A key aspect of this strategy is to involve people with disabilities and their families in all phases of the MAT uptake effort. Early engagement of individuals with disabilities is essential since they are the end-users of services. This includes their involvement in training sessions, obtaining feedback and advocacy efforts (Powell *et al.*, 2015). For example, HCPs should address the issues associated with MAT adoption during patient consultations and facilitate the identification of solutions and additional support for any issues that hinder MAT adoption. This approach can include organising focus groups with Saudi patients and families to gather feedback on MAT usage, ensuring they meet local needs and preferences. This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘innovation recipients’. Specifically, it targets the issues related to personal and environmental barriers addressed in Section 5.3.1.6. It can help overcome cultural stigmas associated with disability and MAT use in Saudi society, promoting greater acceptance and utilisation of MAT.

5.3.2.1.9 Promote adaptability

This strategy requires identifying how these MAT devices can be adapted to meet the needs of the local environment (Powell *et al.*, 2015). The barriers identified in this thesis in Section 5.3.1.3 regarding the innovation domain necessitate a careful examination of MAT’s source, complexity and design to determine necessary adjustments for the Saudi context. Several aspects of the MAT implementation process can be improved to better accommodate local cultural and logistical contexts. For example, addressing delays in MAT provision by developing localised supply chains and partnerships with Saudi manufacturers and improving MAT device quality by establishing Saudi-specific quality control measures and standards. This adaptability can enhance MAT’s overall sustainability and impact.

5.3.2.2 Education strategies

Priority strategies related to education have been identified: 1) develop educational materials; 2) distribute educational materials; 3) conduct educational meetings; 4) inform local opinion leaders; and 5) create a learning collaborative.

5.3.2.2.1 Develop and distribute educational materials

This strategy involves creating various educational resources, including guidelines, manuals, toolkits and other support materials (Powell *et al.*, 2012; Powell *et al.*, 2015). These resources should cover topics such as the benefits of MAT, proper usage techniques and maintenance procedures, all adapted to the specific needs and cultural context. The objective is to simplify the learning process for stakeholders regarding MAT and to assist clinicians in effectively delivering these MAT devices and their related services (Powell *et al.*, 2015). Therefore, these materials must be visually engaging, easily comprehended and culturally appropriate. They should be available in both Arabic and English to ensure widespread accessibility.

Distribution of educational materials must be strategically planned to reach a broad audience in diverse healthcare settings, including urban hospitals, as well as rural healthcare facilities in remote regions. Moreover, it is recommended that various types of media be utilised to tailor messages to different audiences, ensuring that HCPs, leaders, managers and patients are effectively engaged (Powell *et al.*, 2015). To maximise reach and impact, distribution methods should include in-person dissemination, mailing and electronic channels (Powell *et al.*, 2015). These strategies are endorsed by experts as Level-1 strategies to address barriers related to ‘access to knowledge and information’. They directly address the information and awareness barriers highlighted in Section 5.3.1.4, aiming to improve understanding and acceptance of MAT across all levels of the Saudi healthcare system.

5.3.2.2.2 Conduct educational meetings

The triangulation results in Section 5.3.1.4 highlight that a lack of awareness and understanding among HCPs, managers and leaders with divergent views on MAT benefits creates a barrier to MAT adoption. By organising targeted meetings for these stakeholders and involving the community, patients and families, this strategy seeks to enhance knowledge dissemination and engagement about the benefits of MAT (Powell *et al.*, 2015). These meetings could include workshops for HCPs on the latest MAT devices, seminars for hospital managers on the cost-effectiveness and long-term benefits of MAT provision and community outreach programmes to educate patients and families about MAT and addressing cultural stigmas and misconceptions. This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘access to knowledge and information’. It directly addresses the information and awareness barriers highlighted in Section 5.3.1.4.

5.3.2.2.3 Inform local opinion leaders

Informing local opinion leaders involves identifying and engaging influential individuals within healthcare settings who can effectively promote change (Powell *et al.*, 2015). This strategy was endorsed to address barriers within both the ‘innovation domain’ and ‘data needed to guide decisions in MAT provision’, as identified in the triangulation results. These opinion leaders could include respected physicians, prominent hospital administrators involved in healthcare decision-making and well-known healthcare advocates who are trusted and respected by their peers (Powell *et al.*, 2015). By informing and engaging these influential individuals about the benefits and importance of MAT services, this strategy can facilitate broader acceptance and normalisation of MAT within the healthcare community. The influence of these key individuals can be particularly effective in addressing the challenges related to MAT awareness and implementation, leveraging their credibility to encourage wider adoption and improve access to MAT services.

5.3.2.2.4 Create a learning collaboration

This thesis highlights the necessity for enhanced communication and knowledge exchange among different stakeholders in the Saudi healthcare system. Establishing a learning collaborative among hospitals can foster an environment of continuous improvement and sharing of best practices in the provision of MAT. These learning collaboratives should comprise HCPs and organisations dedicated to improving MAT service delivery (Powell *et al.*, 2015). The formation of such collaborations provides members with the opportunity to engage in peer consultation networks and become members of online communities of practice, fostering a collaborative environment that can enhance service delivery (Powell *et al.*, 2012; Powell *et al.*, 2015). This collaboration should include regular workshops, shared online resources and a forum for discussing challenges and solutions.

5.3.2.3 Financing strategies

One priority strategy related to financing has been identified: 1) access new funding.

5.3.2.3.1 Access new funding

Accessing new funding is a key strategy recommended for supporting the implementation of healthcare innovations, emphasising the importance of exploring alternative funding mechanisms to support service improvements (Powell *et al.*, 2015). Potential funding mechanisms within the Saudi healthcare context will be discussed further in Chapter 6

(Section 6.5.1.3). This strategy was endorsed as a Level-1 approach to address two major barriers identified in the triangulation results: the high cost of MAT devices and spare parts (Section 5.3.1.3) and limited available resources for MAT services (Section 5.3.1.5).

5.3.2.4 Quality management strategies

Priority strategies related to quality management have been identified: 1) obtain and use patient and family feedback; 2) audit and provide feedback; 3) promote network weaving; and 4) capture and share local knowledge.

5.3.2.4.1 Obtain and use patient and family feedback

Enhancing patient and family feedback on the MAT uptake effort within healthcare settings is crucial to ensuring patient-centred care and improving service quality (Powell *et al.*, 2012). Feedback from patients and their families can be collected in various ways, such as complaint forms or other techniques that directly send feedback to the advisory board members (Powell *et al.*, 2012). Complaint forms are common in healthcare organisations, and patients and their families may express concerns, complaints or suggestions regarding their care (Powell *et al.*, 2012). This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘innovation recipients’. In particular, it addresses the issues discussed in Section 5.3.1.6.2 related to personal and environmental factors. Capturing diverse perspectives helps tailor MAT services to individual preferences, educational backgrounds and sociodemographic factors prevalent in Saudi society. Moreover, it can shed light on physical, social and cultural environmental barriers specific to different regions of Saudi Arabia.

5.3.2.4.2 Audit and provide feedback

This strategy involves collecting and summarising clinical performance data over a specified period (Powell *et al.*, 2015). These summarised data comprise recommendations and insights from various sources, such as medical records, computerised databases, observations and patient feedback (Powell *et al.*, 2012). The information serves as a powerful tool for highlighting areas of improvement and success, fostering a culture of accountability and informed decision-making (Powell *et al.*, 2012). By implementing this approach, hospitals can better navigate the challenges of adopting MAT and enhance overall healthcare delivery. For instance, audits could track the frequency of MAT prescriptions, usage rates and patient outcomes across different regions of Saudi Arabia. The audit results could be used to advocate increased priority for MAT in healthcare settings where it is currently undervalued.

This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘mission alignment’. In particular, it addresses the issue related to MAT having no priority in healthcare settings, as discussed in Section 5.3.1.5 of the triangulation results.

5.3.2.4.3 Promote network weaving

A key component of this strategy is developing strong working networks and connections both inside and outside the organisation, including between organisational units, teams and external stakeholders (Powell *et al.*, 2015). Through developing relationships among HCPs, physicians, managers and leaders, these professional connections enhance information exchange, collaborative problem-solving, and shared objectives for MAT adoption (Powell *et al.*, 2015). Engaging key stakeholders can be undertaken through regular meetings, interdisciplinary teams and collaborative platforms to ensure that diverse perspectives are incorporated into the decision-making process. This collaborative approach also creates a supportive community that responds better to the needs of patients needing these MAT services. This strategy is endorsed by experts as a Level-1 strategy to address barriers related to ‘partnerships and connections’.

5.3.2.4.4 Capture and share local knowledge

Capturing and sharing local knowledge is a vital strategy to address the barriers to providing MAT in hospitals. It involves collecting insights and practical solutions from sites regarding how implementers successfully integrated these technologies into their settings (Powell *et al.*, 2015). Documenting and disseminating this local knowledge across other sites allows hospitals to benefit from shared experiences and proven approaches, reducing trial-and-error efforts and improving the overall effectiveness of MAT provision (Powell *et al.*, 2012).

5.4 Discussion

This chapter aimed to develop strategies using the CFIR-ERIC matching tool to overcome identified challenges for future research, policy and practice. These strategies are informed by findings from the scoping review (Chapter 2), survey (Chapter 3) and qualitative study (Chapter 4). The triangulation findings were categorised into six categories: healthcare systems and policy barriers, procurement and delivery challenges, devices-related barriers, information and awareness barriers, resources and infrastructure barriers and personal and environmental barriers. These detriments were mapped into 14 constructs of the CFIR. Then, they were mapped to ERIC strategies using the CFIR-ERIC matching tool. In all, 49

implementation strategies were identified that may mitigate barriers and help strengthen the provision of MAT in Saudi Arabia. These strategies were categorised according to Powell's (2012) categories, with 17 related to planning, 12 related to educating, 4 related to financing, 14 related to quality management and 1 related to restructuring. This chapter fulfils its objective of using the CFIR-ERIC matching tool to recommend targeted strategies for future research, policy and practice. This approach aligns with the overall thesis aim, as highlighted in Chapter 1, of investigating the factors influencing the provision of MAT for people with mobility-related disabilities in Saudi Arabia and recommending strategies to overcome these barriers to inform policy. This chapter provides the foundation for the development of an implementation plan for improving MAT uptake and availability, which may be tailored to the needs of specific settings within the Saudi healthcare system.

The findings on barriers integrated in this chapter are consistent with those identified in previous work related to MAT access, such as factors related to resource and infrastructure, economic barriers, such as funding and cost, personal and sociocultural barriers and information and awareness barriers (Rey-Matias, Bundoc and Montes, 2019; WHO, 2022; Mishra *et al.*, 2024). These barriers highlight universal challenges in accessing MAT and reflect the urgent need for a comprehensive approach that addresses these barriers (WHO, 2022).

The majority of strategies endorsed by ERIC relate to the category 'planning', including the highest-endorsed strategy by cumulative percent (332%), which is 'identify and prepare champions'. This strategy targets several barriers across the 'inner setting domain', 'innovation domain', 'process domain', and 'outer setting'. These include the sourcing and availability of MAT devices, leadership engagement deficits, logistical challenges and procurement and delivery challenges. This strategy is endorsed as a Level-1 strategy for one CFIR construct ('engaging') and a Level-2 one for seven constructs. Champions, whether internal or external to the organisation, play a crucial role in ensuring strong advocacy for innovation (Powell *et al.*, 2015). They communicate MAT value, facilitate acceptance and address any resistance that may arise within the organisation (Powell *et al.*, 2015). This strategy also fosters a culture of continuous improvement and openness to new ideas (Damschroder *et al.*, 2009). Researchers have shown that champions play a significant role in health improvement initiatives, particularly in engaging key influencers who can impact healthcare system change (Bonawitz *et al.*, 2020). This strategy has demonstrated a median

absolute improvement of 12% in compliance with desired clinical practices (Powell *et al.*, 2019).

Another important strategy is ‘conducting educational meetings’, with a cumulative percentage of 291%. This strategy was listed as a Level-1 strategy for one barrier related to ‘access to knowledge and information’ and as a Level-2 strategy for five constructs. The findings from this chapter’s triangulation highlighted issues related to information on and awareness of MAT benefits, creating barriers to its adoption. Therefore, organising targeted meetings for stakeholders and involving the community, patients and families can enhance knowledge dissemination and engagement regarding the benefits of MAT. Notably, Powell *et al.* (2019) reported that this strategy has shown an effect size of 6% in improving care outcomes. Two additional strategies yielded high cumulative percentages: the assessment of readiness with barrier identification (272%) and local consensus discussions (270%). While neither strategy qualified as Level-1 for any CFIR constructs, they were classified as Level-2 strategies across five and six CFIR constructs respectively. Given that these ERIC strategies are classified as Level-2 strategies for a considerable number of CFIR constructs, they have the potential to enhance MAT provision more significantly than strategies endorsed as Level-1 for fewer constructs (Waltz *et al.*, 2019).

Some of the strategies identified in this thesis through the CFIR-ERIC matching mirrored those recommendations suggested by WHO (2022). As an example, WHO recommended actively involving users of MAT and their families; this is similar to one of the implementation strategies – involving patients and family members – recommended by the CFIR-ERIC matching tool. This is important and has practical implications, and HCPs can use this strategy to enhance service provision, as patients with disability are ‘end users’, and evidence has shown the effectiveness of using MAT to improve QoL, making it imperative to involve them early in the process. In addition, this project shows how personal factors, such as individual preferences and educational background, and sociodemographic factors also influence MAT adoption. Consequently, HCPs must address this issue during patient visits to better understand individual circumstances and offer appropriate support for factors affecting MAT uptake. The involvement of patients can contribute to the development of patient education and policies, as well as the improvement of governance and service delivery (Bombard *et al.*, 2018). Another recommendation that mirrors the recommendations of the WHO is to increase public awareness and related stigma; this is similar to one of the

implementation strategies – related to educational categories, such as ‘develop, distribute and conduct educational meetings’ – suggested by the CFIR-ERIC matching tool. This is important to ensure policymakers are aware of the need and benefits of MAT. Awareness about MAT and its uses and benefits should be raised to increase public understanding and political support and to reduce stigma (WHO, 2022).

5.4.1 Strengths and limitations

Three chapters in this thesis led to the identification of barriers. These chapters offered rich information about barriers by applying multiple methods, such as scoping review, survey, interviews, document analysis and participant perspectives from various roles and sites. This enhanced the trustworthiness of the findings of the CFIR-ERIC mapping process. Furthermore, this chapter introduces an innovative use of the CFIR-ERIC matching tool to develop strategies to mitigate barriers to MAT provision. As such, it offers a foundational guide for the potential enhancement and strengthening of MAT access and provides a starting point for the development of an implementation plan.

Nevertheless, experts in the field were asked to rank the ERIC strategies based on their effectiveness in addressing CFIR constructs in the CFIR-ERIC matching tool (Waltz *et al.*, 2019). Thus, since the tool was developed based on expert opinion, caution should be taken when interpreting its results (Waltz *et al.*, 2019). Additionally, as most of these experts were from Western countries (USA, Canada and Australia), the tool’s results may predominantly reflect Western healthcare perspectives (Waltz *et al.*, 2019). Further, the effectiveness of the strategies generated by the CFIR-ERIC tool has not been evaluated extensively; this should be tested to determine whether they are adequate to guide local implementation efforts (Waltz *et al.*, 2019). A comprehensive discussion of these limitations is presented in Chapter 6, Section 6.4.

Another limitation of this study is that the contextualisation of ERIC strategies was undertaken by the researcher alone without collaborative input from diverse stakeholders. Whilst the CFIR-ERIC matching tool provided evidence-based recommendations, adapting these strategies to the Saudi context would have benefitted from engagement with individuals with lived experience of mobility disabilities, HCPs, hospital managers, policymakers and representatives from relevant government bodies such as NUPCO and MHRSD. Multi-stakeholder engagement could have enhanced the appropriateness of proposed approaches,

aligning strategies with existing healthcare policies. Future research should employ participatory approaches to engage such stakeholders in ERIC strategy contextualisation. This could help ensure that implementation strategies are feasible, acceptable and in line with local needs and priorities.

5.4.2 Implications for policy, practice and future research

The strategies identified in this chapter serve as a foundation for future research aimed at developing implementation plans to enhance MAT provision in Saudi Arabia. The political landscape in Saudi Arabia, shaped significantly by Vision 2030, provides a supportive environment for implementing these strategies (Saudi Vision 2030, 2016). Stakeholders within the MOH, including those in leadership roles, managers of healthcare organisations, HCPs, policymakers and other local organisations, such as NUPCO and the MHRSD, can utilise these research findings to inform decision-making. The tool's output of potential strategies can guide the design of robust interventions and the formulation of evidence-based policies and programmes to improve MAT service provision (Waltz *et al.*, 2019). HCPs trained under programmes facilitated by the Saudi Commission for Health Specialties are ideally positioned to champion the adoption of these strategies. Practitioners can adapt their approaches to specific contexts and barriers by, for example, engaging in discussions about patients' circumstances during treatment sessions to better understand their challenges and provide further assistance for issues affecting MAT adoption. The development and dissemination of clear, culturally appropriate educational materials can enhance patient and HCP understanding and ensure equitable access to MAT across different populations. Policymakers can use ERIC strategies to plan interventions more effectively to improve MAT provision. Future research should focus on selecting, tailoring and testing these strategies within specific contexts within Saudi Arabia. Researchers can design studies that test the effectiveness of different ERIC strategies in various contexts, which can help refine and improve the strategies over time. A detailed discussion of the implications of ERIC strategies in the Saudi Arabian context is presented in Chapter 6, Section 6.5.1.3.

5.5 Conclusion

This chapter provided a comprehensive overview of the challenges to MAT provision, including issues related to healthcare systems and policy barriers, procurement and delivery challenges, MAT device-related barriers, information and awareness barriers, resource and infrastructure barriers and personal and environmental barriers. Mapping these barriers to

ERIC strategies showed that the most highly endorsed strategies were identifying and preparing champions, conducting educational meetings, assessing readiness, identifying barriers and facilitators and conducting local consensus discussions. The strategies identified in this chapter provided a foundation for future research to develop implementation plans to enhance MAT provision in Saudi Arabia. Future research should focus on conducting empirical evaluations to assess the impact of these strategies.

5.6 Chapter summary

This chapter addressed the fourth objective of this thesis by presenting the methods and results of triangulating data from various chapters in this thesis and mapping barriers to ERIC using the CFIR-ERIC matching tool. It identified several strategies that could mitigate these barriers and enhance the delivery of MAT in Saudi Arabia. This application of implementation science principles using the CFIR-ERIC matching tool directly addressed the thesis aim outlined in Chapter 1: to investigate the factors influencing the provision of MAT for people with mobility-related disabilities in Saudi Arabia and to recommend strategies to overcome these barriers to inform policy. The chapter provided targeted guidance for selecting the most effective interventions, which aimed to assist stakeholders in designing robust interventions and formulating evidence-based policies and programmes to improve MAT service provision in Saudi Arabia. The next chapter (Chapter 6) discusses the key findings and conclusions of the thesis, including strengths, limitations, implications and suggestions for future research. It also presents a plan for future research directions.

Chapter 6: Discussion

6.1 Introduction

This chapter discusses the research findings in relation to the thesis's aim outlined in Chapter 1, Section 1.10: to investigate the factors that influence the provision of MATs for people with mobility-related disabilities in Saudi Arabia's healthcare system and recommend strategies to inform policy to overcome these barriers. Section 6.2 discusses the key findings related to barriers influencing MAT provision, while Section 6.5.1.3 outlines the strategies identified to overcome these barriers.

This chapter addresses each research objective established in Chapter 1, Section 1.10. Objective 1, which was to conduct a scoping review, is addressed in Section 6.2.1 of this chapter, which discusses the key findings from the scoping review presented in Chapter 2. Objective 2, which focused on conducting a survey of current MAT provision practices, is addressed in Section 6.2.2, presenting findings from Chapter 3. Objective 3, which involved qualitative exploration of stakeholder perspectives, is addressed in Sections 6.2.3 and 6.2.4, discussing findings from Chapter 4. Finally, Objective 4, which aimed to develop implementation strategies, is addressed in Section 6.2.5, outlining the ERIC strategies identified in Chapter 5.

The principal findings of this thesis are: (1) A considerable unmet need for MAT exists, with multiple interconnected determinants influencing its provision. (2) MAT provision in the surveyed Saudi hospitals is inconsistent and limited. (3) Several local barriers affect MAT provision in Saudi Arabia, aligning with global trends. (4) These barriers stem from systemic, operational and individual challenges. (5) Several strategies are identified to address these barriers and enhance MAT provision. This chapter concludes by discussing the study's strengths and limitations in Section 6.4 and examining the implications for policy, practice and future research in Section 6.5.

6.1.1 The Saudi Arabian healthcare context presents unique challenges for MAT provision

All healthcare delivery is context specific, with variation between healthcare systems between and within countries. As established in Chapter 1, Section 1.4.2, Saudi Arabia's healthcare system faces challenges in MAT provision, resulting in considerable unmet needs and an

unrelieved health burden. While previous research (Alqahtani, Cooper and Cooper, 2021) has documented these unmet needs, there remains a critical knowledge gap regarding the factors that influence MAT provision within the Saudi healthcare context. This knowledge gap is important given that mobility impairment is the most prevalent type of disability in Saudi Arabia (Saudi General Authority for Statistics, 2022). The complexity of the Saudi healthcare system, characterised by its three-sector structure and four-level care delivery model – with MAT services concentrated at the tertiary and quaternary levels – presents distinct challenges that require systematic investigation (as detailed in Chapter 1, Section 1.5.2). Understanding these influencing factors is crucial for addressing the unmet needs in MAT provision within Saudi Arabia’s unique healthcare context, aligning with UN and WHO imperatives to enhance access to MAT (UN, 2007; WHO, 2022).

6.1.2 This thesis comprehensively investigates MAT provision barriers and proposes strategies for improvement

This thesis addresses the identified knowledge gap through a systematic investigation using the CFIR, which was introduced as the guiding framework for this thesis in Chapter 1, Section 1.6.2. Through this theoretical lens, the research systematically identifies barriers at the individual, operational and systemic levels. This structured approach enables the identification of challenges affecting MAT provision (Section 6.2.4) and assists in generating targeted ERIC implementation strategies to inform policy development (Section 6.2.5).

The scoping review (Chapter 2) combined propositions from different theories and frameworks to develop a model for understanding MAT provision barriers, outlined factors influencing MAT provision as evidenced by existing literature and identified gaps worthy of additional research. This theoretical foundation was enhanced through empirical investigation in the Saudi context, with a survey (Chapter 3) identifying limited access to advanced MAT devices and service inconsistencies across three hospitals in two regions of Saudi Arabia. In-depth interviews with 33 stakeholders and an analysis of six documents (Chapter 4) provided evidence of barriers to MAT provision, emphasising the need for a comprehensive approach to address these challenges. Through the triangulation of findings from Chapters 2–4 discussed in Chapter 5, the research provided a comprehensive overview of MAT provision challenges. These barriers were systematically mapped to ERIC strategies using the CFIR-ERIC matching tool (introduced in

Chapter 5, Section 5.3.2), resulting in 49 implementation strategies to strengthen MAT provision in Saudi Arabia. This systematic approach demonstrates the value of implementation science in addressing complex healthcare challenges and provides evidence-based solutions for improving MAT provision in Saudi Arabia's healthcare system.

6.2 Key findings

This section describes the key findings derived from the scoping review, survey and qualitative study as well as the triangulation of these findings and the strategies identified. Although previous research has emphasised the benefits of MAT, as established in Chapter 1, Section 1.3.3, significant unmet needs and numerous interconnected determinants hinder effective provision (Key Finding 1). The analysis of MAT provision in surveyed Saudi hospitals indicated a lack of consistency and limited availability, which suggested the need for further investigation to understand and address these discrepancies (Key Finding 2). Qualitative research highlighted several local barriers affecting MAT provision in Saudi Arabia, consistent with global trends (Key Finding 3). These barriers originate from the complex interplay of systemic, operational and individual factors that challenge the effectiveness of MAT provision (Key Finding 4). Integration of the findings led to a better understanding of these barriers, emphasising the need for targeted strategies to overcome them. Finally, several strategies were identified to mitigate these barriers, which can serve as a foundation for future research to enhance MAT provision in Saudi Arabia (Key Finding 5).

6.2.1 A considerable unmet need for MAT exists, driven by multiple interconnected determinants

The scoping review (Chapter 2) addressed the first thesis objective by summarising and synthesising the theories, models and frameworks used to understand MAT access, identifying key determinants of access and highlighting knowledge gaps. The review included 18 articles employing eight theories, models and frameworks. The review suggested that the global provision of MAT is notably inconsistent and identified multiple determinants that hinder access to these services, aligning with the unmet needs discussed in Chapter 1, Section 1.4. The synthesised theory discussed in Chapter 2, Section 2.3.3, highlighted the importance of mobility for human well-being (Proposition 1) and acknowledged that certain health conditions can limit mobility (Proposition 2). This limitation can be mitigated by two primary factors: providing

appropriate services (Proposition 3) and ensuring their comprehensive availability (Proposition 4). Institutional policies (Proposition 6) and related costs (Proposition 7) indirectly impact service provision, while environmental (Proposition 5) and personal factors (Proposition 8) affect their access and use. Failing to address these determinants restricts access to MAT and can potentially lead to disabilities (Proposition 9).

These findings align with and expand upon a recent scoping review by Mishra *et al.* (2024) that examined AT access across the European region. While their review covered multiple types of AT, their findings regarding MAT (12 out of 103 publications) identified similar barriers to access, including accessibility, affordability and acceptability. These barriers directly correspond with the synthetic model, which demonstrated how policies (Proposition 6), costs (Proposition 7) and environmental factors (Proposition 5) influence MAT provision. The synthetic model extends this understanding by highlighting the complex interplay between these determinants. The developed model also concurs regarding the importance of service provision and policy. Additionally, it emphasises how personal and environmental factors moderate the effectiveness of these elements. Specifically, it highlights that MAT device choice is deeply personal and influenced by individual perceptions and the perceived value within users' life contexts. These findings align with Gleaton *et al.*'s (2024) review, which highlighted the need to consider user needs, preferences and experiences to increase MAT uptake. Evidence from this systematic review indicates that MAT acceptance is predominantly determined by users' perceived balance between benefits and challenges, particularly the extent to which the MAT device is anticipated to enhance daily functioning without imposing additional constraints (Gleaton *et al.*, 2024). This suggests that effective MAT provision must extend beyond merely ensuring the availability and affordability of MAT devices. In particular, it should also account for individual preferences, cultural factors and users' specific life circumstances. Consequently, this interpretation implies that personalised approaches to MAT provision incorporating user consultation and choice may yield more effective outcomes.

The review also identified key research areas requiring further investigation, such as exploring stakeholder perspectives on barriers to MAT access and provision (Seymour, Geiger and Scheffler, 2019; McIntyre, Cleland and Ramklass, 2021; Serres-Lafontaine *et al.*, 2023). It highlighted the importance of understanding different perspectives based on country,

comprehensive approaches and how environmental factors affect MAT accessibility and provision (Gowran *et al.*, 2021). This aligns with the Medical Research Council framework, which recognises that intervention uptake can be influenced by ‘context’ – a multifaceted concept encompassing setting, roles, interactions and relationships (Pfadenhauer *et al.*, 2017; Skivington *et al.*, 2021). Thus, the scoping review provided a foundation for the subsequent investigation into the specific context of Saudi Arabia. To address MAT provision in Saudi Arabia comprehensively, an in-depth investigation of specific contextual factors is required. This contextual approach is critical for improving MAT services as it allows for developing strategies that consider the local context.

6.2.2 Inconsistent and limited MAT provision in surveyed Saudi hospitals necessitates further investigation

The survey in Chapter 3 addressed the second thesis objective by providing an overview of the MAT available in Saudi Arabia’s healthcare system and recruiting participants for the subsequent qualitative study. The survey included participants from various roles within healthcare services (HCPs, managers and leaders). It covered three government (public) hospitals across two main geographical regions of Saudi Arabia (the central and eastern regions). Among the 67 respondents, the survey highlighted issues such as limited access to advanced MAT devices and inconsistencies in service across different hospitals. Basic MAT devices, including manual wheelchairs, ankle-foot orthoses, canes/sticks, elbow/axillary crutches and walking frames/walkers were reported as generally accessible in Saudi Arabian hospitals (Chapter 3, Section 3.3.2). However, respondents noted much lower availability of more advanced MAT devices such as electrically powered wheelchairs, customised manual wheelchairs, reclining power wheelchairs, lower-limb prostheses, microprocessor-controlled lower-limb prostheses and mobility scooters (Chapter 3, Section 3.3.2). Additionally, differences in availability were observed between hospitals. Hospital C in the eastern region showed lower availability compared to Hospitals A and B in the central region (Chapter 3, Section 3.3.3).

These findings align with global observations from a systematic review of 207 studies, which found that MAT device use among individuals with self-reported mobility difficulties ranged from 0.9% for both prosthetics and electric wheelchairs to 17.6% for manual wheelchairs (Danemayer *et al.*, 2022). However, this review noted important methodological limitations, as

most studies relied solely on self-reported assessments (Danemayer *et al.*, 2022). Within the Saudi context specifically, previous research has indicated that MAT services are predominantly limited to basic MAT devices (Alqahtani, Cooper and Cooper, 2021). However, the survey findings advance current understanding by identifying regional Saudi variations in MAT provision (Chapter 3, Section 3.3.3). The analysis demonstrated disparities in advanced MAT device availability between the eastern region (Hospital C) and central region (Hospitals A and B), which may indicate potential systemic variations in healthcare resource distribution across Saudi Arabia. The observed regional variations in MAT provision warrant consideration within the broader context of mobility needs across Saudi Arabia. For instance, regions such as Madinah, Jizan and Al-Bahah report a higher prevalence of severe mobility limitations, which can be attributed to the ageing population and chronic diseases common in these areas (Bindawas and Vennu, 2018; Saudi General Authority for Statistics, 2022). These survey findings regarding MAT provision suggest a need for targeted interventions and evidence-based policy changes to ensure equitable access to MAT services throughout the country.

Survey findings from Chapter 3 showed that a significant percentage of respondents were unaware of the availability of advanced MAT devices, particularly customisable wheelchairs and specialised prostheses (Section 3.3.2). This finding aligns with both local research (Alqahtani, Cooper and Cooper, 2021) and global studies (Visagie *et al.*, 2021; WHO, 2022; Lee *et al.*, 2024; Mishra *et al.*, 2024). However, while this survey provides valuable insights, it is limited to the perspectives of HCPs, managers and leaders in the healthcare system. In contrast, studies by Lee *et al.* (2024) also include the perspectives of MAT users, providing additional insights into the knowledge gap. This finding informed the development of interview prompts to explore MAT awareness and related barriers in Chapter 4, Section 4.2.5.1.

The results indicate a need to increase access to MATs and assess the challenges hospitals face in providing these services. These regional variations in availability also highlight the need for a deeper understanding of underlying causes. Building on these survey findings, the subsequent qualitative interviews explored specific barriers and challenges hospitals face in MAT provision. This systematic approach provided comprehensive insights into factors affecting MAT availability in Saudi healthcare settings, informing the development of targeted interventions to enhance service delivery.

6.2.3 Several local barriers impede MAT provision in Saudi Arabia, aligning with global trends

The qualitative study (Chapter 4) addressed the third thesis objective through interviews with 33 stakeholders, including HCPs, clinical and administrative managers and healthcare leaders, as well as an analysis of six relevant documents. It identified multiple barriers affecting the provision of MAT in Saudi Arabia across various CFIR domains (Chapter 4, Section 4.3.3) and highlighted the complex challenges hindering MAT provision in Saudi Arabia. The CFIR, which was introduced as the guiding framework for this thesis in Chapter 1, Section 1.6.2, was used to synthesise the barriers identified. These barriers align with global trends observed by several researchers (Gowran *et al.*, 2021; WHO, 2022; Gleaton *et al.*, 2024; Lee *et al.*, 2024; Mishra *et al.*, 2024) but also demonstrate unique local challenges.

Using the CFIR, 52 factors influencing MAT provision were identified across five domains (Figure 6.1). In the innovation domain, local shortages and cost constraints were found to affect MAT quality (Chapter 4, Section 4.3.3.1). The inner setting domain was found to have infrastructural issues, resource allocation problems, communication barriers and unclear roles and training for HCPs (Chapter 4, Section 4.3.3.3). The outer setting domain was found to have restrictive policies, funding disparities and service concentration hindering MAT accessibility and equity (Chapter 4, Section 4.3.3.2). The process domain had a lack of strategic planning and clinical leadership (Chapter 4, Section 4.3.3.4), while the individual domain was associated with socioeconomic, sociodemographic and personal factors influencing patient access and acceptance of MAT (Chapter 4, Section 4.3.3.5).

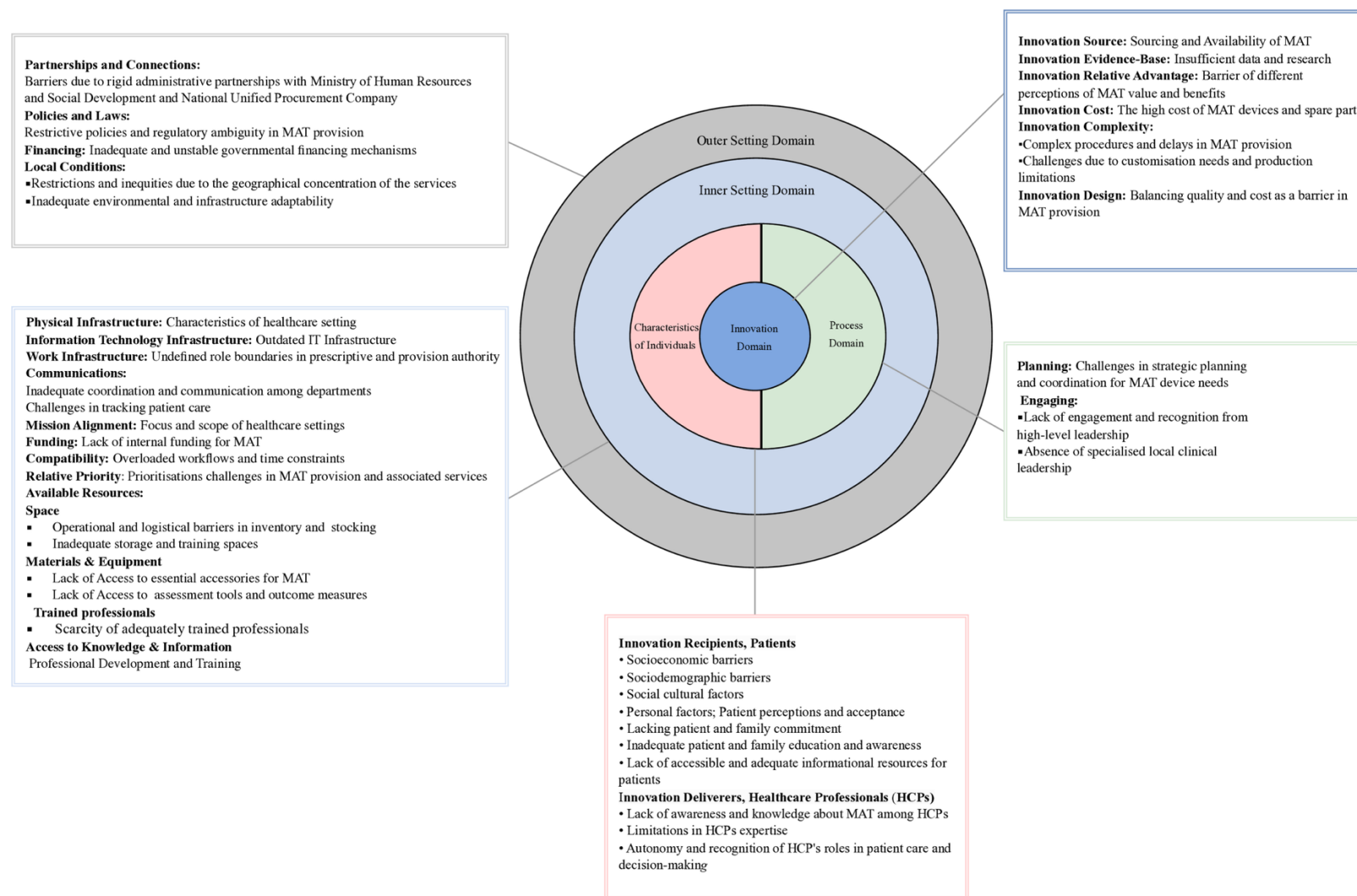


Figure 6.1 Barriers to the provision of mobility assistive technologies (MATs) in Saudi Arabia synthesised using the Consolidated Framework for Implementation Research

One significant challenge to MAT provision is the Saudi healthcare system's heavy reliance on imported MAT due to a weak local manufacturing sector (Al-Hanawi, Khan and Al-Borie, 2019). This dependency on imported MAT threatens supply chain stability and device accessibility. For example, when MAT devices need repairs, the lack of local manufacturers means spare parts must be imported, leading to extended waiting times. Similarly, procurement delays occur due to international shipping timelines, creating service gaps when devices are not available. This challenge is complicated by the broader context of Saudi Arabia's publicly funded healthcare system, which faces increasing demands and resource limitations (Almalki, Fitzgerald and Clark, 2011; Al-Hanawi *et al.*, 2020), as discussed in Chapter 1, Section 1.5.2. The reliance on imports affects availability and affordability, aligning with global observations on MAT device pricing (WHO, 2022). Similar challenges have been reported in other developing countries (Rohwerder, 2018). This emphasises the need for MAT devices to be manufactured with parts that can be repaired, maintained and replaced locally. Such an approach would align with global principles and enhance service delivery (WHO, 2022).

Furthermore, interview participants highlighted that cultural norms significantly influence MAT acceptance, particularly among elderly patients. HCPs reported specific cultural barriers, such as elderly patients' perception of MAT as a sign of dependency, a preference for family assistance over devices and concerns about social stigma. These findings suggest that technical solutions alone may be insufficient for improving MAT provision without addressing these cultural perspectives. Similar cultural barriers have been observed in Kenya and South Africa (Barbareschi *et al.*, 2021; McIntyre, Cleland and Ramklass, 2021). While the current study provides a comprehensive overview of MAT provision barriers in Saudi Arabia, Barbareschi *et al.* (2021) provided additional insights into personal and cultural barriers by conducting focus groups including people with disabilities, noting that disability stigma is one of the most persistent barriers limiting individuals with disabilities from achieving equal rights, including the use of MAT devices. Therefore, it is essential to provide culturally appropriate MAT services considering cultural identity, family perspectives and the meaning of MAT within specific cultural contexts (Ripat and Woodgate, 2011).

In this research, a discrepancy was found between HCPs' needs and management decisions, particularly in MAT procurement and customisation. HCPs criticised the 'one-size-fits-all'

approach, emphasising that it often fails to meet individual patient needs and that MAT devices must be safe and durable to achieve desired outcomes. In contrast, management decisions often prioritised planning and cost considerations, viewing MAT devices as a significant expense for the health system. This divergence in perspectives highlights a crucial gap in understanding the long-term value of MAT provision. Rey-Matias, Bundoc and Montes (2019) offer a perspective that could bridge this gap, arguing that governments should view MAT devices as a strategic investment rather than merely an expense. They emphasise that while initially costly, these MAT devices can enhance the productivity and employability of people with disabilities, enabling them to join the workforce (Rey-Matias, Bundoc and Montes, 2019). This approach could lead to increased tax revenues and reduced reliance on government support, consequently empowering people with disabilities and generating long-term savings (Rey-Matias, Bundoc and Montes, 2019). The findings of this qualitative study also reveal a critical need for comprehensive data on MAT users, including clinical effectiveness (functional outcomes and mobility improvements), cost-effectiveness and patient-reported outcomes (QoL and user satisfaction). This evidence is crucial to validate MAT benefits, inform clinical practices and guide policy development.

The findings also have implications for healthcare policy and practice in Saudi Arabia. The identified barriers to MAT provision emphasise the necessity of developing sustainable healthcare frameworks that align with WHO's (2022) six fundamental principles: accessibility, affordability, availability, adaptability, acceptability and quality. These empirical insights could inform strategic planning within the ongoing health sector transformation programme, a key component of Saudi Vision 2030, which aims to enhance independence and social integration for people with disabilities, as outlined in Chapter 1, Section 1.3.1.

6.2.4 Systemic, operational and individual challenges underlie the complex barriers to MAT provision

The triangulation of data from Chapters 2–4 described in Chapter 5, Section 5.3.1, highlights that the provision of MAT in Saudi Arabia faces multiple barriers stemming from systemic, operational and individual challenges. This analysis led to the identification of six main categories of barriers: (1) healthcare system and policy barriers, (2) procurement and delivery challenges, (3) MAT device-related barriers, (4) information and awareness barriers, (5) resources and infrastructure barriers and (6) personal and environmental barriers (Figure 6.2).

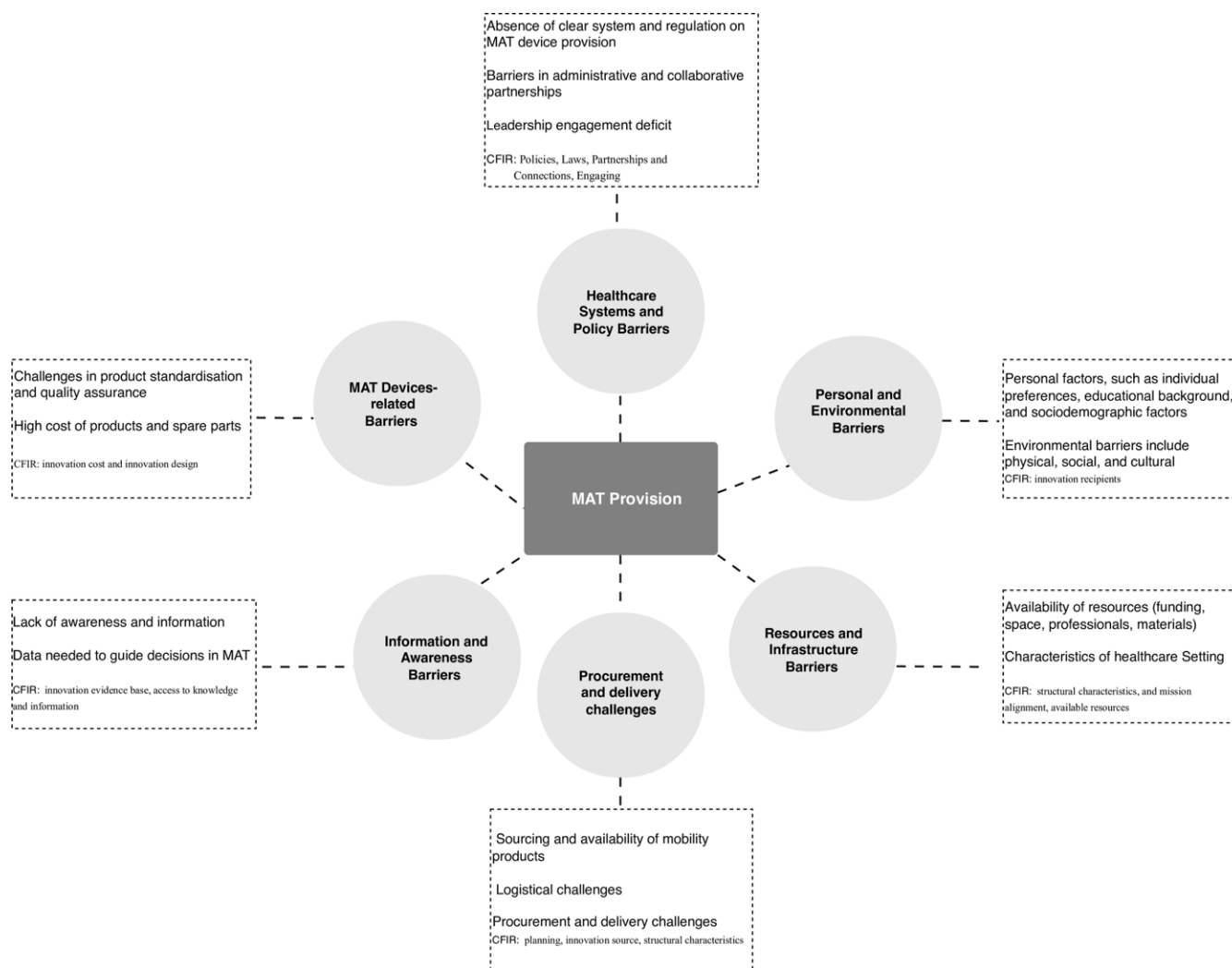


Figure 6.2 Barriers to mobility-assistive technology (MAT) provision in Saudi Arabia: triangulation of findings from Chapters 2–4 and associated consolidated framework for implementation research (CFIR) construct

At the systemic level, the study findings demonstrated that healthcare systems and policy frameworks lack coherent regulations and clear leadership structures, which hinders efficient MAT provision (Chapter 5, Section 5.3.1.1). This research identified that the absence of well-defined policies and limited leadership engagement create barriers to MAT provision. Specifically, the findings revealed limited coordination between healthcare facilities and MAT suppliers, along with insufficient communication channels between HCPs and policymakers. These systemic challenges align with international evidence. Through a systems analysis of South African healthcare facilities, Visagie *et al.* (2020) found that MAT services were inequitable and fragmented, with the public healthcare system meeting only 25%–65% of needs. Their research documented significant variations between provinces and healthcare levels, with rural areas facing the greatest access barriers. Similarly, Wang and Wilson (2022), using multi-method research (citizen panels, stakeholder interviews, surveys and policy dialogues) in Canada, found that 26% of persons with disabilities had unmet needs due to complex uncoordinated systems with varying eligibility criteria and coverage across different regions and healthcare programmes.

On the operational level, the procurement and delivery of MAT are associated with various complexities. These challenges encompass planning deficiencies and sourcing issues that disrupt the supply chain, alongside logistical barriers within the structural characteristics of healthcare settings (Chapter 5, Section 5.3.1.2). In combination, these factors lead to delays and inefficiencies in delivering essential MAT to users. Device-related barriers also play a critical role, with high costs, the availability of spare parts and accessories and concerns over device quality affecting both the accessibility and sustainability of MAT use (Chapter 5, Section 5.3.1.3). These findings reflect a broader global challenge, particularly in resource-constrained settings. Studies focusing on low- and middle-income countries (Rohwerder, 2018; Tangcharoensathien *et al.*, 2018) have reported similar systemic challenges, emphasising how device-related issues, including high costs and maintenance challenges, hinder MAT accessibility across various healthcare systems.

Low information and awareness are also significant barriers to MAT provision (Chapter 5, Section 5.3.1.4). This research found a deficiency in data to inform decision-making and a lack of awareness about available MAT options. This gap in knowledge and information accessibility

impedes informed decision-making, ultimately affecting the effective provision of MATs. This finding agrees with the recent WHO report (WHO, 2022) emphasising the global issue of insufficient knowledge on MAT, which contributes to its low adoption. The situation is further complicated by a lack of reliable information on the types, availability and potential solutions related to MAT (WHO, 2022). Further barriers identified include resources and infrastructure challenges. Inadequate infrastructure and divergent goals within institutions limit the effective provision of MAT, while resource constraints, such as funding, space and personnel limitations, constrain the ability of healthcare systems to support ongoing MAT initiatives (Chapter 5, Section 5.3.1.5). Limitations on human resources have been reported globally. Many countries face a shortage of properly trained personnel capable of offering expertise across a broad range of MAT devices (Rey-Matias, Bundoc and Montes, 2019; WHO, 2022). Further, the findings indicate that the challenge extends beyond a lack of trained personnel. HCPs are often unable to access continuing education programmes, which prevents them from maintaining and updating their skills and knowledge in MAT.

Lastly, this research found that personal and environmental factors strongly influence MAT provision (Chapter 5, Section 5.3.1.6). Individual health conditions, preferences, educational backgrounds and sociodemographic characteristics influence the appropriateness and acceptance of MAT solutions. Simultaneously, the broader environmental context – encompassing social, cultural and physical factors – shapes the feasibility and effectiveness of MAT interventions. Desmond *et al.* (2018) emphasise the importance of addressing these factors in MAT acceptance. The complexity of MAT provision within diverse socio-cultural contexts necessitates ongoing professional development for HCPs, service delivery professionals and technology innovators to enhance their understanding of user-specific needs (Desmond *et al.*, 2018).

The identified barriers resulting from the triangulation were mapped onto CFIR constructs. The mapping process identified several specific CFIR constructs, as detailed in Chapter 5, Section 5.3.1, including innovation characteristics (encompassing innovation complexity, cost, design, source and evidence base), outer setting (including policies, laws, partnerships and connections), inner setting (covering available resources, structural characteristics and mission alignment), individual characteristics (focusing on innovation recipients) and process (involving engaging and planning aspects).

To synthesise these findings and provide a comprehensive model for understanding MAT provision in Saudi Arabia, these CFIR constructs resulting from the triangulation (Chapter 5, Section 5.3.1) were integrated with the original MAT provision model developed in the scoping review (Chapter 2, Section 2.2.3). This integration resulted in an enhanced model (Figure 6.3) that bridges theoretical understanding with empirical findings.

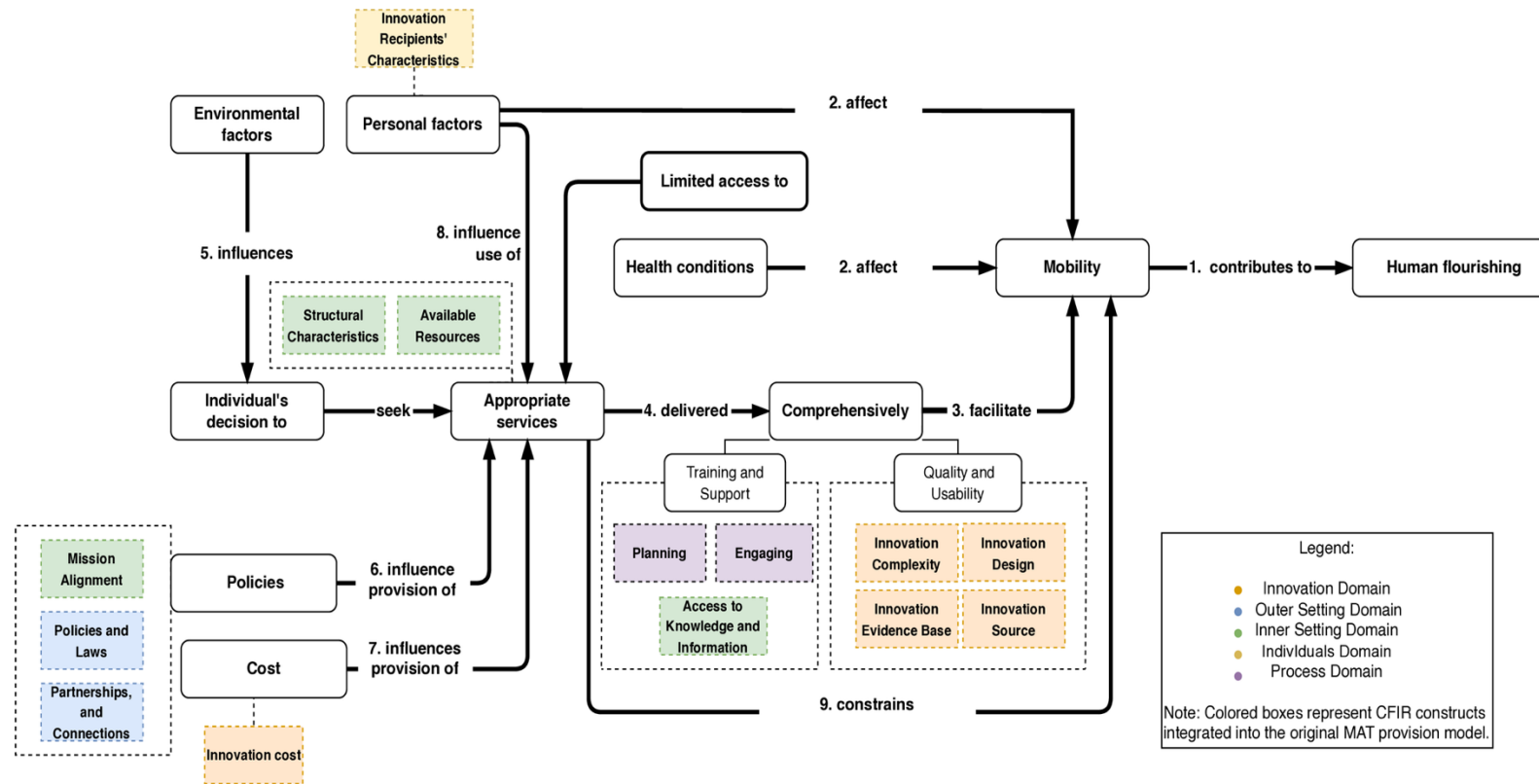


Figure 6.3 Enhanced model of mobility assistive technology (MAT) provision integrating consolidated framework for implementation research (CFIR) constructs

The enhanced model synthesises this thesis's key findings regarding barriers to MAT provision in Saudi Arabia, illustrating the complex nature of MAT provision. It demonstrates that mobility contributes to human flourishing but can be affected by health conditions and limited access to appropriate services. Appropriate services, which are central to effective MAT provision, are shaped by a combination of environmental factors, personal characteristics, policies and costs. These services, when delivered comprehensively with training, support and attention to quality and usability, should facilitate improved mobility for individuals.

The integration of CFIR constructs enriches the findings by highlighting specific areas that influence MAT provision. Innovation characteristics, such as complexity, design and source, emerge as key elements for effective and comprehensive MAT service delivery. Equally important is access to knowledge and information, which facilitates comprehensive service delivery. The model also incorporates outer setting factors, including partnerships, connections, policies and laws, which significantly affect the delivery of appropriate services. Inner setting elements, comprising structural characteristics and available resources, play a crucial role in shaping the organisational capacity for MAT provision. The Individual characteristics domain emphasises the role of personal factors in MAT acceptance and use, acknowledging the importance of user perspectives and experiences. Finally, the process domain, including planning and engagement, was identified as crucial for effective service delivery. Integrating CFIR constructs with the scoping review model provided a comprehensive framework for understanding the multifaceted challenges and opportunities regarding MAT provision in Saudi Arabia. Overall, this offers a comprehensive perspective on the complex interplay of factors influencing MAT.

6.2.5 Identified strategies offer a foundation for enhancing MAT provision through targeted interventions

Chapter 5 addressed the fourth objective of this thesis: to develop strategies using the CFIR-ERIC matching tool to overcome identified challenges for future research, policy and practice. These strategies were informed by findings from the scoping review (Chapter 2), survey (Chapter 3) and qualitative study (Chapter 4). The CFIR-ERIC matching tool was used to identify strategies (Chapter 5, Section 5.3.2) for addressing barriers identified in previous

chapters (Chapter 5, Section 5.3.1). The results showed that 49 implementation strategies could mitigate challenges and strengthen MAT delivery. These strategies are categorised as follows: 17 strategies relate to planning, 12 to education, four to finance, 14 to quality management, and one to restructuring. These strategies can form a foundation for developing tailored implementation plans to improve MAT uptake in Saudi Arabia across various settings. Notably, the predominance of planning and education strategies suggests that the primary barriers to effective MAT provision lie in system-level deficiencies, specifically in terms of service coordination and knowledge dissemination. Among these, the ERIC planning category includes the strategy to ‘identify and prepare champions’, which was rated as a high-priority implementation strategy by expert consensus. Champions play a pivotal role in health improvement initiatives by engaging key influencers to effect change within the healthcare system (Bonawitz *et al.*, 2020).

Another important strategy is ‘conducting educational meetings’. This strategy seeks to enhance knowledge dissemination and engagement regarding the benefits of MAT by organising targeted meetings for stakeholders, including the community, patients and families (Powell *et al.*, 2015). These meetings could include workshops for HCPs on the latest MAT devices, seminars for hospital managers on the cost-effectiveness and long-term benefits of MAT provision, community outreach programmes to educate patients and families about MAT and address cultural stigmas and misconceptions. The emphasis on educational strategies parallels Greenhalgh *et al.*’s (2004) systematic review and findings on the diffusion of innovations in health service organisations. Their comprehensive review identified knowledge dissemination as a critical factor in how innovations spread within healthcare organisations (Greenhalgh *et al.*, 2004).

The CFIR-ERIC tool’s output of potential strategies can guide stakeholders in selecting the most effective strategies for enhancing MAT service provision (Waltz *et al.*, 2019). They aim to assist in designing robust interventions and formulating evidence-based policies and programmes to improve MAT services. It is worth noting that among the ERIC strategies identified, several are endorsed by consensus and have demonstrated effect sizes in clinical practice. The endorsed strategies comprise engaging local clinical champions, delivering educational materials, and conducting educational meetings (Powell *et al.*, 2019). These strategies have demonstrated average effect sizes of 12%, 2%, and 6%, respectively (Powell *et al.*, 2019). However, it is

crucial that these strategies undergo empirical evaluation to assess their impact and ensure their efficacy in real-world settings. The implications of these strategies (those with the highest cumulative endorsement and level-1 strategies for each CFIR barrier) within the Saudi Arabian context will be discussed further in Section 6.5.1.3.

6.3 Philosophical pragmatism

6.3.1 Pragmatic principles facilitate context-specific solutions for MAT provision challenges

This research was guided by the philosophical principles of pragmatism introduced in Chapter 1, Section 1.7. This approach reflects the value of understanding and addressing the complex challenges of MAT provision in Saudi Arabia's healthcare system, considering practical solutions grounded in context. Rather than seeking universal truths, which would align with philosophical realism, this research adopted pragmatism's focus on human experience and context (Wills and Lake, 2020). This was achieved through engaging multiple stakeholders – HCPs, managers and leaders – to understand their lived experiences and perspectives on MAT provision. This emphasis on contextual understanding, grounding the inquiry in human experience (Morgan, 2014; Wills and Lake, 2020), proved particularly valuable in identifying the barriers to MAT provision within Saudi healthcare settings. Throughout the research process, the identified barriers and proposed strategies were not treated as abstract universal truths. Instead, the research focused on practical insights emerging from the specific context of Saudi Arabia's healthcare system, reflecting real challenges and opportunities for improvement. This contextual understanding was strengthened by employing a mixed-methods design combining a scoping review, survey and qualitative case studies. This methodological flexibility aligns with pragmatic principles (Creswell and Poth, 2016) that allow findings to be integrated across methods (Chapter 5, Section 5.3.1) to create a comprehensive understanding of MAT provision challenges.

The practical focus in line with pragmatism was particularly evident in the development of implementation strategies (Chapter 5, Section 5.3.2). This research developed actionable strategies to address barriers using the CFIR-ERIC matching tool and proposed context-specific solutions. This approach aligned with pragmatism's emphasis on practical consequences and problem-solving (Legg and Hookway, 2019; Wills and Lake, 2020). Through consistent

application of pragmatic principles, the research achieved its objectives by grounding inquiry in stakeholder experiences and adopting methodological flexibility, demonstrating the value of this worldview in developing practical solutions for complex MAT provision challenges in Saudi Arabia's healthcare systems.

6.4 Strengths and limitations of this PhD research

6.4.1 The thesis's strengths include its robust theoretical foundation, comprehensive methods, and practical implications

This thesis has several strengths that contribute to its trustworthiness and significance for understanding MAT provision in Saudi Arabia. It offers valuable insights for improving practices and policies through its robust theoretical foundation and comprehensive methodological approach, along with the practical implications of its findings.

One major strength of this thesis is its rigorous application of the CFIR as a theoretical framework to identify barriers to MAT provision in Saudi Arabia. This comprehensive framework allowed for a thorough investigation of factors influencing MAT provision in Saudi Arabia. The use of the CFIR enhanced the trustworthiness of the thesis by guiding the development of data collection tools and providing a structured framework for analysis. The thesis employed a variety of methodological approaches. The research began with a scoping review (Chapter 2), which included a theoretical synthesis. This established a robust evidence-based foundation for planning corrective actions and guiding future work. Through this approach, the study identified a range of barriers and potential areas for improvement, which provided valuable insights to enhance access to and the provision of MAT. The subsequent qualitative study (Chapter 4) drew on these findings, strengthening the interview guide's relevance and focus. This tool was designed according to the CFIR domains and constructs while being enhanced by important findings from the scoping review and the survey, as detailed in Chapter 4, Section 4.2.5.1.

The research design was strengthened through its comprehensive sampling approach in the qualitative study, which included three public hospitals across two geographic regions in Saudi Arabia. The study interviewed 33 participants, comprising 17 HCPs, 10 managers and six leaders, representing diverse roles and organisational levels within the Saudi healthcare system's

MAT services. This broad representation across different sites and roles enriched the analysis by capturing varied perspectives. Additionally, the case study methodology provided a systematic framework that enabled cross-case comparisons, allowing for identification of commonalities and differences across both hospital settings and participant perspectives (Yin, 2018).

The use of multiple data sources, including documents and interviews with stakeholders who contributed their unique experiences and perspectives, enabled the identification of multi-level factors affecting access to MAT. This improved credibility through the triangulation of data sources (Chapter 4, Section 4.2.8) (Shenton, 2004; Yin, 2018). Furthermore, the integration of results from Chapters 2–4 (Chapter 5, Section 5.3.1) conducted in this PhD research provided a comprehensive picture of the barriers identified through multiple methods. This integration strengthened the findings of the CFIR-ERIC mapping process by combining evidence from different methodological approaches and perspectives within the Saudi healthcare context (Shenton, 2004).

This research was further strengthened by its integration of PPI, as detailed in Chapter 1, Section 1.9 and Chapter 4, Section 4.2.10. Patient and expert engagement strengthened multiple aspects of the research process. Initial consultations informed the study design and protocol development, ensuring relevance to local needs. Subsequent engagement with MAT users validated the findings and enriched the understanding of systemic barriers through their lived experiences. This stakeholder involvement strengthened the recommendations by grounding them in real-world challenges within the Saudi healthcare context. The CFIR-ERIC mapping process produced actionable insights that have direct practical implications for policymakers, HCPs and other stakeholders involved in MAT provision, providing clear guidance for future interventions and policy decisions (Chapter 5, Section 5.3.2).

6.4.2 The thesis's limitations include its geographical scope, participant representation, and methodological constraints

Despite its strengths, this PhD research encountered several limitations that should be considered when interpreting its findings. Initially, the research faced limitations in its literature coverage and scope. As detailed in Chapter 2, Section 2.4, the scoping review was constrained in language selection and time frame, which may have impacted the comprehensiveness of the foundational

knowledge on which the study was based. However, the focus on recent English-language peer-reviewed literature, which incorporated studies examining a wide variety of healthcare settings and geographical contexts, allowed for a targeted analysis of current practices in MAT provision. Another limitation of this research lies in its geographical and institutional scope. The empirical data collection was restricted to interviews with participants from three public hospitals across two geographical regions in Saudi Arabia. While this approach yielded in-depth insights, it led to several constraints on the transferability and comprehensiveness of the findings. Firstly, the focus on only two geographical regions may not fully capture the diverse healthcare landscape of Saudi Arabia. Saudi Arabia's healthcare system varies considerably across its 13 administrative regions, each with unique demographic, economic and cultural characteristics that could influence MAT provision (Aljohani *et al.*, 2023). The study's concentration on specific areas might have led to the neglect of important regional variations in healthcare practices, resource allocation and cultural attitudes towards MAT.

Secondly, the exclusive focus on public hospitals, while providing valuable insights into a crucial sector of Saudi healthcare, limits the transferability of findings to other healthcare settings. Private healthcare facilities, which play a role in the Saudi health system, may operate under different financial models, regulatory frameworks and organisational cultures. These differences could substantially impact MAT provision practices and barriers to provision. Furthermore, the study is limited by its focus on only one hospital from other governmental agencies, as these agencies constitute 19% of Saudi healthcare systems and operate their own independent healthcare facilities (as detailed in Chapter 1, Section 1.5.2). This limited sampling means that the variation in MAT provision across different governmental healthcare providers may not have been fully captured.

Despite concerted efforts to broaden the range of participating institutions, time and resource constraints inherent to doctoral research prevented a more expansive study. It is also important to acknowledge the benefits that arose from these limitations. The relatively small selection of hospitals allowed for a depth of data that provides a rich understanding of MAT provision within these settings. The qualitative nature of the study allowed for detailed exploration of contextual factors and individual experiences, offering insights that may be applicable to similar healthcare environments. Additionally, the focus on public hospitals aligns with the fact that these

institutions serve a significant portion of the Saudi population (Chapter 1, Section 1.5.2). The geographical diversity, albeit limited, still provides a basis for understanding some regional variations in MAT practices. This comparative element offers valuable insights into how different local contexts might influence MAT provision, even within the public hospital system.

The participant sample, while diverse in terms of professional roles, had two significant limitations. First, regarding regional representation, although the study included 33 participants, only nine were from the eastern region of Saudi Arabia, potentially underrepresenting this area's unique challenges and practices. Second, the study did not include the perspectives of MAT users and their families, who could have provided valuable insights into personal and environmental barriers to MAT access and acceptance. Methodologically, the use of the CFIR and the CFIR-ERIC matching tool provided a structured approach to data collection, analysis and strategy development. However, these tools have limitations. The qualitative nature of the CFIR constructs introduces an element of subjectivity in their interpretation and application. The researcher's personal background and experiences may have influenced the analysis and interpretation of the data. This potential influence was acknowledged in Chapter 4, Section 4.2.6, which discusses the impact of researcher perspectives on study design and interpretation. To enhance the trustworthiness of the study, measures such as member checking and triangulation were implemented, as detailed in Chapter 4, Section 4.2.8.

The CFIR-ERIC matching tool, while valuable for strategy development, primarily relies on expert opinion rather than empirical evidence (Waltz *et al.*, 2019). At the same time, there is some evidence supporting the tool's effectiveness in healthcare implementation. For instance, a comprehensive five-year evaluation of the Veterans Health Administration by Yakovchenko *et al.* (2021) demonstrated that 48 out of 73 ERIC strategies (66%) showed positive associations with hepatitis C treatment implementation outcomes. While these findings are promising, the strategies have not been specifically tested for MAT provision in the Saudi Arabian context. Although Yakovchenko *et al.*'s (2021) study demonstrates that ERIC strategies can effectively support healthcare implementation when systematically applied, empirical validation within the Saudi healthcare system would be necessary before wide-scale implementation.

A final limitation stems from the study's broad focus on MATs as a general category, albeit with

consideration of the priority MAT devices listed by the WHO detailed in Chapter 1, Section 1.3.2. While this approach provided a comprehensive overview of MAT provision, it may have led to the neglect of unique challenges associated with specific types of MAT. Different MATs, such as wheelchairs, prosthetics or walking aids, may be associated with distinct barriers regarding their provision, maintenance and user adoption. This notion is supported by a study by (Sugawara *et al.*, 2018), which found significant differences in abandonment rates between device types, underscoring the importance of device-specific analysis. This broad approach, while valuable for understanding systemic issues, may have led to the omission of detailed, device-specific challenges that could be crucial to improving MAT provision for particular user groups. Future research might benefit from focusing on certain types of MATs to provide more detailed device-specific insights.

6.5 Research implications

This PhD research aimed to investigate the factors influencing the provision of MAT for people with mobility-related disabilities in Saudi Arabia's healthcare system and recommend strategies to overcome identified barriers. It contributes significantly to the understanding of factors affecting MAT provision, suggesting that accessibility to MATs remains a major concern in Saudi Arabia. The following sections provide insight into the specific implications of this research on MAT provision in Saudi Arabia as well as its relevance to the global context.

6.5.1 Implications for Saudi Arabia

6.5.1.1 Enhancing education, patient engagement, and service quality is critical for MAT provision improvement

The findings of this research have several significant implications for MAT provision within the Saudi healthcare system. The first major implication addresses the identified gaps in HCPs' knowledge and competencies in MAT provision. In particular, the findings indicate the need for comprehensive education and training programmes specifically tailored to the Saudi healthcare system's requirements and context. Strategic collaboration with Saudi universities is recommended to integrate evidence-based research into practical MAT applications, facilitating knowledge transfer and ensuring HCPs develop the necessary clinical competencies.

A second implication of this research is the necessity of developing culturally sensitive patient

engagement strategies within the Saudi healthcare system. The study's findings suggest that MAT provision is significantly affected by both personal and environmental factors, with personal factors including the individual preferences, educational background and sociodemographic characteristics that play crucial roles in MAT acceptance and use. Environmental barriers encompassing physical, social and cultural aspects further complicate MAT provision. To address these complex challenges, the research indicates the necessity of developing educational materials specifically adapted to Saudi Arabia's cultural context, with programmes targeting HCPs on three distinct levels: clinical competencies, leadership and administrative awareness for informed decision-making and resource allocation, and public understanding to enhance acceptance and uptake. While patient engagement strategies have demonstrated considerable success in Western healthcare systems, as evidenced by Hibbard and Greene's (2017) findings of improved health outcomes and reduced costs through increased patient activation, there remains a notable gap in empirical research addressing these approaches within Saudi Arabia (Al-Tannir *et al.*, 2017).

The third implication concerns quality control and procurement systems. The research strongly advocates for implementing rigorous quality control measures in MAT procurement and maintenance. The findings revealed multifaceted challenges in procurement and delivery, encompassing accessibility issues, regulatory framework gaps and planning challenges. These findings highlight the critical need for developing more effective vendor and supplier management systems that can ensure consistent quality and the timely delivery of MAT devices.

The final implication pertains to service delivery and assessment methodologies. The findings emphasise the necessity of implementing assessment tools that comprehensively consider both personal factors and environmental barriers in MAT prescription. This indicates a paradigm shift towards user-centred, personalised MAT service provision is required within the Saudi healthcare system. The implementation of holistic MAT services, encompassing assessment, training and ongoing maintenance, must be carefully adapted to the existing Saudi healthcare infrastructure. This comprehensive approach aims to ensure continuous support for people with disabilities throughout their MAT journey, from initial assessment to long-term care. Furthermore, the findings suggest that practitioners should be empowered to assume leadership roles in advocating for system improvements and ensuring the healthcare system remains

responsive to evolving patient needs.

6.5.1.2 Clear regulations, sustainable funding, and collaborative policies are essential for MAT provision enhancement

The findings indicate several critical areas requiring policy development to improve MAT provision within Saudi Arabia's healthcare system. In particular, the analysis highlights three key areas needing clear regulations and guidelines: procurement processes, quality assurance standards and service delivery protocols. The current regulatory ambiguities and inconsistent service provision within the Saudi healthcare system indicate the necessity of a structured, integrated policy framework. This framework should be developed by the MOH and the Saudi Health Council. These institutions can play a central role in shaping policies that promote inclusive healthcare services for people with disabilities, ensuring equitable and accessible MAT provision across Saudi Arabia.

Another primary policy consideration is the need for sustainable funding mechanisms and resource allocation. Policymakers should view MAT provision as an investment rather than a cost (Rey-Matias, Bundoc and Montes, 2019). This perspective necessitates the development of a comprehensive strategy for MAT procurement and distribution, including policies to encourage local manufacturing through incentives and partnerships with reliable suppliers. Additionally, creating standards for MAT service and repair will be vital for ensuring sustainability and user satisfaction. This research has identified specific ERIC strategies, such as accessing new funding sources, with implications for Saudi Arabia to be discussed in Section 6.5.1.3.

The findings also emphasise the importance of developing culturally appropriate and user-centred MAT provision practices. The WHO Guidelines on the Provision of Wheelchairs (WHO, 2023) provide a practical model, establishing essential principles while allowing countries to tailor service delivery to their local contexts. This approach aligns with the research findings, which highlight the need for MAT services that consider both personal and environmental factors. Furthermore, universal access to both public and private spaces is crucial for effective MAT device use, supported by infrastructure enabling seamless integration into daily life. This aligns with international frameworks such as the guidelines from the UN (2007) and WHO (2022).

The research also highlights the critical need for evidence-based policy development through context-specific data. In Saudi Arabia, the lack of research demonstrating MAT effectiveness and use patterns emphasises the need for policies promoting localised research. Policymakers should implement frameworks encouraging systematic data collection on MAT outcomes, user experiences and cost-effectiveness within their specific healthcare contexts. This evidence-based approach would enable more informed decisions on MAT allocation and enhance service effectiveness. Finally, successful implementation requires robust stakeholder collaboration and accessibility standards. Fostering collaboration among key stakeholders – including HCPs, policymakers and government organisations such as NUPCO and the MHRSD – is essential for a coordinated approach to MAT provision. Importantly, involving individuals with disabilities in policymaking is crucial for developing effective and inclusive MAT provisions, as emphasised by Article 4 of the UNCRPD (UN, 2007).

6.5.1.3 Recommended ERIC strategies offer practical solutions to address MAT provision barriers

This research identifies priority ERIC strategies for addressing barriers to MAT provision in Saudi Arabia's healthcare system, as detailed in Chapter 5, Section 5.3.2. The use of the CFIR-ERIC matching tool was instrumental in identifying these strategies, particularly in the areas of planning, education, financing and quality management. Each of these strategies has important implications for enhancing MAT provision. The implications of the recommended ERIC strategies (those with the highest cumulative endorsement and level-1 strategies for each CFIR barrier) for the provision of MAT services in Saudi Arabia are summarised in Table 6.1, which categorises specific strategies, their implications and the suggested actors for their implementation.

Table 6.1 Implications of this study for the recommended Expert Recommendations for Implementing Change (ERIC) strategies

Strategy Category	Specific ERIC Strategies	Implications for Mobility Assistive Technology (MAT) Provision in Saudi Arabia	Suggested Actor
Planning Strategies	Identify and prepare champions	Champions can advocate for MAT policy changes and implementation efforts.	Saudi Commission for Health Specialties (SCFHS)

	Conduct local consensus discussions	Aligns stakeholders on MAT goals, ensuring culturally relevant solutions.	Ministry of Health (MOH) and local health directorates
	Conduct local needs assessments	Tailors MAT provision to specific regional needs, improving equitable access.	General Authority for Statistics and MOH
	Assess readiness and identify barriers	Determines MAT readiness in healthcare facilities and identifies local challenges.	Saudi Health Council
	Develop a formal implementation blueprint	Ensures a clear, structured plan for MAT implementation aligned with national goals.	MOH
	Build a coalition	Involves key stakeholders such as policymakers, disability associations, the Ministry of Human Resources and Social Development (MHRSD) and National Unified Procurement Company (NUPCO).	MOH in collaboration with MHRSD and NUPCO
	Develop academic partnerships	Establishes collaboration with universities to enhance training and research in MAT provision.	Ministry of Education and SCFHS
	Involve patients and family members	Engages people with disability and families in decision-making, promoting patient-centred care.	Authority for People with Disability
	Promote adaptability	Localises MAT supply chains and implementation to fit cultural and logistical needs.	Saudi Health Council
Educational Strategies	Develop educational materials	Creates culturally tailored resources covering MAT usage and benefits.	SCFHS in collaboration with MOH
	Distribute educational materials	Ensures widespread access to MAT information across different regions.	Ministry of Media in collaboration with MOH

	Conduct educational meetings	Organises workshops for HCPs and seminars for hospital managers and communities.	SCFHS and local health directorates
	Inform local opinion leaders	Engages respected healthcare figures to promote MAT acceptance.	Saudi Health Council
	Create a learning collaborative	Establishes collaboration among hospitals for continuous improvement in MAT provision.	Saudi Health Council
Financing Strategies	Access new funding	Develops alternative funding streams to address healthcare resource constraints.	Ministry of Finance and MOH
Quality Management	Obtain and use patient and family feedback	Tailors MAT services to meet user needs, enhancing patient satisfaction.	Saudi Patient Safety Centre, Healthcare Providers, Hospital Quality Departments
	Audit and provide feedback	Tracks key indicators such as MAT usage rates and patient outcomes.	Saudi National Health Information Centre, Healthcare Providers
	Promote network weaving	Facilitates regular collaboration between key stakeholders through networking events.	Saudi Health Council
	Capture and share local knowledge	Documents and disseminates best practices and lessons learned in MAT provision.	SCFHS in collaboration with MOH

The top strategy identified by the ERIC-CFIR tool in the planning category is the identification and preparation of champions, which was rated as a high-priority implementation strategy by expert consensus. The tool prioritised this strategy as critical for overcoming leadership engagement deficits, which were a significant barrier in this research. Champions can advocate for policy changes related to MAT and drive implementation efforts (Bonawitz *et al.*, 2020). In Saudi Arabia, where leadership engagement in MAT provision has been limited, encouraging

champions through leadership programmes, such as those offered by the SCFHS, can promote progress in improving MAT services (McMahon *et al.*, 2024). Champions can drive change by promoting active leadership involvement in MAT provision decision-making at institutional and policy levels (Powell *et al.*, 2015).

Additionally, other planning strategies identified through the ERIC-CFIR matching tool, such as conducting local needs assessments, have important implications for ensuring that MAT services are responsive to the diverse needs of different regions. Given the geographical and infrastructural disparities highlighted in this research, needs assessments can help tailor service provision to the specific requirements of unserved areas. This strategy aligns with Vision 2030's goal of providing equitable healthcare access across Saudi Arabia and allows for more efficient allocation of resources to areas where MAT services are most needed (Saudi Vision 2030, 2016).

Educational strategies, as identified through the ERIC-CFIR tool, are crucial for addressing two key areas: (1) the knowledge and awareness gaps among HCPs, managers and organisational leaders and (2) public understanding and stigmatisation related to MAT. The development of culturally tailored educational materials is a top strategy for improving awareness and understanding of MAT. These materials will ensure that HCPs are well-equipped to recommend and implement MAT solutions effectively while patients and their families become better informed about MAT benefits. Furthermore, learning collaboratives are a valuable educational strategy that fosters continuous knowledge sharing among HCPs, enabling them to exchange best practices and stay updated on the latest developments in MAT provision.

Access to new funds was identified by the CFIR- ERIC tool as the key financing strategy. In the Saudi context, this requires careful consideration of Saudi Arabia's unique healthcare landscape. As discussed in Chapter 1, Section 1.5.2, the Saudi healthcare system, which is predominantly publicly funded, faces increasing challenges due to growing demand and limited resources (Al-Hanawi *et al.*, 2020), necessitating a tailored funding approach. Leveraging public-private partnerships (PPPs), which involve collaborations between the public and private healthcare sectors, is a key component of Saudi Vision 2030 and offers a culturally appropriate and economically viable solution (Al-Hanawi and Qattan, 2019). These partnerships can alleviate the government's financial burden while enhancing MAT infrastructure (Al-Hanawi and Qattan,

2019). Hospital managers can advocate for MAT investments through PPPs, focusing on staff training programmes, the procurement of MAT devices and patient education.

Quality management strategies, such as auditing and providing feedback, were identified as essential for ensuring that MAT services remain responsive to user needs. The ERIC-CFIR matching tool emphasised the importance of collecting and using data to evaluate the effectiveness of these services. For instance, audits can track the frequency of MAT prescriptions, usage rates and patient outcomes across different regions of Saudi Arabia. The audit data could provide evidence to support the prioritisation of MAT services in healthcare settings where their significance is not fully recognised. Central to these quality management strategies is the incorporation of patient and family feedback into the decision-making process. This approach ensures that services are tailored to meet the specific needs of users, fostering a more responsive healthcare system where MAT services are continuously adapted based on real-world experiences. Additionally, the data collected through auditing can provide valuable insights for policymakers, enabling more informed decisions about future improvements in MAT provision. However, implementing such patient engagement strategies in Saudi Arabia presents unique challenges. Saudi Arabia's healthcare system is influenced by distinct cultural and systemic factors, particularly the traditional paternalism of the doctor–patient relationship (Alkabba *et al.*, 2012). This cultural context, combined with limited local research on patient engagement strategies (Al-Tannir *et al.*, 2017), suggests the need for culturally adapted approaches to enhance patient involvement in MAT services.

6.5.2 Relevance to the global context

6.5.2.1 Applying CFIR-ERIC frameworks provides a systematic approach to global MAT provision challenges

The research findings, although focused on the Saudi Arabian healthcare context, may be relevant to other healthcare systems, particularly in the Gulf region and the Middle East. The six identified barriers – healthcare system and policy barriers, procurement and delivery challenges, device-related barriers, information and awareness barriers, resource and infrastructure barriers, and personal and environmental barriers – align with challenges reported globally (WHO, 2022). This alignment suggests the potential for this research to inform international practice and policy improvements. However, the transferability of these findings requires careful consideration of

each country's unique healthcare infrastructure, regulatory frameworks and socio-cultural contexts. While researchers, policymakers and practitioners in other regions can adapt these insights, successful application depends on thoughtful adaptation to local healthcare structures and cultural contexts.

This research offers methodological insights for studying MAT provision globally. The systematic application of implementation science frameworks (CFIR-ERIC) was found to be an effective approach for analysing complex healthcare interventions and developing targeted strategies. This structured approach to barrier identification and strategy development could inform similar investigations in other healthcare contexts, particularly given the complex nature of MAT provision.

6.5.2.2 Effective MAT provision requires user-centered and evidence-based service delivery

This research also has global implications for service delivery models. In particular, the findings support the development of holistic, user-centred MAT services that integrate assessment, training and long-term support. While implementation would require adaptation to local contexts, this comprehensive approach could inform international discussions about sustainable MAT provision. Furthermore, the identified need for context-specific data on MAT use and outcomes (including usage patterns, user satisfaction, clinical outcomes, and cost-effectiveness) has global implications for evidence-based practice, highlighting the importance of systematic data collection in improving MAT services worldwide.

6.5.3 Implications for future research

6.5.3.1 This research identifies key directions to advance knowledge and practice on MAT provision

This research has enhanced the understanding of MAT provision within Saudi Arabia's healthcare context while also revealing several areas that warrant further investigation. These identified research priorities, while grounded in the Saudi Arabian context, could contribute valuable insights to the broader field of MAT provision. The specific directions for future research are synthesised in Table 6.2.

Table 6.2 Key areas for future research in mobility assistive technologies (MAT) provision

Research Area	Future Research Directions	Specific Research Questions
Evaluating Implementation Strategies for MAT Provision	Further evaluation of Expert Recommendations for Implementing Change (ERIC) strategies in Saudi Arabian healthcare context aiming to improve MAT uptake.	How effective are specific ERIC strategies in improving MAT provision in Saudi healthcare settings?
Sociocultural Factors	Exploration of cultural and social influences on MAT adoption.	What are the key sociocultural barriers and facilitators affecting MAT acceptance among Saudi patients?
Regional Disparities	Analysis of geographical variations in MAT access.	What factors contribute to regional variations in MAT access across different provinces of Saudi Arabia?
Economic Impact Analysis	Evaluation of MAT provision costs and benefits.	What is the cost-effectiveness of MAT provision in Saudi healthcare settings? How does MAT provision impact healthcare use costs and workforce participation rates among users?
Longitudinal Studies	Long-term tracking of patient outcomes following MAT interventions.	What are the long-term functional outcomes and quality of life impacts for MAT users?
Institutional Challenges	Examination of funding, procurement and policy implementation within key organisations such as National Unified Procurement Company (NUPCO) and Ministry of Human Resources and Social Development (MHRSD).	How can NUPCO's procurement and distribution processes be optimised? What organisational factors facilitate or inhibit MAT policy implementation?
National MAT Effectiveness Data	Comprehensive assessment of MAT usage, satisfaction and outcomes.	What are the current patterns of MAT usage across Saudi healthcare facilities?

This research demonstrates the effectiveness of implementation science frameworks, specifically CFIR and ERIC, in systematically identifying barriers and developing targeted interventions for

MAT provision. Future research could extend this methodological approach to examine MAT implementation across different healthcare contexts. The comprehensive nature of this research, combining a scoping review, survey and qualitative interviews, was demonstrated to be effective in capturing the complexity of MAT provision barriers. Future research could benefit from similar mixed-methods designs, which allow for a holistic analysis of the barriers to MAT provision across different healthcare environments.

While this research highlighted the role of sociocultural factors in MAT acceptance, further investigation is needed to understand these complex dynamics. Future studies should examine the interplay among cultural norms, social expectations and individual preferences in MAT adoption. This research direction could provide valuable insights for developing culturally appropriate MAT provision strategies in Saudi Arabia and similar contexts. Furthermore, this research identified regional variations in MAT provision across Saudi Arabia. Further research is needed to investigate geographical disparities in MAT access, particularly in underserved or remote areas. This will contribute to more equitable MAT provision across diverse geographical regions.

Future research should evaluate the comprehensive economic implications of MAT provision. This should encompass both immediate costs and long-term benefits, including potential increases in workforce participation by people with disabilities and reductions in healthcare expenditures. Researchers should develop economic models to project the financial impact of enhanced MAT on healthcare systems. Although existing studies suggest that such technologies, including wheelchairs and mobility aids, can reduce healthcare costs by lowering the need for formal and informal care, the evidence base remains limited and often lacks methodological rigour (Albala *et al.*, 2021). The gaps in current evaluations highlight the need for more robust frameworks to capture the full economic value of these technologies. Another study underscores the importance of integrating measures such as QALYs and work productivity to provide a more comprehensive understanding of the benefits of MAT (Joseph, Brond and Namboodiri, 2022). By addressing these limitations and building on preliminary findings, researchers can generate models that offer valuable data for policymaking and a stronger case for investment in MAT. Furthermore, to understand the sustained impact of MAT provision, future research should design and conduct longitudinal studies tracking patient outcomes, independence and QoL

following MAT interventions. Such long-term investigations will provide crucial data on the effectiveness and sustainability of MAT interventions.

Future studies should also investigate funding mechanisms, procurement processes and policy implementation within institutions like NUPCO and the MHRSD. This focus on organisational and policy barriers will contribute to more efficient and effective MAT provision systems.

Finally, to bridge the gap between theory and practice, future research should evaluate the ERIC strategies identified in this thesis (Chapter 5, Section 5.3.2) in real-world Saudi Arabian healthcare settings. A proposed research plan is detailed in Section 6.5.3.2, focusing on evaluating these implementation strategies to provide practical guidance for improving MAT provision.

6.5.3.2 Proposed future research plan

6.5.3.2.1 Systematic evaluation of ERIC strategies is essential for improving MAT provision

This proposed future research plan aims to systematically test and refine ERIC strategies for enhancing the provision of MAT within healthcare settings, building on the insights gained from this PhD research.

Aim: To evaluate the effectiveness of prioritised ERIC strategies for improving MAT uptake across healthcare sites.

Method: The proposed design would employ three phases: an initial strategy refinement phase, followed by pilot testing and a stepped-wedge cluster randomised evaluation.

Phase One: Strategy Refinement

The initial phase would employ a participatory approach, such as the Delphi method, to engage multiple stakeholders including HCPs, managers, policymakers, patients and families in identifying and prioritising the most relevant ERIC strategies for enhancing MAT provision. This approach would ensure that the resulting implementation package reflects stakeholder needs. This process would narrow down the 49 ERIC strategies through stakeholder engagement, ensuring that the most relevant and impactful strategies are prioritised. For example, strategies such as 'activating local champions,' 'conducting educational meetings,' and 'providing

educational materials' may be prioritised as they are supported by consensus and have demonstrated empirical evidence (Powell *et al.*, 2019).

Phase Two: Pilot Testing

The second phase would include a single-site feasibility study at one healthcare facility to test the prioritised ERIC strategies. This focused pilot study would assess implementation challenges, strategy acceptability and potential effectiveness before expanding to multiple sites. The findings would inform refinements to the strategies and guide the design of the larger evaluation study.

Phase Three: Implementation and Evaluation

Following successful pilot testing, the third phase would involve a larger-scale evaluation using a stepped-wedge cluster randomised design across different healthcare facilities (Hemming *et al.*, 2018). This design would allow for systematic introduction and monitoring of the refined strategies through multiple data collection methods, including surveys, observational assessments and interviews. This methodological approach would provide evidence regarding the effectiveness of ERIC strategies in improving MAT provision within healthcare settings.

6.6 Contributions

6.6.1 This thesis provides context-specific insights into MAT provision barriers in Saudi Arabia

This thesis makes several contributions to the fields of MAT provision and implementation science. The research contributes comprehensive context-specific evidence about barriers to MAT provision within Saudi Arabia's healthcare system, offering valuable new knowledge about MAT provision in a non-Western context. Through a synthesis of theories, models and frameworks related to MAT access, this study developed an integrated model that offers a unique framework for understanding MAT provision.

6.6.2 Applying CFIR enhances understanding of challenges in MAT provision

A key theoretical contribution of this study is its novel application of the CFIR to understand barriers in MAT provision, which demonstrates that implementation science frameworks can effectively inform AT research. While the CFIR has proven valuable in healthcare settings (Kirk

et al., 2016; Damschroder *et al.*, 2022a), its application to MAT provision offers new insights into unique implementation challenges. Building upon successful adaptations to school mental health programmes (Lyon and Bruns, 2019) and telehealth services (Rangachari, Mushiana and Herbert, 2022), the research demonstrates the CFIR's adaptability to new contexts. The framework's application highlighted distinctive characteristics of MAT provision that set it apart from traditional healthcare interventions. While these typically focus on direct health outcomes (e.g., medication, surgery or rehabilitation), MAT provision involves integrating physical devices into users' daily lives. The application of the CFIR illuminated how MAT provision faces unique challenges where device-related barriers (standardisation challenges and high costs) interact with systemic barriers (unclear regulations and leadership engagement). These challenges are further complicated by the interconnection between personal factors (individual preferences and sociocultural background) and resource constraints (funding, space and professionals). This understanding bridges the gap between implementation science and AT research by showing how these multiple barrier categories uniquely affect MAT provision. The CFIR-ERIC matching tool extends this contribution by offering evidence-based strategies to address identified barriers. This application in a non-Western healthcare context demonstrates the framework's global adaptability for AT implementation.

6.6.3 A rigorous methodological approach generates practical recommendations for policy and practice in Saudi Arabia

Methodologically, this thesis provides contributions through its robust triangulation approach combining data from multiple sources, including a scoping review, surveys, qualitative interviews and document analysis. This methodological rigour enhances the credibility and comprehensiveness of the findings on MAT provision barriers. The research also makes practical contributions through its comprehensive presentation of barriers to MAT provision and proposed strategies to inform healthcare policy in Saudi Arabia. The recommendations have the potential to influence future policies on MAT provision and disability support, providing an evidence-based foundation for policymakers to improve the QOL of people with disabilities in Saudi Arabia.

6.7 Conclusion

6.7.1 This thesis provides the first comprehensive investigation of barriers influencing MAT provision in Saudi Arabia and identifies targeted implementation strategies for improvement

This thesis provides the first comprehensive investigation of factors influencing MAT provision in Saudi Arabia. Through systematic analysis, the research identifies six key categories of barriers: healthcare system and policy barriers, procurement and delivery challenges, MAT device-related barriers, information and awareness barriers, resource and infrastructure barriers and personal and environmental barriers. The mapping of these barriers using the CFIR-ERIC matching tool identified targeted implementation strategies, with the highest endorsement for identifying and preparing champions, conducting educational meetings, assessing readiness, identifying barriers and facilitators, and conducting local consensus discussions.

6.7.2 Addressing the complex challenges in MAT provision requires empirical evaluation of strategies to enhance MAT provision in the Saudi healthcare context

These strategies provide a foundation for enhancing MAT provision in Saudi Arabia's healthcare system. Future research should prioritise empirical evaluation of these implementation strategies to assess their effectiveness in improving MAT provision within the Saudi healthcare context. The evaluation of these strategies through empirical research will be crucial for developing evidence-based approaches to MAT provision that are specifically tailored to the Saudi healthcare environment.

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Appendices

Appendix 1. Systematic search conducted in MEDLINE, EMBASE, CINAHL, SCOPUS

Database(s): **Ovid MEDLINE(R)** Search Strategy:

#	Query	Results from 29 Apr 2024
1	(Access* adj10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)).ab,ti.	66,790
2	(Provision* adj10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)).ab,ti.	8,055
3	(Provide* adj10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)).ab,ti.	106,675
4	(Adoption* adj10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)).ab,ti.	7,844
5	Wheelchairs/	5,537
6	Orthotic Devices/	7,015
7	Exoskeleton Device/	1,640
8	Mobility device*.ab,ti.	545
9	Mobility technolog*.ab,ti.	55
10	Wheelchair*.ab,ti.	8,976
11	Scooter*.ab,ti.	865
12	Walker*.ab,ti.	15,558
13	Prosthetic*.ab,ti.	64,965
14	prosthesis/	50,410
15	orthotic*.ab,ti.	3,776
16	Self-Help Devices/	5,878
17	Exoskeleton*.ab,ti.	4,856
18	Orthos*.ab,ti.	26,556
19	power mobility.ab,ti.	135
20	Prosthe* device*.ab,ti.	2,437
21	(Assistive technolog* adj10 mobility).ab,ti.	137
22	(Assistive device* adj10 mobility).ab,ti.	217
23	assistive product*.ab,ti.	114
24	mobility product*.ab,ti.	24
25	Disabled Persons/	48,730
26	Mobility Limitation/	5,333
27	Elder*.ti,ab.	312,960
28	Physical* Disable*.ab,ti.	951
29	Disable*.ab,ti.	29,789
30	Disabilit*.ab,ti.	253,216
31	Walking difficult*.ab,ti.	697
32	Handicap*.ab,ti.	26,114
33	physical* impair*.ab,ti.	3,224
34	physical* Challeng*.ab,ti.	714
35	Ambulat* Difficult*.ab,ti.	90
36	Mobility difficult*.ab,ti.	255
37	Mobility impair*.ab,ti.	1,413
38	Mobility limit*.ab,ti.	1,503

39	Amput*.ab,ti.	54,578
40	Motor difficult*.ab,ti.	553
41	Amputation/	24,235
42	Geriatrics/	31,638
43	(theor* or framework* or model* or taxonom* or classifi* or concept*).ab,ti.	5,908,724
44	(Matching Person and Technology).ab,ti.	22
45	((("abandonment" or "discontinuance") and "model").ab,ti.	665
46	("SETT " or "Student Environment Tasks Tools").ab,ti.	92
47	("WATI" or "Wisconsin Assistive Technology Initiative").ab,ti.	21
48	("ATOMS" or "Assistive Technology Outcomes Measurement System").ab,ti.	113,166
49	1 or 2 or 3 or 4	181,073
50	25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42	703,079
51	5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24	179,179
52	43 or 44 or 45 or 46 or 47 or 48	5,978,819
53	49 and 50 and 51 and 52	129
54	limit 53 to english language	123
55	limit 54 to dt=20000101-20240320	121
56	limit 55 to dt=20230615-20240320	7
57	45 or 46 or 47 or 48	113,944
58	49 and 50 and 51 and 57	1

Database(s): **Ovid Embase** Search Strategy:

#	Query	Results from 29 Apr 2024
1	(Access* adj10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)).ab,ti.	90,641
2	(Provision* adj10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)).ab,ti.	10,610
3	(Provide* adj10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)).ab,ti.	133,811
4	(Adoption* adj10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)).ab,ti.	9,176
5	Wheelchairs/	11,508
6	Orthotic Devices/	7,508
7	Exoskeleton Device/	1,477
8	Mobility device*.ab,ti.	661
9	Mobility technolog*.ab,ti.	63
10	Wheelchair*.ab,ti.	13,489
11	Scooter*.ab,ti.	1,053
12	Walker*.ab,ti.	18,160
13	Prosthetic*.ab,ti.	77,740
14	prosthesis/	34,227
15	orthotic*.ab,ti.	5,449
16	Self-Help Devices/	3,100
17	Exoskeleton*.ab,ti.	5,373
18	Orthos*.ab,ti.	36,813
19	power mobility.ab,ti.	165
20	Prosthe* device*.ab,ti.	2,852
21	(Assistive technolog* adj10 mobility).ab,ti.	170
22	(Assistive device* adj10 mobility).ab,ti.	311
23	assistive product*.ab,ti.	123
24	mobility product*.ab,ti.	24
25	Disabled Persons/	31,998
26	Mobility Limitation/	15,084
27	Elder*.ti,ab.	443,632
28	Physical* Disable*.ab,ti.	1,219
29	Disable*.ab,ti.	38,656
30	Disabilit*.ab,ti.	357,400
31	Walking difficult*.ab,ti.	1,272
32	Handicap*.ab,ti.	31,880
33	physical* impair*.ab,ti.	4,567
34	physical* Challeng*.ab,ti.	982
35	Ambulat* Difficult*.ab,ti.	136
36	Mobility difficult*.ab,ti.	350
37	Mobility impair*.ab,ti.	1,873
38	Mobility limit*.ab,ti.	1,986
39	Amput*.ab,ti.	68,468
40	Motor difficult*.ab,ti.	767
41	Amputation/	27,148

42	Geriatrics/	34,606
43	(theor* or framework* or model* or taxonom* or classifi* or concept*).ab,ti.	7,279,458
44	(Matching Person and Technology).ab,ti.	32
45	((("abandonment" or "discontinuance") and "model").ab,ti.	827
46	("SETT " or "Student Environment Tasks Tools").ab,ti.	156
47	("WATI" or "Wisconsin Assistive Technology Initiative").ab,ti.	45
48	("ATOMS" or "Assistive Technology Outcomes Measurement System").ab,ti.	80,470
49	1 or 2 or 3 or 4	233,091
50	25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42	958,285
51	5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24	189,829
52	43 or 44 or 45 or 46 or 47 or 48	7,328,459
53	49 and 50 and 51 and 52	143
54	limit 53 to english language	140
55	limit 54 to dc=20000101-20240320	138
56	limit 55 to dc=20230615-20240320	10
57	45 or 46 or 47 or 48	81,498
58	49 and 50 and 51 and 57	0

Database(s): **EBSCO CINAHL** Search Strategy:

#	Query	Results from 29 Apr 2024
S58	S49 AND S50 AND S51 AND S57	0
S57	S45 OR S46 OR S47 OR S48	587
S56	(S54 AND EM 20230620-20240320) AND (S45 OR S46 OR S47 OR S48)	0
S55	S54 AND EM 20230620-20240320	4
S54	S53 AND EM 20000101-20240320	83
S53	(S43 OR S44 OR S45 OR S46 OR S47 OR S48) AND (S49 AND S50 AND S51 AND S52) Limiters - Language: English	87
S52	S43 OR S44 OR S45 OR S46 OR S47 OR S48	1,068,868
S51	S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42	295,657
S50	S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24	42,403
S49	S1 OR S2 OR S3 OR S4	73,674
S48	(TI " ATOMS " OR AB " ATOMS " OR TI " Assistive Technology Outcomes Measurement System" OR AB " Assistive Technology Outcomes Measurement System")	325
S47	(TI " WATI " OR AB " WATI " OR TI " Wisconsin Assistive Technology Initiative" OR AB " Wisconsin Assistive Technology Initiative")	13
S46	(TI "SETT" OR AB "SETT" OR TI "Student Environment Tasks Tools" OR AB "Student Environment Tasks Tools")	42
S45	TI (("abandonment" or "discontinuance") and "model") OR AB (("abandonment" or "discontinuance") and "model")	207
S44	TI "Matching Person and Technology" OR AB "Matching Person and Technology"	23
S43	TI (theor* OR framework* OR model* OR taxonom* OR classifi* OR concept*) OR AB (theor* OR framework* OR model* OR taxonom* OR classifi* OR concept*)	1,068,584
S42	(MH "Geriatrics")	6,059
S41	(MH "Amputation")	7,629
S40	TI "Motor difficult*" OR AB "Motor difficult*"	246
S39	TI Amput* OR AB Amput*	15,087
S38	TI "Mobility limit*" OR AB "Mobility limit*"	973
S37	TI "Mobility impair*" OR AB "Mobility impair*"	802
S36	TI "Mobility difficult*" OR AB "Mobility difficult*"	162
S35	TI "Ambulat* Difficult*" OR AB "Ambulat* Difficult*"	25
S34	TI "physical* Challeng*" OR AB "physical* Challeng*"	389
S33	TI "physical* impair*" OR AB "physical* impair*"	1,734
S32	TI Handicap* OR AB Handicap*	6,460
S31	TI "Walking difficult*" OR AB "Walking difficult*"	238
S30	TI Disabilit* OR AB Disabilit*	128,095
S29	TI Disable* OR AB Disable*	12,965
S28	TI "Physical* Disable*" OR AB "Physical* Disable*"	711
S27	TI Elder* OR AB Elder*	114,587
S26	(MH "Physical Mobility")	7,823

S25	(MH "Persons with Disabilities")	37,595
S24	TI "mobility product*" OR AB "mobility product"	6
S23	TI "assistive product*" OR AB "assistive product"	69
S22	TI ("Assistive device*" n10 mobility) OR AB ("Assistive device*" n10 mobility)	157
S21	TI ("Assistive technolog*" n10 mobility) OR AB ("Assistive technolog*" n10 mobility)	131
S20	TI "Prosthet* device*" OR AB "Prosthet* device"	406
S19	TI "power mobility" OR AB "power mobility"	136
S18	TI Orthose* OR AB Orthose*	2,498
S17	TI Exoskeleton* OR AB Exoskeleton*	813
S16	(MH "Assistive Technology Devices")	6,771
S15	TI orthotic* OR AB orthotic*	2,702
S14	(MH "Limb Prosthesis")	3,007
S13	TI Prosthetic* OR AB Prosthetic*	12,814
S12	TI Walker* OR AB Walker*	3,878
S11	TI Scooter* OR AB Scooter*	453
S10	TI Wheelchair* OR AB Wheelchair*	5,824
S9	TI "Mobility technolog*" OR AB "Mobility technolog"	40
S8	TI ("Mobility device*") OR AB ("Mobility device*")	428
S7	(MH "Exoskeleton Devices")	347
S6	(MH "Orthoses")	7,176
S5	(MH "Wheelchairs")	5,140
S4	TI ((Adoption* n10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*))) OR AB ((Adoption* n10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)))	3,272
S3	TI (Provide* n10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*))) OR AB (Provide* n10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)))	40,826
S2	TI ((Provision* n10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*))) OR AB ((Provision* n10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)))	5,221
S1	TI ((Access* n10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*))) OR AB ((Access* n10 (barrier* or challeng* or restrict* or obstacle* or impediment* or difficult* or issue*)))	29,525

Database(s): Scopus Search Strategy:

(((TITLE-ABS (access* W/10 (barrier* OR challeng* OR restrict* OR obstacle* OR impediment* OR difficult* OR issue*)))) OR ((TITLE-ABS (provision* W/10 (barrier* OR challeng* OR restrict* OR obstacle* OR impediment* OR difficult* OR issue*)))) OR ((TITLE-ABS (provide* W/10 (barrier* OR challeng* OR restrict* OR obstacle* OR impediment* OR difficult* OR issue*)))) OR ((TITLE-ABS (adoption* W/10 (barrier* OR challeng* OR restrict* OR obstacle* OR impediment* OR difficult* OR issue*))))) AND (TITLE-ABS ("Disabled Person*" OR "Mobility* Limitation*" OR elder* OR "Physically Disabled" OR disable* OR disabilit* OR "Walking difficult*" OR handicap* OR "physically impair*" OR "Physically Challeng*" OR "Ambulat* difficult*" OR "Mobility difficult*" OR "Mobility impair*" OR "Mobility limit*" OR "Amput*" OR "Motor difficult*" OR amputation*)) AND (TITLE-ABS (theor* OR framework* OR model* OR taxonom* OR classifi* OR concept* OR "Matching Person and Technology" OR (abandonment OR discontinuance AND model))) AND (TITLE-ABS (wheelchair* OR "power mobility*" OR "Mobility device*" OR "Mobility technolog*" OR ("Assistive technolog*" W/10 mobility) OR ("Assistive device*" W/10 mobility) OR orthotic* OR exoskeleton* OR scooter* OR walker* OR prosthet* OR orthos* OR prosthetic* OR "Prosthe* device*" OR orthotic* OR "mobility product*" OR "assistive product*")) AND PUBYEAR > 1999 AND PUBYEAR < 2025 AND (LIMIT-TO (LANGUAGE , "English"))) 173 documents

(((TITLE-ABS (access* W/10 (barrier* OR challeng* OR restrict* OR obstacle* OR impediment* OR difficult* OR issue*)))) OR ((TITLE-ABS (provision* W/10 (barrier* OR challeng* OR restrict* OR obstacle* OR impediment* OR difficult* OR issue*)))) OR ((TITLE-ABS (provide* W/10 (barrier* OR challeng* OR restrict* OR obstacle* OR impediment* OR difficult* OR issue*)))) OR ((TITLE-ABS (adoption* W/10 (barrier* OR challeng* OR restrict* OR obstacle* OR impediment* OR difficult* OR issue*))))) AND (TITLE-ABS ("Disabled Person*" OR "Mobility* Limitation*" OR elder* OR "Physically Disabled" OR disable* OR disabilit* OR "Walking difficult*" OR handicap* OR "physically impair*" OR "Physically Challeng*" OR "Ambulat* difficult*" OR "Mobility difficult*" OR "Mobility impair*" OR "Mobility limit*" OR "Amput*" OR "Motor difficult*" OR amputation*)) AND (TITLE-ABS ("sett" OR "student environment tasks tools" OR "wati" OR "Wisconsin assistive technology initiative" OR "atoms" OR "assistive technology outcomes measurement system" OR ("abandonment" OR "discontinuance" AND "model")))) AND (TITLE-ABS (wheelchair* OR "power mobility*" OR "Mobility device*" OR "Mobility technolog*" OR ("Assistive technolog*" W/10 mobility) OR ("Assistive device*" W/10 mobility) OR orthotic* OR exoskeleton* OR scooter* OR walker* OR prosthet* OR orthos* OR prosthetic* OR "Prosthe* device*" OR orthotic* OR "mobility product*" OR "assistive product*")) AND PUBYEAR > 1999 AND PUBYEAR < 2025 AND (LIMIT-TO (LANGUAGE , "English")))

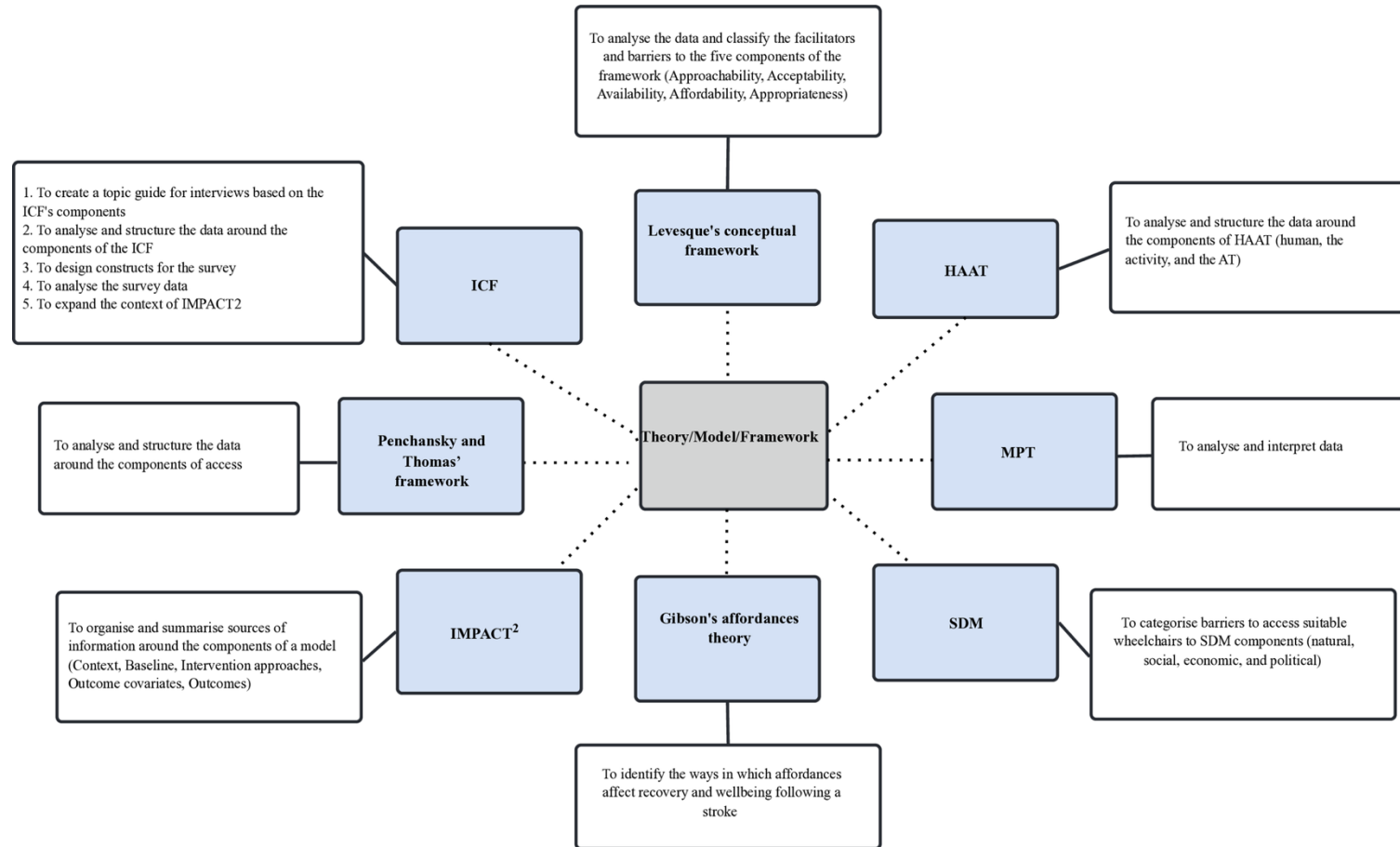
Appendix 2. Characteristics of included papers

Authors and Year	Study design	Aims of the study	Population (n, characteristics)	Country
McIntyre, Cleland and Ramklass (2021)	Qualitative, Semi-structured interviews	To explore facilitators and barriers to accessible wheelchair services	11(8 occupational therapists and 3 physiotherapists)	South Africa
Dorjbal et al. (2020)	Qualitative, Semi-structured interviews	To identify environmental barriers and their influence on daily life	16(SCI patients)	Mongolia
Jindal et al. (2018)	Qualitative, Semi-structured interviews	To investigate parents' perceptions of rehabilitation and their information needs for their child with cerebral palsy (CP)	18 (parents of children with CP)	India and Canada
Bhidayasiri et al. (2022)	Review article	To present clinical viewpoints on the unfulfilled needs of wearable technology, such as exoskeletons and orthoses	N/A	N/A
Layton (2012)	Mixed method	To identify barriers and facilitators to optimal mobility from the perspective of AT users	100 (AT users. Neurological conditions)	Australia, Survey, Open-ended responses
Mairami et al. (2017)	Qualitative, case study, Semi-structured interview	1. To illustrate how AT influences stroke recovery and how the environment might be altered to facilitate recovery 2. To examine the issues of AT affordability and accessibility	1(Stroke patient)	Malaysia

Dwyer and Mulligan (2015)	Literature review	To determine the obstacles and enablers for community reintegration as experienced by individuals with SCI	A total of 373 participants in the 7 included studies	New Zealand
Seymour, Geiger and Scheffler (2019)	Qualitative, Focus group	To identify the issues associated with wheelchair provision and the elements that contribute to or mitigate these challenges	21 (Community rehabilitation workers)	Uganda
Gonçalves Junior, Knabben and Luz (2017)	Qualitative, Semi-structured interviews	To demonstrate how people with lower limb amputation function and express their limitations	6 (patients with amputation)	Brazil
Arthanat, Elsaesser and Bauer (2017)	Quantitative, Survey	To explore how AT providers perceive their education and training, the use of evidence and guidelines, financing policies.	318 (AT providers)	US
Gowran et al. (2021)	Position Paper	To examine the global challenges related to wheelchair accessibility	N/A	N/A
Steel and Layton (2016)	Feature Article	An exploration of the complexities of AT provision in Australia	N/A	Australia
Widehammar et al. (2020)	Qualitative, Semi-structured interviews	An exploration of how users' experiences of power mobility products are influenced by environmental factors	14(AT users)	Sweden
Hammel et al. (2013)	Qualitative, multiple case study, Focus groups	Multiple stakeholders' perspectives, issues, and priorities related to accessing, using, and evaluating MATs	65(45 AT users, 10 caregivers, 10 service providers)	USA and Canada
Serres-Lafontaine et al. (2023)	Qualitative, photovoice method	To study how peer training affects social involvement	10 Wheelchair users (SCI patients)	Tanzania

Oskar et al. (2011)	A postal questionnaire	To explore and assess the experiences of active wheelchair prescribers under the regulations and provisions set by local Swedish governments	278 prescribers	Sweden
Smith et al. (2016)	Review article	To investigate the determinants influencing participation among wheelchair users	35 studies were included	N/A
Nabizadeh et al., (2023)	Qualitative, Semi-structured interviews	To explore barriers and facilitators to prosthetic services for lower limb amputees	29 individuals with lower limb amputation	Iran

Appendix 3. TMFs used in the included studies



Appendix 4. Propositions identified in the theories, models and frameworks

Name of the theory, model or framework	Propositions
International Classification of Functioning, Disability, and Health (ICF)	1. A health condition can affect both the mental and physical body functions. 2. An individual's activities are impacted by their health condition. 3. Health conditions affect an individual's engagement in activities, determining their level of participation. 4. External factors, for example, social factors, can either inhibit or facilitate an individual's level of functioning. 5. Society may create barriers, for example, inaccessible services or lack of facilitators, such as the unavailability of AT, which can affect an individual's performance. 6. An individual's functioning is affected by the presence or absence of services, for example, equipment, products, and technologies in their environment. 7. External elements like systems and policies that regulate and facilitate the provision of services can impact a person's functional capacity.

	8. An individual's level of functioning can also be influenced by external factors such as support and relationships, including family, people in positions of authority, and health professionals. 9. Personal factors of an individual represent their internal aspects, including psychological factors, that can affect their level of functioning. 10. Individuals' functioning and disabilities are influenced by their health status as well as contextual factors, such as environmental and personal factors. 11. Functioning is defined as encompassing body functions, body structures, activities, and participation. 12. An impairment, an activity limitation, or a restriction on participation constitutes a disability.
Levesque's conceptual framework	1. The concept of approachability is related to the ability of individuals with health needs to recognise the existence of available services, access them, and receive effective healthcare that can improve their health.

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2. Cultural and social factors determine the acceptability of health services within their context.
 3. The reachability of health services depends on their physical presence and timeliness.
 4. Factors like personal mobility, transportation availability, adaptability in occupation, and knowledge of accessible health services are interconnected and contribute to an individual's capacity to access healthcare providers physically.
 5. The concept of affordability in healthcare refers to the ability of people to pay for services without causing undue financial hardship or affecting their ability to afford basic necessities.
 6. The ability to afford healthcare services is connected to a person's financial resources, including income, savings, and borrowing capacity.
 7. Appropriateness in healthcare refers to the fit between the services provided and the needs and preferences of clients, as well as the quality and safety of those services.
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	8. Engaging in healthcare involves the active participation of clients in decision-making and treatment planning, which helps to ensure that care is aligned with their goals and values. 9. Accessibility of health services is affected by the availability of information. 10. Personal autonomy and the ability to choose care-seeking are linked to the ability to access health care.
The Human Activity Assistive Technology model (HAAT)	1. AT enhances an individual's capabilities to complete desired tasks. 2. Human activities are essential, learnable, and influenced by societal and cultural contexts. 3. The use of desired technology is influenced by human skills and abilities (physical, cognitive, emotional). 4. An individual's ability to perform activities is affected by their skills and abilities (physical, cognitive, emotional). 5. The use of AT to perform an activity is influenced by various factors in the environment, including physical, social, cultural, and institutional elements.

	6. Choosing and implementing the right AT requires considering the interaction between different elements, including the activity being performed, the user's needs and abilities, and the broader environmental context in which the technology will be used. 7. The process of performing an activity leads to a functional result of human performance.
Gibson's affordances theory	1. Cognition: Affordances exist as a cognitive process which comes through people and organisations interacting with material entities. 2. Perception: Affordances need to be perceived or recognised by the person or organisation. 3. Behaviour: the affordance is actualised as the behaviour that people/organisations adopt acting on the perceived opportunity for action. 4. Evaluation: Evaluating the effects of this behaviour. 5. Environmental factors and structures can impact disabilities.

Systemic development model (SDM)	1. Understanding personal, organisational, and institutional capacity requires consideration of factors such as health, culture, economics, and politics. 2. It is crucial to provide appropriate services to improve the health, well-being, and fundamental freedoms of individuals in need. 3. Limited access to services can create a cycle of poverty and disability. 4. Service delivery systems that are tailored to specific contexts play a significant role in ensuring appropriate service provision. 5. Economic factors impact the availability of products and services and can affect the viability of service provision. 6. Evaluation of the quality, development, performance, and procurement standards of products is crucial for improving service delivery systems and individual health outcomes. 7. Political governance also plays a role in ensuring access to appropriate services.
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Multi Intervention Paradigm for Assessment and Application of Concurrent Treatments (IMPACT ²)	1. The results of interventions can be outlined by examining the six phases, including: 1) Pre-Intervention, 2) Context, 3) Baseline, 4) Intervention Strategies, 5) Outcome Covariates, and 6) Outcomes. 2. Personal and contextual factors influence the products and services used by individuals to perform activities. 3. Universal design and health promotion are two methods that can be utilised to enhance functional performance. 4. The context in which AT is used to perform a task within an environment is crucial for improving participation and QoL. 5. Intervention approaches, such as reducing the impairment, compensating for the impairment, using AT, and redesigning the activity, are used to support the use of AT and optimise an individual's functioning. 6. Consumer satisfaction is a desirable outcome of AT provision. 7. Outcome(function) is defined as participation, QoL, and engagement.
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	8. Cost influences the Intervention approaches therefore affecting Outcomes.
Matching Person and Technology (MPT)	1. AT serves as a bridge between individual capabilities and the demands of tasks within their environment. 2. Personal autonomy and the performance of everyday activities are enhanced by integrating technology that matches individual needs. 3. The compatibility of assistive products with the user's lifestyle is crucial for successful adoption and satisfaction. 4. The user's physical, cognitive, and emotional dimensions must be considered to optimise the functionality of AT. 5. AT should empower individuals, promoting independence and self-efficacy in their desired roles and activities. 6. The design and functionality of assistive technology must reflect the user's self-image and socio-cultural identity to foster acceptance. 7. AT should assist and elevate the user's ability to engage in social roles and activities with confidence and ease.

	8. The choice of AT is personal, influenced by individual preferences, aspirations, and the context of their lives. 9. Effective AT integrates into the user's environment, enhancing their capabilities without introducing new barriers. 10. The success of an assistive product is measured not only by its technical features but also by its ability to align with the user's psychosocial context and enhance their QoL.
Penchansky and Thomas' framework of access	1. Access is defined by the degree to which healthcare systems are equipped to meet the requirements of patients 2. Affordability assesses whether the costs imposed by the provider align with the client's financial capacity and willingness to pay for the services offered. 3. Availability refers to the provider's capacity to meet the client's needs through adequate resources, including staff and technology.

-
4. Accessibility concerns the ease with which clients can physically reach the provider's location.
 5. Accommodation evaluates the extent to which the provider's operational procedures, such as hours of operation and telephone communication, are convenient for the client.
 6. Acceptability pertains to the degree of comfort the client experiences with the provider's fixed characteristics and encompasses considerations of the client's health condition and type of health coverage.
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Appendix 5. Gaps analysis

Gaps	Recommendations for future research
Remote Regions and Accessibility	Key areas for future investigation included examining access to AT in remote regions by investigating challenges and barriers faced in remote regions, and explore the differences between men and women in accessing services, and concentrating on modifiable elements like wheelchair skills and ease of access
Stakeholder Perspectives	The included papers in this review draw attention to several issues, such as investigating policymakers' and HCPs' views on rehabilitation services. Understanding the challenges faced by people with disabilities. This includes understanding stakeholder perspectives on the various aspects of access by identifying the enablers and barriers that might aid in planning to increase access to AT services.
Funding, Policy, and Legislation	Future research should investigate funding and policy-related barriers, the impact of legislation on accessibility and participation for powered mobility product users, fostering low-cost approaches in low- and middle-income countries, and promoting inclusive solutions for wheelchair service provision.
Data Collection and methodological improvements	Adoption of standardised instruments to assess functioning and disability is needed. Comparing perceptions users with and without AT. Exploration of user satisfaction, choice, and control in relation to MATs and its impact on

	overall outcomes. Development of standards for testing AT effectiveness. Additionally, research could explore the long-term effects of delayed services on individuals with disabilities.
Contextual Understanding and service evaluation	Importance of investigating in-country perspectives consideration of personal, social, economic, environmental, historical, and political factors. Incorporating subjective measures in service evaluations. Assessing the effects of new products on work environments and identifying the annually prescribed types of AT are essential undertakings.

Appendix 6. Survey Instrument

Start of Block: Consent

I would greatly appreciate your taking the time to complete the following short and anonymous questionnaire. The form should not take more than five minutes to complete. Only me, Asma Aldawood, PhD Student at the University of Sheffield and my supervisors will have access to the information you provide. Your participation in the study is completely voluntary, and you may withdraw at any time. Nobody will be able to identify you from any of the information you provide. Your participation in the study will be important in determining the barriers to the provision of mobility assistive technologies (MATs) and associated services in Saudi Arabia as well as making recommendations on how to overcome these barriers.

Q1 Informed Consent

- ☐ I confirm that I have read and understood the participant information provided in the email asking me to participate in the survey. (1)
- ☐ I understand that neither my name nor other identifying information will be requested unless I agree to take part in further research and if I do consent to further research. (2)
- ☐ I understand my name and other details will be kept strictly confidential. (3)
- ☐ I understand that my responses to this online survey will be kept strictly confidential. (4)
- ☐ I give permission for the researcher to have access to my responses on an anonymous basis only. (5)
- ☐ I understand that I will be asked by the researcher if I will be willing for her to contact me to take part in an interview. (6)
- ☐ I agree to take part in this survey. (7)

End of Block: Consent

Start of Block: Background information

Q2 Where are you employed? (Hospital names have been redacted to maintain confidentiality)

☐ Hospital A (1)

☐ Hospital B (2)

☐ Hospital C (5)

☐ Other please specify (6) _____

Page Break

Q3 What is your gender?

☐ Male (1)

☐ Female (2)

Page Break

Q4 What is your age?

☐ 21-30 (1)

☐ 31-40 (2)

☐ 41-50 (3)

☐ 51-60 (4)

Page Break

Q5 What is your educational level?

- ☐ Diploma (1)
- ☐ Bachelor (2)
- ☐ Master (3)
- ☐ PhD (4)
- ☐ Other (5) _____

Page Break

Q6 What are your working experiences(years)?

- ☐ <5 (1)
- ☐ 5-10 (2)
- ☐ 11-20 (3)
- ☐ >20 (4)

Page Break

Q7 What is your position?

- ☐ Healthcare professional (1)
- ☐ Manager please specify (2) _____
- ☐ Decision-maker please specify (3) _____
- ☐ Other, please specify (4) _____

End of Block: Background information

Start of Block: Healthcare professional

Display this question:

If What is your position? = Healthcare professional

Q7.1 What is your profession?

- ☐ Occupational therapist (1)
- ☐ Physical therapist (2)
- ☐ AT specialist (3)
- ☐ Other, please specify (4) _____
-

Page Break

Display this question:

If What is your position? = Healthcare professional

Q7.2 What is your speciality?

- ☐ Pediatrics (1)
- ☐ Geriatrics (2)
- ☐ Cardiovascular and pulmonary (3)
- ☐ Neurology (4)
- ☐ Orthopedics (5)
- ☐ Other, please specify (6) _____
-

Page Break

Q8 Please indicate which of the following mobility devices are unavailable or inaccessible to your patients in your hospital. Yes: available, No: not available.

	Yes (1)	No (2)	I don't know (3)
Manual Wheelchair, Lightweight	☐	☐	☐
Manual Power-Assist Wheelchair	☐	☐	☐
Wheelchairs, Electrically Powered	☐	☐	☐
Wheelchairs, Manual With Postural Support	☐	☐	☐
Reclining Power Wheelchair	☐	☐	☐
Mobility Scooter	☐	☐	☐
Lower limb Prosthesis (Microprocessor-controlled)	☐	☐	☐
Ankle-Foot Orthoses (AFO)	☐	☐	☐
Carbon Fibre Ankle Foot Orthosis	☐	☐	☐
The 3D Printed Ankle-Foot Orthoses (AFO)	☐	☐	☐
Lower Limb Prostheses	☐	☐	☐
Wearable Powered Exoskeleton	☐	☐	☐
Canes/sticks, tripod and quadripod	☐	☐	☐
Crutches, axillary/elbow	☐	☐	☐
Walking frames/walkers	☐	☐	☐
Other, please specify	☐	☐	☐

Page Break

End of Block: Healthcare professional

Start of Block: interview

Q11 Do you agree to be contacted by me for an interview? I expect the interview to last no more than 60 minutes.

- ☐ Yes, I am willing to be contacted for an interview. (1)
- ☐ No, I am not willing to be contacted. (2)

Skip To: End of Block If Do you agree to be contacted by me for an interview? I expect the interview to last no more than... = No, I am not willing to be contacted.

Page Break

Display this question:

If Do you agree to be contacted by me for an interview? I expect the interview to last no more than... = Yes, I am willing to be contacted for an interview.

Q11.1 Thank you. Please can you provide your email address:

End of Block: interview

Start of Block: NOTIFY END

Q12 You have now completed the survey. If you would like to change any of your answers please use the backwards arrow button to navigate to the relevant question. If you click the forwards arrow button below your responses will be recorded and you will not be able to go back and make changes. Please click the forwards arrow button below to confirm that you are happy for your responses to be recorded.

End of Block: NOTIFY END

Confidential Appendix 7. Ethical Approvals

(A)

(B)

(C)

Appendix 8. Comparison of MATs availability across hospitals

Type of MATs		Total	Hospital A (Central region)	Hospital B (Central region)	Hospital C (Eastern region)
Lightweight Manual Wheelchair	Available	57.0	16.0	24.0	17.0
		85.1%	84.2%	96.0%	73.9%
	Not Available	7.0	0.0	1.0	6.0
		10.4%	0.0%	4.0%	26.1%
	Unaware	3.0	3.0	0.0	0.0
		4.5%	15.8%	0.0%	0.0%
Power-Assist Manual Wheelchair	Available	5.0	0.0	4.0	1.0
		7.5%	0.0%	16.0%	4.3%
	Not Available	40.0	11.0	13.0	16.0
		59.7%	57.9%	52.0%	69.6%
	Unaware	22.0	8.0	8.0	6.0
		32.8%	42.1%	32.0%	26.1%
Electrically Powered Basic Wheelchair	Available	41.0	15.0	23.0	3.0
		61.2%	78.9%	92.0%	13.0%
	Not Available	21.0	1.0	2.0	18.0
		31.3%	5.3%	8.0%	78.3%
	Unaware	5.0	3.0	0.0	2.0
		7.5%	15.8%	0.0%	8.7%
Manual Wheelchair with Postural Support	Available	17.0	8.0	8.0	1.0
		25.4%	42.1%	32.0%	4.3%
	Not Available	38.0	6.0	13.0	19.0
		56.7%	31.6%	52.0%	82.6%
	Unaware	12.0	5.0	4.0	3.0
		17.9%	26.3%	16.0%	13.0%
Reclining Power Wheelchair	Available	21.0	7.0	12.0	2.0
		31.3%	36.8%	48.0%	8.7%
	Not Available	35.0	7.0	12.0	16.0
		52.2%	36.8%	48.0%	69.6%
	Unaware	11.0	5.0	1.0	5.0
		16.4%	26.3%	4.0%	21.7%
Mobility Scooter	Available	1.0	0.0	1.0	0.0
		1.5%	0.0%	4.0%	0.0%
	Not Available	55.0	13.0	21.0	21.0
		82.1%	68.4%	84.0%	91.3%
	Unaware	11.0	6.0	3.0	2.0
		16.4%	31.6%	12.0%	8.7%

Microprocessor- Controlled Lower Limb Prosthesis	Available	9.0	4.0	4.0	1.0
		13.4%	21.1%	16.0%	4.3%
	Not Available	39.0	5.0	14.0	20.0
		58.2%	26.3%	56.0%	87.0%
	Unaware	19.0	10.0	7.0	2.0
		28.4%	52.6%	28.0%	8.7%
Ankle-Foot Orthoses	Available	58.0	15.0	24.0	19.0
		86.6%	78.9%	96.0%	82.6%
	Not Available	3.0	0.0	0.0	3.0
		4.5%	0.0%	0.0%	13.0%
	Unaware	6.0	4.0	1.0	1.0
		9.0%	21.1%	4.0%	4.3%
Carbon Fibre Ankle-Foot Orthosis	Available	30.0	13.0	12.0	5.0
		44.8%	68.4%	48.0%	21.7%
	Not Available	18.0	0.0	5.0	13.0
		26.9%	0.0%	20.0%	56.5%
	Unaware	19.0	6.0	8.0	5.0
		28.4%	31.6%	32.0%	21.7%
3D Printed Ankle-Foot Orthoses	Available	20.0	2.0	14.0	4.0
		29.9%	10.5%	56.0%	17.4%
	Not Available	26.0	6.0	6.0	14.0
		38.8%	31.6%	24.0%	60.9%
	Unaware	21.0	11.0	5.0	5.0
		31.3%	57.9%	20.0%	21.7%
Lower Limb Prosthesis, Socket	Available	39.0	16.0	20.0	3.0
		58.2%	84.2%	80.0%	13.0%
	Not Available	20.0	0.0	3.0	17.0
		29.9%	0.0%	12.0%	73.9%
	Unaware	8.0	3.0	2.0	3.0
		11.9%	15.8%	8.0%	13.0%
Wearable Powered Exoskeleton	Available	7.0	4.0	2.0	1.0
		10.4%	21.1%	8.0%	4.3%
	Not Available	38.0	7.0	13.0	18.0
		56.7%	36.8%	52.0%	78.3%
	Unaware	22.0	8.0	10.0	4.0
		32.8%	42.1%	40.0%	17.4%
Canes/Sticks, Tripod and Quadripod	Available	61.0	14.0	25.0	22.0
		91.0%	73.7%	100.0%	95.7%
	Not Available	2.0	1.0	0.0	1.0
		3.0%	5.3%	0.0%	4.3%
	Unaware	4.0	4.0	0.0	0.0
		6.0%	21.1%	0.0%	0.0%

Axillary/Elbow Crutches	Available	62.0	16.0	24.0	22.0
		92.5%	84.2%	96.0%	95.7%
	Not Available	2.0	1.0	1.0	0.0
		3.0%	5.3%	4.0%	0.0%
	Unaware	3.0	2.0	0.0	1.0
		4.5%	10.5%	0.0%	4.3%
Walking Frames/Walkers	Available	64.0	16.0	25.0	23.0
		95.5%	84.2%	100.0%	100.0%
	Not Available	1.0	1.0	0.0	0.0
		1.5%	5.3%	0.0%	0.0%
	Unaware	2.0	2.0	0.0	0.0
		3.0%	10.5%	0.0%	0.0%

Appendix 9. Interview guide

Hello, I am Asma Aldawood, a PhD student at the University of Sheffield. Today, I will be interviewing you regarding assistive technologies for mobility at your hospital. First, I would like to confirm that you have read the participant information sheet. This interview is intended to explore barriers to the provision of mobility assistive technologies. Participation in this interview is voluntary, and you have the option to withdraw at any time.

Please let me know if you do not wish to answer a specific question.

I am interested in your opinion, and there is no right or wrong answer.

The identities of all participants will remain strictly confidential, and individuals will not be identifiable from the study results.

Can we proceed with the interview now? It will take approximately 60 minutes.

This interview will be recorded to ensure that I do not miss any important points, as you are aware from the information sheet and consent form. However, I would like to emphasise that this conversation is confidential. Are you still comfortable with that?

Section 1. General Start Question

- Could you please describe your current involvement in providing mobility assistive technologies?
- You indicated in the survey that is/are unavailable or inaccessible to your patients. Would you be interested in talking to me further about these?

Section 2. CFIR Constructs

CFIR: Innovation Domain

- How robust is the evidence that [innovation name] will be effective in your setting? [Prompt: Based on your own research? Practice guidelines? Published literature? Colleagues' experiences?]
- What about the [innovation name]'s development? Who developed it? [Prompt: How are they sourced in your facility?]
- How does the [innovation name] compare to current practice? [Prompt: advantages and disadvantages?]
- How adaptable and testable is [innovation name]? [Prompt: What changes would you need to make to implement them in your setting?]
- What are your views on the complexity of [innovation name]? [Prompt: Consider clinical aspects (patient influence and acceptance) and non-clinical aspects (eligibility, funding mechanisms, service delivery)]
- How well-designed are the [innovation name] and their associated materials and resources?
- How affordable are [innovation name] purchase and operating costs?

CFIR: Inner Setting

- How essential is this [innovation name] to meet the needs of patients or hospital mission and goals?
- How would the infrastructure of your hospital facilitate/hinder the provision of the [innovation name]? [Prompt: Consider technology infrastructure, task responsibilities, social architecture, technological systems, hospital maturity, size, and physical layout]
- How do you think your hospital's culture (general beliefs, values) would affect the provision of the [innovation name]? [Prompt: Is it welcomed, encouraged, and supported?]
- To what extent does your hospital share values and norms around addressing patient and deliverer needs and using data to improve practice?
- Describe your working relationships with colleagues within and across hospital departments
- How do you typically hear about updates or information within your hospital?
- What is the priority of provision [innovation name] compared to other initiatives?
- To what extent are necessary resources available for provision? (Space, time, funding, materials, equipment)
- How would the [innovation name] fit with existing work processes and practices in your hospital?
- What kinds of training and guidance are available to support the provision?

CFIR: Outer Setting

- What attitudes exist within your hospital system and broader community toward people with disabilities, and how do these attitudes, along with economic, environmental, or political conditions, enable or hinder [innovation name]?
- To what extent does your hospital establish partnerships with other organisations? *[Prompt: Describe these connections and information sharing]*
- How does the presence of [innovation name] in other hospitals influence your setting's provision decisions?
- What external funding is needed for provision? To what extent is this funding available?
- What kinds of local, state, or national performance measures, policies, regulations, or societal pressures influence the provision?

CFIR: Process Domain

- Can you describe any current or potential plan to provide [innovation name] in your hospital?
- How are barriers and facilitators to MAT provision being identified and assessed?
- What strategies or approaches exist for improving MAT provision?
- How are patients and HCPs engaged in MAT decision-making and provision?
- What plans or methods are being considered to evaluate the success of MAT provision?

CFIR: Individual Domain

- To what extent do you have needs that could be met by the provision of [innovation name]
- To what extent do you have interpersonal competence, knowledge, and skills to fulfil your role in MAT provision? *[Survey Prompt: You mentioned being unaware of some devices. What limits your exposure or knowledge?]*
- To what extent do you have the availability, scope, and power to fulfil your role in MAT services
- To what extent are you committed to fulfilling your role in MAT provision?
- From your perspective, what are the key needs of patients that could be addressed by MAT? *[Scoping Review Prompt: Can you elaborate on patients' awareness of their own healthcare needs?]*
- To what extent do you think patients have the knowledge or skills to benefit from MAT? *[Scoping Review Prompt: How do patients currently access information about these technologies? What barriers might limit their understanding?]*
- How motivated do you believe patients are to use MAT? *[Scoping Review Prompt: What individual characteristics influence patients' motivation? How does societal acceptance impact their willingness to use these technologies?]*
- What opportunities do patients have for accessing MAT? *[Scoping Review Prompt: How do individual patient characteristics influence their healthcare utilisation?]*

Section 4. General Final Question

- Is there anything else you would like to add I didn't mention in this interview?
- Do you have any questions?
- Are there any other people you think I should interview?
- Are there any documents, reports, or resources that you think would be helpful or relevant to understanding this topic
- Would you be comfortable with receiving the summary of the interview by email in approximately ... months?

Thank you for participating in this interview.

Appendix 10. CFIR codebook guidance

The definitions for each construct and sub-construct were obtained from the CFIR website <https://cfirguide.org/>. Where additional clarification was required, the CFIR Guide, which can be found on the same website, was consulted. I added comments to define the subject for each domain in this project and specified the project-specific language. Double coding was avoided to ensure clarity. *The coding tree using the CFIR framework is presented after this table.*

I. INNOVATION DOMAIN Innovation: The “thing” being implemented, e.g., a new clinical treatment, educational program, or city service. [Document the innovation being implemented, e.g., innovation type, innovation core vs. adaptable components, using a published reporting guideline. Distinguish the innovation (the “thing” that continues when implementation is complete) from the implementation process and strategies used to implement the innovation (activities that end after implementation is complete).]		INNOVATION DOMAIN : The subject of the innovation domain for this project is MATs, which are defined as assistive products for mobility and related systems and services. These assistive products include devices, software, or instruments specifically designed or widely available to enhance an individual's functioning. They support or substitute the ability to move, facilitating movement from one location to another. Examples include wheelchairs, walking frames, rollators, and prosthetic and orthotic products.
Construct Name	Construct Definition <i>The degree to which:</i>	Comments, project-specific language
A. Innovation Source	The group that developed and/or visibly sponsored use of the innovation is reputable, credible, and/or trustable.	Include statements about the source of the assistive products for mobility and the extent to which interviewees view the degree to which group developed/sponsored device is reputable, credible, and/or trustable.
B. Innovation Evidence-Base	The innovation has robust evidence supporting its effectiveness.	Include statements regarding the degree to which assistive products for mobility has evidence supporting its effectiveness
C. Innovation Relative Advantage	The innovation is better than other available innovations or current practice.	Include statements that demonstrate the degree to which assistive products for mobility is better (or worse) than existing current practice.
D. Innovation Adaptability	The innovation can be modified, tailored, or refined to fit local context or needs.	Include statements that demonstrate the degree to which the assistive products for mobility can be modified, tailored, or refined to fit local context or needs.
E. Innovation Trialability	The innovation can be tested or piloted on a small scale and undone.	Include statements that demonstrate the degree to to which the assistive products for mobility can be tested or piloted on a small scale and undone

F. Innovation Complexity	The innovation is complicated, which may be reflected by its scope and/or the nature and number of connections and steps.	Include statements that demonstrate the degree to which the assistive products for mobility and services are complicated
G. Innovation Design	The innovation is well designed and packaged, including how it is assembled, bundled, and presented.	Include statements that demonstrate the degree to which the assistive products for mobility is well designed
H. Innovation Cost	The innovation purchase and operating costs are affordable.	Include statements that demonstrate the degree to which the assistive products for mobility purchase and operating costs are affordable. Text coded under 'cost' is distinguished from text coded under 'available resources "funding"' relating to financial need. When the text refers to the cost of device itself, it is coded under the current construct.
II. OUTER SETTING DOMAIN Outer Setting: The setting in which the Inner Setting exists, e.g., hospital system, school district, state. There may be multiple Outer Settings and/or multiple levels within the Outer Setting (e.g., community, system, state). Project Outer Setting(s): [Document the actual Outer Setting in the project, e.g., type, location, and the boundary between the Outer Setting and the Inner Setting.]		OUTER SETTING DOMAIN: The Outer Settings for this project include the hospital system, as well as the broader community that interacts with and is affected by this system. This encompasses not only the physical locations but also the sociocultural and economic environments that influence the implementation and accessibility of MATs.
Construct Name	Construct Definition <i>The degree to which:</i>	Comments, project-specific language
A. Critical Incidents	Large-scale and/or unanticipated events disrupt implementation and/or delivery of the innovation.	Include statements the degree to which unanticipated events disrupt delivery of the assistive products for mobility.
B. Local Attitudes	Sociocultural values (e.g., shared responsibility in helping recipients) and beliefs (e.g., convictions about the worthiness of recipients) encourage the Outer Setting to support implementation and/or delivery of the innovation.	Include statements the degree to which Sociocultural values encourage the Outer Setting to support delivery of the assistive products for mobility.
C. Local Conditions	Economic, environmental, political, and/or technological conditions enable the Outer Setting to support implementation and/or delivery of the innovation.	Include statements the degree to which economic, environmental, political, and/or technological conditions enable the outer setting to support delivery of the assistive products for mobility.
D. Partnerships & Connections	The Inner Setting is networked with external entities, including referral networks, academic affiliations, and professional organization networks.	Include statements the degree to which the Inner Setting is networked with external entities.

E. Policies & Laws	Legislation, regulations, professional group guidelines and recommendations, or accreditation standards support implementation and/or delivery of the innovation.	Include statements the degree to which Legislation, regulations, hospital system, community support delivery of the assistive products for mobility.
F. Financing	Funding from external entities (e.g., grants, reimbursement) is available to implement and/or deliver the innovation.	Include statements the degree to which funding from external entities is available to assistive products for mobility. Text relating to financial need from external entities will be coded under this construct when the text refers to allocation of internal funds, it is coded under, Available resources "funding"
G. External Pressure	External pressures drive implementation and/or delivery of the innovation. Note: Use this construct to capture themes related to External Pressures that are not included in the subconstructs below.	Include statements the degree to which external pressures drive delivery of the assistive products for mobility. Note: Use this construct to capture themes related to External Pressures that are not included in the subconstructs below.
1. Societal Pressure	Mass media campaigns, advocacy groups, or social movements or protests drive implementation and/or delivery of the innovation.	Include statements the degree to which Mass media campaigns, advocacy groups, or social movements or protests drive delivery of the assistive products for mobility.
2. Market Pressure	Competing with and/or imitating peer entities drives implementation and/or delivery of the innovation.	Include statements the degree to which Competing with and/or imitating peer entities drives delivery of the assistive products for mobility.
3. Performance-Measurement Pressure	Quality or benchmarking metrics or established service goals drive implementation and/or delivery of the innovation.	Include statements the degree to which Quality or benchmarking metrics or established service goals drive delivery of the assistive products for mobility.
III. INNER SETTING DOMAIN Inner Setting: The setting in which the innovation is implemented, e.g., hospital, school, city. There may be multiple Inner Settings and/or multiple levels within the Inner Setting, e.g., unit, classroom, team. Project Inner Setting(s): [Document the actual Inner Setting in the project, e.g., type, location, and the boundary between the Outer Setting and the Inner Setting.]		INNER SETTING DOMAIN: The Inner Setting for this project is defined as the specific areas within the hospital system, which include departments such as rehabilitation, occupational therapy, physiotherapy, and assistive technology—units where the assessment and provision of MATs occur
Construct Name	Construct Definition <i>The degree to which:</i>	Comments, project-specific language
<i>Note:</i>	<i>Constructs A – D exist in the Inner Setting regardless of implementation and/or delivery of the innovation, i.e.,</i>	

	<i>they are persistent general characteristics of the Inner Setting.</i>	
A. Structural Characteristics	Infrastructure components support functional performance of the Inner Setting. Note: Use this construct to capture themes related to Structural Characteristics that are not included in the subconstructs below.	
1. Physical Infrastructure	Layout and configuration of space and other tangible material features support functional performance of the Inner Setting.	Include statements the degree to which Layout and configuration of space and other tangible material features support functional performance of the Inner Setting.
2. Information Technology Infrastructure	Technological systems for telecommunication, electronic documentation, and data storage, management, reporting, and analysis support functional performance of the Inner Setting.	Include statements the degree to which technological systems for telecommunication, electronic documentation, and data storage, management, reporting, and analysis support functional performance of the Inner Setting.
3. Work Infrastructure	Organization of tasks and responsibilities within and between individuals and teams, and general staffing levels, support functional performance of the Inner Setting.	Include statements the degree to which organization of tasks and responsibilities within and between individuals and teams, and general staffing levels, support functional performance of the Inner Setting.
B. Relational Connections	There are high quality formal and informal relationships, networks, and teams within and across Inner Setting boundaries (e.g., structural, professional).	Include statements the degree to which there are high quality formal and informal relationships, networks, and teams within and across Inner Setting boundaries (e.g., structural, professional).
C. Communications	There are high quality formal and informal information sharing practices within and across Inner Setting boundaries (e.g., structural, professional).	Include statements the degree to which there are high quality formal and informal information sharing practices within and across Inner Setting boundaries (e.g., structural, professional).
D. Culture	There are shared values, beliefs, and norms across the Inner Setting. Note: Use this construct to capture themes related to Culture that are not included in the subconstructs below.	Note: Use this construct to capture themes related to Culture that are not included in the subconstructs below.
1. Human Equality-Centeredness	There are shared values, beliefs, and norms about the inherent equal worth and value of all human beings.	Include statements the degree to which there are shared values, beliefs, and norms about the inherent equal worth and value of all human beings.
2. Recipient-Centeredness	There are shared values, beliefs, and norms around caring,	Include statements the degree to which there are shared values, beliefs, and norms around caring,

	supporting, and addressing the needs and welfare of recipients.	supporting, and addressing the needs and welfare of recipients.
3. Deliverer-Centeredness	There are shared values, beliefs, and norms around caring, supporting, and addressing the needs and welfare of deliverers.	Include statements the degree to which there are shared values, beliefs, and norms around caring, supporting, and addressing the needs and welfare of deliverers.
4. Learning-Centeredness	There are shared values, beliefs, and norms around psychological safety, continual improvement, and using data to inform practice.	Include statements the degree to which there are shared values, beliefs, and norms around psychological safety, continual improvement, and using data to inform practice.
<i>Note:</i>	<i>Constructs E – K are specific to the implementation and/or delivery of the innovation.</i>	
E. Tension for Change	The current situation is intolerable and needs to change.	Include statements the degree to the current situation is intolerable and needs to change.
F. Compatibility	The innovation fits with workflows, systems, and processes.	Include statements the degree to which the current situation is intolerable and needs to change.
G. Relative Priority	Implementing and delivering the innovation is important compared to other initiatives.	Include statements the degree to which Implementing and delivering the innovation is important compared to other initiatives.
H. Incentive Systems	Tangible and/or intangible incentives and rewards and/or disincentives and punishments support implementation and delivery of the innovation.	Include statements the degree to which tangible and/or intangible incentives and rewards and/or disincentives and punishments support implementation and delivery of the assistive products for mobility.
I. Mission Alignment	Implementing and delivering the innovation is in line with the overarching commitment, purpose, or goals in the Inner Setting.	Include statements the degree to which Implementing and delivering the assistive products for mobility is in line with the overarching commitment, purpose, or goals in the Inner Setting.
J. Available Resources	Resources are available to implement and deliver the innovation. Note: Use this construct to capture themes related to Available Resources that are not included in the subconstructs below.	Note: Use this construct to capture themes related to Available Resources that are not included in the subconstructs below.
1. Funding	Funding is available to implement and deliver the innovation.	Include statements The degree to which Funding is available to implement and deliver the assistive products for mobility. When the text refers to allocation of internal funds, it is coded under the current construct text relating to financial need from

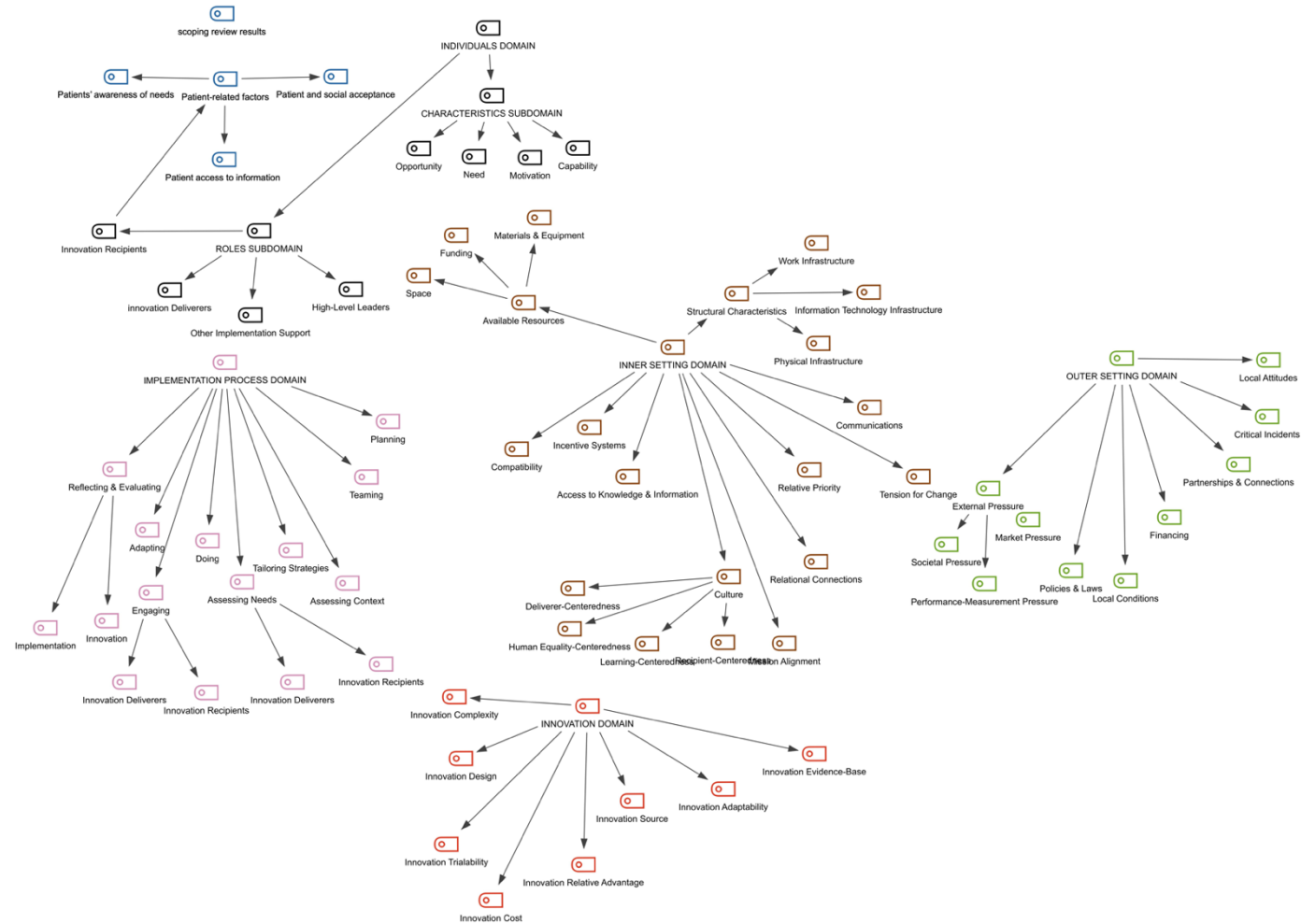
		external entities will be coded under Financing
2. Space	Physical space is available to implement and deliver the innovation.	Include statements the degree to which Physical space is available to implement and deliver the assistive products for mobility.
3. Materials & Equipment	Supplies are available to implement and deliver the innovation.	Include statements the degree to which Supplies are available to implement and deliver the assistive products for mobility.
K. Access to Knowledge & Information	Guidance and/or training is accessible to implement and deliver the innovation.	Include statements the degree to which Guidance and/or training is accessible to deliver the assistive products for mobility and associated services.
ROLES SUBDOMAIN Project Roles: [Document the roles applicable to the project and their location in the Inner or Outer Setting.]		Several vital roles have been identified, each playing a crucial part in the Inner or Outer Setting of the project. These roles are as follow
Construct Name	Construct Definition	Comments, project-specific language
A. High-level Leaders	Individuals with a high level of authority, including key decision-makers, executive leaders, or directors.	Include leaders of hospitals;
B. Mid-level Leaders	Individuals with a moderate level of authority, including leaders supervised by a high-level leader and who supervise others.	Include clinical supervisors
G. Other Implementation Support	Individuals who support the Implementation Leads and/or Implementation Team Members to implement the innovation.	Include administrative managers
H. Innovation Deliverers	Individuals who are directly or indirectly delivering the innovation.	Include HCPs
I. Innovation Recipients	Individuals who are directly or indirectly receiving the innovation.	Include patients
CHARACTERISTICS SUBDOMAIN Project Characteristics: [Document the characteristics applicable to the roles in the project based on the COM-B system or role-specific theories.]		
Construct Name	Construct Definition: <i>The degree to which:</i>	
A. Need	The individual(s) has deficits related to survival, well-being, or personal fulfillment, which will be addressed by implementation and/or delivery of the innovation.	

B. Capability	The individual(s) has interpersonal competence, knowledge, and skills to fulfill Role.	
C. Opportunity	The individual(s) has availability, scope, and power to fulfill Role.	
D. Motivation	The individual(s) is committed to fulfilling Role.	
V. IMPLEMENTATION PROCESS DOMAIN Implementation Process: The activities and strategies used to implement the innovation. Project Implementation Process: [Document the implementation process framework and/or activities and strategies being used to implement the innovation. Distinguish the implementation process used to implement the innovation (activities that end after implementation is complete) from the innovation (the “thing” that continues when implementation is complete).]		The implementation process for this project is defined as the set of activities and strategies used to implement the MATs
Construct Name	Construct Definition <i>The degree to which individuals:</i>	Comments, project-specific language
A. Teaming	Join together, intentionally coordinating and collaborating on interdependent tasks, to implement the innovation.	Include statements the degree to which Join together, intentionally coordinating and collaborating on interdependent tasks, to implement the assistive products for mobility and associated services.
B. Assessing Needs	Collect information about priorities, preferences, and needs of people. Note: Use this construct to capture themes related to Assessing Needs that are not included in the subconstructs below.	Include statements the degree to which Collect information about priorities, preferences, and needs of people. Note: Use this construct to capture themes related to Assessing Needs that are not included in the subconstructs below.
1. Innovation Deliverers	Collect information about the priorities, preferences, and needs of deliverers to guide implementation and delivery of the innovation.	Include statements the degree to which Collect information about the priorities, preferences, and needs of deliverers to guide implementation and delivery of the assistive products for mobility and associated services.
2. Innovation Recipients	Collect information about the priorities, preferences, and needs of recipients to guide implementation and delivery of the innovation.	Include statements the degree to which Collect information about the priorities, preferences, and needs of recipients to guide implementation and delivery of the assistive products for mobility and associated services.
C. Assessing Context	Collect information to identify and appraise barriers and facilitators to implementation and delivery of the innovation.	Include statements the degree to which Collect information to identify and appraise barriers and facilitators to implementation and delivery of the assistive products for mobility and associated services.

D. Planning	Identify roles and responsibilities, outline specific steps and milestones, and define goals and measures for implementation success in advance.	Include statements the degree to which Identify roles and responsibilities, outline specific steps and milestones, and define goals and measures for implementation success in advance.
E. Tailoring Strategies	Choose and operationalize implementation strategies to address barriers, leverage facilitators, and fit context.	Include statements the degree to which Choose and operationalize implementation strategies to address barriers, leverage facilitators, and fit context.
F. Engaging	Attract and encourage participation in implementation and/or the innovation. Note: Use this construct to capture themes related to Engaging that are not included in the subconstructs below.	Include statements the degree to which Attract and encourage participation in implementation and/or the assistive products for mobility and associated services. Note: Use this construct to capture themes related to Engaging that are not included in the subconstructs below.
1. Innovation Deliverers	Attract and encourage deliverers to serve on the implementation team and/or to deliver the innovation.	Include statements the degree to which Attract and encourage deliverers to serve on the implementation team and/or to deliver the assistive products for mobility and associated services.
2. Innovation Recipients	Attract and encourage recipients to serve on the implementation team and/or participate in the innovation.	Include statements the degree to which Attract and encourage recipients to serve on the implementation team and/or participate in the assistive products for mobility and associated services.
G. Doing	Implement in small steps, tests, or cycles of change to trial and cumulatively optimize delivery of the innovation.	Include statements the degree to which Implement in small steps, tests, or cycles of change to trial and cumulatively optimize delivery of the assistive products for mobility and associated services.
H. Reflecting & Evaluating	Collect and discuss quantitative and qualitative information about the success of implementation. Note: Use this construct to capture themes related to Reflecting & Evaluating that are not included in the subconstructs below.	Include statements the degree to which Collect and discuss quantitative and qualitative information about the success of implementation. Note: Use this construct to capture themes related to Reflecting & Evaluating that are not included in the subconstructs below.
1. Implementation	Collect and discuss quantitative and qualitative information about the success of implementation.	Include statements the degree to which Collect and discuss quantitative and qualitative information about the success of implementation.

2. Innovation	Collect and discuss quantitative and qualitative information about the success of the innovation.	Include statements the degree to which Collect and discuss quantitative and qualitative information about the success of the assistive products for mobility and associated services.
I. Adapting	Modify the innovation and/or the Inner Setting for optimal fit and integration into work processes.	Include statements the degree to which Modify the innovation and/or the Inner Setting for optimal fit and integration into work processes.

Qualitative analysis coding tree using CFIR



Appendix 11. Example of a detailed comparison between sites and participants' views

Note: The quotes presented in these tables have been selected because they represent the collective views of each participant group

Table 3 Illustrative quotes and summary for the themes and sub-themes under the Innovation Domain

CFIR construct under the Innovation Domain	Themes identified	Sub-themes	HCPs	Administrative Managers	Clinical Managers	Leaders	Convergence, complementarity, disagreement, and silence
Innovation Source	Sourcing and Availability of MAT		Some devices/components are rare in the local market or aren't manufactured extensively here. <i>Illustrative quote:</i> <i>"These are Saudi companies that don't manufacture but only import. The company that I mentioned...., is an importer" (P3, HCP)</i>	- Decision-making doesn't solely determine which company provides a device or its specifications. - Within Saudi Arabia, there's a strong emphasis on prioritising local content. If a particular item is not available locally, then sourcing begins from abroad. - There's an evident lack of trust in local sources for MATs and their maintenance. <i>Illustrative quote:</i> <i>"Most of them are foreign. Most are not locally available; the companies order them from abroad. We mostly deal with a German company [name of the company] and we have [name of the company],</i>	Depend heavily on the reliability and performance of suppliers. - Market maintenance is a challenge; quality is weak. - Frequent breakdowns of specific parts, like leg rests. - Companies persuade families to buy larger sizes or suggest limited stock options. <i>Illustrative quote:</i> <i>"Her matter is simple; sometimes we struggle if we have zero stock items, depending on the suppliers" (P22, Clinical Manager)</i>	- You don't determine which company supplies the device or manufactures the MATs - You don't decide its quality or the specifications you need. - If both local and foreign products are available, the local product (Saudi) is usually given priority. - There's an acknowledgment that specialists in assistive devices may have better insights when it comes to the availability of	Convergence, all participant groups across all hospitals report a reliance on foreign sources for MAT.

				<i>a Swiss company." (P24, Manager)</i>		certain types of devices. <i>Illustrative quote: "And the primary reason I mentioned is that there is no provider of this type of devices." (P7, Executive)</i>	
Innovation Evidence-Base	Insufficient data and research	Data Needed to Guide Decisions in MAT	•On a national level, data about the general use of MATs such as wheelchairs is sought after but not easily found. •The commitment of governmental entities towards accessibility is questionable, based on personal observations. •There's a need for studies to determine the strengths and weaknesses in the current service provision before establishing any policy or protocol regarding equipment provision. <i>Illustrative quote: "Yes, it's possible at a national level, I always look for general numbers.</i>	A comparative analysis is suggested between patients who have assistive devices and those who don't, to understand potential costs and benefits. <i>Illustrative quote: "As an equipment coordinator, I am trying to do a 'saving budget' to rescue the situation basically, and we must see if this is really effective?" (P23, Administrative Manager)</i>	The availability of a wide range of devices prompts questions about their effectiveness. <i>Illustrative quote: "Almost the same idea, look, we are talking about, now one of the important things they now call efficiency, there's a lot now in devices, ah. I mean, now in terms of rehabilitation, but when you see all the examples, the benefits are not necessarily correct, and what you want, but you can benefit from its efficiency now, especially in some with some</i>	•Currently, there's an abundance of devices available in the rehabilitation field. •However, not all of these devices are necessarily useful for every patient. •For instance, while there are advanced prostheses available, their efficacy might vary based on the patient's needs. •Before deciding on a device, it's essential to re-evaluate the patient's requirements and identify the	Complementarity: All participants groups concerns regarding the necessity for more detailed, context-specific research

			<i>For example, how many people use a wheelchair? Use it regularly? I don't know, honestly, I've searched everywhere. There isn't [any information]. For example, the extent of governmental bodies' commitment to accessibility. I don't see, I mean" (P11, HCP).</i>		<i>patients" (P22, Clinical manger)</i>	most suitable equipment for them. •When investing in medical equipment, it's crucial to base decisions on sufficient data that backs the device's claims. <i>Illustrative quote: "But what I'm saying is that when we want to go and buy something, you really need a sufficient data to see that. Yes, it is what it says.Okay, so this will be a little reluctance and that's why I would like to see a lot of data on it" (P9, leader)</i>	
Innovation Relative Advantage	Different Perceived Value and Benefits of MAT		• Non-mobilised patients often return with complications like bed sores, which are costly to treat. •Many elderly patients get hospitalised due to fractures from falls,	• The costs of these devices, when accumulated over a few days, might sometimes be less than a single day's cost in a hospital. By focusing on cost-effective measures, the manager seeks to	•AT They are pivotal in ensuring a better quality of life and are considered high-priority, a good seating system and correct positioning are critical for most of their time.	• Not providing the necessary MATs can escalate costs for the ministry or any entity.	Disagreement: Difference in prioritising financial outcomes over clinical ones. Complementarity: Both views highlight the importance of

			leading to significant costs. • Stresses the vital role of specialised MATs, especially for patients with brain injuries. • The use of specific MATs has significantly improved the lives of patients and their caregivers. Patients who were once restricted can now move around more easily. With the right interventions and devices, the quality of life of both patients and their caregivers has markedly improved. • There's a strong emphasis on the vital role that MAT plays in enhancing patient lives, reducing the burden on caregivers, and ensuring patients' safety. <i>Illustrative quote: "I always say technology, in general, is a necessity, not an accessory." (P25 HCP)</i>	maintain the budget efficiently. • The approach of home-based care with the necessary medical equipment helps in increasing the turnover of hospital beds, which is beneficial for the facility. This frees up beds for other patients and ensures better resource utilisation. <i>Illustrative quote: "There is something they call 'operation cost.' This, which comes every day, for example, the food to the room, a nurse comes to the room, aside from the liquids that are given every day. So, these costs, they cost me daily. When you add it up, an average of 4 or 5 days, sometimes it doesn't come to the value of even one day, it comes to the value of all the devices that you could give the patient. So as expenses, budget-wise, it preserves the budget... they have many advantages for the facility itself, like the discharge turnover for the beds, many things.</i>	• The integration of technology can provide enhanced benefits, especially in school or work environments. • By providing these MAT, we can transition to the next stage, ensuring better function for the patient and realising cost savings. <i>Illustrative quote: "of course, it makes the person more functionally independent and can facilitate his QoL by himself. It's highly needed; it's a priority." (P29, Clinical Manager)</i>	<i>Illustrative quote: "It's important to make sure that the devices are available to minimize the patient's return to the clinic." (P20, Leader)</i>	patient outcomes from different perspectives.
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				<i>This way, it's saving the budget and it's effective" (P23, Administrative Manager)</i>			
Innovation Cost	The High Cost of Devices and Spare Parts		•A specific price mentioned was around 24,000 to 25,000. •Wheelchairs and similar equipment tend to be expensive.possibly exceeding 60-70 for a single wheelchair. •Regular patients, who only need ordinary equipment costing around 1,000 to 2,000, can't afford these high-end wheelchairs. <i>Illustrative quote: "The good wheelchairs that I know of, those above seven thousand, and when I give this information to the families, they go back and forth, they told me, the prices very expensive, the seating system alone costs ten thousand and above." (P4, HCP)</i>	•Costs do play a significant role in decision-making, but price isn't always a barrier <i>Illustrative quote: "The reasons are the price; we always look for the best price that matches the specifications." (P10, Administrative Manager)</i>	•Wheelchairs can cost between ten to fourteen thousand, but sometimes what reaches the families is only around one thousand five hundred to two thousand riyals, creating a substantial financial gap. This becomes particularly challenging when aiming to provide the best solutions for patients, and families struggle to cover the remaining amount. •Unfortunately, there hasn't been a found solution to this issue. Customised equipment is expectedly more expensive since it's tailored to specific needs and requires maintenance.	•There's an emphasis on acquiring devices at the lowest possible price while still meeting required specifications. •while they understand the budgetary concerns and processes, they don't have direct involvement or authority in cost determination, especially when it comes to high-end prostheses. This decision-making lies with entities like NUPCO, which has the authority to determine cost limits and approve such devices. <i>Illustrative quote:" I mean, you see, we're talking about a</i>	Convergence: All participant groups across all hospitals report a high cost of MAT

					<i>Illustrative quote: "wheelchairs may cost maybe from ten to fourteen thousand, and sometimes the support that reaches the family, for example, is a thousand and five hundred, so there is a big gap. Especially if we want to bring the best solution for the patient. And for some families, it's difficult for them to cover the rest of the amount." (P30, Clinical Manager)</i>	<i>wheelchair that costs a hundred thousand riyals, I mean a hundred thousand riyals for just one person definitely requires several people to approve it, it incurs a very high budget on the department. Because the budget for the devices is very high, there is a reservation from the department about the entire matter " (P20, leaders)</i>	
Innovation Complexity	Customisation and Production Constraints		•Some devices require a specialist's touch. The patient can't use them at home. They need a proper set-up, setting adjustments, and treatment plans. <i>Illustrative quote: "Of course, because the artificial limb or prosthesis is custom-made, it's not ready-made. We don't have ready-made prostheses, so it's</i>	•There are cases, as previously mentioned, where they felt the process was complex. Their team couldn't handle some situations clearly. For instance, they noted overweight patients and the chairs available couldn't support them. They sent requests to multiple companies a few days ago and are awaiting replies to see what's available in the market	•Custom-made solutions, like chairs, are essential for specific conditions, e.g., scoliosis. •A distinction exists between ready-made and custom-made products, with wheelchairs often requiring customisation.	•There are common issues they are accustomed to. It's possible for devices to become faulty or slightly misaligned, but rarely do they encounter cosmetic problems. <i>Illustrative quote: "Yes, but wheelchairs or,</i>	Convergence: All participant groups across all hospitals report concerns about the complex customisation requirements in assistive technology.

			<i>custom-made and tailored for the patient himself." (P11, HCP)</i>	before making a purchase. <i>Illustrative quote: "The situation is complicated. Our team is not able to handle it clearly. We noticed we have overweight patients, and the chairs we have are not strong enough and not sufficient. So, we made a request. I just sent all the orders to various companies two days ago. But I'm waiting for a response to see what's available in the market and then place a purchase order." (P21, Admin Managers)</i>	<i>Illustrative quote: "Some cases are complicated and must be custom-made. And anything that? Hmm, I mean, yes, what is not available in this form, always the things that are provided through [NUPCO] and such, which are ready-made, usually in a specific M or size, or typically wheelchairs can be custom-made." (P32, Clinical Managers)</i>	<i>for example, some devices now need customization, I expect it takes a long time. Why does it take a long time? Hmm, because now you need a long time to prepare the device to be suitable for the patient." (P6, Leader)</i>	
Complex Procedures and Delays in MAT Provision		•HCPs indicate that patients often need more clarity in the acquisition processes. •Sometimes, it can take a month or more for certain acquisitions. •There are instances where patients return post-discharge due to simple issues like not receiving the necessary assistive device or medical equipment.	•There are complexities in the procedures as seen in the image. •Requests are raised and everything seems fine until they reach the spending efficiency authority where they can be delayed for months. •The trending process is lengthy and is followed by supply chain coordination. <i>Illustrative quote: "Logistic side, of course, when you order a</i>	•Discuss the process of transferring a patient to social workers if the patient's needs can't be met. The social workers collaborate with a charitable organisation, which conducts a financial assessment for patients or their families.	•The acquisition process in hospitals varies and can be time-consuming. •An order might take a long time from raising it, to studying it in the concerned department, then elevating it to the rehab administration, and finally communicating with the	Convergence: Participants across all hospitals agree that complex acquisition processes for MAT significantly affect its comprehensive provision.	

		•The waiting period, like delivery time, often remains uncertain. •Some patients might wait for more than a year to receive their devices. <i>Illustrative quote: "The process takes a very long time because there are codes, approval, and several parties involved in the matter"(P2, HCP)</i>	<i>device, you don't just order a device randomly; it goes through a recommendation process by the OT and the doctor themselves, and the request is submitted in SBR, something called a Purchase Order, and it goes through channels in the Medical Equipment Committee where they review it and say yes, indeed, this is what the patient needs and they approve it when the device is available, like always, anything involving financial budgets always takes time. Of course, in the medical equipment department, where do the devices come from? The devices usually operate on contracts, tenders, and such; they have a Change of Command, a Supply Chain, and a specific process in purchasing."</i> (P23, Administrative Managers)	<i>Illustrative quote: "The process is complicated and takes time."(P22, Clinical manager)</i>	company especially if a device is unavailable. •It can take approximately six months for a competition to be approved and for a company to start delivery. <i>Illustrative quote: "Truly, it is a very lengthy process, it has multiple layers, every year, we have a strategic plan; as part of the strategic plan, we raise it, it's raised to the financial management, legal management, operational management, and medical management, and it includes a response plan (P24, Leader)</i>	
	Quality-Cost Balance in MAT provision	•The majority of the devices they encountered is not of good quality.	<i>Illustrative quote: "Quality matters, but it's more important to balance it with cost to really understand its</i>	<i>Illustrative quote: "And there are some expensive options. So, when we switch to a</i>	•Some options are expensive, so when choosing a slightly cheaper	Convergence: Participants from all hospitals report compromised equipment quality

			•Safety and comparing "quality with price" are major considerations. •Availability of devices with appropriate quality is crucial. Even though they can buy cheaper device, if the quality isn't suitable, it's not a viable option. <i>Illustrative quote:</i> <i>"There was a problem from the side of the patients, of course, from what the patients themselves say, that they give us the wheelchair, but they are not the same as the specification and sizes written in the description." (P5, HCP)</i>	<i>value. It's not just about having the best quality; it's about meeting what's needed in a way that's affordable and works well." (P10, Administrative Manger)</i>	<i>slightly cheaper chair, we lose some features. Yes, this was one of the challenges with the ministry. I mean, it gets the job done, but not as good as when some companies provide high quality at a lower cost." (P30, Clinical Manager)</i>	chair, certain features are compromised. •There have been challenges with the Ministry or certain areas in the past when they provided chairs that were "just okay" in quality but not as good as what some companies offer in high-quality chairs. <i>Illustrative quote: "Yes, they faced problems with a patient; the wheelchair they brought us here started falling apart, obviously poor quality." (P20, Leader)</i>	and sizing inconsistencies, suggesting a systemic problem with the procurement of mobility products.
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Table 2 Illustrative quotes and summary for the themes and sub-themes under the outer setting domain

CFIR construct under the outer setting domain	Themes identified	Sub-themes	Illustrative quotations HCP	Illustrative quotations Administrative Managers	Illustrative quotations Clinical Managers	Illustrative quotations Leaders	Convergence, complementarity, disagreement, and silence
Partnerships and Connections	Challenges in Rigid Administrative Partnerships		• Instead of providing the device directly, the Ministry provides financial support to patients. This allows patients to purchase the device that suits them best. • The application process for this financial support has moved online, and there's a periodic renewal system. • There's uncertainty about whether other hospitals provide outpatients with equipment, as the primary responsibility lies with the Ministry of Social Affairs due to their dedicated budget for such purposes.	• Unified Purchase Platform: NUPCO is the go-to for purchasing needs in Saudi Arabia. <i>Illustrative quote: "NUPCO company is like a mediator or a unified purchasing company for all government entities. Based on competition, it needs time until it's put forward by the procurement, until the offers are presented, until they are... inspected. The offer inspection committee meets to determine the appropriate offer. All these processes take about six months to a year until the competition is approved. Only after that, when I issue the authorization, does the company start to supply." (P8,</i>	The ministry of social affairs has been changing their systems and regulations. Some reports suggest that obtaining equipment took years, while others suggest it took only a few months. However, the accuracy of these reports is uncertain. <i>Illustrative quote: "The sources of devices have become different. It might be from the Ministry of Social Services, or through our central warehouse, or through charitable associations. So,</i>	Accreditation platform for direct submission of requirements. NUPCO operates under the government's guidance to streamline medical tenders and procurement. An expert committee ensures clarity in item specifications before NUPCO initiates the bidding process. Approximately 1,700 items related to physical therapy are managed by NUPCO components and supplies	Convergence, all participant groups across all hospitals report a Rigid and Administrative Partnerships (MHRSD) and (NUPCO)

			<i>Illustrative quote: "It means that even the latest specifications they have are standard specifications. When the patient goes to the ministry, to the warehouse, he meets someone who decides he needs a wheelchair. They look at any wheelchair and give it to him without considering the size or type—standard, recliner, tilt.</i>	<i>Administrative Managers)</i>	<i>with different sources, the devices vary. Imagine now a patient comes to you, and you dispense something to him, not from your department but from another ministry!" (P30, Clinical Manager)</i>	for prosthetics and orthotics in Saudi Arabia. <i>Illustrative quote: "The issue has become that introducing a new product into [NUPCO] is very difficult. They conduct comparisons and look at several companies that provide [products] and see if there is a local alternative available. Several things they have to do in order to be able to request a new product." (P20, Leader)</i>	
Policies and Laws		Restrictive Policies and Regulatory Ambiguity in MAT Provision	Policies were first established to manage challenges related to discharging patients needing long-term care or rehabilitation. Restrictive Service Availability:	•There are challenges related to serving patients who come through exceptions or emergencies. •Patients who are not affiliated with the hospital and come through emergencies are referred to social	<i>Illustrative quote: "We use a form in our prescription that the patient uses; they buy it with their money. I mean, usually, it's the patient himself who looks</i>	<i>Illustrative quote: "These outpatients, whom we call the 'unknown path', we cannot provide them with anything due to the dispensing</i>	Convergence: Participants from all participating hospitals agree that restrictive and inflexible hospital policies and procedures, such as those concerning eligibility, significantly impact the

			1.Services primarily target inpatients needing intensive rehabilitation. 2.Outpatients have limited access to rehabilitation services. <i>Illustrative quote: "It's not a sustainable system. It's not a system that can work, obviously, because we have no control over what outpatients receive. It should ideally be through a better process for inpatients. We have a very good process. Outpatients know we can't always ensure that the patient receives the equipment that they should receive. This policy comes from the hospital according to the budget capabilities (HCP P5)</i>	services to find them a sponsor. •Generally, their program is more focused on serving inpatients and chronic patients, particularly those in home healthcare. <i>Illustrative quote: "If we receive a case that is not from the hospital's affiliates, as you said, we refer them to Social Services so that they can find them a sponsor." (P21, Administrative Managers)</i>	<i>for it. We don't provide anything. Some patients use simple things; they go and get simple pillows, a sheet they roll up to adjust the car. Honestly, this is what's happening, even if I referred it and knew what needs to be provided, in the end, they might not be able to buy it. The barrier is always there." (P32, Clinical Managers)</i>	<i>policies. Either they receive [assistance] through Social Services, and they distribute., as we say, anything they have just for the sake of saying that they've dispensed. Or it's distributed from the Ministry of Resources, which is an external body." (P20, Leader)</i>	comprehensive delivery of services.
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		Absence of Clear system and Regulation on Device Provision	Lack of Clear Protocol There isn't a clear protocol on device provision and follow-up. <i>Illustrative quote:</i> "So, there is no protocol or clear system. We, who hand over the equipment from the warehouse, not occupational therapy or what they call hand management or case management, sometimes the delay in providing the device delays the patient's discharge. So typically, sometimes (we are not accurate with the sizes) and that's why we give them what is available...There is no protocol for follow-up or training." (P12, HCP)	•After patients are discharged from their care, they usually don't return. This might be because patients find external sources to continue their treatment. •However, certain patients have almost regular visits. A patient might receive a device and the next check-up could be a year later. <i>Illustrative quote:</i> "Actually, the idea came from the fact that we have a number of patients who stay in the hospital for long periods as medical treatment, medical plan. The doctor doesn't have any other solution in the medical plan, so he says, 'This patient is ready to go home.' Most families, okay, how do they go home? Do they just go home like that? Or should they be prepared for something? Of course, they go home, but how? Just like that? Or should they be prepared for	•Rare instances where the prescribed wheelchair is cross-checked with what the patient receives. <i>Illustrative quote:</i> "Look, devices like walkers and canes, any patient with a referral is eligible, so we give them what we have, no problem. The bigger problem, I think, is for our colleagues in OT (occupational therapy), which is wheelchairs. In providing them in the right size, there is no clear mechanism for it, and often they are referred to Social Services." (P22, Clinical manager)	•The process isn't precise. There are two pathways; if the patient is an inpatient, they get their needs through the hospital to facilitate discharge. If a patient is waiting for discharge due to a wheelchair, sometimes the hospital might procure it for the patient to facilitate discharge. <i>Illustrative quote:</i> "There is no clear policy, nor is there a clear system. I mean, even the dispensing system is not clear." (P33, Leader)	Convergence:Participants are in agreement that the absence of clear policies and regulations concerning the provision, maintenance, and follow-up of MAT significantly impacts its comprehensive delivery.
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				<i>something so they can go home? Then this idea came along, and the devices came, and we started doing discharges for the patients, and they go home. From there, the patient gets ready with his devices before..." (P23, Administrative Managers)</i>			
Financing	Inadequate and Unstable Governmental Financing Mechanisms		No data	<i>Illustrative quote: "The Ministry of Finance is the one that will provide, it is the funder that will approve the budget for you and provide the amounts we need. Excellent... We submit a request to the Ministry of Health, through the Ministry of Health to the Ministry of Finance, so that they approve financial allocations for our tenders at the beginning of the fiscal year. Yes, usually... it's not necessarily that the allocation covers one fiscal year, it could be, for example, allocated for three years. The duration of the competition is usually three to five years, and sometimes</i>	<i>Illustrative quote: "This could be an excellent step, but it needs to cover the cost of the devices because the contract with the ministry or other sponsors does not cover it." (P31, Clinical Supervisors)</i>	<i>Illustrative quote: "Generally speaking, we are talking about the second health cluster and a budget from the cluster's budget, which may not be sufficient." (P7, Leader)</i>	Convergence: Managers and leaders from all hospitals report concerns about inadequate and unstable governmental financing mechanisms affecting healthcare provision. Silence: HCPs have not reported any concerns regarding governmental financing mechanisms, which may indicate that such issues are outside the scope of their daily responsibilities or that they may not be aware of the financing complexitie.

				<i>just one year, so they might request their needs for the next year or maybe for the next three years. All government entities, whether health-related or otherwise, this requirement is called the preparation of the fiscal year budget project." (P8, Administrative Managers)</i>			
Local Conditions	Restrictions and Inequities due to Geographical Concentration		<i>Illustrative quote: "Most of the patients are from outside Riyadh. I don't know, usually here, for example, the relatives come, take the prescription, and leave." (P17, HCP)</i>	<i>No data</i>	<i>Illustrative quote: "Yes, some patients are transferred to major cities to receive appropriate treatment because the major rehabilitation hospitals are located in the main cities, and patients often prefer them." (P31, Clinical Supervisors)</i>	<i>Illustrative quote: "For most patients, when the cases become difficult, they immediately make a referral to Riyadh, either to [Hospital Name] or [Another Hospital Name]." (P33, Leader)</i>	Convergence: Participants across various roles and hospitals concur that restrictions and inequities in service provision due to geographical concentration, especially in main cities, significantly impact access to healthcare services. This agreement highlights a systemic challenge in ensuring equitable healthcare distribution across different regions.
	Inadequate Environmental and Infrastructure Adaptability		<i>Illustrative quote: "We face this a lot. Some patients come and say that there is a device that helps with mobility and so on, but they say,</i>	<i>No data</i>	<i>No data</i>	<i>No data</i>	Silence

			<i>'My home itself is not prepared. I mean, the basics at my home are not ready. If the basics are adjusted, maybe I can think about the devices. If I brought it to my house in such-and-such village, I wouldn't benefit from it at all. I don't have a car, or a car big enough to fit it, so it becomes an obstacle for me. It's better for someone to push me, to have a caregiver with me to help, because of the area and so on. But actually, the device would benefit them, but because of the surrounding obstacles and problems, it made them decide that no, currently I don't need it.'</i>(P1, HCP)				
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Table 3 Illustrative quotes and summary for the themes and sub-themes under the inner setting domain

CFIR construct under the inner setting domain	Themes identified	Sub-themes	Illustrative quotations HCP	Illustrative quotations Administrative Managers	Illustrative quotations Clinical Managers	Illustrative quotations Leaders	Convergence, complementarity, disagreement, and silence
Physical Infrastructure	Characteristics of healthcare setting		<i>Illustrative quote: "Maybe because we are not a center, I mean a large rehabilitation center, but as a hospital, we provide services in the acute stage for patients and then the follow-up happens in our outpatient [department] only. We are focused on many things, honestly, there are more than one department, and the hospital is trying to cover them." (P15, HCP)</i>	<i>Illustrative quote: "The type of hospital affects the services it offers and what it provides. If it's a hospital serving primary healthcare, for example, it's not considered a hospital, it's considered a clinic or perhaps secondary [care]. And how many beds it serves, these things have an impact, plus the location of the hospital." (P23, Administrative Manager)</i>	<i>Illustrative quote: "Another point, maybe, was that for us as a specialty hospital, the types of cases we see in the specialty are more complex. Usually, the core competency in our hospital is neuro, of course, with neuro cases, even those like autoimmune, tumor cases, and things related to CNS, and oncology, these kinds of cases." (P32, Clinical Manager)</i>	<i>Illustrative quote: "The hospital services are based on the patient flow. Traffic accidents, as well as the presence of salvage limb, are among the reasons that allow a patient to enter our hospital. If it's a threatening limb or life-threatening, it is accepted automatically, which has facilitated procedures for us. The frequency of traffic accidents, and in the end, the most common cases we have, are diabetic foot, which are amputations due to diabetic foot. We have a large number of diabetic</i>	Convergence: Participants agree that the specific characteristics of their healthcare settings, whether acute or rehabilitation, significantly influence the comprehensive provision of MAT.

						patients in the kingdom, and despite education and awareness, it is still the major source of patients." (P24, Leader)	
Information Technology Infrastructure	Outdated IT Infrastructure		No data	<i>Illustrative quote: " Instead of writing a paper and giving it to someone to come and upload it to the system and then raise it to us and then we review it. So now, I'm connecting the Oracle system with BestCare so that both of them can share and serve each other, and no one gets tired, and even the doctor doesn't get tired; it becomes a double list. Most of the papers will stop; signatures will be electronic requests, all of them will be electronic. We are now mostly electronic, but there are papers that must be signed by the doctor, these are not electronic. So now, we are</i>	No data	<i>Illustrative quote: "First of all, of course, we need to use technology. There must be a system. You see, we are working with PT and doing a lot of work, we're doing a lot of Excel sheets, but you have to keep the tracking. And in the end, things still turn out wrong, because maybe someone will make an entry, there's no barcode, there are no things, there's no system synchronizing things together. So, it needs a real system" (P33, leader)</i>	Partial Convergence: Participants from two hospitals report challenges with outdated and unsynchronised IT infrastructure, affecting various aspects of healthcare delivery and the provision of MAT. Silence from One Hospital: Participants from the third hospital did not report concerns regarding IT infrastructure, indicating a possible divergence in experiences or perspectives related to technological resources.

				<i>systemizing these things, and the big obstacle was that there was no loop, no operation between BestCare and Oracle (P23, Administrative Managers)</i>			
Work Infrastructure	Undefined Role Boundaries in Prescriptive Authority		<i>Illustrative quote: "Another problem is that they don't have the medical background. The social services, I mean, don't know what we are talking about, right? And we come to say, honestly, we need a specific measurement for a patient. Okay, they will ask me, 'Why do you give this to the patient who is already bedridden?' No, she is not bedridden; she is bedridden because there is no assistive device that can help her to get out of the bed. So, maybe the medical</i>	<i>Illustrative quote: "Our department is Medical Equipments, within a department that includes Bed Management. These policies are the hospital's policy, they have nothing to do with OT. OT is a Technical Department, as a department that looks at the Patient and says this patient needs this and that recommendation. Others determine things like Bed Management, which says, for example, this patient needs a wheelchair or this patient needs a medical bed from the review they have. Who determines these things? Bed</i>	<i>Illustrative quote: "Okay, of course, in terms of the prescription, we don't have the authority to prescribe, although we tried since 2013. But, for example, when the patient is transferred, let's say to physical therapy, occupational therapy, we do an assessment, we give recommendations, but then the matter is transferred to physical medicine. They are the ones who can issue [the prescription]. Sometimes the physiatrists do it, and sometimes the social workers</i>	<i>Illustrative quote: "The main goal is that we give him a wheelchair not because of his disability or because, for example, he has a fall risk or a precaution, so it has become a means for us to do a discharge for him. We, the OT, the Social Services Department, and the Bed Management Department, these three departments intervene together to dispense just one wheelchair. Sometimes you add a fourth department, which is the Purchasing Department. So if you notice the mechanism, for just one</i>	Complementarity: There is agreement among HCPs and some managers about the complexity and challenges of the current system, highlighting the need for clear role delineation and prescriptive authority within the process of providing MAT. Disagreement: However, some managers believe these responsibilities should fall under a different department to optimise patient discharge preparations, which contrasts with the views expressed by other HCPs and perhaps different managers

			background they have can be a barrier. I say the first problem is that the accommodation, the service itself, is supposed to not be under bed management. It is supposed to be under rehabilitation, let's say occupational therapy." (P12, HCP)	Management. We have a department called Material Management; they have the warehouses and things. We store these things of ours in the warehouses that they are custodians of and accountable from their administrations the devices are owned by Bed Management and can't be dispensed or released or taken out unless there is a request from Bed Management." (P21, Administrative Manager)	get involved, and they bring devices that are donations from associations, even when they don't fit the patient properly. Sometimes, our OTs do measurements and put recommendations, and we place things, but they don't come 100% perfect, unfortunately. Even the form that comes to us from the physiatrists is just to fill the measurements, and we send it all together." (P31, Clinical Managers)	wheelchair, maybe six employees get involved to dispense the wheelchair, it doesn't take that, I mean, as you might say, we might say, it's not a precise process that we have." (P20, Leader)	who see the current arrangement as problematic.
Communications	Inadequate Coordination and Communication Among Departments		Illustrative quote: "Okay, of course, regarding the prescription, we don't have the authority to prescribe, and we put recommendations and we add things, but it doesn't come out	No data	Illustrative quote: "We need integration in the matter of MDT (Multidisciplinary Team)." (P30, Clinical Managers)	Illustrative quote: "The reasons, I expect, are miscommunication between the departments." (P33, Leader)	Convergence within hospital C: There are reports of inadequate interdepartmental coordination and communication, with feelings of being unheard, especially among non-doctor staff, and leaders acknowledging

			<i>100% correct. Why? We don't know" (P25, HCP)</i>				miscommunication as a primary issue. Silence in Other Hospitals A, B: No issues related to interdepartmental coordination and communication have been reported
	Communication Barriers between HCPs and Patients		<i>Illustrative quote: "So we don't always know what type of quality they received." (P5, HCP)</i>	<i>No data</i>	<i>No data</i>	<i>No data</i>	Convergence among HCPs across all hospitals: Communication barriers exist post-prescription, with no structured follow-up on the equipment's use and suitability. HCPs across all hospitals express concerns about the absence of formal follow-up mechanisms. Silence among Managers and Leaders: Despite HCPs reporting these issues, managers and leaders do not mention communication barriers, suggesting a potential

							disconnect between frontline experiences and higher-level perceptions or priorities
Mission Alignment	Focus and Scope of Healthcare Settings		<i>Illustrative quote: "I don't blame them; they deal with the patient (acute medical bed), and we deal with rehabilitation. We want to return maximum independence, meaning he manages on his own, they don't, right? If you have a fracture, it gets fixed, medical optimization, there is no infection, no... no problems, then discharge. We are a trauma center, it's customary that it treats trauma cases. They don't skimp on the requests, but the devices, up until now, it's difficult for them to be as abundant as we</i>	<i>Illustrative quote: "In [hospital name], they have a rehabilitation hospital. We are here in a small department; this is indeed a crucial point that makes a difference." (P21, Administrative Manager)</i>	<i>Illustrative quote: "I mean, the plan was for it to be the first comprehensive rehabilitation center in the specialty, and there was a section for inpatient rehabilitation. But because of the space issue and since oncology is available only in this hospital, which is only available in the specialty in the Eastern Province, it was taken." (P32, Clinical Manager)</i>	<i>Illustrative quote: "The whole approach that the Guard is now heading towards is that the patient doesn't always stay in the hospital. We've emphasized its importance a lot. Every time we get the response, 'We are not a rehabilitation hospital.' The goals of the hospital and its mission are to try to take care of [patients] in an environment other than the hospital environment, whether they rely on outpatient care, home health care, telecare, virtual clinics, or preventive medicine." (P20, Leader)</i>	Convergence: Participants agree that organisational alignment and prioritisation significantly impact the comprehensive delivery of services.

			would like them to be." (P11, HCP) "The recommendation, because currently in the 2030 vision, we are working on prevention more than treatment, and prevention means a high quality of life. When we talk about quality of life, we talk about how to make the patient live his life appropriately. In prosthetics, maybe at some point it was a rare thing, but I think now it has become a necessity, especially in amputations. It's supposed to be provided in all sectors and hospitals." (P11, HCP)				
Funding	Availability of Internal Funding for MAT		<i>Illustrative quote: "You know, the department has a</i>	<i>Illustrative quote: "Due to budget planning and budget execution."</i>	<i>Illustrative quote: "No, the budget does not cover the devices." (P22,</i>	<i>Illustrative quote: "And then also you need to make sure where the</i>	Convergence, All participant groups across all hospitals report Lack of

			<i>certain budget and there are pre-required things during the year. So, in case they are not available, and we can't provide them to the patient, we always advise the patient to look for them elsewhere. I believe, yes, the management here is limited by budget, and based on it, they request what they need." (P13, HCP)</i>	<i>(P10, Administrative Manager)</i>	<i>Clinical manager)</i>	<i>funding comes from." (P9, Leader)</i>	Internal Funding for MAT
Compatibility	Overloaded Workflows and Time Constraints		<i>Illustrative quote: " There isn't enough time, 'So they can't take training.' I can't train them because I have limited time. 'I don't have in my hospital, in my clinic, a wheelchair for training.' So, mostly I just do education, show them." (P19, HCP)</i>	<i>No data</i>	<i>No data</i>	<i>No data</i>	Convergence among HCPs across all hospitals: HCPs frequently deal with follow-up appointments and patient education under time constraints. HCPs from both hospitals adapt to these constraints by utilising available resources, individual judgment, and

							prioritising patient education when comprehensive training is impossible. Silence among Managers and Leaders: There are no reports or comments from managers and leaders regarding the overloaded workflows and time constraints faced by HCPs
Relative Priority	Prioritisations Challenges in MAT Delivery and Associated Services		<i>Illustrative quote: "There might be a priority, and I return to say that the priority is not rehabilitation at the moment, possibly because the budget they have is specific and limited to essential things. So, they serve the basic [needs], and that [rehabilitation] is not considered basic for them. They serve things related to emergencies and urgent surgeries,</i>	<i>Illustrative quote: "Medical things, whether medications or medical devices, are always a priority. For example, we have items, 1) Infrastructure development, 2) Replacement and development of infrastructure. There is usually a prioritization, but generally, the provision of all devices, whether of high priority or lower, is prioritised. So, there is, I mean, a</i>	<i>Illustrative quote: "Like I told you, they calculate based on cost-effectiveness. I mean, they look at what the majority needs, you know, logistic things, they think a lot about it. It's possible to pay a high cost for features that are not essential. I believe we haven't reached such a level of perfection yet that we think about preferred things. They are accessories, I</i>	<i>Illustrative quote: "Even if there is a budget, it's not a priority, it's not on the priority list that the matter needs because indeed, the issue is significant and costly for the department." (P20, Leader)</i>	Convergence: all Participants from hospitals report that insufficient infrastructure and the allocation of priorities, favouring acute care over rehabilitation services, hinder the effective provision of MAT.

			<i>but they don't serve what is related to the final stage of rehabilitation because their budget is limited." (P3, HCP)</i>	<i>prioritisation among these things." (P8, Administrative Managers, Budget Administration)</i>	<i>think they view assistive devices this way." (P22, Clinical Manager)</i>		
Available Resources	Scarcity of adequately trained professionals		<i>Illustrative quote: "So, I think that we have few assistive specialists, so no one knows exactly what we are talking about. Right, this is related to employment, meaning the specialists themselves, even those in prosthetics, are few and they want more." (P1, HCP)</i>	<i>Illustrative quote: "The department started with one person, then two, so we had a shortage in manpower. But now, thankfully, we have reached about five people, among them two Saudis." (P21, Administrative Manager)</i>	<i>Illustrative quote: "For example, we had a shortage in the staff, and it all ended in rejection because of the budget." (P32, Clinical Manager)</i>	<i>Illustrative quote: "Currently, we have a shortage of manpower in Saudi Arabia." (P24, Leader)</i>	Convergence: Participants from all hospitals agree that the scarcity of adequately trained professionals significantly impacts the comprehensive delivery of services.
Available Resources ,Space	Operational and Logistical barriers in Inventory and Stocking		<i>Illustrative quote: "There is an issue with organization in that they have to produce a barcode for this thing, for the device, let's say the wheelchair, for example. But</i>	<i>Illustrative quote: "I always ask companies why they don't have a local warehouse to provide simple parts. I mean, don't stock large quantities; just provide me one or two pieces of each</i>	<i>Illustrative quote: "No, the store is small. For example, push chairs and wheelchairs are not in high quantities." (P31, Clinical Manager)</i>	<i>Illustrative quote: "They refer the patient to us, and the patient comes saying it's not available, so it's a long journey for the patients and it's a headache. In the end, there is no system to</i>	Convergence: There is a consensus agreement among participants from all hospitals that operational and logistical inefficiencies in inventory and stocking

			<i>our problem, not really a problem, it's just the nature of the work, that this chair will be dispensed to the patient and they will leave with it outside the hospital, it won't be returned. I think it was like this, I mean. But it's an internal matter, I don't know exactly how, I mean this topic." (P2, HCP)</i>	<i>thing, so even if I order them, they are delivered quickly and I don't have to wait for so long. But they always had this excuse that most of it is difficult to store or requires a specific environment for storage, so they don't store it in Saudi Arabia. It's more convenient for them to order it online. If we had a warehouse, I could store these things at a certain level of storage. For example, a silicone liner, I can't just store it anywhere, right? It needs a certain level of humidity and a specific place away from dust or anything, so I can use it for a long period." (P21, Administrative Managers)</i>		<i>indicate whether it's available or not available, which means to simplify the life of the patient." (P33, Leader)</i>	significantly impact the comprehensive delivery of services.
	Inadequate Storage and Training Spaces		<i>Illustrative quote: "A small room, you might say its size is three by five</i>	<i>Illustrative " quote:" The geographic location of the hospital affects its ability to</i>	<i>Illustrative quote: "No, the storeroom is small. We have two storerooms.</i>	<i>Illustrative quote: "Currently, the workshop we have is a small one due to space</i>	Convergence: Participants from all participating hospitals concur that inadequate

			meters, rectangular, and it does not have many cabinets. There is actually no place for devices, just storing boxes and a bit of chaos." (P14, HCP)	have warehouses. Therefore, it is forced to rent from outside in order to be able to store [items]." (P23, Administrative Manager)	We also have a space problem. In the hospital, we have these two storerooms and a large one. Sometimes they go to bring [items] from there too." (P29, Clinical Manager)	limitations. We don't have enough space currently, and there will be [more], because the workshop doesn't rely only on small parts. It needs an oven, it needs many things. So this is among the issues we have, which is the space, and also..." (P24, Leader)	storage and training spaces significantly impact the comprehensive delivery of services.
Available Resources, Materials & Equipment	Access to Materials and Equipment		Illustrative quote: "Most of them don't have an adapted car, nor do they have a prepared place. The chairs need a good cushion, like the Roho." (P26, HCP)	No data	No data	No data	Convergence: HCP participants from all three hospitals report that shortcomings in accessing essential accessories and transportation resources for MAT hinder its effective provision. Silence from Leaders and Managers: No similar concerns regarding the shortcomings in accessing essential accessories and transportation resources for MAT have been reported

							by leaders and managers.
	AT Assessment Tools and Outcome Measures		<i>Illustrative quote: “The standard, we usually take three important things: width, depth, height. These are the main things, and then we put the external things that might be needed, like whether the handrest is removable or not. Yes, of course, we include all of these in the clicks. We don’t have a follow-up, so we don’t have an official form to see the outcome and the satisfaction. It’s just prescriptions only.” (P5, HCP)</i>	<i>No data</i>	<i>No data</i>	<i>No data</i>	Convergence: HCP participants Silence from Leaders and Managers

Access to Knowledge & Information	Professional Development and Training	Poorly Designed Educational Programs	<i>Illustrative quote: "I believe that training and other things, no, I was not trained on them. For example, sport wheelchairs, lightweight wheelchairs, specific measurements, and these things, no, I was not trained on them at the university, only through experience." ((P19, HCP</i>	<i>Illustrative quote: "Yes, we currently have a shortage; there are two Saudis in the department who are trained."(P21, Administrative Manager)</i>	<i>Illustrative quote: "Of course, their training will be based on their experience with the bachelor's degree, nothing more."(P31, Clinical Manager)</i>	<i>Illustrative quote: "We have a lack of educational outputs. We only have one Saudi university, which is Taibah University, that graduates specialists in prosthetics. Some educational institutions, I think, had a level of technician, and they graduate [students]. One of the recommendations is that universities should start looking into this field." (P24, Leader)</i>	Convergence among participants on the need for access to knowledge and information, professional development, and training
		Training Deficiencies	<i>Illustrative quote: "I have encountered this a lot. I used to wish that I could do something; the idea is welcome. That's why, when I come to tell you about it, honestly, my management is receptive because they understand that</i>	<i>Illustrative quote: "Yes, we currently have a shortage; there are two Saudis in the department who are trained."(P21, Administrative Manager)</i>	<i>Illustrative quote: "Most of the specialists are not certified, they just have experience." (P22, Clinical Manager)</i>	<i>Illustrative quote: "Because the staff are not qualified, this company has a very, very excellent follow-up process because they send us the product and send someone with it who comes to check and provide follow-up for the modifications." (P20, Leader)</i>	Convergence: Participants from all groups and hospitals agree that there are training deficiencies among HCPs, which affect their ability to effectively provide services. This agreement highlights a systemic issue in the professional

			<i>this is needed. They might give you educational leave, but in the end, I might end up paying for it myself, you know? Then I go back and reconsider: does this thing deserve that I pay such an amount? I mean, for me, how much of an investment is it when I put something in and get something out of it in the end? Of course, it's worth it or not? So, it didn't happen, I mean, the matter." (P27, HCP)</i>				development and preparation of HCPs, with implications for the quality of care delivered.
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Table 4 Illustrative quotes and summary for the themes and sub-themes under the process domain

CFIR construct under the process domain	Themes identified	Sub-themes	Illustrative quotations HCP	Illustrative quotations Administrative Managers	Illustrative quotations Clinical Managers	Illustrative quotations Leaders	Convergence, complementarity, disagreement, and silence
Planning	Challenges in Strategic Planning and Coordination for Device Needs		<i>Illustrative quote:</i> <i>"We have randomness and confusion in terms of quantity and quality. How do they accommodate? Based on what they are requesting, for example, 100 wheelchairs, and 50 commodes per month. So, based on that, what statistics do you have? They don't even have access to the patient's demands for equipment, right? Then we also have the problem of sizes. They make sure to order one size 18, but we have overweight patients, and many patients need size 16. Okay, it might not matter for a patient who will use the wheelchair for 2-3 weeks, but we are supposed to give the wheelchair in the</i>	<i>Illustrative quote:</i> <i>"In terms of the facility, you have many things that are divided into two main categories: planning and budget. In terms of planning, when the hospital plans properly for the demand for these devices, the planning won't be effective without the presence of a budget. So, I have a database, and I know my needs, how much is required. Therefore, I can make a plan for the assets for the next four years. The demand is usually not going to decrease."</i> (P23, Administrative manager)	<i>Illustrative quote:</i> <i>"Yes, not every year, but almost every quarter, this is for basic mobility aids like canes and walkers. But we have consumptions regularly, and every year we determine [our needs] based on the consumptions we had the previous year. For example, last year we had so-and-so, we always make our reserves, honestly."</i> (P22, Clinical manager)	<i>Illustrative quote:</i> <i>"But periodically, I honestly don't remember exactly, we raise a tender and they send us even a long Excel sheet, look at the things you need beforehand, like annually plan. But these things, honestly, I can't help you with these because the people in logistics, who know what is what, there are things directly purchased, and others not..... There are things that are continuously requested like basic mobility aids, and sometimes they are out of stock,</i>	Complementarity: There is an acknowledgment from certain groups (managers and leaders) within the hospitals of challenges in strategic planning and coordination for device needs. These insights complement each other and provide a broader understanding of organizational and logistical challenges in managing device needs.

			<i>right size, the correct size suitable for his condition!" (P16, HCP)</i>			<i>and the patient buys them from outside. As for wheelchairs, prostheses, and such items, actually, we don't provide them here." (P33, leader)</i>	
Engaging	Lack of Engagement and Recognition from High-Level Leadership		<i>Illustrative quote: "In reality, it will end up in the higher management. 'I feel, no, they are not interested, but if they knew the importance of assistive devices, they would definitely provide them.'" (P18, HCP)</i>	<i>Illustrative quote: "For higher management and decision-makers, you can make a proposal and raise it to them, saying, 'I see that this device serves a large segment of people, this is within your scope because you actually see that this device serves this segment of people.' It's not a decision-maker, it's a committee, so they can process your medical equipment needs upon the total budget. They have a higher insight into the entire hospital, not just your areas. Right? So, the decisions, the choices like, say, the mechanical ventilator in the ICU, the nursing, they want things, you know?"</i> <i>(P21, Administrative Manager)</i>	<i>Illustrative quote: "There used to be a project, but it was a long time ago, several years back when we had a head who supported us in setting up a seating clinic. It's usually run by OT [Occupational Therapy]; this is part of their job, to do the assessment, like what's needed for a wheelchair, and the wheelchair and the trolley should have certain measurements, so that the person sits in a certain way. But this clinic didn't continue; it started initially but didn't last. So, now if I have a patient and I see they need</i>	<i>Illustrative quote: "No, they don't feel it's important, I mean, they don't realise its importance... So if the physicians, for example, became advocates for having a seating clinic, and we provide... We even raised a proposal and requested to have a wheelchair clinic. We put a budget for it and made a complete study, but it's gone with the wind." (P33, Leader)</i>	Convergence: There is a consensus among all participant groups across all hospitals that the lack of engagement and recognition from high-level leadership are significant issues impacting the provision of MAT services.

					<i>this, I can refer them to OT and they do an assessment for their seating system and give recommendations, but the problem is in the implementation afterwards. I don't think there's much interest. To be honest, when we set up the seating clinic before, the doctor who was there at the time, he was the acting CEO, his specialty was pediatrics, he believed in the role of physiotherapy, he was supportive, he was the one who let us start the clinic, he helped us. So, it depends on the person, generally speaking." (P28, Clinical Manager)</i>		
	Absence of Specialised Local Clinical Leadership		<i>Illustrative quote: "As staff, sometimes, I mean, they ask us, but there is nothing official, like 'not a committee' as you said. No, they don't gather here and</i>	No data	No data	<i>Illustrative quote: "It's a very important step that there are people concerned with assistive devices</i>	Convergence: There is a consensus among participants that specialised local clinical leadership is crucial for efficient

			<i>such, but they send us an email, for example, asking whether we use a certain device or not. If we don't use it, we tell them we don't use it. So, what happens? They save money and allocate it for something else, instead of it sitting in the store not being used. It ends up not being ordered again. So, these are some of the things that we participate in." (P13, HCP)</i>		<i>matters." (P6, Leader)</i>	management and utilisation of resources. This includes the proper allocation and use of devices, informed by feedback from staff, to ensure that investments are directed towards devices that are necessary and actively used in clinical settings.
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Table 5 Illustrative quotes and summary for the themes and sub-themes under the individual domain

CFIR construct under the individual domain		themes	Illustrative quotations HCP	Illustrative quotations Administrative Managers	Illustrative quotations Clinical Managers	Illustrative quotations Leaders	Convergence, complementarity, disagreement, and silence
Innovation Recipients, Patients	Need	Type of functional difficulty	<i>"When the patient entered, I found her weighing 150 kg, very overweight, and there were many overweight patients. And she is conscious, GCS 15 out of 15, she talks to you, everything, but she has a problem with mobility out of the bed, definitely she needs a power wheelchair. Okay, when we come to take her measurements according to her size and we put specific criteria in the power wheelchair, it's going to be very very hard to provide. Even if we give it to the case manager, they won't be able to provide it."(P12, HCP)</i>	No data	No data	No data	Convergence: Healthcare professionals from all hospitals agree that the complexity of patient health conditions significantly affects the provision of MAT. This shared understanding highlights the challenges faced by HCPs in delivering MAT services to patients with complex health needs. Silence from Managers and Leaders: There is no reported commentary or input from managers and leaders. This absence of feedback might indicate that such clinical intricacies

							are primarily the concern of frontline healthcare providers, or these complexities may not be directly encountered or acknowledged at the managerial and leadership levels.
	Motivation	Cultural and Social Influences on AT Acceptance	<i>"There is a stigma around it in society; patients want to appear to be normal and hence they have high expectations with regards to rehabilitation, to be able to walk again. Yes, I think society still does. There is still a stigma around patients with wheelchairs." (P5, HCP)</i>	<i>No data</i>	<i>No data</i>	<i>No data</i>	Convergence: There is a consensus among HCPs across all hospitals regarding the lack of acceptance of certain practices or devices due to societal and cultural perceptions and pressures. This indicates a shared recognition of external socio-cultural factors influencing healthcare delivery and patient acceptance of treatments or technologies. Silence from Managers and Leaders: Managers and

							leaders have not reported, suggesting either a lack of awareness or focus on these external factors in their roles, or possibly that these factors do not significantly impact their decision-making processes.
		Lacking Patient and Family Commitment	<i>"Or what is needed, and you buy it, but unfortunately, the compliance was very low from the patients and their families regarding these matters." (P26, HCP)</i>	<i>No data</i>	<i>No data</i>	<i>No data</i>	Convergence among HCPs and hospitals that insufficient patient and family commitment, motivation, and education significantly affect the accessibility and utilisation of MAT.
	Capability	Patient Perceptions and Acceptance of AT	<i>"Some patients don't accept it at all. If you tell them that you will dispense devices, they think that it means they can no longer write, they can no longer walk, that they can't do anything anymore! Some patients just don't accept it; they have basic needs</i>	<i>No data</i>	<i>No data</i>	<i>No data</i>	Convergence: There is a agreement among HCPs across all hospitals about the lack of acceptance of certain treatments or practices, attributed to personal perceptions and pressures. This highlights a consistent concern

			<i>that they need to provide in their home first." (P1, HCP)</i>				among frontline healthcare providers regarding the influence of individual beliefs and pressures on healthcare decisions and treatment acceptance. Silence from Managers and Leaders: Despite the concerns raised by HCPs, managers and leaders have not commented. This silence could suggest that these factors are less visible or considered at the managerial and leadership levels, or they may not be directly involved in aspects where such personal perceptions play a critical role.
		Inadequate Patient and Family Education and Awareness	<i>"I mean, most of the Patients and thire families 'not well-educated' , so when they are educated, yes, parents come to</i>	<i>No data</i>	<i>"Some patients take the financial support money for buying devices and purchase other things they might need</i>	<i>No data</i>	Convergence: Healthcare professionals and clinical managers from all hospitals agree that inadequate patient

			<i>you and discuss, saying 'I saw this, I saw that.' but they are rare, you can count them on your fingers. But the majority, no, there is little interest in this matter." (P27, HCP)</i>		<i>instead. There are also reported cases where the caregiver buys other tools for the patient without consulting the patient. So, it's almost like a cycle around these reasons. A patient might buy something that is not the required thing but takes the payment and does not buy what is recommended for them. They might have other priorities. It could be that the patient's awareness of these tools is low, or the patient might request something that's not suitable for them, even though they were given education, or maybe they weren't given enough education. Or they need the tools, but they arrive too late, and the patient</i>		and family awareness and knowledge of their specific needs and the available solutions significantly affect the accessibility of MAT. Silence from Managers and Leaders: There is no reported commentary from administrative managers and leaders regarding patient and family awareness issues, suggesting either a different area of focus in their roles or a lack of recognition of this issue at the managerial and leadership levels.
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					<i>has developed complications and can't use them. I mean the hospital, should be responsible for discharging the patient with the tools. This would greatly help many families."</i> <i>(P31, Clinical Manager)</i>		
	Opportunity	Lack of Accessible and Adequate Informational Resources for Patients	<i>"Indeed, the patient gets lost between the departments, between home care, social services, or rehabilitation. Those who come asking, we try to help. We go and tell them that you have alternatives, you have solutions one, two, three... If you're buying from outside or if someone is buying for you, I tell them you have to take this type. Some might go, like in the past, to the social services' warehouses, and they give them</i>	No data	<i>"A patient who is referred to us gets enough education about the available items or alternatives if they exist with us; this is the only way. We don't have access even to the website. We have the intention to do it, and one of the ideas proposed is to put it on the rehabilitation page on the website."</i> <i>(P22, Clinical Supervisor)</i>	No data	Convergence: HCP and clinical managers from all hospitals agree that the lack of accessible and adequate informational resources for patients significantly affects the accessibility of MAT. This shared viewpoint underscores a key area needing improvement to enhance patient awareness and utilisation of MAT. Silence from Administrative Managers and

			<i>something that is not their size. This has happened a lot."</i> <i>(P1, HCP)</i>				Leaders: There is no reported input or commentary from administrative managers and leaders on the issue of informational resource accessibility for MAT, indicating either a lack of awareness or a different focus within their roles.
		Accessibility and Financial Barriers	<i>"Some families, some of them don't want to wait because the dispensing of devices takes a long time, so they say they prefer to buy it themselves. So, we help them. We look, they come to us, they show us, even with pictures, they show us. We all help them on this journey until they get the right wheelchair. But some patients say they can't afford a wheelchair, even if it costs two</i>	<i>"Definitely, it's costly for the patient, I mean, if they go to buy it with those amounts, it becomes expensive."(P21, Administrative Managers)</i>	<i>"There is a big gap, especially if we want to provide the best solution for the patient. And it's hard for some families to cover the remaining amount." (P30, Clinical Supervisor)</i>	<i>"We use a form we have for prescriptions that the patient uses, and it's possible for them to get it dispensed from outside. But they buy it with their own money, no. And what I was going to say is that the more advanced and more expensive things, we don't bring them at all. Usually, it's up to the patient themselves to look for and</i>	Convergence: All participants, across various roles and hospitals, report that there is a significant financial burden on patients in accessing MAT. This shared viewpoint highlights a systemic issue affecting patient access to and the affordability of care.

			<i>thousand riyals."(P4, HCP)</i>			<i>find them, or they don't know exactly where to go, or if they go and find, they say it's expensive. So, they end up using simple things, they go buy simple pillows, sheets that they wrap into a roll. Honestly, this is what works more with patients, especially in pediatrics, it turns into a sort of improvisation. Even if I transferred it and knew what needs to be provided, in the end, they won't be able to buy it, always an obstacle. So, some of them, even... I remember one of my patients took a long- sleeved t-shirt, an old cotton one, cut it and</i>	
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						<i>stuffed it with cotton and used it as a cuff, like that. This is what happens, especially among people with medium or low income."</i> (P33, Leader)	
Innovation Deliverers, Health Professionals	Capability	Awareness and Knowledge about MAT among HCPs	<i>"Difficult cases that have core mobility issues, those I don't know how to work with, or those with spine problems, they become 'difficult for me to do an assessment for them, to do the assessment and to choose devices suitable.' So, I book an appointment for them and call the company, arrange with the company. They send two people from the company, including OTs, or two OTs do it. They have to do the assessment with me... Based on their assessment, we</i>	<i>Innovation Deliverers, Health Professionals</i>	No data	No data	Silence

			<i>make a request."</i> <i>(P18, HCP)</i>				
		Limitations in HCP Expertise	<i>"I know the basics, but for complex cases and so on, everyone [has their limitations]. No, those have specific people; we must refer them to them."</i> (P25, HCP)	No data	No data	No data	Convergence: Healthcare professionals across all hospitals agree that there are training deficiencies among HCPs, which affect their ability to effectively provide services.
	Opportunity	Autonomy and Recognition of HCP's Roles in Patient Care and Decision-Making	<i>"Like I told you, my role ends after I do the equipment description only, but the decision-making is done by the higher management."</i> (P17, HCP)	No data	No data	No data	Convergence: Healthcare professionals across all hospitals agree that there is a lack of autonomy and recognition of HCPs' roles in patient care and decision-making. This shared view among HCPs highlights a significant concern regarding their ability to influence patient care effectively.

							Silence from Managers and Leaders: There is no reported input or commentary from managers and leaders regarding the autonomy and role recognition of HCPs, indicating either a lack of awareness of this issue among these groups or different priorities in their roles.
Other Implementation Support, Administrative, clinical Managers	Need	Strategic Planning and Staff Expertise	<i>No data</i>	<i>"Here, the delay sometimes is due to planning, that the requests were not made early enough. The solution, as we said, is early planning. There must be early planning. When we send, we need them to provide us with the orders they need. This is the first step. So, always the requesting department or administration should ideally present their preliminary plans based on which future shortages in any required device can be avoided."</i>	<i>"We need the staff to be competent; we need competency to be applied to them." (P22, Clinical Manager)</i>	<i>No data</i>	Convergence among Managers agree on the importance of early strategic planning and staff competence for efficient operations and to prevent devices shortages.

				<i>(P8, Administrative Manager)</i>			
	Motivation	Logistics and Resource Management in MAT Provision	<i>No data</i>	<i>"Why don't you have a local warehouse that provides simple parts? I mean, don't store large quantities, just provide me with one or two pieces of everything, so that even if I order them, they are delivered quickly and I don't have to wait this long."</i> <i>(P21, Administrative Manager)</i>	<i>"Because not providing the necessary tools, unfortunately, will increase the cost, whether for the ministry or any fund, since the patient will keep going around in the same circle. But if we provide the tools, we will move on to the next stage, which is more safe for the patient, offers better function for them, and also, it's cost saving."</i> <i>(P31, Clinical Manager)</i>	<i>No data</i>	Convergence among managers agree that logistics and having a local supply of essential devices and their parts can reduce costs and improve patient outcomes in MAT provision.
	Capability	Advocacy and Awareness	<i>No data</i>	<i>No data</i>	<i>"No, they don't feel aware, I mean, they don't feel it's important. Also, the wheelchairs available in the hospital that the patients need are almost expired and pose a safety risk to the patients. For</i>	<i>No data</i>	Convergence among clinical managers recognise the need for increased advocacy and awareness regarding the capability of assistive devices.

					<i>instance, we get a patient coming in on a wheelchair that needs a hub replacement. It comes from the car to the clinic, for example, without breaks, you cannot remove the feet, so there are obstacles. Even what is currently available is not safe. If the physicians, for example, were to advocate for having a seating clinic and we dispense [wheelchairs], but we raised a proposal and requested to have a wheelchair clinic, set a budget for it, and did a complete study, but it's gone with the window." (P32, Clinical Manager)</i>		
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	Opportunity	Expanding Opportunities in Patient Support			<i>"We face many difficulties with the families, and unfortunately, I don't have solutions that I can offer them. I don't have the ability to refer them to another service, nor do I have the authority." (P30, Clinical Manager)</i>		Convergence among clinical managers recognise the need expanding opportunities in patient support
High-level Leaders	Need	Building Expert Networks for Enhanced MAT Services				<i>"Yes, we need experts from all over the kingdom, representatives of course. If the tenders are related to chairs, they request experts specialized in chairs from all sides that have the desire to purchase, and there should be a representative."</i> <i>(P7, Leader)</i>	Convergence among leaders recognise the need to build expert networks for enhanced mat services
	Motivation	The Need for Empowerment and Recognition of HCP in				<i>"And we have no involvement in the matter at all. I feel that there is an area</i>	Convergence among leaders recognise the need the need for empowerment and

		MAT provision				<i>of improvement, but unfortunately, no one is paying attention. In the hospital now, it's almost been 10 years since we had the authority to dispense wheelchairs. Even though we submitted a proposal to open a wheelchair clinic, excellent, but no one considered the topic. Their treatment is left to the role of rehabilitation, which are the physical medicine, the physiatrists. In this matter, no matter what we say, we are classified in allied health; our voice is not strong in the hospital like the physicians. I</i>	recognition of HCP in MATprovision
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						<i>have seen physical therapy in Riyadh and physical therapy in the Eastern Province, and it's taken mostly from the U.S. It's totally different. Here in the Eastern Province, I consider our physical therapy to be very much behind compared to Riyadh. There, there is support, there is a voice for physical therapy. Here, we are made, you could say, technicians, the most important thing is just that the patient is discharged after the surgery."</i> <i>(P33, Leader)</i>	
	Opportunity	Empowering Rehabilitation with				<i>"The reason is that rehabilitation</i>	Convergence among leaders recognise the need

		Autonomy for Improved Patient Care				<i>does not have full autonomy for this entire process.</i> <i>Autonomy is the main issue; we don't have complete autonomy for the whole process." (P20, Leader)</i>	to empower rehabilitation with autonomy for improved patient care
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Table 6 Summary Comparison Between Sites under the Innovation Domain

CFIR construct under the Innovation Domain	Themes identified	Sub-themes	Identified at Hospitals	Hospital (A)	Hospital (B)	Hospital (C)
Innovation Source	Sourcing and Availability of MAT	Dependence on Foreign AT Suppliers	A, B, C	• Unclear or lack of a standardised procedure in determining suppliers for MATs • A clear preference for using national (Saudi) products over foreign ones. • Challenges in finding suppliers for certain types of MATs.	Most foreign companies have an agent in Saudi Arabia. Rarely are items locally available. Often deals with a German company called "... " and a Swiss one called "....."	Few local options or companies available for servicing and maintaining equipment. Because of this limitation, they depend on the original sellers or manufacturers of the equipment for its maintenance and repair. This dependence on original vendors can suggest a potential weakness, especially if these vendors are not easily accessible or have expensive services.
Innovation Evidence-Base	Data and Research	Insufficient Data and Research	A, B	Need for comprehensive data on device effectiveness, especially for advanced prostheses' performance and durability	• lack of national statistics on assistive technology use and the commitment of governmental entities to accessibility • need for a preliminary study to identify strengths and weaknesses in current service provision before setting policies or protocols regarding equipment. • A research gap in evaluating the real-world effectiveness of efficiency-focused	No data

					devices in rehabilitation, indicating a need for targeted studies to validate their benefits.	
Innovation Relative Advantage	Different Perceived Value and Benefits of MAT		B, C	No data	○ Limited understanding of the Benefits of MAT's Contribution to Improving Patient Care and Ensuring Cost-Efficiency Limited understanding of the social advantages of MAT in patient care. ○ Inconsistent perception of cost benefits While daily costs of MAT can be high, they might be more economical over a longer period. MAT can help in saving costs for facilities	○ Limited understanding of the Benefits of MAT's Contribution to Improving Patient Care and Ensuring Cost-Efficiency Limited understanding of the social advantages of MAT in patient care. The provision of these devices moves the patient to the next phase of care, making it safer and more functional, ensuring cost-efficiency by preventing the recurring costs associated with the absence of suitable devices.
Innovation Cost	The High Cost of Devices and Spare Parts		A, B, C	Organisational budgets are limited, making it difficult to afford high-cost devices and spare parts.	○ Devices like specialised chairs can be exceedingly expensive, costing up to 100,000 riyals. Compared to other solutions, MAT can be more expensive.	○ Devices like specialised chairs can be exceedingly expensive, costing up to 100,000 riyals.
	Customisation and Production Constraints		A, B, C	need to be custom-made	• Difficulty in accommodating unique and complex patient needs, e.g. obesity. When confronted with patients with unique needs like being	assistive devices need to be custom-made and are not readily available in standard sizes, leading to a more extended provisioning process

					overweight, the existing assistive devices might not suffice. This necessitates a process where multiple companies are contacted for potential solutions. This introduces delays and potential inadequacies in care provision. • Customisation needs and the absence of ready-made solutions for certain devices like prosthetics. • Certain components are rarely manufactured locally	
Innovation Complexity	Complex Procedures and Delays in MAT Provision		A, B, C	Procurement involves multiple layers of approval and diverse stakeholders, resulting in significant time delays in purchasing the devices.	○ Procurement involves multiple layers of approval and diverse stakeholders, resulting in significant time delays in purchasing the devices. ○ Delays and Timeframe Uncertainties due to external dependencies	Procurement involves multiple layers of approval and diverse stakeholders, resulting in significant time delays in purchasing the devices
	Quality-Cost Balance in MAT provision		A, B, C	○ The true value in MAT provision is found not only in high quality but in balancing that quality with cost to ensure both efficacy and affordability	○ Encountered problems with the wheelchair's quality. ○ Main challenge: Providing the right sizes, especially for exceptionally tall or short individuals.	Main challenge: Providing the right sizes

					Limited standard sizes from some companies. ○ Equipment was of low quality due to market shortages. Challenges in sourcing reliable equipment and some were deemed unsafe	
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Table 7 Summary Comparison Between Sites under the Outer Setting Domain

CFIR construct under the Innovation Domain	Themes identified	Sub-themes	Identified at Hospitals	Hospital (A)	Hospital (B)	Hospital (C)
Partnerships and Connections	Challenges in Rigid Administrative Partnerships		A, B, C	NUPCO's centralised role adds bureaucracy, complicates direct purchasing due to regulations, and causes delays through complex logistics and expert reviews. Collaboration with the Ministry of Social Services often leads to the supply of generic aids that do not meet patients' specific needs	NUPCO 's centralised role adds bureaucracy, complicates direct purchasing due to regulations, and causes delays through complex logistics and expert reviews. Collaboration with the Ministry of Social Services often leads to the supply of generic aids that do not meet patients' specific needs.	Collaboration with the Ministry of Social Services often leads to the supply of generic aids that do not meet patients' specific needs.
Policies and Laws		Restrictive Policies and Regulatory Ambiguity in MAT Provision	A, B, C	- Only predefined list; requires committee approval - Justification required for higher-cost devices - Multi-level managerial approval for device order - Policies prefer generic over brand name Varying policies and procedures in Inpatient vs Outpatient	Some devices (like wheelchairs) have stricter distribution criteria due to factors like cost or availability. Eligibility Concerns, Not all patients, especially those not affiliated with specific institutions are eligible. Multi-level managerial approval for device order Reliance on external entities like social services can delay or even prevent the provision of necessary equipment. Varying policies and procedures in Inpatient vs Outpatient	Strict evaluation criteria are in place to determine a patient's financial capability to afford equipment, including reviewing bank statements and current job status. Equipment, typically, is not given for personal use but is more of a loan during the patient's stay in the hospital. The hospital does not provide wheelchairs readily

		Absence of Clear system and Regulation on Device Provision	B, C	no data	○ The hospital lacks comprehensive policies governing the provision, maintenance, and equitable distribution of medical devices. There is also an absence of structured follow-up procedures and limitations on device eligibility. ○ In-patients may receive devices like wheelchairs to facilitate hospital discharge, not necessarily based on genuine need. ○ Emphasis on daily hospital costs and the cost-saving benefits of early discharges. Budget constraints might limit the availability or quality of assistive technology provided. The institution may prioritise cost-saving measures over the comprehensive provision of technologies. ○ Patients getting equipped before discharge	The hospital lacks comprehensive policies governing the provision, maintenance, and equitable distribution of medical devices
Financing	Inadequate and Unstable Governmental		A, B, C	Budget is sourced from a health cluster and needs multi-ministerial approval. It can be allocated annually or for	Financing Issues	Previously, there were advanced acquisitions and the budget was robust, but current

	Financing Mechanisms			multiple years, affecting device availability.		projects are not completed and existing services like screening clinics had to be closed due to resource shortages and shifts to electronic referrals, causing patient confusion and disruptions in service delivery.
Local Conditions	Restrictions and Inequities due to Geographical Concentration		A, B, C	Patients often travel from outside Riyadh to access main rehabilitation centers, facing limited availability of essential mobility assistive technologies and budget constraints for these services.	Some patients from outside the main city send relatives to get prescriptions	Rehabilitation and assistive technology are in main cities. More often, patients who experience specialised medical conditions are typically referred to facilities in major cities like Riyadh since local medical services may not have the required specialisation. This dependency on distant specialised facilities can pose significant delays and increase inconvenience for patients. This localised service provision makes it exceptionally hard for those residing in farther regions to access needed healthcare services.
	Inadequate Environmental and Infrastructure Adaptability		A	Patients face challenges in adapting mobility assistive technologies at home due to lack of infrastructure. In public spaces, there is a lack of accessible areas that can accommodate assistive technologies	No data	No data

Table 8 Summary Comparison Between Sites under the Inner Setting Domain

CFIR construct under the Innovation Domain	Themes identified	Sub-themes	Identified at Hospitals	Hospital (A)	Hospital (B)	Hospital (C)
Physical Infrastructure	Characteristics of healthcare setting		B, C	No data	Focusing on acute care, only one ward which accepts a limited number, just 21 beds. Limited Rehabilitation Capacity; The rehabilitation unit is constrained with limited beds. Compared to the number of trauma cases, the capacity is deemed insufficient. The facility operates primarily as an acute setting, and there's a limitation in equipment particularly for patients in the acute phase. The setting may not have as expansive a rehabilitation facility. Only life-threatening equipment is given utmost importance; MAT is considered significant but	Focusing on acute care. The hospital has prioritized other medical services like transplant oncology over rehabilitation services. Although there is a department for rehabilitation, it is not activated, indicating a lesser focus on rehab services in the presence of acute cases and more prioritized medical services.

					doesn't have the urgency of life-threatening equipment	
Information Technology Infrastructure	Outdated IT Infrastructure		B, C	No data	The infrastructure of this facility is somewhat old. There was a challenge in system integration and financial considerations in integrating systems from two different vendors	Lack of a systematic and synchronized IT infrastructure, reliance on manual and clerical work, error-prone processes due to manual entries. e.g. The current IT infrastructure is insufficient and lacks systematic and synchronized functionalities, leading to a reliance on manual, clerical work such as using Excel sheets for tracking. The absence of features like barcodes and other synchronizing elements in the existing system makes the process prone to errors due to manual entries and lack of real-time synchronization.
Work Infrastructure	Undefined Role Boundaries in Prescriptive Authority		B, C	No data	The distinction between who determines the patient's needs and who authorises the provision of the required equipment can lead to issue. For instance, while the OT assesses the patient, the actual provision of assistive devices	OTs, PT are not directly involved in the device allocation process. It is under rehabilitation medicine. Lack of authority to prescribe, reliance on others for issuing equipment. e.g. Assessments are conducted and recommendations are made, but there is no

					falls under the administrative of the "Bed Management" department. this division can lead to delays and potential miscommunications, as the OTs, despite identifying the need, are not directly involved in the device allocation process. OT and PT roles in the process, with OTs being closer to patients but having limited authority on device specifications	authority to prescribe, requiring the involvement of physical medicine or other entities to issue equipment or implement recommendations. Attempts have been made since 2013 to gain prescribing authority, causing dependencies on other departments and entities to fulfill patient needs based on the recommendations made, which are not always fully implemented or fitting.
Communications	Inadequate Coordination and Communication Among Departments		C	No data	No data	The involvement of different entities like social workers and external donations sometimes results in equipment that doesn't fit the patient properly. Even the forms used are primarily for measurement purposes, sent from other departments, emphasizing a lack of integration and role clarity in the process. Lack of proper communication between different departments, potentially leading to inefficiencies or misunderstandings in operational processes.

	Challenges in Tracking Patient Care		A, B, C	HCPs are not always aware of the quality of devices purchased by outpatient individuals	The quality/type of devices that patients take from the bed management is frequently unknown	HCPs are not always aware of the quality of devices purchased by patient,outpatient/inpatient
Mission Alignment	Focus and Scope of Healthcare Settings		B, C	no data	○ Focuses and scopes, with some being specialized rehabilitation centers while others have broader healthcare objectives ○ The trend is to keep patients out of hospitals and emphasize outpatient care	Space limitations and competing departmental needs impacting the realization of organizational plans and goals for rehabilitation services.e.g .There was a plan for the specialized unit to be the first integrated rehabilitation center, with a dedicated department in the hospital for rehabilitation. However, due to space limitations and the priority given to oncology—being the only specialized unit in the region—the plans could not be realized, and the intended space was taken by oncology.
Funding	Availability of Internal Funding for MAT		A, B, C	Budgetary Priorities	Budgetary Priorities	Constraints in budget and financial resources affecting the availability and allocation of necessary resources and accessories for MAT. The organization is possibly in a transitional phase, with internal financial constraints from the hospital itself, where there is no allocated budget, leading to difficulties in realizing plans and

						provisioning resources for MAT.
Compatibility	Overloaded Workflows and Time Constraints		A, B	Due to busy workflows, healthcare providers find it challenging to engage in regular, meaningful interactions with patients, impacting device provision.	HCPs frequently deal with follow-up appointments and patient education under time constraints	No data
Relative Priority	Prioritisations Challenges in MAT Delivery and Associated Services		A, B, C	Budgets are limited and may focus more on acute care than rehabilitation services. Core issues like emergency and urgent surgeries get priority, but the reason for such prioritisation is unclear	Only life-threatening equipment is given utmost importance; MAT is considered significant but doesn't have the urgency of life-threatening equipment	Lack of prioritization and comparative assessment of rehabilitation services compared to other medical services like oncology.
Available Resources	Scarcity of adequately trained professionals		A, B, C	Limited number of specialists familiar with MAT, causing communication and implementation issues	Limited number of specialists familiar with MAT, causing communication and implementation issues	Limited number of specialists familiar with MAT, causing communication and implementation issues
Available Resources ,Space	Operational and Logistical barriers in Inventory and Stocking		A, B, C	Internal issue related to barcode generation for MAT items causes operational hindrances. Multi-step approval process for receiving stocks causes delays and makes timely provision of MATs difficult.	The warehouse needs to maintain particular storage conditions. For example, "silicon liners" have specific storage conditions such as certain humidity levels and must be stored away from dust to ensure their longevity.	Lack of system to efficiently manage and communicate the availability of items, leading to difficulties and inconveniences for the patients. Patients experience long journeys and inconvenience due to the lack of a system that accurately and promptly informs about the

					There's a recommendation that the warehouse should be directly under the rehabilitation department.	availability of items in the warehouse.
	Inadequate Storage and Training Spaces		A, B, C	Limited storage spaces, no dedicated areas for MAT-related training, remote external storage locations	Limited storage spaces, no dedicated areas for MAT-related training, remote external storage locations	Space limitations and competing departmental needs impacting the realization of organizational plans and goals for rehabilitation services.e.g .There was a plan for the specialized unit to be the first integrated rehabilitation center, with a dedicated department in the hospital for rehabilitation. However, due to space limitations and the priority given to oncology—being the only specialized unit in the region—the plans could not be realized, and the intended space was taken by oncology.
Available Resources, Materials & Equipment	Access to Materials and Equipment		A, B, C	E.g. Providing a patient with a mobility solution like a wheelchair is insufficient without considering additional needs like cushions to prevent pressure sores. If a critical component is missing, the solution is ineffective	E.g. Lack of specialised vehicles for MAT transport	shortcomings in accessing essential accessories and transportation resources for MAT hinder its effective provision.

	AT Assessment Tools and Outcome Measures		A, B,C	No standardised forms to monitor the results or check if patients are happy with the products	Focus primarily on three dimensions: width, depth, and height	Focus primarily on three dimensions: width, depth, and height prescription only, not provision; not sure if the participant will receive it, so no follow-up assessment
Access to Knowledge & Information	Professional Development and Training	Poorly Designed Educational Programs	A, B, C	No formal instruction on various types of wheelchairs or their specific measurements at university Knowledge in these areas comes purely from hands-on experience	There's a deficit in educational programs producing specialists in the field of prosthetics, with only Taibah University offering a dedicated specialist program in Saudi Arabia. Some institutes offer a technician level education.	The educational infrastructure for training is underdeveloped
		Training Deficiencies	A, B, C	Concerns were raised about who will fund additional educational programs, Gaps in the scope of on-the-job training for ATs and delays in responses from the administration for educational support.	Limited educational institutions are producing graduates in the domain of prosthetics or artificial limbs Concerns were raised about who will fund additional educational programs, Gaps in the scope of on-the-job training for ATs and delays in responses from the administration for educational support.	Gaps in the scope of on-the-job training for ATs

Table 9 Summary Comparison Between Sites under the process domain

CFIR construct under the Innovation Domain	Themes identified	Sub-themes	Identified at Hospitals	Hospital (A)	Hospital (B)	Hospital (C)
Planning	Challenges in Strategic Planning and Coordination for Device Needs		A, B	Early in the year, a fixed quantity of devices are ordered based on departmental assessments, which may later prove insufficient. Delays in identifying needs and submitting requests can lead to delayed procurement and service interruptions.	The overarching issue is the lack of coordination and clarity in the provision of devices, such as wheelchairs, with mismatches in supply, patient needs, and equipment sizes leading to inefficiencies in meeting patients' specific requirements.	No data
Engaging	Lack of Engagement and Recognition from High-Level Leadership		A, B,C	Limited Recognition of OT's Role Uncertainty about decision-making processes, and lack of clarity from higher authorities	Limited Recognition of OT's Role Uncertainty about decision-making processes, and lack of clarity from higher authorities	Limited Recognition of rehabilitation Role Lack of authority and advocacy impacts the ability to effect changes or improvements, with proposals and requests often being ignored or not acted upon. Physical therapy is considered to be behind compared to other areas, with a lack of support and voice in decision-making processes.

	Absence of Specialised Local Clinical Leadership		A, B,C	Lack of people specialised in high-tech assistive devices and advanced rehab devices.	The absence of a dedicated committee or specialised clinical leadership to oversee such decisions in MAT provision.	A need for more formalised and transparent governance to optimise the allocation of medical resources.
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Table 10 Summary Comparison Between Sites under the individual domain

CFIR construct under the Innovation Domain	Themes identified	Sub-themes	Identified at Hospitals	Hospital (A)	Hospital (B)	Hospital (C)
Innovation Recipients, Patients	Need	Type of functional difficulty	A, B, C	E.g. Patients with spinal cord injuries usually know their needs and require minimal evaluation. In contrast, children or those with severe cognitive or physical impairments need specialized, individualized solutions	Cases involve amputated patients. However, issues like weakness, heart problems, or other conditions affect the decision. E.g. obese patients	Basic medical equipment provision is streamlined, but for complex seating and positioning needs, arising due to severe health conditions like scoliosis or paralysis, specialized intervention is required.
	Motivation	Cultural and Social Influences on AT Acceptance	A, B, C	There's a noticeable pattern where many patients, especially those who have been walking independently or are young, often refuse the use of assistive devices such as wheelchairs or walking frames	Familial and societal pressures also play a role, with families sometimes discouraging the use of these devices due to social perceptions.	Rejecting to use assistive devices due to societal perceptions and personal feelings. Eg. Preference for inconspicuous solutions like strollers over wheelchairs for children, to avoid drawing attention Concerns over bullying or being pointed out due to the conspicuousness of devices like wheelchairs or braces (KAFOs) can lead to refusal to use them.

		Lacking Patient and Family Commitment	A, B, C	Non-compliance with prescribed instructions and medical advice is common, especially among those from distant locations. This leads to complications like neuromuscular scoliosis.	HCPs notice that some patients aren't aware of the proper usage of their assistive devices. This can lead to devices getting damaged quickly or not being utilized effectively.	There's a noted low compliance from patients and their families concerning their healthcare needs and understanding of equipment. Even with education provided, there is a chance that it might not be enough, and patients might still end up buying inappropriate items, highlighting the need for adequate and continuous education and awareness programs.
	Capability	Patient Perceptions and Acceptance of AT	A, B,C	Some patients are reluctant to accept assistive devices due to stigmatisation or the feeling of incapability. Others care more about appearing "normal" rather than device functionality.	○ Cultural norms where dependence on family is seen as normal or even preferable. ○ This social dynamic can lead to resistance against using assistive	○ Some patients see mobility aids as a sign of dependence, requiring more education on use.

					technologies, as they promote independence.	
		Inadequate Patient and Family Education and Awareness	A, B, C	Family lifestyles, such as staying mostly at home, also influence the choice of devices. The need for holistic evaluation and consideration of settings is important. Some patients and families purchase devices different from what was prescribed, often buying larger devices with the assumption that they will "grow into them," leading to posture issues.	Patients and families often base their knowledge on personal experiences or what they've seen others use, leading to potentially misguided requests for certain devices.	lack of awareness of available financial aid can lead to inappropriate purchases by the patients.
	Opportunity	Lack of Accessible and Adequate Informational Resources for Patients	A, B, C	Patients sometimes "get lost" navigating between home care and social services, leading to lack of proper care or treatment.	• Patients often lack knowledge about different options, leading to poor choices in terms of assistive technology. • HCPs indicated there's no presence of leaflets or booklets for assistive devices, making it complex for patients to get the	Limited patient knowledge about available options; lack of informative resources like websites; unclear or unknown information presented to rehab staff.

					information they need	
		Accessibility and Financial Barriers	A, B, C	Over 80% of patients face financial constraints. Some prefer to buy devices themselves to avoid waiting.	patients face financial constraints. Some prefer to buy devices themselves to avoid waiting.	Approval from affairs often comes with insufficient funds, forcing patients to pay out of pocket, especially for high-end, specialised equipment like Push chairs, active wheelchairs, and electric wheelchairs. Such discrepancies between market prices and approved amounts render acquiring necessary equipment a financial issues for many patients. There is a gap, especially when trying to provide the best solutions for patients. Families find it hard to cover the remaining amount for the best solutions. Even with proper referrals and awareness of what needs to be provided,

						the financial barrier remains a significant obstacle, forcing patients, especially those with moderate or low income, to resort to makeshift solutions
Innovation Deliverers, Health Professionals	Capability	Awareness and Knowledge about MAT among HCPs	A, B, C	Scope of training for staff is limited to the practical experience they acquire during their bachelor's degree program, with no additional or advanced training beyond that academic foundation	HCPs highlights the lack of knowledge about the available assistive devices that can be provided to patients. Without proactive investigation or inquiries, they remain unaware of the existing assistive devices.	lack of knowledge
		Limitations in HCP Expertise	A, B, C	Concerns were raised about who will fund additional educational programs, Gaps in the scope of on-the-job training for ATs and delays in responses from the administration for educational support.	Limited educational institutions are producing graduates in the domain of prosthetics or artificial limbs Concerns were raised about who will fund additional educational programs, Gaps in the scope of on-the-job training for ATs and delays in responses from the administration for educational support.	Gaps in the scope of on-the-job training for ATs

	Opportunity	Autonomy and Recognition of HCP's Roles in Patient Care and Decision-Making	A, B,C	Decision-making authority in financial matters is controlled by an external financial entity; limiting OT's influence	The therapist's role appears to end once they have completed the documentation, which can potentially limit the continuum of care and restrict the therapist from further involvement in the patient's treatment or follow-up. The role of the OT in acute patient care appears to be limited, implying restricted autonomy in decision-making and interventions for acute patients	Limited Recognition of OT's, PT's Role
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Appendix 12. Example of within-case analysis of CFIR inner setting domain - hospital A: available resources and knowledge access

CFIR Inner setting domain		Available Resources					Access to Knowledge & Information
		Funding	Space		Materials & Equipment	Personnel Shortage	Access to Knowledge & Information
Institutional and Systemic factors Hospital A	Key themes	Availability and Allocation of Internal Funding for MAT	Warehouse condition & management policy	Storage and training spaces	Struggles in Sourcing Medical Device Materials		Training Deficiencies
P1 HCP (AT specialist) M, experience (11-20)		- Patients must pay for parts costs - High costs burden for many patients who can't afford parts - System changed: no longer special requests possible, now online submission with fixed amounts (P1, 02-02-2023, Text:34-36, 44, 102)		-Problems with dedicated storage space allocation -Issues with warehouse management (P1, 02-02-2023, Text:58)	-Limited parts availability -Suggests online ordering as alternative to local vendors -Uses returned devices as spare parts when possible (P1, 02-02-2023, Text:32,28)	-Few AT specialists available -Single person responsible for all maintenance -Daily maintenance requests overwhelming -Staffing challenges in prosthetics department (P1, 02-02-2023, Text:48,52)	-Conducts awareness sessions for specialists -Knowledge sharing during case conferences (P1, 02-02-2023, Text:160)

P2 HCP (AT specialist) F, experience (<5)		-System changed from direct device provision to financial aid -Financial aid amount is less than actual device costs -Delay in receiving financial support (P2, 01-02-2023, Text:18,20)	- Issues with barcode system for equipment tracking -Complex internal processes for warehouse codes -Two storage locations: small room in hospital and external warehouse -Weekly trips needed to external warehouse for stock collection -Limited storage capacity affects stock management (P2, 01-02-2023, Text:48,52: "there was an issue with barcodes for devices... internal processes, I don't exactly know how this works")	-Recently acquired small storage room -Weekly trips required to external warehouse - Limited storage capacity in hospital - Complex internal processes for warehouse codes (P2, 01-02-2023, Text:40,48,52,132,136)	-Relying on previous years' stock -Weekly collection from external warehouse -Long processes for new stock with multiple approvals needed (P2, 01-02-2023, Text:40,64)		
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P3 HCP (OT) M, experience (<5) Speciality: Orthopedics		-Limited budget availability -Lengthy process for approvals (P3, 27-01-2023, Text:262)	-Two-tier storage system: internal and external warehouses - External warehouse used for outpatient equipment - AT specialists must collect equipment in advance for patient training (P3, 27-01-2023, Text:177,185: "they have internal and external warehouses... mainly outpatient equipment in external warehouses")	-Separate internal and external warehouses -Outpatient equipment stored in external warehouses - AT specialists retrieve equipment in advance for inpatient training (P3, 27-01-2023, Text:177,185)			-Challenges with accessing training due to costs -Issues with getting responses for training requests (P3, 27-01-2023, Text:230,238)
P4 HCP (OT) F, experience (<5), Speciality: Pediatrics		- System changed from providing wheelchairs to giving financial average -Reduction in allocated amounts		Warehouses located far from city (P4, 09-02-2023, Text:65)			

		(from 10-15,000 to 2-3,000) (P4, 09-02-2023, Text:65)					
P5 HCP (OT) M, experience (11-20) Speciality: Orthopedics		No Data	-Different storage arrangements for different equipment types -Large equipment stored externally -Smaller devices stored in hospital -PT department has dedicated storage for basic mobility aids (P5, 14-02-2023, Text:42: "we don't have specific store... equipment goes there and then comes to us")	-No specific store for large equipment like wheelchairs -Adequate storage for smaller devices -No dedicated wheelchair training area -Use basement and outdoor areas for training (P5, 14-02-2023, Text:18,42)			-On-job training for new hires -Annual competency checks for wheelchair prescriptions -Regular vendor training for prosthetics -Training rated as "acceptable but could be better" (P5, 14-02-2023, Text:50)

Appendix 13. Summarised table of the documentary analysis findings

Table 4 Hospital Findings Comparison Table for Documents D1, D2, D3

Finding	Hospital A (D2)	Hospital B (D1)	Hospital C (D3)
Type of Hospital	Public (government) hospital D2	Public (government) hospital D1	Public (government) hospital D3
City	Riyadh	Riyadh	Dammam
Eligibility Concerning AT	The patient must be admitted as an inpatient on their first admission; otherwise, they need a referral to MSD or will have to pay out-of-pocket.	Patients must be affiliated with the hospital to be eligible. Non-eligible and outpatients need referral to MSD or must pay out-of-pocket if funding is unavailable.	Basic devices such as canes, crutches, and walkers are provided. Others, like wheelchairs, require assessment and referral to MSD, or patients must pay out-of-pocket.
Prescription Requirements	Mandatory (Class A), necessary (Class B), and optional (Class C).	Based on patient mobility, medical conditions, and home environment.	None
Patient Mobility Consideration	Involves OT, SLP, RT roles, and timelines.	Criteria include immobility, limited mobility, and specific medical conditions.	None
Home Environment	Facilitates provision through ministry or self-finance.	Needs to be suitable for the devices.	None
Patient Acceptance	Class C is optional, and it is the patient's choice and responsibility to obtain these devices; payment is out-of-pocket.	Patients need to express willingness to use the devices.	None
Equipment Classification	Mandatory (Class A), necessary (Class B), and optional (Class C).	Categorises equipment based on medical conditions and physical requirements.	None
Provision and Sponsorship	For first-time admitted patients after injury/illness.	Affiliation and eligibility within the hospital are required.	None
Prescription Process	Involves OT, SLP, RT roles, and timelines if the device is available.	The process is not clear; OT assessment is followed by administration providing the device if available.	None
Assistive Technology Unit Role	Facilitates provision through hospital, ministry of social services, or self-finance.	None	None
Training and Follow-up	Provides training for inpatients. The AT Unit ensures the suitability of items and trains patients/caregivers on proper and safe use.	None	None

Table 2 Summary Table of Government Documents (D4, D5, D6)

Document	Purpose	Key Points	Observations
Financial Assistance Procedures for Medical Devices [D4]	Guidelines to provide financial support for acquiring assistive devices	• Patients can access financial support for assistive devices; providers need to be informed of this policy to guide patients. • Patients can access the ministry's website, select services, create an account, and complete a disability assessment. • Facilitates access to assistive technology for eligible individuals. • Establishes a clear pathway for patients to obtain financial support, from initial application to follow-up.	The lack of specificity in procurement mechanisms could lead to confusion and impede timely access to devices. The dilemma of handling out-of-pocket expenses or enduring waits for government approvals exacerbates barriers to acquiring devices. Quality and sourcing concerns arise when procurement sources are not explicitly identified, risking patient safety and efficacy of care.
The Implementing Regulations of the Competition and Government Procurement System [D5]	Outlining government procurement and financial regulations	• Covers contracting procedures, financial approvals, and budget considerations for government entities • Affects how government entities procure and provide assistive technology, influencing the availability and accessibility • Highlight the legal and financial frameworks governing procurement and contracts.	Challenges in strategic planning and coordination for assistive device needs are evident. Custom-made devices present a complex challenge within the procurement framework due to their highly individualised nature. There is a need for procurement processes that accommodate customisation, with flexible timelines and specialised expertise.
Assistive Technologies and Their Employment for Individuals with Disabilities in Saudi Arabia [D6]	Policy report about empowering individuals with disabilities using assistive technologies	• Covers the role of assistive technologies, types available, historical development, challenges in implementation, and strategic goals in Saudi Arabia • Highlights the impact of technologies on improving the quality of life for individuals with disabilities. • Provides insights into the types of technologies available and the challenges faced in adoption and utilisation. • Emphasizes training and awareness.	Despite strategic efforts, such as Vision 2030, there is a misalignment that may impede the optimal deployment of assistive technologies within healthcare institutions.

Appendix 14. Cross-case analysis and document integration details

Cases	Hospital A		Hospital B		Hospital C		Integration
	Interview Data	Document Data	Interview Data	Document Data	Interview Data	Document Data	
Procurement	Significant delays due to multiple approval layers	Highlighted procurement regulations, lengthy process (Government Document, D5, Page 14)	Procurement involves multiple layers of approval and diverse stakeholders, resulting in significant time delays and timeframe uncertainties due to external dependencies..	Highlighted procurement regulations, lengthy process (Government Document, D5, Page 14)	Procurement involves multiple layers of approval and diverse stakeholders, resulting in significant time delays in purchasing the devices.	Highlighted procurement regulations, lengthy process (Government Document, D5, Page 14).	Regulatory frameworks affecting accessibility, planning challenges, and procurement delays hinder timely access to MATs due to multi-layer approval.
Customisation Needs	Devices need custom-making for unique needs	Must follow specific regulatory requirements (Article Twenty-Two) Government Document, D5, Page 13).	Unique patient needs, like obesity, require multiple company contacts for custom devices, causing delays and care inadequacies, especially without local manufacturing	Must follow specific regulatory requirements (Article Twenty-Two) Government Document, D5, Page 13).	Need to be custom-made and are not readily available in standard sizes, resulting in a longer provisioning process.	Must follow specific regulatory requirements (Article Twenty-Two) Government Document, D5, Page 13).	Customisation delays due to regulatory adherence and specific patient needs
Budget Constraints	Limited funds, acute care prioritised,	Provided by the rehabilitation hospital for	Budget priorities focus on life-	Financial aid process, importance of fund availability	Financial constraints,	Financial aid process, importance of fund availability	Budget constraints impacting

	unclear prioritization reasons	training or until external sponsorship is secured before discharge (D2, page 2). Engage with the Ministry of Social Affairs or the hospital's self-finance fund to provide required equipment (D2, page 3). Share estimated costs and procurement information for devices with Class B and C patients or their families (D2, page 3). Financial aid process, importance of fund availability (Government Document, D5, Page 14). Applying for financial aid for assistive medical devices involves the Ministry of Human Resources and Social Development	threatening equipment	(Government Document, D5, Page 14). Applying for financial aid for assistive medical devices involves the Ministry of Human Resources and Social Development (Government Document, D4, Page 1)	limited allocated budget	(Government Document, D5, Page 14). Applying for financial aid for assistive medical devices involves the Ministry of Human Resources and Social Development (Government Document, D4, Page 1)	resource allocation, dependency on external funding, financial prioritization issues
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		(Government Document, D4, Page 1)					
2030 Vision	Emphasis on well-being and disability rights exists, but current resource allocation is inadequate to meet these needs.	The Kingdom's 2030 Vision and legal frameworks, including international treaties, aim to enhance well-being and protect the rights of all citizens, particularly persons with disabilities, in health, education, and employment (Government Document, D6, page 4).	Vision 2030 promoting preventive care, necessity of prosthetics	The Kingdom's 2030 Vision and legal frameworks, including international treaties, aim to enhance well-being and protect the rights of all citizens, particularly persons with disabilities, in health, education, and employment (Government Document, D6, page 4).	Space limitations and competing departmental needs, such as prioritizing oncology over rehabilitation services, hindered the realization of plans for an integrated rehabilitation center, misaligning with the 2030 Vision goals.	Quality-of-Life Program focuses on well-being (Government Document, D6, page 4).	Alignment with Vision 2030's preventive care and well-being goals, current resource allocation misalignment
Role Clarity	Clear roles, administrative delays	Document highlights clear roles: Involves OT, SLP, RT roles, and timelines if the device is available (D2, page 1).	OTs involved but lack authority, bed management department manages provision	The process is not clear; OT assessment is followed by administration providing the device if available.	OT and PT involvement, reliance on other departments for prescriptions	Wheelchair assessment managed by physical medicine (D3)	Need for clear roles and prescriptive authority, delays due to division of responsibilities, administrative restriction
Eligibility & Training	Inpatient training, device provision based on eligibility	Patients must be admitted as inpatients on their first admission or require a referral to MSD or pay out-of-pocket. The AT Unit provides training for inpatients, ensuring item	Eligibility issues, stricter criteria for device provision	Patients must be eligible (employee or their family) or pay out-of-pocket if funding is unavailable, with no training or follow-up services provided (D1, page 1)	Strict evaluation criteria, including bank statements and job status, determine a patient's financial capability for equipment, which is typically loaned	Basic devices are provided, but complex devices like wheelchairs require an assessment and referral to MSD or out-of-pocket payment, with no training or follow-up services (D3).	Inflexible policies affecting service delivery, reliance on external entities, lack of comprehensive policies and structured follow-up procedures

		suitability and training patients/caregivers on proper and safe use (D2, page 1-2).			during the hospital stay; the hospital lacks comprehensive policies for the provision, maintenance, and equitable distribution of medical devices, including wheelchairs.		
Accessibility Issues	Patients travel for access, infrastructure limitations	-	Some patients from outside the main city send relatives to obtain device prescriptions.	Requirements for prescription, suitability for living environment.” (D1, page 7)	Patients travel for access, dependency on major city facilities	-	Accessibility challenges, infrastructure inadequacies, dependency on specialized facilities
Partnership Issue	NUPCO's centralized role adds bureaucracy and delays due to regulations, logistics, and expert reviews, while collaboration with the Ministry of Social Services often results in generic aids that do not meet specific patient needs	The AT Unit will facilitate the required device through the Ministry of Social Affairs or the hospital's self-finance fund (D2, Page 2).	NUPCO bureaucracy causing delays, generic aids not meeting needs.	-	Collaboration with the Ministry of Social Services often leads to the supply of generic aids that do not meet patients' specific needs.	-	Rigid administrative partnerships causing delays and inadequate customization of aids

Financial Burden	Over 80% face financial constraints, some buy devices themselves	Assistive Devices Prescription Form required, financial review (Government Document, D5, Page 4) For first-time admitted patients after injury/illness, Procedure 6.3 requires filling out the Assistive Devices Prescription Form, including the estimated cost and information on where the patient can find the device for Class C. (D2, Page 3).	Financial constraints, out-of-pocket payments for non-eligible patients	Assistive Devices Prescription Form required, financial review (Government Document, D5, Page 4) Eligibility within the hospital is required. Referral to MSD or must pay out-of-pocket if funding is unavailable (D1, Page 1).	Previously, budgets were strong and acquisitions advanced, but now projects are incomplete, screening clinics are closed due to resource shortages, and shifts to electronic referrals cause patient confusion and out-of-pocket payments for devices.	Assistive Devices Prescription Form required, financial review (Government Document, D5, Page 4) Referral to MSD or must pay out-of-pocket (D3)	Significant financial burden on both patients and hospitals, gaps between funding and actual costs, and patients resorting to makeshift solutions due to financial barriers
Planning	Devices are ordered early in the year based on departmental assessments. This initial order may be insufficient due to delays in identifying needs and submitting requests, leading to procurement delays and	The organisation is required to publish its work and purchase plans, including specific information, during the first quarter of each financial year in accordance with the system. (D5, Page 2).	There is a significant lack of coordination and clarity in the provision of devices such as wheelchairs, leading to mismatches between supply, patient needs, and equipment sizes. This causes	The organisation is required to publish its work and purchase plans, including specific information, during the first quarter of each financial year in accordance with the system. (D5, Page 2).	-	The organisation is required to publish its work and purchase plans, including specific information, during the first quarter of each financial year in accordance with the system. (D5, Page 2).	Certain groups, including managers and leaders within hospitals, acknowledge challenges in strategic planning and coordination for device needs. These insights provide a broader understanding of the organisational and logistical

	service interruptions..		inefficiencies in meeting patients' specific requirements.				challenges in managing device needs.
Cultural and personal perceptions	Stigmatisation, reluctance to use assistive devices.	Class C Devices: Optional devices that patients can choose to obtain at their own expense, emphasizing patient autonomy and willingness (D1, Page 7; D2, Page 2).	Cultural norms favor family dependence, resistance to technology	Patients need to express willingness to use the devices (D1, Page 5- 7)	Some patients view mobility aids as a sign of dependence, highlighting the need for more education on their use	-	Cultural and personal perceptions affecting acceptance and use of assistive technologies, need for education and awareness

Appendix 15. Mapping constructs from the original CFIR (2009) to the updated CFIR (2022)

This supplementary document provides a detailed mapping of the constructs from the original Consolidated Framework for Implementation Research (CFIR), first published in 2009, to the constructs in the updated CFIR released in 2022. The mapping was conducted by Damschroder, Reardon, Widerquist, and colleagues in 2022.

I. INTERVENTION CHARACTERISTICS DOMAIN		I. INNOVATION DOMAIN	
Old Construct Name	Old Construct Definition	Updated Construct Name	Construct Definition
Intervention Source	Perception of key stakeholders about whether the intervention is externally or internally developed.	A. Innovation Source	The group that developed and/or visibly sponsored use of the innovation is reputable, credible, and/or trustable.
Evidence Strength & Quality	Stakeholders' perceptions of the quality and validity of evidence supporting the belief that the intervention will have desired outcomes.	B. Innovation Evidence-Base	The innovation has robust evidence supporting its effectiveness.
Complexity	Perceived difficulty of implementation, reflected by duration, scope, radicalness, disruptiveness, centrality, and intricacy and number of steps required to implement.	F. Innovation Complexity	The innovation is complicated, which may be reflected by its scope and/or the nature and number of connections and steps.
Design Quality and Packaging	Perceived excellence in how the intervention is bundled, presented, and assembled.	G. Innovation Design	The innovation is well designed and packaged, including how it is assembled, bundled, and presented.
Cost	Costs of the intervention and costs associated with implementing that intervention including investment, supply, and opportunity costs.	H. Innovation Cost	The innovation purchase and operating costs are affordable.
II. OUTER SETTING DOMAIN		II. OUTER SETTING DOMAIN	
Old Construct Name	Old Construct Definition	Updated Construct Name	Construct Definition
Patient Needs & Resources	The extent to which patient needs, as well as barriers and facilitators to meet those needs, are accurately	<i>see Roles Subdomain, Innovation Recipients</i>	<i>Construct separated and relocated; see Roles Subdomain: Innovation Recipients; Characteristics</i>

	known and prioritized by the organization.		<i>Subdomain: Need; and Inner Setting Domain: Culture: Recipient-Centeredness.</i>
Cosmopolitanism	The degree to which an organization is networked with other external organizations.	D. Partnerships & Connections	The Inner Setting is networked with external entities, including referral networks, academic affiliations, and professional organization networks.
External Policies & Incentives	A broad construct that includes external strategies to spread interventions including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting.	E. Policies & Laws	Legislation, regulations, professional group guidelines and recommendations, or accreditation standards support implementation and/or delivery of the innovation.
III. INNER SETTING DOMAIN		III. INNER SETTING DOMAIN	
Old Construct Name	Old Construct Definition	Updated Construct Name	Construct Definition
Structural Characteristics	The social architecture, age, maturity, and size of an organization.	A. Structural Characteristics	Infrastructure components support functional performance of the Inner Setting. <i>Use this construct to capture themes related to Structural Characteristics that are not included in the subconstructs below.</i>
Goals & Feedback	The degree to which goals are clearly communicated, acted upon, and fed back to staff, and alignment of that feedback with goals.	I. Mission Alignment	Implementing and delivering the innovation is in line with the overarching commitment, purpose, or goals in the Inner Setting.
Available Resources	The level of resources dedicated for implementation and on-going operations including money, training, education, physical space, and time.	J. Available Resources	Resources are available to implement and deliver the innovation. <i>Use this construct to capture themes related to Available Resources that are not included in the subconstructs below.</i>

Access to knowledge and information	Ease of access to digestible information and knowledge about the intervention and how to incorporate it into work tasks.	K. Access to Knowledge & Information	Guidance and/or training is accessible to implement and deliver the innovation.
IV. CHARACTERISTICS OF INDIVIDUALS		IV. INDIVIDUALS DOMAIN	
Old Construct Name	Old Construct Definition	Updated Construct Name	Construct Definition
<i>None</i>	<i>See Outer Setting: Patient Needs & Resources.</i>	I. Innovation Recipients	Individuals who are directly or indirectly receiving the innovation.
V. PROCESS		V. IMPLEMENTATION PROCESS DOMAIN	
Old Construct Name	Old Construct Definition	Updated Construct Name	Construct Definition:
Planning	The degree to which a scheme or method of behavior and tasks for implementing an intervention are developed in advance and the quality of those schemes or methods.	D. Planning	Identify roles and responsibilities, outline specific steps and milestones, and define goals and measures for implementation success in advance.
Engaging	Attracting and involving appropriate individuals in the implementation and use of the intervention through a combined strategy of social marketing, education, role modeling, training, and other similar activities.	F. Engaging	Attract and encourage participation in implementation and/or the innovation. <i>Use this construct to capture themes related to Engaging that are not included in the subconstructs below.</i>

Themes and subthemes identified from triangulation and mapped to CFIR domains

Themes	Subthemes	CFIR
Healthcare systems and policy barriers	• Absence of Clear System and Regulation on Device Provision • Barriers in Administrative and Collaborative Partnerships • Leadership Engagement Deficit	• Outer setting domain: Policies, Laws and Partnerships and Connections • Process domain; Engaging
Procurement and delivery challenges	• Sourcing and Availability of mobility products • Logistical challenges • Procurement and delivery challenges	• Process domain, planning • Innovation domain, innovation source, Inner setting domain, structural characteristics.
Device-related barriers	• Challenges in product standardisation and quality assurance • The High Cost of products and Spare Parts	• Innovation domain, innovation cost and innovation design
Information and awareness barriers	• Lack of awareness and information • Data needed to guide decisions in mat	• Innovation domain, innovation evidence base • Inner setting domain, access to knowledge and information
Resource and Infrastructure Barriers	• Availability of Resources (funding, space, professionals, materials) • Characteristics of Healthcare Setting	• Inner setting domain, structural characteristics, and mission alignment • Inner setting domain, available resources
Personal and environmental barriers	• Personal factors, such as individual preferences, educational background, and sociodemographic factors • Environmental barriers include physical, social, and cultural	• Individuals' domain and outer setting domain, innovation recipients, policies, laws

Appendix 16. Strategies identified from this thesis and their definitions

from "A Refined Compilation of Implementation Strategies: Results from the Expert Recommendations for Implementing Change (ERIC) Project" (Powell et al., 2015)

ERIC Strategies	Definition
1. Identify and prepare champions	Identify and prepare individuals who dedicate themselves to supporting, marketing, and driving through an implementation, overcoming indifference or resistance that the intervention may provoke in an organization
2. Conduct educational meetings	Hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, and community, patient/consumer, and family stakeholders) to teach them about the clinical innovation
3. Assess for readiness and identify barriers and facilitators	Assess various aspects of an organization to determine its degree of readiness to implement, barriers that may impede implementation, and strengths that can be used in the implementation effort
4. Conduct local consensus discussions	include local providers and other stakeholders in discussions that address whether the chosen problem is important and whether the clinical innovation to address it is appropriate
5. Capture and share local knowledge	Capture local knowledge from implementation sites on how implementers and clinicians made something work in their setting and then share it with other sites
6. Create a learning collaborative	Facilitate the formation of groups of providers or provider organizations and foster a collaborative learning environment to improve implementation of the clinical innovation
7. Develop a formal implementation blueprint	Develop a formal implementation blueprint that includes all goals and strategies. The blueprint should include the following: 1) aim/purpose of the implementation; 2) scope of the change (e.g., what organizational units are affected); 3) timeframe and milestones; and 4) appropriate performance/progress measures. Use and update this plan to guide the implementation effort over time
8. Build a coalition	Recruit and cultivate relationships with partners in the implementation effort
9. Inform local opinion leaders	Inform providers identified by colleagues as opinion leaders or “educationally influential” about the clinical innovation in the hopes that they will influence colleagues to adopt it
10. Promote adaptability	Identify the ways a clinical innovation can be tailored to meet local needs and clarify which elements of the innovation must be maintained to preserve fidelity
11. Conduct local needs assessment	collect and analyze data related to the need for the innovation
12. Access new funding	Access new or existing money to facilitate the implementation

13. Use advisory boards	Create and engage a formal group of multiple kinds of stakeholders to provide input and advice on implementation efforts and to elicit recommendations for improvements
14. Develop educational materials	Develop and format manuals, toolkits, and other supporting materials in ways that make it easier for stakeholders to learn about the innovation and for clinicians to learn how to deliver the clinical innovation
15. Alter incentive structures	Work to incentivize the adoption and implementation of the clinical innovation
16. Obtain and use patients and family feedback	Develop strategies to increase patient/consumer and family feedback on the implementation effort
17. Involve patients and family members	Engage or include patients/consumers and families in the implementation effort
18. Conduct educational visits	Have a trained person meet with providers in their practice settings to educate providers about the clinical innovation with the intent of changing the provider's practice
19. Involve executive boards	Involve existing governing structures (e.g., boards of directors, medical staff boards of governance) in the implementation effort, including the review of data on implementation processes
20. Tailor strategies	Tailor the implementation strategies to address barriers and leverage facilitators that were identified through earlier data collection
21. Identify early adopters	Identify early adopters at the local site to learn from their experiences with the practice innovation
22. Develop academic partnerships	Partner with a university or academic unit for the purposes of shared training and bringing research skills to an implementation project
23. Facilitation	A process of interactive problem solving and support that occurs in a context of a recognized need for improvement and a supportive interpersonal relationship
24. Visit other sites	Visit sites where a similar implementation effort has been considered successful
25. Conduct cyclical small tests of change	implement changes in a cyclical fashion using small tests of change before taking changes system-wide. Tests of change benefit from systematic measurement, and results of the tests of change are studied for insights on how to do better. This process continues serially over time, and refinement is added with each cycle
26. Conduct ongoing training	Plan for and conduct training in the clinical innovation in an ongoing way
27. Distribute educational materials	Distribute educational materials (including guidelines, manuals, and toolkits) in person, by mail, and/or electronically
28. Develop and implement tools for quality monitoring	Develop, test, and introduce into quality-monitoring systems the right input—the appropriate language, protocols, algorithms, standards, and measures (of processes, patient/consumer outcomes, and

	implementation outcomes) that are often specific to the innovation being implemented
29. Promote network weaving	Identify and build on existing high-quality working relationships and networks within and outside the organization, organizational units, teams, etc. to promote information sharing, collaborative problem-solving, and a shared vision/goal related to implementing the innovation
30. Organize clinician implementation team meetings	Develop and support teams of clinicians who are implementing the innovation and give them protected time to reflect on the implementation effort, share lessons learned, and support one another's learning
31. Use an implementation adviser	seek guidance from experts in implementation
32. Provide local technical assistance	Develop and use a centralized system to deliver technical assistance focused on implementation issues
33. Purposely reexamine the implementation	Monitor progress and adjust clinical practices and implementation strategies to continuously improve the quality of care
34. Fund and contract for clinical innovation	Governments and other payers of services issue requests for proposals to deliver the innovation, use contracting processes to motivate providers to deliver the clinical innovation, and develop new funding formulas that make it more likely that providers will deliver the innovation
35. Model and simulate change	Model or simulate the change that will be implemented prior to implementation
36. Recruit, designate and train for leadership	Recruit, designate, and train leaders for the change effort
37. Audit and provide feedback	Collect and summarize clinical performance data over a specified time period and give it to clinicians and administrators to monitor, evaluate, and modify provider behavior
38. Provide ongoing consultation	Provide ongoing consultation with one or more experts in the strategies used to support implementing the innovation
39. Develop resource sharing agreements	Develop partnerships with organizations that have resources needed to implement the innovation
40. Facilitate relay of clinical data to providers	Provide as close to real-time data as possible about key measures of process/outcomes using integrated modes/channels of communication in a way that promotes use of the targeted innovation
41. Stage implementations scale up	Phase implementation efforts by starting with small pilots or demonstration projects and gradually move to a system wide rollout
42. Work with educational institutions	Encourage educational institutions to train clinicians in the innovation
43. Develop and organize quality monitoring systems	Develop and organize systems and procedures that monitor clinical processes and/or outcomes for the purpose of quality assurance and improvement
44. Obtain formal commitments	Obtain written commitments from key partners that state what they will do to implement the innovation

45. Prepare patients/consumers to be active participants	Prepare patients/consumers to be active in their care, to ask questions, and specifically to inquire about care guidelines, the evidence behind clinical decisions, or about available evidence-supported treatments
46. Intervene with patients to enhance uptake & adherence	Develop strategies with patients to encourage and problem solve around adherence
47. Alter patient/consumer fees	Create fee structures where patients/consumers pay less for preferred treatments (the clinical innovation) and more for less-preferred treatments
48. Develop an implementation glossary	Develop and distribute a list of terms describing the innovation, implementation, and stakeholders in the organizational change
49. Shadow other experts	Provide ways for key individuals to directly observe experienced people engage with or use the targeted practice change/innovation