From Perception to Practice

Investigating The Role of Health Belief in mHealth App Adoption Among Chronic CVD Patients

MOT2910: Master Thesis Project

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Preface

Two years ago, I took one of the biggest leaps of my life, leaving behind the comfort of my job, my home country, and the familiar rhythms of daily life to pursue a Masters degree in the Netherlands. The thought of starting over in a new country, surrounded by a different culture, was both thrilling and intimidating. Yet, this step marked the beginning of a journey that has shaped me in ways I could have never anticipated. It taught me how to embrace uncertainty, to grow through challenges, and to discover strength I didnt know I had. Transitioning from professional life back into academia was not always easy. The long hours of research, endless drafts, and constant pursuit of clarity pushed me beyond my comfort zone. But along the way, I was fortunate to encounter incredible people who guided, supported, and inspired me.

I am deeply grateful to my thesis committee. First, my heartfelt thanks to Dr. Robert Verburg, Chair of my committee, for his thoughtful feedback and encouragement throughout the process. I am especially grateful to my first supervisor, Dr. Pieter Vandekerckhove, who guided me with remarkable patience and wisdom, always willing to listen to my ideas and steer me back on track when needed. My sincere thanks to Dr. Helma Torkamaan, my second supervisor, whose constructive feedback and kind support greatly enriched my work. I am also truly thankful to Ronald Vollebregt and Katrien Van De Wijdeven-Verspaandonk, my external supervisors at Amgen Breda, for their valuable insights and ongoing support that connected my research to real-world challenges. I owe a special debt of gratitude to the many healthcare professionals, experts, and patients who generously shared their time and perspectives during my interviews. Without their openness and contributions, this thesis would not have been possible.

Beyond academic support, I am deeply thankful to my family - my Appa, Amma, and Thangachi, for their unconditional love, constant encouragement, and sacrifices that made this journey possible. Your belief in me has been my greatest strength throughout this process.

I am equally grateful to my friends, who have been a constant source of support, joy, and motivation. A special thanks to Sanjana, Prithvi, Anuj, Vidhi, Esther, Danielle, Elen, Anurag, Bhavesh, Sayak, and so many others who have stood by me through every high and low. Your friendship, late-night conversations, and countless memorable moments made this journey not only achievable but truly unforgettable.

Looking back on this journey fills me with gratitude. The road was not always smooth, but every moment, both joyful and difficult, has helped me grow into who I am today. This experience has deepened my passion for learning, strengthened my resilience, and reaffirmed my desire to contribute to meaningful work that makes a difference.

Jabez M. Joseph
Delft, June 2025

Executive Summary

Chronic cardiovascular diseases (CVD) represent a growing global health burden, where therapeutic compliance is critical for effective disease management and prevention of complications. Mobile health (mHealth) applications have emerged as promising tools to support patients in managing chronic conditions, yet their adoption remains inconsistent. Existing technology adoption models often fail to fully capture the psychological dimensions that influence patient decisions. This study addresses this gap by investigating how health beliefs shape the adoption of mHealth applications for therapeutic compliance among chronic CVD patients.

The research integrates the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM) to explore both psychological health beliefs and technology readiness traits in tandem. The study adopts a qualitative, exploratory design, employing semi-structured interviews with 11 CVD patients in the long-term management phase. Thematic analysis, supported by ATLAS.ti, was used to develop three key themes from participant narratives.

The findings reveal that while health beliefs strongly motivate patients' intention to adopt mHealth applications, their influence is intertwined with technology readiness traits. Perceived severity and susceptibility heightened patients' awareness of health risks, fostering openness toward supportive tools. However, low optimism, conditional innovativeness, and high discomfort, driven by complex interfaces, cognitive burden, and emotional overwhelm, limited confidence in mHealth applications. Insecurity over data privacy and lack of clinical endorsement further eroded trust in mHealth applications. Adoption was ultimately filtered through perceptions of usefulness and ease of use: patients valued apps that simplified care routines and reduced management burden but were deterred by technical complexity, emotional insecurity, financial concerns, and attachment to familiar routines. Trust, particularly via clinical recommendations, emerged as a critical factor, especially for digitally hesitant patients.

The core of this research is that the adoption of mHealth applications in chronic CVD care is shaped by the dynamic interaction between health beliefs, technology readiness, and the perception of technology itself. Simply offering access to digital tools is insufficient; effective adoption requires addressing patients' perceived health risks, confidence in technology, and perceived value of the applications. This explains why even digitally competent patients may hesitate to adopt mHealth applications when their health beliefs are not adequately addressed.

The study contributes to the academic literature by demonstrating the relevance of health beliefs in the adoption research of the mHealth apps. It demonstrates that adoption is not driven by health beliefs or technology readiness alone, but by their interaction with technological perceptions, and other contextual factors. Practically, the findings offer insights for mHealth app developers, healthcare providers, and pol-

icymakers. Developers could create patient-centered apps that simplify care, support emotional confidence, and address psychological barriers. Healthcare providers could tailor recommendations based on individual beliefs and digital readiness, while policymakers can promote digital literacy initiatives to enhance confidence and trust in digital health tools.

In conclusion, successful adoption of mHealth applications for chronic CVD management requires a holistic understanding of both psychological and technological factors. Incorporating patient-centered, belief-informed design principles holds promise for improving adoption of mHealth applications and enhancing patient outcomes in chronic disease care.

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Nomenclature

Abbreviations

Abbreviation	Definition
BI	Behavioral Intention to Use
CAD	Coronary Artery Disease
CVD	Cardiovascular Disease
HBM	Health Belief Model
mHealth	Mobile Health
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
TAM	Technology Acceptance Model
TRAM	Technology Readiness and Acceptance Model
UTAUT	The Unified Theory of Acceptance and Use of Technology

Table 1: *List of Abbreviations*

1

Introduction

1.1. Background and Context

Cardiovascular disease continues to be the primary cause of mortality globally, responsible for approximately 17.9 million deaths annually, which equates to 32% of all global fatalities (WHO, 2021). The persistent high rates of cardiovascular mortality are primarily attributed to inadequate progress in managing key modifiable risk factors, including physical inactivity, smoking, and diabetes (Mozaffarian et al., 2015). Effective management of these modifiable risk factors relies significantly on compliance to prescribed therapeutic regimens, encompassing both pharmacotherapy and lifestyle modifications (Dunbar-Jacob et al., 2000).

However, therapeutic non-compliance remains a critical barrier to achieving improved health outcomes. It is estimated that nearly half of patients fail to comply with their prescribed medication regimens (Brown and Bussell, 2011). This lack of compliance significantly reduces the potential benefits of treatment, often resulting in worsened clinical outcomes, increased hospital readmissions, and elevated healthcare cost (Ho et al., 2009). Addressing this gap in long-term compliance is therefore a key challenge in the CVD management.

In recent years, digital health technologies, particularly mobile health applications, have emerged as a promising approach to enhance therapeutic compliance among patients with cardiovascular disease (Gandapur et al., 2016). These mobile health applications provide patients with reminders, educational resources, and real-time feedback, thereby empowering them to more effectively manage their cardiovascular health conditions. In the context of cardiovascular care, mHealth applications has demonstrated the ability to improve therapeutic compliance by reminding patients to take their medications through mobile apps or text messages (Ni et al., 2022). Furthermore, the widespread availability of smartphones enhances the accessibility and scalability of mHealth interventions, making them a potentially valuable tool for CVD prevention and management (Triantafyllidis et al., 2019).

Despite the potential benefits of mHealth applications, the adoption and effective use of these technologies remains suboptimal (Standing and Standing, 2008; Fleming et al.,

2018). This adoption gap cannot be attributed solely to technological barriers; rather, it is increasingly recognized that patients' health-related perceptions significantly influence their engagement with mHealth applications (Dou et al., 2017). Specifically, patients' health beliefs regarding their susceptibility to disease, perceived severity of consequences, expected benefits of behavioral change, and perceived barriers play a critical role in determining whether individuals engage with health-promoting behaviors (Rosenstock, 1974). Within this context, patient engagement with mHealth applications is conceptualized as a form of health-promoting behavior.

These health beliefs become especially salient during the post-acute and long-term management phase of CVD care, when patients transition from hospital-based secondary care to community-based primary care (Singh et al., 2023). During this stage, the onus of disease management shifts from healthcare providers to patients themselves, making self-management practices such as medication compliance and lifestyle changes even more critical (SarzyskaDugosz, 2023). In this context, mHealth applications can serve as vital enablers of long-term compliance, provided patients perceive them as beneficial, easy to use, and aligned with their personal beliefs about their health and disease.

To fully leverage the potential of mHealth applications during this self-management phase, it is essential to understand the psychological factors that govern patient adoption. Specifically, patients' perceptions of health threats, their evaluation of the benefits and barriers associated with mHealth applications, and their confidence in using such technologies play a pivotal role in shaping both initial adoption and long-term use (Dou et al., 2017; Zhou et al., 2019a; Alpar and Driebe, 2021). Thus, understanding mHealth app adoption in cardiovascular care requires more than a technological assessment of functionality; it demands an exploration of how patients' health beliefs interact with their willingness to embrace digital health interventions. Yet, the extent to which these health beliefs shape mHealth adoption, especially during long-term CVD management remains insufficiently explored.

1.2. Problem Statement

Despite increasing interest in mHealth applications to support long-term cardiovascular disease (CVD) management, their adoption remains sub-optimal. As outlined earlier, this is not only due to technical or usability factors but is increasingly linked to patients' psychological dispositions and underlying health beliefs.

Although health belief constructs such as perceived severity, susceptibility, and self-efficacy are known to influence health behavior, much of the existing research on mHealth app adoption relies heavily on technology acceptance models (e.g., TAM, TRAM), often neglecting the role of health beliefs (Lin et al., 2007; Ráti and Kemény, 2023; Zhou et al., 2019b). Conversely, studies that have employed health behavior theories frequently overlook how an individual's technology readiness to adopt new technologies may mediate their behavioral intentions (Kaladharan et al., 2023; Chuang et al., 2013; Hsieh and Tsai, 2013). While some studies have explored integrated models to understand health app usage, their application has been largely directed towards general wellness or preventative actions rather than the complexities of therapeutic compliance in chronic cardiovascular disease (Dou et al., 2017; Zahed et al., 2023; Alpar and Driebe, 2021).

As such, there remains a critical gap in the literature: a lack of targeted, integrative research exploring how health beliefs influence the intention to use mHealth applications focused on improving long-term therapeutic compliance among chronic CVD patients. Bridging this gap is essential for informing the design of belief-informed mHealth applications that better support therapeutic compliance among chronic CVD patients.

1.3. Research Objective

The objective of this study is to investigate how health beliefs shape the intention to use mobile health (mHealth) applications to support long-term therapeutic compliance among patients with chronic cardiovascular disease (CVD) during their long-term management phase. By integrating the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM), the study explores how patients' health beliefs, technology readiness, and perceptions of mHealth applications interact to influence adoption intentions.

1.4. Research Question and Sub-Questions

The study is guided by the following main research question:

How do health beliefs shape chronic CVD patients' intention to use mHealth applications for improving therapeutic compliance during the long-term management phase?

To answer this question, the study explores three intersecting dimensions that influence the intention to adopt mHealth applications: personal health beliefs, individual readiness to engage with mHealth applications, and perceptions of the technology itself. Each sub-question targets one of these dimensions, based on the theoretical foundations of the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM). These dimensions are complementary rather than strictly sequential. Together, they provide a well-rounded understanding of the key factors that shape patients' intention to adopt mHealth applications.

Understanding Health Beliefs (HBM):

What are the key health beliefs held by chronic CVD patients regarding their condition during the long-term management phase?

This sub-question establishes the foundational beliefs that influence patients' intention to engage in a particular health behaviour based on how they perceive their health risk and the severity of their condition.

Exploring Individual Technology Readiness (TRAM):

Which technology readiness traits influence how chronic CVD patients in the long-term management phase approach the use of mHealth applications?

This sub-question examines personal predispositions toward technology, which shape patients' openness or hesitation in adopting mHealth applications for managing their condition.

Exploring Health Technology Perceptions (HBM & TRAM):

How do chronic CVD patients perceive the usefulness, ease of use, and barriers related to their intention to use mHealth applications?

This sub-question examines how patients evaluate mHealth applications in terms of their practical benefits, usability and associated barriers, which are crucial for forming behavioral intentions.

1.5. Significance of Study

This study contributes to the growing body of research at the intersection of health psychology and digital health by exploring how health beliefs influence the adoption of mHealth applications.

Theoretically, by integrating the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM), the study adopts a dual-framework approach that offers a holistic lens for analyzing technology adoption in healthcare. This perspective enhances our understanding of how health-related perceptions and individual readiness traits may jointly shape behavioral intentions toward mHealth application use.

Empirically, this study addresses a critical gap in the existing literature, which has largely concentrated on early diagnosis and prevention. By focusing on the adoption of mHealth applications during the long-term management phase of chronic CVD care, it provides new insights into how patients perceive and engage with digital health tools to support sustained therapeutic compliance.

Practically, The findings provide exploratory insights that can support the development of patient-centered mHealth applications. By identifying key belief related factors influencing adoption, the study may inform the design of interventions that better align with patients' belief system. This alignment is particularly relevant in long-term care settings, where improved mHealth app adoption may support better adherence and health outcomes.

1.6. Structure of the Report

This report is structured into six chapters, each building on the previous to develop a comprehensive understanding of how perceptions of health and technology drive the adoption of mHealth applications among chronic CVD patients:

- **Chapter 1: Introduction**
  This chapter sets the stage for the research study by introducing the topic, providing necessary background and context, defining the research problem, articulating the key objectives and research questions, and highlighting the significance and potential contributions of the study.
- **Chapter 2: Literature Review**
  This chapter reviews existing literature on therapeutic compliance in cardiovascular disease management, mHealth applications for therapeutic complaince, and theoretical frameworks such as the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM). It identifies gaps in current research and lays the foundation for the conceptual framework and presents the integrated

conceptual framework combining HBM and TRAM.

- **Chapter 3: Research Design**
  This chapter outlines the qualitative research design, including sampling approach, data collection methods, and analysis techniques.
- **Chapter 4: Findings**
  This chapter presents the key findings from the interviews, organized thematically in alignment with the research questions and theoretical constructs.
- **Chapter 5: Discussion**
  This chapter interprets the findings in light of existing literature and theoretical frameworks, discussing the interplay between health beliefs, technology readiness, and technological perceptions in influencing mHealth adoption, discusses limitations, and provides recommendations for future research and practical implementation of mHealth applications.
- **Chapter 6: Conclusion**
  This chapter summarizes the key insights of the study, reflects on its academic and practical contributions.

2

Literature Review

This chapter critically reviews the existing literature to establish the foundation for investigating how health beliefs influence chronic cardiovascular disease (CVD) patients' intention to adopt mobile health (mHealth) applications for improving therapeutic compliance.

The review begins by discussing the behavioral challenges associated with long-term therapeutic compliance in chronic CVD management, emphasizing the role of patient-driven factors in adherence. It then examines the potential of mHealth applications to support therapeutic compliance, while highlighting persistent challenges in real-world adoption and engagement. Following this, the chapter reviews existing technology adoption models, with a focus on the Technology Readiness and Acceptance Model (TRAM), to evaluate their strengths and limitations in healthcare contexts.

Subsequently, the review introduces the Health Belief Model (HBM) as a framework that captures health-related motivational drivers often overlooked in technology acceptance research. The integration of TRAM and HBM is then explored to provide a more comprehensive understanding of both the technological and psychological dimensions influencing mHealth adoption in chronic CVD care. Finally, the chapter identifies specific gaps in the literature that motivate the present study's qualitative exploration.

2.1. Therapeutic Compliance in Chronic Cardiovascular Disease

Cardiovascular diseases encompass a diverse array of conditions affecting the heart and vascular system, such as coronary artery disease, heart failure, stroke, and hypertension (de la Zerda and Wang, 2022). It continues to be the primary driver of illness and death globally, accounting for approximately one-third of all fatalities worldwide, despite substantial progress in medical treatments and preventive measures (WHO, 2021). The World Health Organization projects that approximately 23.6 million individuals will succumb to cardiovascular diseases by the year 2030 (WHO, 2024).

Beyond its clinical impact, CVD imposes a substantial economic and social burden.

The costs associated with hospitalisations, medications, rehabilitation programs and long-term care place a strain on healthcare systems (Benjamin et al., 2017; Heidenreich et al., 2011). On an individual level, patients often experience diminished quality of life, reduced productivity, and emotional stress (Eaton et al., 2017; Savira et al., 2020; Chatzinikolaou et al., 2021). All of which can further complicate disease management and recovery.

The chronic nature of CVD requires patients to adhere to continuous and often complex therapeutic regimes over extended periods to manage symptoms, prevent disease progression and reduce the risk of acute events (Bodenheimer, 2002). This adherence is referred to as *therapeutic compliance*, which reflects the degree to which a patient's behavior corresponds to the recommendations agreed upon with their healthcare provider (Cramer et al., 2007).

Therapeutic compliance in CVD care involves adherence to both pharmacotherapy as well as non-pharmacological behaviours. Pharmacotherapy often includes medications such as antiplatelets, beta-blockers, statins, and antihypertensives, which require strict adherence to dosing schedules to achieve optimal outcomes (Aronow and Frishman, 2016). In parallel, non-pharmacological adherence includes lifestyle modifications, such as, maintaining a healthy diet, engaging in regular physical activity, avoiding tobacco use, managing stress, and attending follow-up appointments (Arnett et al., 2019). Leading clinical practice guidelines, including those issued by the American Heart Association and the European Society of Cardiology, consistently underscore the pivotal importance of adherence not only to pharmacological therapies but also to non-pharmacological interventions in achieving improved cardiovascular outcomes and mitigating the overall disease burden (Fegers-Wustrow et al., 2022; Arnett et al., 2019).

The importance of therapeutic compliance becomes even more pronounced during the long-term management phase, following the transition from hospital-based secondary care to self-managed community-based care. During this period, patients are expected to maintain adherence to therapy with less direct clinical supervision, making self-efficacy, motivation, and personal health beliefs critical determinants of ongoing compliance (Zanatta et al., 2020; Al-Noumani et al., 2019).

Despite its importance, adherence rates among cardiovascular disease patients remain concerningly low, with studies indicating that nearly half of these patients fail to adhere adequately to their prescribed medications (Brown and Bussell, 2011). According to a comprehensive meta-analysis encompassing nearly 2 million patients, the adherence rate to cardiovascular medications was found to be approximately 60% (Dugunchi et al., 2024). Suboptimal compliance represents a major obstacle in CVD management, undermining the effectiveness of prescribed treatments, increasing the risk of disease progression, leading to frequent rehospitalization thereby driving up healthcare costs (AlGanmi et al., 2020).

While systemic, logistical, and economic barriers undoubtedly play a role, there is increasing recognition that patient-driven factors are among the most critical determinants of adherence. One of the most common is simple forgetfulness, missing doses or neglecting lifestyle routines due to everyday distractions (Orozco-Moreno et al., 2025; Carratalá-Munuera et al., 2022). However, deeper psychological and perceptual factors are often at

play. For instance, patients who do not perceive their condition as severe or feel personally vulnerable to its progression may not prioritize adherence (Keenan, 2017; Dugunchi et al., 2024). Patients' beliefs about their medications significantly influence their adherence, with negative perceptions or concerns about side effects leading to intentional non-adherence (Kalantarzadeh et al., 2022; Krishnamoorthy et al., 2022).

While medication adherence is the most commonly studied domain, lifestyle-related compliance poses equal if not greater challenges. Long-term changes in diet, exercise, and smoking behavior demand sustained willpower, habit formation, and social or environmental support (Middleton et al., 2013). Patients often struggle with integrating these recommendations into daily routines, especially when immediate benefits are not apparent or when such changes disrupt family, cultural, or occupational norms (Kalantarzadeh et al., 2022). The complex interplay of these barriers contributes to the pervasive problem of non-adherence in CVD management, underscoring the need for multifaceted interventions that is both scalable and patient-centered.

Traditional interventions such as patient education sessions, counselling and simplified drug regimes have yielded only modest improvements and often fail to address the dynamic and personalized nature of patients' daily lives (Keenan, 2017). As healthcare systems strive for more scalable, patient-centered solutions, there is a growing recognition that continuous and adaptive supporting tools are necessary to sustain long-term therapeutic engagement.

2.2. mHealth Apps for Therapeutic Compliance: Promise vs Practice

As defined by the World Health Organization's Global Observatory for eHealth, mHealth includes the use of mobile phones, patient monitoring devices, and other wireless technologies to facilitate health service delivery and self-management (WHO, 2011). While mHealth includes a range of mobile and wireless health technologies such as SMS systems, wearables, and remote monitoring tools, this study specifically focuses on smartphone-based mobile health applications (apps) designed to support patients' therapeutic compliance. Mobile health (mHealth) applications have arisen as a promising alternative to conventional care interventions. For patients managing chronic CVD, these apps offer functionalities such as medication reminders, educational content, symptom tracking, and behavioral nudges, which aim to improve adherence to both pharmacological and lifestyle interventions (Gandapur et al., 2016).

A substantial body of research demonstrates the potential of mHealth applications in enhancing therapeutic compliance. In the domain of medication adherence, randomized controlled trials (RCTs) across diverse settings have shown that mHealth interventions can significantly improve outcomes. For instance, a WeChat-based app used in China improved adherence scores within 60 to 90 days (Ni et al., 2022), and an intervention in Kenya led to a 38.3% higher adherence rate compared to standard care (Mutua et al., 2023). A network meta-analysis of 21 trials also concluded that multi-component interventions, such as SMS reminders coupled with phone supportare particularly effective for chronic conditions like CVD (Miao et al., 2024). However, not all results are consis-

tently positive. An RCT by Maddison et al. (2021) found no significant improvement in medication adherence among CVD patients using an SMS-based tool, highlighting how population characteristics, app design, and baseline adherence levels may influence effectiveness.

Beyond medication adherence, mHealth applications have shown promise in supporting lifestyle modifications, a key component of CVD self-management. Interventions such as EVITE and eMOTIVA have led to improved dietary adherence, increased physical activity, and higher smoking cessation rates (Bernal-Jiménez et al., 2024; Cruz-Cobo et al., 2024). Features such as gamification (e.g., MyHeartMate) and cultural tailoring (e.g., FAITH! app) have further improved user engagement and behavioral outcomes (Parker et al., 2023; Lalika et al., 2024) . Meta-reviews also confirm positive effects on key cardiovascular risk indicators such as BMI, blood pressure, and glycemic control (Bushey et al., 2024).

Despite the promising potential of mHealth applications in enhancing therapeutic compliance, mHealth app adoption in real-world settings remains inconsistent and often disappointingly low. Studies consistently report limited initial uptake and high dropout rates among users, undermining the long-term impact of these interventions (Druce et al., 2019; Amagai et al., 2022; Fleming et al., 2018). While technical accessibility and app availability are rarely barriers today, many patients still choose not to use these tools or discontinue use shortly after starting. This gap between demonstrated efficacy of mHealth applications and real-world utilization highlights the influence of non-technical factors.

Adoption challenges are often rooted in perceptual barriers. Patients may feel overwhelmed by complex app interfaces, or mistrust the security and reliability of digital health platforms (Searcy et al., 2019; Zhou et al., 2019a). Others may perceive low relevance, especially if they do not feel their condition is severe, or may struggle with motivation and self-efficacy in managing their health digitally (Dou et al., 2017; Alpar and Driebe, 2021). These barriers are especially pronounced in chronic care settings, where technology use is voluntary, personal, and continuous over time.

Consequently, the success of mHealth interventions depends not only on their functional design but also on patients' psychological acceptance. Adoption is not merely a matter of providing reminders or tracking tools, it is also shaped by whether patients perceive the tools as useful, trustworthy, and aligned with their personal health goals (Dou et al., 2017; Tsai, 2014). This means that understanding patient behavior, motivation, and beliefs is just as important as technological innovation.

In light of these complexities, this study takes a psychological perspective on mHealth app adoption. It argues that to fully understand why some patients engage with mHealth tools and others do not, we must explore the interplay between health-related beliefs and technology perceptions. To this end, the study draws on two complementary frameworks: the Health Belief Model (HBM), which captures individuals' perceptions of health threats and behavior change drivers, and the Technology Readiness and Acceptance Model (TRAM), which examines patients' predispositions and attitudes toward adopting new technologies. The following section elaborates on the theoretical basis for this integration.

2.3. Shortcomings of Traditional Technology Adoption Models in Healthcare Context

Gaining insights into patients' interaction with mHealth applications helps identify how these tools can better support long-term therapeutic compliance in chronic CVD care. To better explain such user behaviors, several technology adoption models have emerged over the past decades, focusing particularly on perceptions of usefulness, ease of use, and acceptance. These models, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), have contributed significantly to understanding how individuals evaluate and use digital innovations, particularly around usability and perceived utility.. In the context of healthcare, they offer a foundation for examining patient interaction with mHealth applications. However, while these models are useful in capturing surface-level acceptance dynamics, their application in chronic health contexts, where behavior change, motivation, and personal beliefs play a central role, has exposed critical limitations (Alpar and Driebe, 2021; Dou et al., 2017).

Technology Acceptance Model (TAM)

The Technology Acceptance Model, introduced by Davis (1989), is one of the pioneering and extensively utilized frameworks for understanding individuals' adoption of new technologies. TAM posits that two beliefs, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), directly influence a user's Behavioral Intention to Use (BI) a system. Importantly, PEOU also influences PU, suggesting that if a user finds a system easy to use, they are more likely to see it as useful. These beliefs are often shaped by external factors (e.g., training, support) but the model itself is relatively narrow in scope, focusing primarily on system-specific attributes and overlooking broader individual or contextual factors such as trust or health-specific risks.

TAM has been widely applied in health informatics to evaluate the success of digital health technologies (Zhou et al., 2019b; Liu et al., 2013). However, it has faced growing criticism for its limited consideration of emotional, social, and contextual factors, elements that are particularly relevant in healthcare, where engagement is often personal, emotionally complex, and voluntary (Sun et al., 2024; Ráti and Kemény, 2023).

Unified Theory of Acceptance and Use of Technology (UTAUT)

To overcome some of these shortcomings, Venkatesh et al. (2003) proposed the Unified Theory of Acceptance and Use of Technology, an integrated framework that incorporates constructs from various technology adoption models, including the Technology Acceptance Model, Theory of Planned Behavior, and Diffusion of Innovations. UTAUT adds dimensions such as social influence and facilitating conditions, offering a more holistic view of technology adoption, especially in institutional or workplace settings.

Although UTAUT offers valuable insights for large-scale technology adoption, particularly in institutional settings, it has been critiqued for its complexity and limited consideration of individual-level psychological traits such as emotional readiness, anxiety, or distrust, factors that are especially relevant for chronically ill populations (Williams et al., 2015). Its strong emphasis on organizational and social drivers makes it less

suitable for understanding adoption in personal, self-managed contexts like mHealth application usage among chronic disease patients.

Technology Readiness and Acceptance Model (TRAM): A Step Forward, But Not Enough

Recognizing the need for a model that incorporates both individual-level predispositions and system-specific evaluations, Lin et al. (2007) proposed the Technology Readiness and Acceptance Model (TRAM). TRAM integrates core components from TAM with the concept of the Technology Readiness Index, which captures an individual's overarching inclination to adopt or resist new technologies (Parasuraman, 2000).

TRAM is composed of three central components:

1. **Technology Readiness Traits** - capturing an individual's inherent predisposition toward adopting technology,
2. **Technology Acceptance Beliefs** - derived from TAM, focusing on perceptions of usefulness and ease of use, and
3. **Behavioural Intention** - captures the user's motivational readiness to adopt the technology.

The key constructs of Technology Readiness include:

- **Optimism:** The extent to which an individual holds a favorable outlook on technology and perceives it as a means to enhance their quality of life (Parasuraman, 2000).
- **Innovativeness:** The tendency to be an early adopter of new technologies (Parasuraman, 2000).
- **Discomfort:** Feelings of being overwhelmed by or lacking control over technology (Parasuraman, 2000).
- **Insecurity:** Distrust of technology and skepticism about its ability to perform reliably or protect privacy (Parasuraman, 2000).

The key constructs of Technology Acceptance include:

- **Perceived Ease of Use (PEOU):** The belief that using a technology will be free of effort (Davis, 1989).
- **Perceived Usefulness (PU):** The belief that using a technology will enhance one's health management or life outcomes (Davis, 1989).

Behavioural Intention Construct include:

- **Intention to Use (BI):** This final construct encapsulates the user's motivational inclination to adopt the technology. When individuals perceive the technology as both useful and effortless to use, and when their inherent technology readiness traits exhibit a favorable alignment, their intention to utilize the technology is reinforced.

Unlike TAM, which focuses on system-specific perceptions, TRAM introduces a dual-layered mechanism by incorporating individual-specific predispositions toward technol-

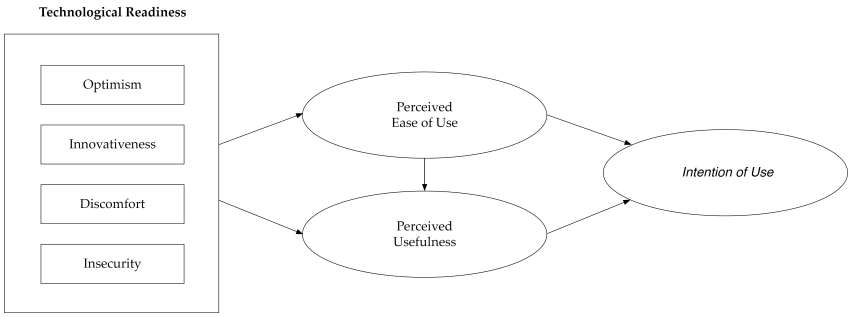

Figure 2.1: *Technology Readiness and Acceptance Model*

ogy. It posits that a person's general technology readiness, comprising traits such as optimism, innovativeness, discomfort, and insecurity, influences their specific evaluations of a technology's ease of use and usefulness, which in turn shape their behavioral intention to adopt the technology. Optimism and innovativeness are shown to have a positive impact on perceived ease of use (PEOU) and perceived usefulness (PU), while discomfort and insecurity exert a negative influence. Additionally, perceived ease of use enhances perceived usefulness, and perceived usefulness is the most significant direct predictor of behavioral intention (BI). Empirical evidence from Lin et al. (2007) confirms that the effect of technology readiness on behavioral intention is fully mediated by PEOU and PU, indicating that users' general beliefs about technology influence adoption only through their specific perceptions of the system. This causal pathway makes TRAM particularly relevant in mHealth contexts, where adoption is voluntary, personal, and influenced by individual differences in trust, comfort, and perceived value. TRAM is illustrated in the figure 2.1.

Given the individualistic, voluntary, and health-sensitive nature of mHealth app adoption among CVD patients, TRAM offers a promising starting point for this research. Its integration of psychological predispositions, such as optimism, innovativeness, discomfort, and insecurity, with perceived usefulness and ease of use allows for a more comprehensive understanding of usertechnology interaction than other technology acceptance models.

However, TRAM's explanatory power in chronic healthcare settings may be limited by its technology-centric lens. The model primarily assumes that behavioral intention arises from an individual's evaluation of the technology itself, whether it is perceived as useful, easy to use, or aligned with their attitudes toward innovation. This framing may be overly narrow in chronic care, where digital engagement is often shaped by deeper

psychological factors, such as personal risk perception, self-efficacy, and beliefs about long-term illness management.

For example, a patient who perceives their condition as serious and manageable might be more willing to experiment with digital health tools, while another, despite being technologically optimistic, might avoid adoption due to beliefs about disease incurability or emotional burnout. TRAM does not explicitly account for such health-related beliefs or the lived experience of illness, which can significantly shape engagement with mHealth applications.

Therefore, while TRAM contributes valuable insights into how individual technology readiness influences adoption, it may not fully capture the health-specific drivers of adoption. To address this gap, the next section introduces the Health Belief Model (HBM), a psychological framework focused on perceptions of health risk, benefits of action, barriers, and self-efficacy. By integrating HBM with TRAM, this study seeks to generate a more holistic understanding of both the technological and health-related dimensions of mHealth adoption in chronic CVD care.

2.4. Health Belief Model and Its Relevance to mHealth Adoption

Health behavior encompasses any actions undertaken by an individual, irrespective of their actual or perceived health state, with the aim of promoting, protecting, or preserving well-being (Nutbeam et al., 1998). In this context, adopting and using digital technologies to manage one's health can also be considered a health behavior. These behaviors are often shaped by underlying health beliefs, such as, individuals' perceptions of their susceptibility to illness, the severity of potential conditions, and the perceived benefits and barriers to taking action (Janz and Becker, 1984; Rosenstock, 1974). Such beliefs significantly influence whether people engage in behaviors that promote health, prevent disease, or manage chronic conditions.

Framing mHealth app adoption as a health behavior places it firmly within the domain of behavioral health research. Understanding what motivates or deters patients from using these tools, particularly in the context of chronic illness, requires insight into the psychological and perceptual factors that shape their choices. One of the most widely used frameworks for explaining such behavior is the Health Belief Model (HBM), which is explained below.

Health Belief Model (HBM):

The Health Belief Model (HBM) is a widely recognized psychological framework developed to explain why individuals engage in health-promoting behaviors. Originating from the work of Rosenstock (1974) and later expanded by Janz and Becker (1984), HBM was initially used to understand the limited uptake of preventive health services, such as tuberculosis screening. Over time, HBM has evolved into a comprehensive framework applicable to a wide range of health behaviors, particularly in the context of chronic disease management (Hsieh and Tsai, 2013). HBM is particularly suited to explore factors that has a strong emphasis on individual perceptions related to disease management and

preventive behavior.

At its core, HBM postulates that people are more likely to adopt a health behavior when they perceive themselves to be at risk, believe the consequences of inaction are severe, and see clear benefits to taking action, particularly if perceived barriers are low and cues to act are present. These principles make HBM highly relevant for understanding not only traditional health behaviors but also the adoption of digital health tools like mobile health (mHealth) applications (Dou et al., 2017; Zahed et al., 2023). In the context of chronic cardiovascular disease (CVD), where long-term self-management is essential, the HBM offers a meaningful lens to explore how patient beliefs influence their intention to use mHealth applications.

HBM comprises six core constructs that influence health behavior: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. Each of these elements can significantly impact a patient's willingness to adopt and consistently use mHealth tools.

- **Perceived Susceptibility**: Refers to an individual's belief about the likelihood of experiencing a health problem (Rosenstock, 1974).
- **Perceived Severity**: Represents an individual's belief regarding the seriousness of a health condition and its potential consequences (Rosenstock, 1974).
- **Perceived Benefits**: Involves the belief that a particular action will reduce susceptibility to or severity of the condition (Rosenstock, 1974).
- **Perceived Barriers**: Captures the perceived obstacles that impede health-related behavior (Rosenstock, 1974).
- **Cues to Action**: External or internal stimuli that trigger the decision-making process to adopt a health behavior (Rosenstock, 1974).
- **Self-Efficacy**: The belief in one's own ability to successfully perform the behavior (Rosenstock, 1974).

The model illustrated in figure 2.2, suggests that individuals weigh these constructs when deciding whether to take action. For instance, a patient who perceives high susceptibility and severity, recognizes strong benefits, faces low barriers, receives actionable cues, and has high self-efficacy is more likely to engage in health-promoting behavior, such as adopting an mHealth app for disease management.

Application of HBM in Chronic Disease Context

The Health Belief Model (HBM) has been widely employed in understanding health-related behaviors, particularly in the context of chronic disease management, including diabetes, and hypertension, where long-term therapeutic compliance is critical (Dou et al., 2017; Alpar and Driebe, 2021; Alsulimani and Bouaguel, 2024; Zahed et al., 2023).

For instance, Al-Noumani et al. (2019) conducted a systematic review that found perceived barriers and self-efficacy were among the most consistent predictors of medication adherence in hypertensive patients. Patients who believed in the effectiveness of their medicationand felt confident in managing side effectswere significantly more compliant.

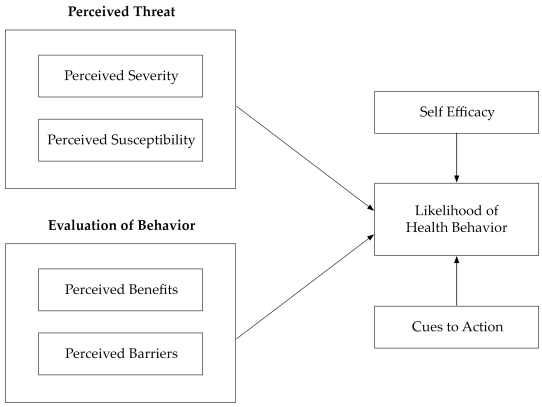

Figure 2.2: *Health Belief Model*

Wang et al. (2021) conducted a large-scale study on non-communicable disease prevention and found that self-efficacy and perceived barriers were the most influential HBM constructs in predicting health behavior. The findings suggest that enhancing psychological empowerment and minimizing obstacles are more effective than simply increasing risk awareness. This insight is especially relevant to mHealth design, where empowering users and reducing usability challenges can drive greater engagement, particularly in chronic conditions like CVD, where behavior change must be sustained over time.

Chiang et al. (2021) systematically reviewed HBM-based interventions for individuals with cardiometabolic risk and concluded that programs targeting self-efficacy, perceived benefits, and susceptibility had the most positive impact on compliance behaviors. Their review reinforces the value of multi-construct HBM engagement and highlights the need for theory-driven, standardized approaches, especially when applying HBM in digital or app-based interventions for chronic disease management.

These findings underscore the model's utility in chronic disease management. Particularly in digital health settings, HBM provides a valuable foundation for identifying patient motivations, emotional drivers, and engagement barriers, all critical for the adoption of mHealth applications.

Limitations of HBM as a Standalone Model in mHealth Research

While HBM offers valuable insights into how individuals perceive health risks and the benefits or barriers to action, it may be underutilized in mHealth adoption research for good reason. As a standalone model, HBM was not originally designed to explain engagement with technological systems, and it does not account for usability, aesthetic factors, or digital confidence, elements that are crucial in technology acceptance.

In mHealth contexts, where user engagement is shaped not only by personal risk perception but also by interface design, device trust, and tech-related anxiety, HBM may provide an incomplete picture. This may explain its relatively limited use in technology-focused studies, where models like TAM, UTAUT, or TRAM have historically been more dominant.

Nonetheless, when paired with a technology adoption model, HBM contributes essential psychological depth by capturing health-specific motivations that tech models often neglect. Its integration with TRAM therefore allows this study to explore both why patients feel motivated to adopt mHealth applications and how their technological readiness shapes their engagement.

2.5. Integration of HBM & TRAM for Digital Health

Rationale for Integration

To explore how the health beliefs of chronic cardiovascular disease (CVD) patients influence their decision to adopt mobile health (mHealth) applications for therapeutic compliance, this study integrates two well-established models: the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM). While TRAM focuses on individuals' psychological predispositions toward technology and their perceptions of usefulness and ease of use, it does not address health-related motivations that are particularly relevant in chronic care contexts. In contrast, HBM emphasizes health beliefs such as perceived severity, susceptibility, and benefits of behavior change, but lacks constructs that capture technology readiness or acceptance.

This integration is particularly important for understanding mHealth adoption, which requires both a belief in the value of health behaviors and confidence in one's ability to engage with digital tools. Decisions to adopt such tools are shaped not only by how useful or usable they are perceived to be, but also by how patients interpret their health risks, the expected benefits of adoption, and the psychological barriers they encounter.

Empirical Support for Integrated Models

While studies integrating psychological health theories with technology acceptance models remain limited, several recent works demonstrate both the potential and challenges of such integration in digital health contexts.

Dou et al. (2017) employed an extended HBM combined with TAM to examine smartphone-based health technology acceptance among hypertension patients. Perceived health threat and perceived usefulness emerged as key predictors, while resistance to change negatively affected adoption. The study confirmed the complementary value of combining health beliefs with technology perceptions but noted limitations related to sample diversity and exclusion of factors like privacy concerns.

Similarly, Zahed et al. (2023) investigated adoption intentions for a diabetes self-management device, integrating HBM and TAM through path analysis. Perceived usefulness, health threat, and cues to action significantly influenced behavioral intention, whereas perceived barriers and severity were less predictive. Limitations included reliance on self-reported health status and a relatively young, homogeneous sample, suggesting a need for further

research on diverse patient populations.

In Taiwan, Hsieh and Tsai (2013) applied an extended HBM framework to explore telehealth adoption among elderly residents. The study emphasized self-efficacy and cues to action as critical enablers of adoption. Tsai (2014) extended this line of research by integrating trust variables, showing that institutional trust strengthened perceived usefulness and ease of use, thereby increasing adoption intention. Both studies reaffirmed the importance of addressing both health beliefs and technological confidence in older and rural populations.

Collectively, these studies demonstrate that integrating HBM with technology acceptance models improves explanatory power in predicting digital health adoption across different chronic disease contexts. Constructs such as self-efficacy, perceived threat, benefits, barriers, and cues to action consistently enhance our understanding when paired with technology-oriented perceptions like usefulness, ease of use, and readiness traits.

However, several recurring limitations exist across these studies: most relied on cross-sectional designs, focused on behavioral intention rather than actual usage, and were conducted in narrowly defined populations with limited generalizability. Many also omitted important behavioral factors such as trust, privacy concerns, or habit, underscoring the need for more comprehensive frameworks.

Despite these gaps, the cumulative evidence supports the integration of HBM with models like TRAM to capture both health-specific motivation and technology readiness. This combined approach provides a stronger foundation for investigating mHealth app adoption in chronic care settings like cardiovascular disease, where both health risk perceptions and digital engagement play a critical role in sustained therapeutic compliance.

Building on these insights, the conceptual framework that combines the Health Belief Model and the Technology Readiness and Acceptance Model (TRAM) has been presented below. This dual-framework approach aims to capture the interplay between patients' health-related beliefs and their technological readiness to adopt digital health interventions, offering a holistic lens to examine mHealth app adoption among chronic CVD patients.

Overview of Key Constructs

Table 2.1 presents the key constructs derived from the HBM and TRAM frameworks. The definition of each construct is discussed in sections 2.4 and 2.3 respectively.

Conceptual Compatibility and Overlap between HBM and TRAM

The integration of the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM) offers both theoretical complementarity and areas of conceptual overlap. While originating from different disciplinary traditions, HBM from health psychology and TRAM from information systems research, both models address key cognitive and motivational processes that shape behavior. In the context of mHealth app adoption for chronic cardiovascular disease (CVD) patients, these two frameworks capture distinct but interrelated dimensions of decision-making.

At the conceptual level, compatibility exists because both models share an underlying

Table 2.1: *Key Constructs in the Integrated Conceptual Framework*

Integrated Constructs	Theoretical Source	Relevance to Research (Qualitative Framing)
Perceived Susceptibility & Perceived Severity	HBM	Helps explore how patients interpret the seriousness of CVD and how this perception shapes their thinking about mHealth.
Perceived Benefits of mHealth	HBM	Provides insight into what patients view as valuable outcomes of using mHealth tools for disease management.
Perceived Barriers of mHealth	HBM	Helps identify perceived obstacles, both practical and emotional, that may discourage engagement with mHealth.
Cues to Action	HBM	Enables exploration of external triggers (e.g., provider recommendations, app alerts) that patients perceive as motivating.
Technology Readiness: Optimism & Innovativeness; Discomfort & Insecurity	TRAM	Helps understand how patients' general attitudes toward technology shape their openness or resistance to mHealth.
Perceived Usefulness & Perceived Ease of Use	TRAM (via TAM)	Guides investigation into how patients perceive the ease and usefulness of mHealth tools in their daily lives.
Intention to Use	TRAM	Reveals patients' motivation and readiness to adopt mHealth tools, bridging belief and actual behavior.

assumption: individuals adopt new behaviors (whether health-related or technology-related) based on their subjective evaluations of risks, benefits, barriers, and confidence in their ability to act. HBM provides a rich lens to examine how patients perceive their health risks, behavioural benefits, and barriers to behavioral change. TRAM, on the other hand, adds critical insight into how patients' technological readiness, such as optimism, innovativeness, discomfort, or insecurity, shapes their engagement with digital health tools.

However, several construct overlaps emerge in this integration. For instance, perceived usefulness (TRAM) and perceived benefits (HBM) both reflect individuals' evaluations of value, though from different reference points: technological utility versus health outcomes. Similarly, perceived barriers (HBM) overlap conceptually with TRAM's discomfort and insecurity, all reflecting obstacles to engagement, though barriers tend to emphasize practical concerns while discomfort and insecurity capture emotional or psychological resistance to technology. These overlaps are not necessarily redundant but instead offer complementary insights that allows for a richer understanding of how patients perceive challenges and facilitators from both a health and technology perspective.

In qualitative research, such conceptual overlaps are not problematic but rather serve

as productive entry points for deeper exploration of patient meaning-making. Each construct functions as a *sensitizing concept* (Bowen, 2006), guiding inquiry while allowing for inductive refinement based on participants' lived experiences. Rather than treating these constructs as fixed variables within a hypothesis-testing model, the integrated conceptual framework uses them to inform the design of interview questions and organize thematic analysis. This flexible approach directs the researcher's attention toward relevant domains of experience, including patients' health beliefs, motivational triggers, psychological readiness, and evaluations of technology, enabling a open-ended exploration of how patients navigate the decision to adopt or avoid mHealth tools in managing their condition.

In sum, while HBM and TRAM originate from distinct traditions, they are conceptually compatible when applied to mHealth adoption in chronic care contexts. Their integration allows for a comprehensive understanding of how health beliefs and technology readiness jointly shape patients' intention to use mHealth application. This compatibility forms the theoretical foundation for the present study's qualitative exploration.

2.6. Identified Research Gap

Mobile health (mHealth) applications have become increasingly relevant in supporting cardiovascular disease (CVD) management, particularly in improving therapeutic compliance. While mHealth applications offers significant potential to facilitate self-management, adoption of these tools remains limited. A careful review of the existing literature reveals three interrelated gaps that this study seeks to address.

A key theoretical gap in mHealth app adoption research lies in the limited consideration of patients underlying health beliefs, particularly in chronic disease contexts where long-term self-management is required. Existing technology acceptance models, such as the Technology Readiness and Acceptance Model (TRAM), have been extensively applied to mHealth app adoption but focus primarily on technology-specific factors. While these models effectively capture technology-specific drivers of adoption, they tend to underrepresent patients' underlying health-related beliefs that shape their intention to engage with mHealth application. In contrast, health behavior models, particularly the Health Belief Model (HBM), emphasize these belief factors, which are central to understanding patients' health decisions. However, these models often fail to account for technology-specific perceptions that may determine patients' openness to adopt mHealth applications. Despite the complementary strengths of both models, there remains limited empirical research integrating health beliefs with technology acceptance, especially in the context of mHealth applications designed to support long-term therapeutic compliance in chronic CVD care.

Secondly, a population gap exists due to limited attention given to patients with chronic cardiovascular disease who require long-term care management. Many mHealth app adoption studies address general patient populations or acute care settings, overlooking the unique challenges faced by patients navigating prolonged transitions from clinical supervision to self-directed community-based care. These patients confront complex psychological hurdle that demand a more nuanced understanding of the beliefs that shape their long-term self-management practices.

Finally, there remains a clear methodological gap in the dominant reliance on quantitative, survey-based approaches. While quantitative models are valuable for identifying associations among predefined variables, they offer limited insight into how patients subjectively experience, and articulate their health beliefs and technology perceptions in real-world decision-making. Qualitative research is crucial to uncover these complex contextual factors that shape patients adoption decisions, particularly in the context of long-term self-management of chronic CVD.

Taken together, these three gaps highlight the need for integrative, context-specific, and patient-centered research. Specifically, there is a need to explore how patients health beliefs shape their intention to adopt mHealth applications, by using a qualitative, theory-driven approach in the context of chronic cardiovascular care. Addressing this gap leads to the central research question of this study:

> *How do health beliefs shape chronic CVD patients' intention to use mHealth applications for improving therapeutic compliance during the long-term management phase?*

3

Methodology

3.1. Research Design

In this research, the corresponding researcher, JJ, adopts a single-centre, prospective, qualitative design, guided by an integrated theoretical framework, and conducts semi-structured interviews to explore how chronic CVD patients perceive, experience, and make decisions about adopting mHealth applications focused on therapeutic compliance. According to Merriam (2009), given the focus on individual experiences, health beliefs, and subjective interpretations of technology, a qualitative approach is the most appropriate.

This research is grounded in an interpretivist paradigm, which assumes that individuals construct reality through social interaction and lived experience. Instead of testing hypotheses or seeking generalizable results, JJ focuses on developing a context-sensitive understanding of the perceptual factors, specially health beliefs influencing mHealth app adoption. The ultimate goal is to uncover patterns of meaning that can inform more belief-informed approaches to the design and implementation of digital health solutions. Figure 3.1 illustrates the research design employed in this study and its alignment with the structure of this thesis report.

Guiding Framework

This study is guided by an integrated conceptual framework that combines the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM). This integrated framework is described in detail in section 2.5. While HBM provides a lens for understanding individuals' health-related motivations, beliefs, and behaviors, TRAM adds insights into their psychological readiness to adopt and engage with digital technologies. Together, these models offer a complementary perspective on the technological, and perceptual factors that influence the adoption of mobile health (mHealth) applications among patients with chronic cardiovascular disease (CVD).

In this qualitative, exploratory study, the framework is not used to test hypotheses or establish causal relationships. Instead, it serves as a set of sensitizing concepts that guide the development of interview questions and structure the thematic analysis (Bowen,

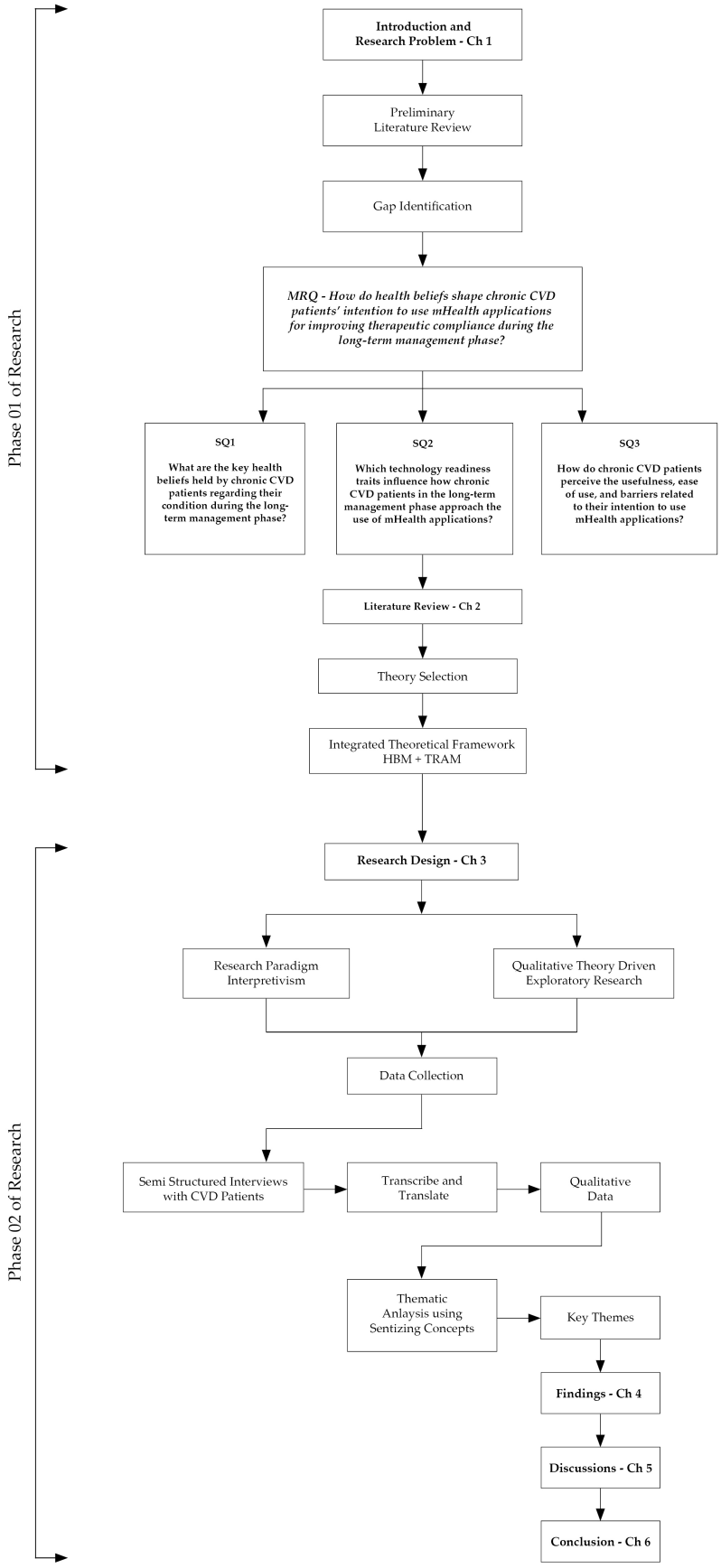

Figure 3.1: *Visualised Research Methodology*

2006). This approach ensures that data collection remains open-ended and participant-driven while still being grounded in well-established theoretical constructs.

The framework directs attention toward several key domains of experience: patients' health behaviour (e.g., daily medication-taking habits, adherence to lifestyle recommendations), health beliefs (e.g., perceived susceptibility, severity, benefits, and barriers), and technology-related perceptions (e.g., perceived usefulness, ease of use, optimism, discomfort). These domains help shape the inquiry while leaving room for participants to introduce new, unanticipated perspectives that may further enrich or challenge existing theoretical assumptions.

Rationale for a Theory-Driven Qualitative Approach

JJ adopts a qualitative methodology because the study is exploratory and focuses on meaning-making. Most existing research on mHealth app adoption relies on quantitative methods, such as structured surveys and statistical models to predict behavior. However, these approaches often overlook the contextual and experiential nuances that shape patient decision-making. This limitation is particularly relevant in chronic disease management, where self-management are critical. By using a qualitative design, JJ aims to generate insights into how CVD patients interpret their condition, engage with mHeath applications.

Although the research is exploratory, JJ grounds the inquiry in an integrated theoretical framework that combines the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM). This theory-driven approach helps JJ focus on established constructs such as perceived severity, perceived susceptibility, perceived usefulness, and innovativeness, while also leaving space for participants to introduce new and unanticipated perspectives.

By integrating theory within a flexible qualitative design, JJ balances structure with openness, enabling the study to produce findings that are both theoretically grounded and reflective of lived experience. This approach contributes to a more balanced and practically relevant understanding of patient adoption in digital health.

3.2. Data Collection

Participant Recruitment

The target population for this study consists of adult patients diagnosed with chronic cardiovascular disease (CVD) who are in the long-term management phase. This phase refers to the period following initial diagnosis or stabilization, during which patients are engaged in sustained self-care practices such as medication adherence, lifestyle modifications, symptom monitoring, and ongoing interaction with healthcare providers. These activities are aimed at preventing disease progression and maintaining quality of life. The specific eligibility criteria for participants are presented in Table 3.1.

To recruit participants, JJ collaborated with a third-party homecare management company specializing in CVD care through his external supervisor. With JJ's support, the homecare provider distributed a recruitment email to approximately 150 patients in their database. The email outlined the study, highlighted the voluntary nature of participa-

Table 3.1: *Inclusion and Exclusion Criteria*

Inclusion Criteria	**Exclusion Criteria**
1. Aged 18 years or older	1. Currently undergoing acute treatment or hospitalization for a cardiovascular event
2. Diagnosed with a chronic cardiovascular disease (e.g., hypertension, heart failure)	2. Diagnosed cognitive impairments that limit ability to consent or participate (e.g., dementia)
3. In the long-term management phase (>= 6 months post-diagnosis or stabilization)	3. Inability to understand or communicate in English/Dutch
4. Cognitively and physically able to participate in a one-on-one interview	4. Severe physical impairments preventing participation in an online interview without support
5. Able to understand and communicate in English/Dutch	

tion, and included a link to a digital form where interested individuals could submit their contact details and availability. After patients completed the form, the homecare provider compiled the responses and forwarded them to JJ.

Eight patients responded to the email. JJ included all eight in the study due to the limited response pool. This recruitment approach followed a self-selection sampling strategy, as participants voluntarily opted into the study based on their interest and eligibility. JJ had no control over who responded and included every individual who met the inclusion criteria.

In addition to the third-party recruitment, JJ recruited three more participants through convenience sampling by approaching personal contacts who also met the eligibility requirements. This supplemental strategy enabled JJ to reach a sufficient sample size to support thematic saturation.

JJ recruited a total of 11 participants. While this sample does not aim for representativeness, it aligns with the objectives of qualitative, exploratory research, which emphasize the identification of meaningful patterns and perspectives over statistical generalizability. After completing 11 interviews, JJ observed that no significant new insights or themes were emerging, indicating that data saturation had been reached, which is defined as the point at which additional interviews yield limited new information (Guest et al., 2005). JJ deemed the final sample sufficient to capture a diverse range of experiences and perceptions while enabling meaningful qualitative analysis.

Development of Interview Guide

JJ developed the interview guide based on the integrated conceptual framework combining the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM). He designed the guide to explore how participants perceive their health risks, evaluate the value of mHealth apps, and navigate the psychological and contextual factors that influence their use. The full interview guide is attached in Appendix A.

JJ structured the interview questions to cover the following key domains:

Table 3.2: *Overview of Research Domains, Theoretical Relevance, Research Question and Contribution to Main Research Question*

Domain	**Theoretical Relevance**	**Relevant Research Question**	**Contribution to Main Research Question**
Health Beliefs	HBM	What are the key health beliefs held by chronic CVD patients regarding their condition during the long-term management phase?	Identifies how patients' perceptions of their chronic condition shape their motivation to engage in health behaviors, including adoption of mHealth application.
Individual Technology Readiness	TRAM	Which technology readiness traits influence how chronic CVD patients in the long-term management phase approach the use of mHealth applications?	Examines personal technological predispositions that influence patients' openness, confidence, or hesitation in adopting mHealth applications.
Health Technology Perceptions	HBM + TRAM	How do chronic CVD patients perceive the usefulness, ease of use, and barriers related to their intention to use mHealth applications?	Explores both facilitators and barriers that influence adoption intention toward mHealth applications.

To ensure clarity and alignment with the study's objectives, JJ piloted the guide with a small group of individuals from his personal network. He then refined the wording, flow, and structure based on their feedback.

Interview Procedure

JJ conducted semi-structured interviews with chronic cardiovascular disease (CVD) patients in May 2025. He held all interviews in Microsoft Teams, a secure video conferencing platform. JJ scheduled each interview to last between 30 and 45 minutes, ensuring a manageable cognitive load for patients. Before each session, he emailed participants a digital information sheet outlining the study's purpose, the voluntary nature of participation, and assurances regarding confidentiality and data protection. At the start of each interview, JJ introduced his professional background, role as a researcher, and training in qualitative interviewing to build transparency and rapport. Before starting the main interview questions, JJ collected basic demographic and contextual information from each participant, including age, gender, diagnosis, time since diagnosis, and prior experience with mHealth technologies. Out of the 11 interviews, 6 were in Dutch to accommodate participants who felt more comfortable speaking in their native language. For these sessions, a Dutch-speaking colleague (KS) joined as an interviewer. KS utilised the translated dutch interview guide for these sessions. JJ ensured that the dutch interviews followed the same protocol as the English-language ones. With participants' consent, he audio-recorded each session for transcription and analysis. This structured yet flexible interview procedure enabled JJ to capture diverse patient perspectives on mHealth adoption.

3.3. Data Analysis

To explore how chronic CVD patients perceive and engage with mobile health (mHealth) applications, JJ conducted a thematic analysis of the interview data. Thematic analysis is well-suited for qualitative, exploratory research as it allows for the identification and interpretation of patterns of meaning across rich, narrative data (Braun and Clarke, 2017). While inductive in structure, this analysis was informed by sensitizing concepts from the Health Belief Model (HBM) and Technology Readiness and Acceptance Model (TRAM), enabling both data-driven discovery and theory-aligned interpretation.

JJ transcribed each audio-recorded interview using MS Teams audio transcription feature. For the six interviews conducted in Dutch, JJ collaborated with his Dutch-speaking colleague (KS) to translate the content into English. JJ then imported the transcripts into ATLAS.ti Version 25.0.1 for Mac, a qualitative data analysis software used to organize, code, and analyze the dataset systematically.

Coding Process

JJ followed a structured, multi-stage coding process:

Step 1: Familiarization with the Data

Immediately after transcription, JJ immersed himself in the interview data by reading the transcripts in full. This stage helped JJ grasp the depth and tone of participants' responses. Memos were created to capture initial reflections and hunches. An interesting

impression was a disconnect between general digital familiarity and hesitancy toward health apps, which prompted deeper attention to these tensions in later coding.

One participant noted:

"I use my phone all the time, for news, to-do lists, reminders. I'm already digitally active, so health apps feel like just another tool."
(P10, 68, male, retired, CAD)

Yet another added:

"I use WhatsApp because it's simple and effective for keeping in touch."
(P01, 75, male, retired, CAD)

But still remained hesitant to use mHealth apps. This contrast laid the groundwork for exploring why frequent digital tool users remained reluctant about mHealth applications.

Step 2: Initial Coding (Open Coding)

In the first cycle of coding, JJ conducted line-by-line open coding, staying close to the participants' narrative. Codes were assigned to meaningful segments of data without imposing any predefined structure. This phase aimed to preserve the richness of individual narratives and surface unexpected insights.

Examples:

Quote: *"It's 18 years already and I have not skipped a single day of medication."*
Codes: *Routine Adherence to Medical Regimen, Self-Driven Motivation*

Quote: *"My father had a stroke at 70, and I've lost two uncles to heart-related issues... That stays with me. I know I'm not invincible."*
Codes: *Family history of heart disease*

These quotes highlighted intrinsic motivation and emotional legacy as anchors of therapeutic discipline. In total, over 100 open codes were generated and later refined.

Step 3: Focused Coding and Theme Development

After generating an extensive list of open codes, JJ conducted a second cycle of focused coding. Here, JJ grouped similar codes together, examining their underlying conceptual patterns. Codes were clustered based on shared meanings and were refined through constant comparison.

For example:

- *Preference for hands-on learning*, and *Video tutorials improve adoption* were grouped under the focused category: "*Guided and Experiential Learning Preferences*"
- Feeding into the sub-theme: *Perceived Value and Confidence as Conditions for mHealth Engagement*

Similarly:

- *Dissonance in perceived severity and Symptom-based understanding of illness* informed: *"Minimization and Misalignment of Severity"*

- Forming a sub-theme *"Perceived Severity"* within *Key Health Beliefs Among CVD Patients*

Step 4: Codebook Construction

As codes stabilized and themes began to emerge, JJ developed a detailed codebook to ensure consistency and transparency. Each code was assigned:

- **Code Name**: *Desire for Centralized Health App*
- **Definition**: The participant expresses a preference for apps that consolidate health tasks like reminders, hospital updates, and medication records
- **Illustrative Quote**:

  "If an app could bring all of that into one place, it would really simplify things."
  (Desire for Centralized Health App, P04)

This enabled JJ to track how codes matured from semantic fragments to theoretical categories.

Step 5: Integrating Theory Through Sensitizing Concepts

Although the initial phase was inductive, JJ gradually integrated theoretical lenses from HBM and TRAM as themes matured. These frameworks provided sensitizing concepts, not strict categories, that helped frame and interpret the data:

For example:

- The sub-theme *Perceived Susceptibility* emerged from participant reflections such as:

  "That stays with me. I know I'm not invincible."
  (Family history of heart disease, P05)

- *Discomfort***,** a TRAM trait, was developed from codes like:

  "I've tried a few apps, but they confuse me. Too many buttons"
  (Concern about usability, P01)

- Cues to Action, was developed from:

  "If my doctor or someone I trust said, This app works well,' I'd be more inclined to give it a try."
  (Trust in physician recommendation, P05)

These concepts helped JJ organize emergent insights without forcing them into rigid categories.

Step 6: Finalizing Themes

Final themes were evaluated for clarity, internal coherence, and theoretical resonance. Five final themes were constructed:

1. **Key Health Beliefs Among CVD Patients**
   - *Perceived Severity*

- *Perceived Susceptibility*
- *Cues to Action as a Facilitating Belief*

2. **Technological Readiness Traits of CVD Patients**
    - *Innovativeness*
    - *Discomfort*
    - *Insecurity*
    - *Digital Literacy*
3. **Facilitators and Barriers Shaping mHealth Adoption Intentions**
    - *Perceived Value and Confidence as Facilitators for mHealth Engagement*
    - *Perceived Barriers for Intention to Use mHealth Apps*

Each theme was grounded in participant narratives and supported by well-defined codes from the codebook. The final structure reflected a layered understanding of how digital and psychological factors converge in shaping mHealth app adoption behavior.

JJ allowed the data to challenge, extend, or refine the theoretical constructs wherever appropriate. This flexible use of theory helped him maintain a strong connection to participants' lived experiences while also ensuring that the findings contributed to broader conceptual insights. By grounding the analysis in participants' narratives and integrating relevant theoretical models, JJ developed a meaningful understanding of how health beliefs and technology perceptions interact in the context of digital health adoption.

3.4. Rigor and Trustworthiness

Establishing rigor and trustworthiness was central to ensuring the credibility, relevance, and ethical integrity of this qualitative research. JJ adopted strategies aligned with Lincoln et al. (1985), focusing on credibility, transferability and reflexivity to enhance the quality and trustworthiness of the research.. The following practices strengthened the quality and integrity of the research process.

Credibility

To ensure the findings accurately reflected participants' lived experiences, JJ employed multiple strategies to enhance credibility:

- **Expert Checking**: JJ shared the preliminary findings and thematic interpretations with two experts in digital health (TK) and cardiology (VK) after completing the initial thematic analysis. These experts reviewed the coherence, clarity, and alignment of the emergent themes with the theoretical framework and research objectives. Based on their feedback, JJ refined the theme definitions and confirmed the analytical coherence, thereby ensuring the findings were theoretically grounded and methodologically sound.

  Although member checking, which is, validating results directly with participants, is a widely used technique in qualitative research, JJ chose not to apply it in this study. Given the potential cognitive burden on participants managing chronic

illness and practical limitations in re-contacting them, JJ prioritized expert validation to maintain analytical rigor and ensure theoretical consistency, especially given the use of sensitizing concepts from HBM and TRAM.

- **Theoretical Triangulation**: JJ employed analytical triangulation by interpreting the data through the lenses of two complementary theoretical models, HBM and TRAM. Although JJ collected data through a single method (semi-structured interviews), the application of dual theoretical perspectives helped deepen the analytical insights and reduce interpretive bias by exploring both health-related motivations and technology-related readiness.

Transferability

JJ enhanced transferability by providing rich, detailed descriptions of the research context, participant characteristics, and the data collection process. These descriptions enable readers to evaluate the applicability of the findings to other settings, particularly those involving chronic CVD patients navigating healthcare and digital technology adoption.

Reflexivity

JJ practiced continuous reflexivity throughout the research process. He maintained a reflexive journal to document assumptions, decisions, and potential biases during data collection and analysis. This reflective practice helped JJ remain aware of his positionality and ensured that interpretations remained grounded in participants' perspectives rather than being influenced by his prior knowledge or professional background in digital health. JJ paid close attention to how his familiarity with mHealth technologies might shape his interactions with participants and interpretation of data, taking deliberate steps to mitigate potential bias.

3.5. Ethical Considerations

JJ prioritized ethical integrity throughout the design and execution of this study, particularly due to the involvement of human participants sharing personal experiences related to chronic illness and digital health technologies.

Informed Consent

JJ provided all participants with a detailed information sheet that explained the study's purpose, what participation would involve, the voluntary nature of involvement, and their right to withdraw at any point without consequence. JJ obtained informed consent through a digital consent form before each interview. In addition, JJ asked for and received verbal consent at the start of each session. JJ encouraged participants to ask questions and allowed them sufficient time to review all study materials before agreeing to participate.

Confidentiality and Anonymity

To protect participant identities, JJ anonymized all interview transcripts during the transcription process. JJ assigned pseudonyms and removed or generalized any potentially identifying details. JJ saved the transcripts in a secure, access-controlled environment.

Only JJ had access to the raw data. JJ ensured that all findings were presented in a way that preserved anonymity and prevented the attribution of quotes to specific individuals.

Ethics Approval

The Human Research Ethics Committee (HREC) at TU Delft granted ethical approval for this study. JJ submitted the research protocol, consent materials, and data management plan for review, and the committee approved them in accordance with institutional and international ethical guidelines for research involving human participants.

4

Findings

4.1. Overview of Findings

The findings of this study explore how health beliefs shape chronic CVD patients' intention to adopt mHealth applications for long-term therapeutic compliance. Through thematic analysis of semi-structured interviews with 11 participants, three core themes were developed, each addressing distinct but interconnected aspects of the adoption process. These themes are grounded in the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM), providing an integrated lens on both health-related and technology-related factors.

The first theme, **Key Health Beliefs Among CVD Patients**, examines how patients perceive the severity of their condition, their susceptibility to future health risks, and the cues that trigger health behaviors. These health beliefs form the motivational foundation for engaging with mHealth applications.

The second theme, **Technological Readiness Traits of CVD Patients**, highlights individual differences in patients predispositions toward technology adoption. This includes varying levels of innovativeness, digital discomfort, insecurity, and digital literacy, which collectively influence openness or resistance to mHealth engagement.

The third theme, **Facilitators and Barriers Shaping mHealth Adoption Intentions**, captures how patients evaluate mHealth applications based on perceived value, confidence, and perceived barriers. Two sub-themes emerged within this domain: (A) *Perceived Value and Confidence as Conditions for mHealth Engagement*, reflecting patients views on usefulness and confidence in using mHealth tools, and (B) *Perceived Barriers for Intention to Use mHealth Apps*, reflecting concerns related to usability, cost, privacy, and emotional readiness.

Together, these findings offer an understanding of the psychological and perceptual dynamics that shape the adoption of mHealth applications in chronic cardiovascular care. They lay the foundation for the subsequent Discussion in Chapter 5, which interprets these findings in relation to existing literature and theoretical models.

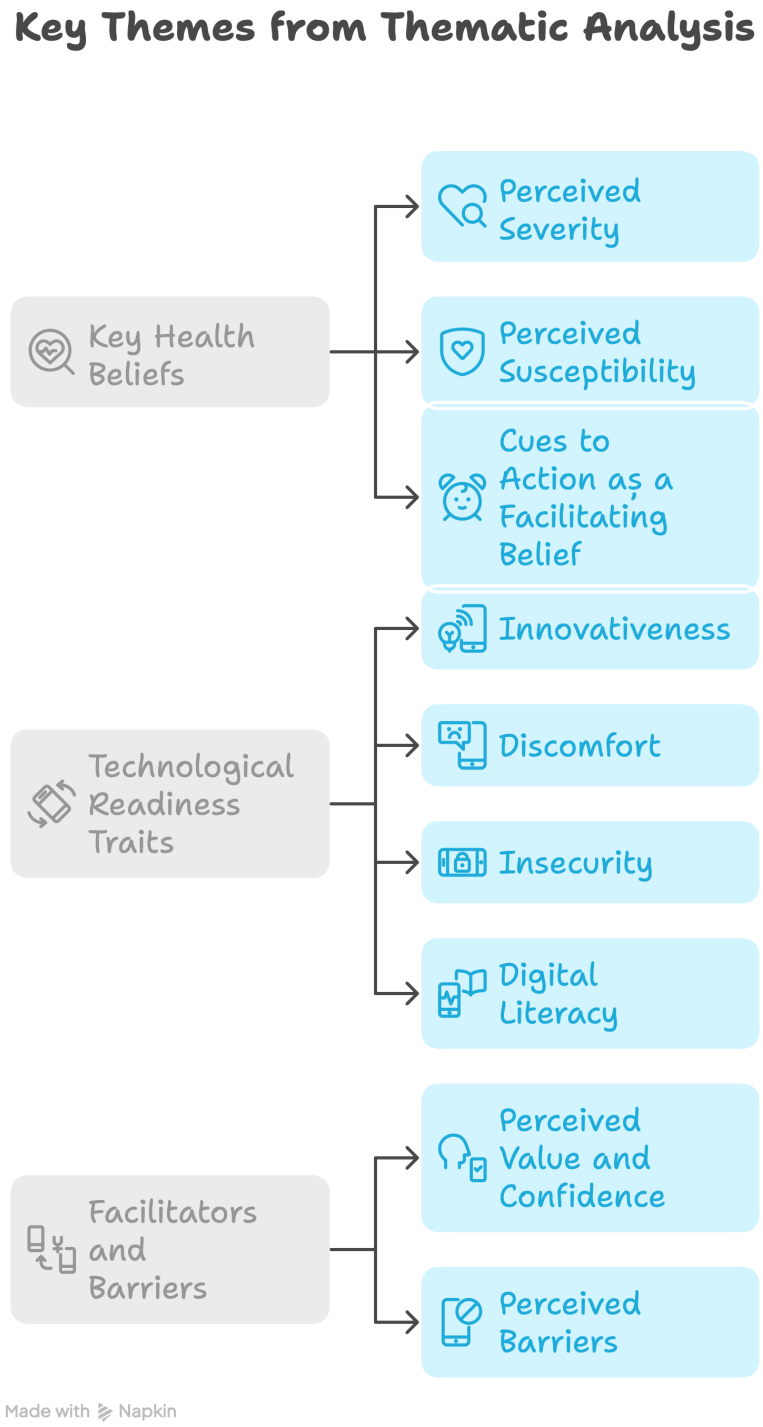

Figure 4.1: *Overview of Key Themes*

Linking Data Analysis and Key Themes

The themes presented in this chapter were developed through a thematic analysis process (Braun and Clarke, 2017), as outlined in the Methodology section. While initial coding followed an inductive, data-driven approach, the analysis was informed by sensitizing concepts derived from the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM). As coding progressed, these theoretical constructs guided the organization and interpretation of emerging patterns. For example, health beliefs constructs such as perceived severity, susceptibility, and cues to action (HBM) informed Theme 1; technology readiness traits such as innovativeness, discomfort, and insecurity (TRAM) shaped Theme 2; and combined perceptions of usefulness, ease of use, and barriers (HBM + TRAM) informed Theme 3. This integration allowed the findings to reflect both participants lived experiences and the theoretical frameworks guiding the study.

As shown in Table 4.1, the resulting themes directly reflect the domains and constructs outlined in the research design.

Table 4.1: *Overview of Domains, Theoretical Relevance, Constructs, Themes, and Link to Research Question*

Domain	**Theoretical Relevance**	**Constructs**	**Theme**	**Link to Research Question**
Health Beliefs	HBM	Perceived Severity, Perceived Susceptibility, Cues to Action	Key Health Beliefs Among CVD Patients	Answers SRQ1 by identifying key health beliefs held by chronic CVD patients.
Individual Technology Readiness	TRAM	Innovativeness, Discomfort, Insecurity, Digital Literacy	Technological Readiness Traits of CVD Patients	Answers SRQ2 by explaining how individual technology-related traits influence confidence, openness, or resistance to adopt mHealth applications.
Health Technology Perception	HBM + TRAM	Perceived Usefulness, Ease of Use, Perceived Benefits, Perceived Barriers	Facilitators and Barriers Shaping mHealth Adoption Intentions	Answers SRQ3 by identifying key factors influencing the perception of usefulness, usability and barriers to mHealth application adoption intention.

4.2. Participant Overview

The study included 11 participants diagnosed with chronic cardiovascular conditions, primarily coronary artery disease. The sample was relatively homogenous, consisting mostly of older, retired males with long-term experience managing their condition. Two female participants and one younger participant diagnosed with hypertension provided some variation in age, gender, and condition type. All participants were in the long-term management phase, having lived with their diagnosis for at least several years. Prior experience with mHealth applications was mixed, with some having experimented with digital tools and others having no previous exposure.

While the study offers valuable insights into the factors shaping mHealth app adoption among chronic CVD patients, it is important to acknowledge the limitations of the participant sample. The sample size was small and qualitative in nature, limiting the generalizability of findings to the broader CVD patient population. The results should therefore be interpreted as context-specific, reflecting the lived experiences and subjective evaluations of this particular group, rather than providing statistically representative conclusions. Nevertheless, the participants' narratives contribute meaningfully to understanding the beliefs and perceptual factors that influence mHealth app adoption in chronic care contexts.

Table 4.2: *Overview of Participant Demographics*

ID	Age	Gender	Employment Status	Diagnosis	Years Since Diagnosis	mHealth Use
P01	75	Male	Retired	Coronary Artery Disease	17	Yes
P02	63	Male	Retired	Coronary Artery Disease	18	No
P03	25	Male	Student	Hypertension	4	Yes
P04	63	Male	Retired	Coronary Artery Disease	12	No
P05	63	Male	Employed (Part-Time)	Coronary Artery Disease	3.5	Yes
P06	59	Female	Employed (Full-Time)	Coronary Artery Disease	18	Yes
P07	77	Female	Retired	High Cholesterol and Arrhythmia	>20	No
P08	72	Male	Retired	Coronary Artery Disease	12	No
P09	73	Male	Retired	Coronary Artery Disease	6	No
P10	68	Male	Retired	Coronary Artery Disease	10	Yes
P11	55	Male	Retired	Coronary Artery Disease	7	No

4.3. Key Health Beliefs Among CVD Patients

This theme examines the belief systems that shape how chronic CVD patients perceive and respond to their health condition. These beliefs are often implicit, emotional, or based on lived experience, form the cognitive scaffolding that guides their daily behaviors, motivations for compliance, and openness to trying new forms of support like mHealth apps.

This theme addresses the foundational constructs of the Health Belief Model (HBM), which posits that health behavior is shaped by how individuals perceive the threat of their condition (severity and susceptibility), what motivates action (cues to action), and how they weigh perceived barriers and benefits. While some of these constructs are discussed in later themes (e.g., barriers and benefits), Theme 1 centers explicitly on how patients interpret their illness and what drives them to act (or not).

The findings are organized into three sub-themes:

A. Perceived Severity - How serious patients believe their condition is, both physically and emotionally.

B. Perceived Susceptibility - How vulnerable they feel to disease progression or future complications.

C. Cues to Action as a Facilitating Belief - The internal and external events or triggers that activate compliance or interest in supportive tools.

Together, these health beliefs provide critical insight into why patients behave the way they do, revealing patterns that influence not just compliance, but also risk awareness, emotional coping, and attitudes toward self-management. These beliefs are not static; they evolve with time, experience, and feedback from the body or healthcare system, making them a vital context for interpreting digital engagement throughout the chronic care journey.

4.3.1. Sub-Theme A: Perceived Severity

This subtheme explores how patients interpret the seriousness of their cardiovascular condition, both in terms of physical threat and emotional burden. Within the Health Belief Model (HBM), perceived severity refers to an individual's belief regarding the seriousness of their health condition and its potential consequences. Among chronic CVD patients, this perception shaped not only how they described their diagnosis, but also how committed they were to lifestyle changes, treatment compliance, and (in some cases) openness to external tools like mHealth applications.

Severity as a Wake-Up Call

For many participants, a major cardiovascular event, such as a heart attack, hospitalization, or chronic pain, was a pivotal moment that reframed the seriousness of their condition. These experiences often catalyzed long-term behavioral shifts.

"I had a mild heart attack about five years ago, it came out of nowhere and completely shook me. Until then, I thought I was doing alright. I wasn't in terrible shape, but I wasn't really watching my diet or stress levels either. That incident was a wake-up call.

I had to reevaluate a lot, what I ate, how active I was, and how I coped with stress."
(P04, 63, male, retired, CAD)

"When you've seen the inside of a hospital room, things hit differently. I don't ever want to go back there."
(P09, 73, male, retired, CAD)

In these accounts, the emotional weight of the event, often described with terms like "frightening," "shocking," or "a turning point", was just as impactful as the clinical diagnosis.

Long-Term Vigilance and Emotional Weight

Even among those who were stable or symptom-free, the long-term nature of the disease created a baseline awareness of its seriousness. Participants described managing CVD not as a phase, but as a lifelong task requiring consistency and self-monitoring.

"You can't switch off. Even when things are fine, you know it's still there. You just manage it."
(P06, 59, female, full-time employed, CAD)

"It doesn't go away, right? You have to live with it and be careful every day."
(P10, 68, male, retired, CAD)

For these patients, perceived severity translated into sustained caution, a quiet but persistent force in their daily routines and decision-making.

Variation in Severity Interpretation

Notably, perceptions of severity were not universal. Few participants, particularly those with early-stage or less symptomatic conditions, described their illness with more emotional distance.

"I know I have hypertension, but I feel okay most days. So I don't always think about it."
(P03, 25, male, student, hypertension)

In such cases, absence of symptoms led to lowered threat perception, which in turn could reduce compliance urgency. These accounts demonstrate how subjective illness experience, not just diagnosis, shapes severity beliefs.

4.3.2. Sub-Theme B: Perceived Susceptibility

This subtheme explores how chronic CVD patients assess their personal vulnerability to disease progression or relapse. Within the Health Belief Model (HBM), perceived susceptibility refers to an individual's belief about their likelihood of experiencing future complications or worsening health if they fail to take preventive action. Among participants in this study, this belief shaped how urgently they engaged with lifestyle changes, medication compliance, and openness to supportive interventions like mHealth apps.

Heightened Awareness from Past Health Crises

For many participants, susceptibility was informed by firsthand or secondhand experiences like previous cardiac events, hospitalizations, or witnessing others suffer due to non-compliance. These experiences fostered a sense of being at risk, even in periods of physical stability.

"I've already had two heart issues. So yes, I do feel I'm at risk. That's why I stick to the schedule. I can't afford to be casual."
(P02, 63, male, retired, CAD)

"My father had a stroke at 70, and I've lost two uncles to heart-related issues... That stays with me. I know I'm not invincible."
(P05, 65, male, part-time employed, CAD)

These responses reflect a high susceptibility mindset, where prior experience translated into vigilance, reinforcing daily health behaviors and caution.

Conditional or Passive Susceptibility

In contrast, a few participants articulated a lower or conditional sense of susceptibility, acknowledging the diagnosis but downplaying risk due to age, or symptom control.

"I have hypertension, but I'm young. I try to be careful, but I don't think about it all the time."
(P03, 25, male, student, hypertension)

"They said my numbers are under control, so I don't worry much now."
(P08, 72, male, retired, CAD)

In these cases, susceptibility was often be situational rather than sustained, fluctuating based on symptoms, test results, or reassurance from healthcare providers. This more relaxed orientation could lead to inconsistent compliance or delay in adopting new tools.

Influence of Familial and Genetic Risk Awareness

Some participants referenced hereditary risk factors as part of their susceptibility calculus. Acknowledging genetic predisposition reinforced their belief in ongoing vulnerability, even if they felt physically well.

"Unfortunately, heart problems run in the family. That's why I try to stay ahead of it. I don't want to go down the same path."
(P04, 63, male, retired, CAD)

This sense of inherited risk often fostered a preventive orientation, with participants engaging in healthy routines or remaining open to new tools that could support monitoring.

4.3.3. Sub-Theme C: Cues to Action as a Facilitating Belief

This subtheme explores the internal and external triggers that prompted participants to take health-related action, whether adhering to treatment, adopting healthier routines, or considering new tools like mHealth apps. In the Health Belief Model (HBM), cues to action are factors that activate readiness and turn belief into behavior. Among CVD

patients, these cues ranged from emotional wake-up calls to medical advice and social encouragement.

Medical Events and Professional Advice

The most powerful and frequently mentioned cues were serious health events, like a heart attack or stroke, and subsequent interactions with healthcare professionals. These experiences often reoriented participants toward proactive disease management.

"The doctor told me straight, this is serious. That hit hard. From then on, I didn't skip a dose."
(P02, 63, male, retired, CAD)

"When I had the heart attack, the cardiologist didn't sugarcoat anything. He told me plainly that if I didn't change my lifestyle, I was basically inviting another one, and it could be far worse, maybe even fatal."
(P04, 63, male, retired, CAD)

These accounts illustrate how clinical interventions served as both cognitive and emotional catalysts, reinforcing the perceived severity and urgency to act.

Social Support and Accountability

Another set of cues came from family members, caregivers, or peers, who either reminded participants of their routines or emotionally reinforced their responsibilities.

"My wife always checks if I've taken my meds. It's annoying sometimes, but it helps."
(P09, 73, male, retired, CAD)

"I feel bad when my daughter asks me if I've walked today. That guilt pushes me."
(P06, 59, female, full-time employed, CAD)

These interpersonal dynamics were subtle but influential, operating less through command than through emotional accountability and shared concern.

Doctor and Family Recommendations as Digital Cues

In addition to health events and emotional accountability, several participants emphasized the importance of trusted recommendations, especially from doctors and close family members, as key triggers for engaging with mHealth tools. These endorsements offered not just credibility, but also reassurance in navigating unfamiliar digital environments.

"If it came recommended by my doctor, I'd be much more likely to try it. I trust her judgment, she's been guiding me through this condition for years now. If she told me a particular app could help and showed me how to use it or even just explained what it does, I'd be more open to giving it a try."
(P04, 63, male, retired, CAD)

"Yes, I think so. If my doctor or someone I trust said, This app works well, I'd be more inclined to give it a try. When you have to figure everything out on your own, it can be a bit overwhelming."
(P05, 65, male, part-time employed, CAD)

"If a healthcare provider recommended one, I'd definitely consider using it."
(P11, male, CAD)

Family members also helped bridge the gap between willingness and action, particularly for those less confident with technology.

"Usually, I talk to my son or grandson. They're both good with technology, and they're patient with me when I have questions. If they tell me it's useful and show me how it works, then I'm more willing to give it a shot."
(P04, 63, male, retired, CAD)

"When something new comes up, I usually ask someone in my family or social circle if it's worth the effort before trying it myself."
(P01, 75, male, retired, CAD)

These responses reveal that social and professional credibility often acts as a deciding factor, particularly for participants with low digital confidence. A trusted recommendation doesn't just provide information; it acts as a psychological nudge, transforming curiosity into actionable intent.

Theme 1 underscores that patient behavior in chronic cardiovascular care is not driven solely by instructions, features, or tools, it is shaped by how individuals understand their condition, interpret risk, and find meaning in their health journey. These beliefs about severity, vulnerability, and what prompts action, are often forged in emotional experiences and sustained by everyday cues. For some, the threat of relapse remains a constant motivator; for others, the absence of symptoms or reassurance from doctors leads to reduced vigilance and looser compliance.

Crucially, these beliefs help explain the variability in patient engagement observed across other themes. Whether a patient finds an app useful, feels confident using it, or perceives barriers, these decisions are filtered through the lens of personal health beliefs. Perceived severity can drive motivation, perceived susceptibility can spark caution, and cues to action can tip the scale toward behavioral change.

By examining this psychological framework, Theme 1 provides essential insight into the "why" behind compliance and digital engagement. It reinforces that effective interventions, whether technological or behavioral, must align not just with patient needs, but with their psychological models of illness, responsibility, and control.

4.4. Technological Readiness Traits of CVD Patients

While previous themes explored the belief system held by chronic CVD patients, this theme focuses on the underlying personal traits and dispositions that shape how chronic CVD patients relate to digital technology. Intention to use mHealth apps is not solely determined by app design or health urgency, it is also influenced by the patient's technological mindset, including their comfort, confidence, and habitual use of digital tools. These traits help explain why some participants were more willing to experiment with health apps, while others remained cautious or disengaged, even when supportive structures were present.

This theme aligns closely with the Technology Readiness and Acceptance Model (TRAM), which identifies key psychological enablers and inhibitors of technology use: innovativeness, discomfort, insecurity, and optimism. While optimism was less pronounced in this study, the other three dimensions emerged clearly across interviews. Additionally, an important and related construct, Digital literacy, surfaced organically in participant narratives. Although not a formal part of TRAM, digital literacy functioned as a foundational readiness factor, enabling or constraining participants' ability to act on their attitudes toward mHealth.

The findings are organized into four subthemes:

A. Innovativeness - The tendency to try new technologies or explore digital tools independently.

B. Discomfort - Feelings of stress, confusion, or overwhelm associated with technology use.

C. Insecurity - Mistrust in app credibility, data safety, or cloud-based systems.

D. Digital Literacy - The everyday familiarity with and purposeful use of digital tools, which shaped confidence and perceived control.

Together, these subthemes offer a portrait of the technological readiness landscape among CVD patients, highlighting that readiness is not fixed or binary, but shaped by personal traits, prior experience, and perceived digital fluency.

4.4.1. Sub-Theme A: Innovativeness

This subtheme captures how participants' natural curiosity and openness to experimentation shaped their engagement with mHealth applications. For some, this innovativeness, defined in the TRAM framework as a personality trait reflecting a tendency to try new technologies, functioned as a key enabler of patients' intention to use mHealth apps. These individuals did not necessarily wait for external prompts; instead, they proactively explored new digital solutions out of interest, convenience, or a desire to stay ahead.

Self-Initiated Exploration and Curiosity

Participants who exhibited high innovativeness often described a willingness to try digital tools without external pressure, even in unfamiliar domains. P03, a 25-year-old student, reflected a classic early-adopter mindset:

"When I got diagnosed, I started looking for ways to track everything. I tried a bunch of apps, even some experimental ones. I like to experiment and figure out what works." (P03, male, student, hypertension)

His motivation was not simply about health necessity, but also a personal drive to explore and understand the technological landscape.

Similarly, P06 demonstrated a forward-thinking orientation by seeking to integrate new digital routines into her health management:

"I keep trying new things, apps for sleep, for blood pressure. If I see something interesting on Instagram or YouTube, I'll check it out."
(P06, 59, female, full-time employed, CAD)

These participants viewed innovation as empowering, framing app experimentation as a tool for autonomy and self-monitoring.

Digital Engagement Across Domains

Importantly, innovativeness was not restricted to health contexts. Participants who used digital tools for other areas of life, e.g., finance, scheduling, communication, were more likely to perceive mHealth apps as logical extensions of existing behaviors. P10 explained:

"I already use apps to track my expenses and to-do lists. So tracking my medication doesn't feel like a big leap."
(P10, 68, male, retired, CAD)

This cross-domain confidence helped reduce friction when encountering health-specific platforms, suggesting that general digital openness supports domain-specific adoption.

Lower-End Expressions of Innovativeness: The "Wait and See" Strategy

While some participants demonstrated strong curiosity and a willingness to try new digital tools, others expressed a more cautious orientation toward mHealth technology, what can be described as a "wait and see" strategy. These individuals were not dismissive of digital health, but they preferred to observe how others used such tools before making a personal decision.

P04 articulated this reserved stance clearly:

"Not really, I'm not the kind of person who jumps on the latest gadget or app as soon as it comes out."
(P04, 63, male, retired, CAD)

Similarly, P01 (75, male, retired, CAD) shared:

"I definitely prefer to wait."

P02 echoed this sentiment in nearly identical terms:

"Not really. I'm more of a wait-and-see person."
(P02, 63, male, retired, CAD)

P05 expanded on the rationale behind this approach:

"No, I'm more the type who waits a bit. I like to see how things develop, how others experience it."
(P05, 65, male, part-time employed, CAD)

These responses illustrate that innovativeness exists on a continuum. While some participants actively seek out new technologies, others require reassurance, often from observing peers or family members before engaging. This strategic caution reflects a form of conditional openness, where adoption is possible but only after trust and perceived

value are established externally. For these individuals, external validation functions as a precursor to digital engagement, underscoring the importance of social proof in shaping mHealth application readiness.

4.4.2. Sub-Theme B: Discomfort

This subtheme captures the sense of unease, frustration, or overwhelm that some participants experienced when interacting with digital tools, particularly health-related apps. According to TRAM, discomfort arises when individuals feel they lack control over technology or are dependent on others for help. In this study, discomfort manifested as avoidance, emotional fatigue, or confusion, especially when participants encountered unintuitive interfaces, unclear instructions, or frequent updates.

Frustration with Complexity and Interface Overload

Several participants expressed that even when they were willing to try an app, the design complexity quickly discouraged sustained use. P01 described how seemingly minor interface issues triggered disengagement:

"I've tried a few apps, but they confuse me. Too many buttons and updates. I prefer things that are clear and simple."
(P01, 75, male, retired, CAD)

This kind of feedback was common among older participants, who emphasized the need for clarity and visual simplicity. When apps became too "busy" or demanded repeated logins or updates, they were quickly abandoned.

App and Notification Saturation

Beyond the technical interface, several participants described a broader emotional discomfort with the volume of apps and notifications in their digital lives. P04 framed this as digital saturation:

"There are just too many apps these days. Everything is an app. It becomes too much."
(P04, 63, male, retired, CAD)

"I really can't stand apps that bombard you with ads or pop-ups, it's distracting and makes the whole experience feel cheap."
(P03, 25, male, student, Hypertension)

Even those who were otherwise digitally active expressed a desire for simplicity and consolidation, suggesting that discomfort was not just about the app itself but about the cognitive burden of managing multiple platforms.

Dependence on Others and Loss of Autonomy

A subtle but important form of discomfort involved relying on others for digital help, which for some participants was emotionally or socially uncomfortable. P07 explained:

"I always have to ask my granddaughter to help me. I don't like bothering her every time I want to use something."
(P07, 77, female, retired, high cholesterol & arrhythmia)

This kind of dependency reduced participants' sense of control and competence, reinforcing the idea that mHealth applications, even if useful, were not made for them.

4.4.3. Sub-Theme C: Insecurity

This subtheme reflects participants' mistrust in digital health technologies, particularly concerning data privacy, credibility of app sources, and the fear of unintended consequences. In the TRAM framework, insecurity refers to skepticism about whether technology will function reliably and safely. In the context of mHealth application, this translated into worries about who has access to personal health data, how apps use or store that data, and whether users can trust the content or recommendations provided.

Concerns About Privacy and Data Misuse

For several participants, especially those already cautious about digital engagement, the idea of sharing sensitive health data through an app raised immediate red flags. P05 described it as an issue of personal boundaries:

"That's (privacy) very important.. I don't want my personal information floating around. So if I'm going to use an app like this (mHealth), it has to be clear about how it protects my data."
(P05, 65, male, part-time employed, CAD)

Others raised similar concerns about the unknown entities behind app platforms, expressing doubt over what companies might do with their information.

"You never really know who's behind these apps or what they do with your data. I'd rather not take the risk."
(P10, 68, male, retired, CAD)

These participants did not necessarily reject technology, but their caution reflected a desire for transparency, control, and endorsement from trusted medical sources.

Distrust of App Credibility and Content Validity

Beyond data privacy, insecurity also stemmed from uncertainty about whether app content was reliable or medically accurate. P11 highlighted this concern:

"A lot of these apps say they can help you track symptoms or recommend actions, but who's actually behind that? A doctor? A company? I don't know."
(P11, 55, male, retired, CAD)

This skepticism was especially prominent among participants who had previously encountered misleading or poorly vetted apps. In their eyes, lack of oversight made mHealth apps feel risky, especially when managing a serious chronic condition.

Reluctance to Rely on Cloud-Based Systems

Participants also expressed hesitation about cloud storage and the invisibility of data flow in digital systems. P11 captured this sense of unease:

"The cloud is just a mystery to me. I don't know where the data goes or who sees it. That's enough to make me uncomfortable."

(P11, 55, male, retired, CAD)

These reflections reveal that insecurity isn't only about specific past harms, it is also about the perceived lack of control in digital health environments.

4.4.4. Sub-Theme D: Digital Literacy

While personality traits like innovativeness, discomfort, and insecurity shaped patient attitudes toward mHealth apps, a more foundational enabler of readiness was digital literacy. This subtheme captures participants' ability to confidently use digital tools in their everyday lives, not just for health management, but across broader domains like communication, scheduling, and information search. These competencies formed the practical infrastructure that supported (or constrained) participants' willingness to try mHealth applications.

Everyday Digital Fluency

Several participants demonstrated a clear comfort level with routine digital tasks, including browsing, emailing, messaging, and using productivity or news apps. For these individuals, app use was embedded in daily habits, and health apps were seen as an extension of that familiarity.

"I use my phone all the time, for news, to-do lists, reminders. I'm already digitally active, so health apps feel like just another tool."
(P10, 68, male, retired, CAD)

"I'm very used to using my laptop and phone for almost everything. It's not hard to pick up a new app."
(P03, 25, male, student, hypertension)

These narratives show that prior experience with general apps (e.g., daily news, exercise, calendar tools) lowers the cognitive barrier to experimenting with health-specific platforms.

Demographic Variation and Motivation

Interestingly, digital literacy was not strictly correlated with age. While younger participant showed higher fluency, some older individuals demonstrated equally strong digital habits, often shaped by prior work or personal interests. P06 explained:

"At work, I've always had to deal with new systems and tools. You get used to it. I actually enjoy learning new features if they help me."
(P06, 59, female, full-time employed, CAD)

These accounts suggest that digital literacy is shaped as much by exposure and motivation as by generational differences. Moreover, those who used digital tools with intention, rather than passively, were more likely to see value in adopting a health-focused app.

Theme 2 sheds light on the inner landscape of technological readiness that shapes how chronic CVD patients approach mHealth application. Rather than treating technology acceptance as a simple matter of preference or access, this theme uncovers how patients' behaviors are informed by a combination of traits (like innovativeness), emotional re-

sponses (such as discomfort and insecurity), and underlying capabilities (like digital literacy). These findings suggest that adoption of mHealth application is not only a question of motivation, but of confidence, trust, and day-to-day digital fluency.

While some participants were eager to try new tools and integrate them into their routines, others experienced cognitive strain, emotional hesitation, or skepticism, despite seeing potential value. This highlights a critical insight: technological readiness is not universal. It must be assessed and supported on a case-by-case basis, particularly when designing interventions for long-term chronic disease management.

4.5. Facilitators and Barriers Shaping mHealth Adoption Intentions

This theme captures the factors that influence chronic CVD patients evaluation of mobile health (mHealth) applications as viable tools to support their long-term condition management. Participants demonstrated a thoughtful and pragmatic approach, carefully weighing both the potential value and possible limitations of mHealth application in relation to their personal care routines.

While most participants were not yet regular users of formal health apps, many articulated clear expectations regarding what would make such tools worthwhile. Their considerations extended beyond technical capabilities, encompassing emotional, psychological, and practical factors.

The findings within this theme are organized into two sub-themes that reflect the dual forces shaping patients intentions to use mHealth application:

A: Perceived Value and Confidence as Facilitators for mHealth Engagement - patients perceptions of usefulness and confidence in using mHealth applications.

B: Perceived Barriers for Intention to Use mHealth Apps - patients perceived obstacles that hinder mHealth app adoption.

Together, these sub-themes illustrate that patients decisions about mHealth adoption are not simply a matter of interest or disinterest. Instead, they emerge from a deliberate and reflective evaluation of both opportunities and concerns, rooted in patients lived experiences, expectations, and personal values.

The findings within this theme draw on constructs from both the Technology Readiness and Acceptance Model (TRAM), including perceived usefulness, ease of use, discomfort, and insecurity, and the Health Belief Model (HBM), particularly perceived benefits, perceived barriers. Collectively, these factors highlight the complex evaluative process through which patients form their mHealth application intentions, balancing enthusiasm for potential support against skepticism rooted in both technical limitations and personal readiness.

4.5.1. Sub-Theme A: Perceived Value and Confidence as Facilitators for mHealth Engagement

This sub-theme shifts focuses on how chronic CVD patients assess the potential role of mobile health (mHealth) applications in supporting their ongoing care. It examines the conditions under which mHealth technologies are perceived as valuable and usable.

Two interdependent dimensions emerged as central to patients' intention to use mHealth apps: first, the perceived utility of the application in helping manage chronic illness; and second, the confidence individuals feel in their ability to use it effectively. These dimensions were not purely technical or functional. Participants frequently highlighted emotional and psychological conditions for engagement, including trust in the tool, intuitive design, and low-pressure opportunities to explore and learn.

These findings align closely with constructs from the Technology Readiness and Acceptance Model (TRAM), particularly perceived usefulness, perceived ease of use, discomfort, and insecurity.

The analysis revealed two dimensions:

- ***Conditions for Perceiving Value and Utility*** - the practical features and contextual needs that determine whether patients see mHealth apps as helpful in simplifying and improving their health routines.
- ***Confidence Through Support and Trial*** - the experiential and emotional factors that influence patients' readiness to adopt and engage with mHealth tools.

Together, these dimensions provide insights on how patients evaluate both the usefulness and ease of use of mHealth applications in the context of long-term cardiovascular disease management.

Conditions for Perceiving Value and Utility

This dimension captures the practical and motivational factors that shape patients' belief in the usefulness of mHealth applications. Across the interviews, participants consistently emphasized that their willingness to adopt a health app was contingent on clear utility, specifically, whether it would help them simplify, manage, or improve their health routines. For most, the value of mHealth was not hypothetical; it had to be demonstrated through relevance, functionality, and design clarity.

1. *Centralization and Integration*

   Many participants were drawn to the idea of a centralized system that combines medication schedules, test results, hospital communication, and personal health tracking. This integration was viewed as a significant time-saver and a way to reduce the mental load of managing chronic conditions:

   "One of the hardest parts of managing this condition is staying organized, remembering when to take which medication, tracking appointments, checking in on my blood pressure or heart rate. If an app could bring all of that into one place, it would really simplify things."
   (P04, 63, male, retired, CAD)

P10 echoed this view, emphasizing the fragmentation of current systems:

"All results from tests blood tests, scans, etc., should be available in one place, whether it comes from the GP, the hospital or a clinic."
(P10, 68, male, retired, CAD)

Several participants explicitly stated they would be more willing to adopt a digital tool if it offered a consolidated health overview that connects to existing medical infrastructure.

2. *Functional Relevance*

   For participants, functional relevance of an mHealth app was a key condition for their intention to use, particularly in terms of its ability to reduce complexity, save time, and fit naturally into daily routines. Usefulness was not defined narrowly as clinical tracking alone, but more broadly as offering *functional relevance* to patients' lived experiences.

   Many participants expressed a practical stance toward technology, emphasizing that they only intend to use mHealth apps, if the tool demonstrated clear and tangible benefits. As one participant put it:

   "Technology is helpful, but it's not something I naturally gravitate toward unless it's clearly useful."
   (P01, 75, male, retired, CAD)

   "I need to know it's going to work well and actually help me in some way before I invest my time and energy in it."
   (P04, 63, male, retired, CAD)

   Participants were not interested in apps for novelty's sake. For adoption to occur, the utility had to be tangible, and visible improvements in daily management were a precondition for sustained use.

3. *Simplicity and Interface Design*

   A common refrain across demographic groups was the need for simplicity and intuitive design. Participants emphasized that complex interfaces or jargon-heavy apps would be immediate turn-offs:

   "First of all, it has to be simple to use. If it's complicated or full of jargon, I'll lose interest."
   (P05, 65, male, part-time employed, CAD)

   Even those with a higher comfort level with digital tools placed value on ease of use:

   "If the UI looks promising enough, yes... but even for me, it has to be clean and not cluttered."
   (P03, 25, male, student, hypertension)

   The value of simplicity extended beyond navigation, it was also linked to emotional engagement. A confusing or poorly designed app was not just a functional barrier but a psychological one, undermining the motivation to engage.

While participants placed high importance on the app's usefulness and design, perceived value alone was not sufficient to drive patients' intention to use mHealth app. For many, particularly older adults or those with limited digital experience, feeling confident in their ability to use the app emerged as equally essential. Even when an mHealth application was described as relevant or convenient, hesitation remained unless users were assured of guidance, support, or a chance to try the app at their own pace. This highlights a second dimension for patients' intention to use mHealth app: the experiential conditions under which patients feel ready to engage with technology. This dimension explores how trialability, tutorials, and supportive onboarding contribute to building the confidence necessary for mHealth engagement.

Confidence Through Support and Trial

This dimension focuses on the experiential conditions under which patients feel confident enough to engage with mHealth applications. While participants often expressed openness to using digital health tools, their actual readiness depended on whether they felt supported in the learning process. Confidence was not assumed; it had to be built, through clear onboarding, opportunities to try the app without pressure, and the reassurance that mistakes wouldn't have serious consequences. Especially for older or less tech-savvy individuals, having time to explore the app and access to guidance played a key role in shaping their willingness to use mHealth apps. These findings highlight that patients' intention to use mHealth app is not just about perceived usefulness, but also about whether the experience feels safe, manageable, and emotionally supportive.

1. *Importance of Trial and Experimentation*

   Several participants expressed a strong desire for trial opportunities before committing to regular use. Trying the app in a no-risk environment helped them build confidence and determine whether the tool was genuinely helpful for their needs.

   As one participant explained:

   "But I'd still want to test it out first, see if it fits into my routine. I don't want to commit to something only to find out it's frustrating or not really useful for me. A trial period or test version would help me see if it's worth continuing."
   (P04, 63, male, retired, CAD)

   Another participant reinforced the importance of exploratory learning and intuitive design:

   "Yes, definitely. A trial period would give me the chance to explore the features and see if it fits into my lifestyle. If it works and feels intuitive, I'd consider continuing even after the trial."
   (P01, 75, male, retired, CAD)

   These accounts reflect a need for *experiential trust-building*, where patients learn by doing. Participants were more open if the app allowed space to learn without judgment or pressure, an idea that aligns closely with TRAM's constructs of *discomfort* and *insecurity*.

2. *Role of Guided Support and Step-by-Step Learning*

For many, especially those without prior mHealth exposure, human support and structured learning were critical conditions for success. Participants described needing simple explanations, onboarding tutorials, or assistance from healthcare providers or tech-literate family members.

"If someone shows me step-by-step how to use it, then yes, I'd be more confident. Not just once. Maybe a few times."
(P07, 77, female, retired, high cholesterol and arrhythmia)

"I'm open to using something like that, but only if it's explained to me properly. Like with examples, or a video, not just a manual."
(P02, 63, male, retired, CAD)

The need for tailored support suggests that digital engagement is not only about app features, but also about user on-boarding strategy. Whether through a healthcare professional or a trusted peer, support was seen as the bridge between interest and action.

3. *Emotional Safety and Control*

Underlying these requests was a broader desire for emotional safety and autonomy. Participants wanted to feel that they were not being overwhelmed, judged, or left behind. The app had to be something they could explore at their own pace, with low stakes and high control:

"If it's too complicated, I'll leave it. But if I'm shown clearly what to do and it feels easy, I might stick with it."
(P05, 65, male, part-time employed, CAD)

"I just don't want to feel like I'm doing something wrong all the time."
(P06, 59, female, full-time employed, CAD)

These remarks reinforce that confidence in using mHealth apps is not only technical, it is deeply emotional, shaped by experiences of frustration, fear of failure, and the need to feel in control of one's care journey.

These findings suggest that intention to use mHealth application depends on addressing both instrumental value and emotional readiness. A tool perceived as useful must also feel accessible, and users are more likely to use it when they are guided and empowered. In this sense, perceived value and confidence act as twin pillars of digital health adoption.

However, even when these conditions were met, not all participants felt ready to embrace mHealth. Persistent hesitation was often linked to deeper beliefs, past experiences, or external constraints. The next sub-theme explores these underlying barriers that continue to limit or delay the use of mHealth applications among patients with chronic cardiovascular disease.

4.5.2. Sub-Theme A: Perceived Barriers for Intention to Use mHealth Apps

While many participants expressed openness to using mHealth applications, particularly when they perceived clear value and felt confident in their ability to engage with the

technology, this openness was not universal. A significant portion of the sample voiced concerns, hesitations, or outright resistance toward the adoption of mHealth applications. These perceived barriers were not limited to the technical performance of the applications but extended to emotional discomfort, cost-related doubts, and a preference for traditional, non-digital forms of care.

Drawing from participants' narratives, it becomes evident that barriers are often multilayered, involving usability frustrations, financial considerations, and deeper issues of trust, routine, and identity. For many, these concerns outweighed the potential benefits described in earlier themes, creating a psychological threshold that mHealth tools must overcome to be seen as viable.

This sub-theme is informed by Technology Readiness and Acceptance Model (TRAM) constructs such as discomfort and insecurity, as well as Health Belief Model (HBM) elements of perceived barriers. However, the accounts also move beyond theoretical constructs to reflect real-world structural and emotional constraints, making this subtheme crucial for understanding why even well-designed digital interventions may face adoption resistance among chronic CVD patients.

The findings are organized into three dimensions:

- **Technical Barriers** - frustrations with app design, usability, and digital fatigue.
- **Cost Barriers** - concerns about affordability, subscription models, and insurance coverage.
- **Psychological Barriers** - preference for analog methods, distrust in digital solutions, and resistance to changing routines.

Together, these dimensions illustrate that non-adoption is not a matter of indifference or ignorance, it is a product of deliberate evaluation, rooted in patients' lived experiences, expectations, and personal values.

Technical Barriers

A consistent deterrent to mHealth app adoption across the sample was the perception of poor technical design and user experience. Participants shared frustrations with app complexity, intrusive advertisements, and feature overload. These experiences not only discouraged continued use but, in many cases, prevented initial adoption altogether. This dimension reflects how perceived discomfort, and cognitive overload can act as a barrier to mHealth applications, key constructs in the Technology Readiness and Acceptance Model (TRAM) and Health Belief Model (HBM).

1. *Frustration with Advertisements and Pop-Ups*

   Multiple participants described excessive advertising as a major disruption to the user experience. These interruptions were perceived not only as annoying but as signs that the app was not trustworthy or serious enough for health management.

   "Some of these apps have a lot of ads and that's not good. I really can't stand apps that bombard you with ads or pop-ups, it's distracting and makes the whole experience feel cheap."
   (P03, 25, male, student, hypertension)

The presence of ads was framed as especially inappropriate in a healthcare context, where patients expected professionalism, simplicity, and focus.

2. *Overcomplexity and Feature Fatigue*

   Participants repeatedly emphasized that mHealth apps must remain focused and simple. When apps included too many functions, notifications, or unclear interfaces, they were seen as overwhelming and frustrating.

   "When it comes to health apps, I feel a bit uncertain. They seem more complex, with a lot more features and medical terms that I might not fully understand."
   (P04, 63, male, retired, CAD)

   "If it starts becoming complicated or stops being helpful, I'll probably stop using it."
   (P05, 65, male, part-time employed, CAD)

   Others criticized apps for losing sight of their core function by trying to be too many things at once, ultimately deterring consistent use.

   As P03 states:

   "If they lose their core functionality, I might start losing interest in them. These apps start doing too many times beyond the reach of their capabilities and it's annoying."
   (P03, 25, male, student, hypertension)

This feedback suggests that user control, and minimalism are not just design preferences, they are essential for long-term engagement. While technical issues such as poor design and overwhelming features discouraged participants from using mHealth apps, these barriers were often compounded by concerns about financial accessibility. Even when an app functioned smoothly, many patients were unwilling to engage if it came with recurring costs or unclear pricing structures. This underscores that the decision to adopt is not only shaped by how an app works, but also by whether it feels financially sustainable or justified. The next dimension explores how pricing models, insurance gaps, and cost-benefit calculations influence patients' intention to use mHealth applications.

Cost Barriers

Many participants expressed financial hesitation as a central barrier to adopting mHealth applications. Even when apps were described as potentially useful or convenient, the prospect of subscription fees or insurance exclusions was enough to deter engagement. For patients managing a chronic condition long-term, costs were seen not only as an immediate burden but also as a sustainability issue, raising doubts about whether such tools were worth committing to financially.

1. *Subscription Fatigue and Paywall Aversion*

   Across the interviews, the idea of monthly subscription models emerged as particularly unappealing. Participants were wary of committing to recurring payments for health apps, especially when they perceived similar functionality available through traditional or free alternatives.

   "Yes, cost would definitely be something I'd think about. If the app requires a

monthly subscription, I'd probably look for something else."
(P04, 63, male, retired, CAD)

"But once the app started charging for features, I stopped using it."
(P01, 75, male, retired, CAD)

These accounts reflect not just cost sensitivity, but also a sense of principled resistance to health-related tools being monetized in a way that feels excessive or exploitative.

2. *Preference for Free or Low-Cost Alternatives*

   Participants consistently described free access as a baseline expectation, particularly when the app's utility was not proven upfront. P02 and P05 emphasized that willingness to pay would depend entirely on simplicity, functionality, and perceived impact:

   "If the app were free, I might consider it, but only if it offered clear advantages like daily reminders or hospital integration."
   (P02, 63, male, retired, CAD)

   "Only if it was very simple and free."
   (P02, continued)

   "I don't want to pay a monthly subscription. Maybe a small one-time fee is okay, but I don't want another recurring charge."
   (P05, 65, male, part-time employed, CAD)

   This distinction between one-time payment and continuous cost was crucial: participants were more open to single-access models, especially if the app's value was proven, but rejected ongoing fees for features they felt should be basic.

3. *Systemic Concerns: Insurance and Access Equity*

   A few participants also raised questions about health system coverage and economic fairness. If mHealth tools are intended to support chronic disease management, they argued, they should be available through public or private insurance plans, just like medications or medical equipment:

   "Yes, it should really just be covered like, included through the health insurance provider."
   (P10, 68, male, retired, CAD)

   "No, if it requires a co-payment, then I wouldn't use it."
   (P11, 55, male, retired, CAD)

   P07 highlighted the price ceiling that made continued use unfeasible:

   "Yes, but it's expensive about €100 a month. Not worth it for me."
   (P07, 77, female, retired, high cholesterol & arrhythmia)

   These reflections suggest that even among participants who found value in digital tools, financial accessibility remained a decisive constraint. The assumption

that users are willing or able to invest consistently in digital health is not universally valid, especially in populations living on fixed incomes or prioritizing other healthcare expenses.

Yet even when apps were technically functional and financially accessible, some participants still chose not to adopt them. Their reasons reflected personal preferences, emotional hesitations, and deep-rooted behavioral habits that could not be addressed through usability or cost adjustments alone. These more internal, psychological barriers, such as comfort with traditional routines, need for human validation, or distrust of unfamiliar tools, point to the powerful role of belief systems and identity in shaping digital health behaviors. The final dimension examines how these psychological dynamics influence non-adoption among chronic CVD patients.

Psychological Barriers

Beyond technical frustrations and cost-related concerns, many participants expressed psychological resistance to adopting mHealth applications. This resistance was not grounded in a lack of awareness or aversion to health management, but rather in deeply rooted preferences, habits, and interpersonal expectations. For these individuals, their existing analog routines were not only sufficient, they were preferable.

1. *Comfort with Established Non-Digital Routines*

   Several participants described how their current systems, whether notebooks, pill organizers, or SMS reminders, worked well enough, making digital alternatives feel unnecessary or even disruptive.

   "I'm not very tech-savvy, and I prefer to do things in a simple, old-fashioned way."
   (P02, 63, male, retired, CAD)

   These responses highlight a sense of self-efficacy in analog systems, where traditional habits offered structure, familiarity, and control, making digital alternatives feel redundant.

2. *Desire for Human Interaction and Validation*

   A recurring psychological barrier was the need for human touchpoints. For several participants, the interpersonal aspects of care, hearing a voice, or visiting in person, provided emotional assurance and legitimacy that apps could not replicate.

   "I prefer a phone call for appointments."
   (P07, 77, female, retired, high cholesterol & arrhythmia)

   "We still require the human touch to be sure. Even when I have an ECG, if it's taken by a machine, I still want a doctor to confirm."
   (P03, 25, male, student, hypertension)

   Others suggested that digital outputs, no matter how accurate, still left space for doubt:

   "Is it something I did wrong because I'm interacting with this technology? In the real world, doctors give more reassurance."
   (P03, continued)

This preference for human confirmation over digital feedback reflects a form of emotional trust that many patients place in human contact, an element not easily replaced by automation.

3. *Distrust Toward Unverified Apps*

   A more subtle but critical barrier was skepticism about app credibility. Participants expressed hesitation around downloading unfamiliar tools, citing concerns about misinformation, inconsistent quality, or lack of medical endorsement:

   "There are so many options out there, and it's hard to tell which ones are reliable. Some of them have lots of medical jargon or confusing reviews. I didn't want to waste time downloading something that turns out to be useless or hard to use." (P04, 63, male, retired, CAD)

This reluctance to experiment reflects a desire for verified, trustworthy sources, especially when dealing with medical information. Participants emphasized the importance of recommendation and endorsement, not just availability.

This sub-theme reveals that barriers to mHealth adoption are multifaceted and deeply personal. Participants did not reject digital health tools out of ignorance or indifference; rather, they made informed decisions grounded in past experiences, emotional preferences, and perceived limitations. For some, the complexity of app design and overload of features created frustration and digital fatigue. For others, the presence of paywalls or monthly subscriptions introduced doubts about long-term affordability and sustainability. Still others expressed a strong preference for human interaction, handwritten routines, or medically endorsed channels, viewing mHealth apps as optional rather than essential.

Taken together, these barriers highlight that non-adoption is not passive but deliberate, shaped by both structural conditions and internal beliefs. They offer a necessary counterbalance to the earlier themes, which focused on facilitators. The findings here suggest that successful adoption of mHealth application depends not only on enhancing value and usability but also on mitigating resistance, clarifying expectations, and respecting patient autonomy.

Table 4.3: *Theme Summary Table*

Themes	Theme Description	Example Codes	Example Quotes	Times	Participants
Theme 1: Key Health Beliefs Among CVD Patients	Uncovers how patients' beliefs about their illness influence their behaviors and mHealth engagement.	-	-	32	11
Subtheme 1A: Perceived Severity	Interpretation of seriousness and long-term threat of their condition.	Chronic Cardiac Disease History, Minimization and Misalignment of Severity	"It doesn't go away you have to live with it and be careful every day."(P10)	21	9
Subtheme 1B: Perceived Susceptibility	Beliefs about likelihood of complications or relapse.	Family History of Heart Disease, Past Experience of Symptom Recurrence	"That stays with me. I know I'm not invincible."(P05)	27	9
Subtheme 1C: Cues to Action as a Facilitating Belief	Triggers that prompt behaviormedical, social, or emotional.	Family Support in Adherence, Trust in Physician Recommendation	"If my doctor or someone I trust said, This app works well,' I'd be more inclined to give it a try."(P05)	10	7
Theme 2: Technological Readiness Traits of CVD Patients	Highlights individual traits such as innovativeness, discomfort, and digital literacy that shape technology adoption.	-	-	55	11
Subtheme 2A: Innovativeness	Willingness to try new tools, from proactive experimentation to cautious observation.	Wait and See Approach to Technology, Early Adopter of Technology	"Not really. I'm more of a wait-and-see person."(P02)	8	7
Subtheme 2B: Discomfort	Emotional or cognitive strain from using digital tools.	Loss of Autonomy, Concern about Usability	"I've tried a few apps, but they confuse me. Too many buttons"(P01)	15	5
Subtheme 2C: Insecurity	Lack of trust in apps' credibility or data safety.	Concern About Privacy, Concern About App Credibility	"The cloud is just a mystery to me. I don't know where the data goes"(P11)	10	6
Subtheme 2D: Digital Literacy	Practical digital fluency across life domains that enables or hinders mHealth use.	Routine Digital Engagement, Basic Digital Literacy	"I use my phone all the time so health apps feel like just another tool."(P10)	22	11

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Themes	Theme Description	Example Codes	Example Quotes	Times	Participants
Theme 3: Facilitators and Barriers Shaping mHealth Adoption Intentions	Focuses on factors that facilitate or act as barrier to mHealth applications' adoption intention.	-	-	99	11
Subtheme 3A: Perceived Value and Confidence as Conditions for mHealth Engagement	Focuses on conditions under which mHealth tools are perceived appealing and usable.	Desire for Centralized Health App, Preference for Simple and Intuitive Interface	"One of the hardest parts of managing this condition is staying organized"(P04)	53	10
Subtheme 3B: Perceived Barriers for Intention to Use mHealth Apps	Explores reasons for reluctance or resistance, including technical frustrations, cost, and emotional discomfort.	Overcomplexity Discourages Usage, Ads Aversion in Apps	"Too many apps these days It becomes too much."(P04)	46	10

5

Discussion

This study investigated how health beliefs influence the intention to use mobile health (mHealth) applications among patients managing chronic cardiovascular disease (CVD) in the long-term phase of care. Anchored in an integrated conceptual framework that combines the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM), the research aimed to illuminate the psychological and perceptual factors that shape digital health engagement beyond traditional usage metrics.

In this chapter, the study's findings are critically examined in light of the research questions. The discussion situates the results within the broader academic literature, identifying areas of alignment, extension, or departure from prior research. The chapter further reflects on the theoretical and practical significance of the findings, outlining their contribution to both scholarly understanding and real-world application. Limitations of the study are acknowledged and their implications for interpreting the outcomes are considered. Directions for future research are proposed to build upon the insights generated. Finally, a reflection on relevance of this research with respect to the Management of Technology (MoT) is presented.

5.1. Sub-Question 1: Understanding Health Beliefs (HBM)

SQ1: What are the key health beliefs held by chronic CVD patients regarding their condition during the long-term management phase?

To answer this research question, findings from *Theme 1 - Key Health Beliefs Among CVD Patients* are used. The qualitative data underscore the critical role of health beliefs, particularly perceived severity, susceptibility, and cues to action in shaping health behaviour among chronic CVD patients. These dimensions, as theorized by the Health Belief Model (HBM) (Janz and Becker, 1984; Rosenstock, 1974), were not only evident but dynamically expressed through participants' personal narratives.

Perceived severity was especially pronounced among participants with prior cardiac events or a strong family history of cardiovascular disease. These patients consistently reported heightened awareness of the potential consequences of non-adherence, which motivated them to maintain therapeutic routines. This aligns with previous research by

Wang et al. (2021) and Al-Noumani et al. (2019), who emphasize that elevated risk perception strengthens behavioral intentions in chronic disease contexts. Moreover, several participants (e.g., P04, P09) described how emotional memories of past health scares reinforced their vigilance, contradicting Goodman et al. (2012)'s findings, which highlight the negative influence of emotional representation in self-care.

Perceived susceptibility showed considerable variation across participants. While some participants demonstrated heightened vulnerability driven by past health crises or family history, others, particularly younger or asymptomatic individuals, tended to minimize their perceived risk, viewing their condition as stable or manageable. For these patients, a lack of symptoms or reassurance from healthcare providers reduced the urgency to engage actively with ongoing management tools. This conditional sense of susceptibility led to fluctuating motivation and, at times, lower engagement with preventive behaviors and by extension, their openness to use mHealth applications. These findings align with previous research indicating that when perceived vulnerability is low, patients may be less motivated to adopt supportive technologies, even when such tools are readily available (Zahed et al., 2023; Hsieh and Tsai, 2013).

The role of cues to action as a facilitating belief was especially prominent and multifaceted. Internal cues such as symptom recurrence, and external cues such as strong physician recommendations or family encouragement, often acted as decisive turning points for behavior change. This aligns with Dou et al. (2017), who found that doctor's endorsement significantly enhanced the perceived value of digital health tools. In this study, cues to action were frequently emotional and social, triggered not only by clinical advice, but by feelings of guilt or accountability within relationships, expanding the typical framing found in more instrumentally focused models like TAM or TRAM.

These findings not only affirm the relevance of HBM constructs in chronic disease contexts but also extend them by showing how beliefs are fluid, shaped by personal experience, social reinforcement, and emotional cues. This contrasts with much of the earlier literature, which tends to present beliefs as stable predictors within digital health context (e.g., Ahadzadeh et al. (2015)).

These findings directly address the first sub-question. The key health beliefs identified in the long-term management phase among chronic CVD patients include:

1. **high perceived severity**, driven by past events and family history,
2. **variable perceived susceptibility**, influenced by age and symptom presence, and
3. **strong, often emotionally anchored cues to action**, stemming from both clinical and social sources.

They confirm that perceived severity, susceptibility, and cues to action are central to patients' motivation to manage their health and by extension, are likely to influence their openness to supportive technologies such as mHealth applications. Importantly, this study extends existing literature by showing that these beliefs are not static predictors but rather dynamic, emotionally anchored, and socially reinforced perceptions that evolve through lived experience. Understanding these belief structures is essential for designing mHealth applications that are not only functionally useful but also resonant with the patient belief system, thereby enhancing their potential for meaningful

engagement.

5.2. Sub-Question 2: Exploring Individual Technology Readiness (TRAM)

SQ2: Which technology readiness traits influence how chronic CVD patients in the long-term management phase approach the use of mHealth applications?

The second theme that emerged from the data, *Technological Readiness Traits of CVD Patients*, answers this research question by uncovering the patients' underlying readiness to engage with mHealth application, captured through the constructs of innovativeness, discomfort, and insecurity, as outlined in the Technology Readiness and Acceptance Model (TRAM) (Parasuraman, 2000; Lin et al., 2007).

Several participants did not exhibit strong signs of optimism as described in the Technology Readiness Index, namely, a belief that technology would improve their control or efficiency in managing health. In fact, such techno-enthusiasm was notably absent from most narratives. Instead, participants tended to adopt a pragmatic and cautious stance, where usefulness was judged in relation to existing routines, not speculative benefits. A major reason for this lack of optimism for digital tools was participants' comfort with traditional methods, such as handwritten schedules, physical pillboxes, and direct advice from healthcare providers. These analog practices were familiar, emotionally reassuring, and perceived as sufficient for managing daily routines. This cautious stance suggests that for many patients, optimism toward digital solutions is tempered by emotional attachment to established practices, contributing to a broader pattern of resistance to change as described by Zahed et al. (2023). As a result, there was limited motivation to explore digital alternatives unless clearly necessary.

Innovativeness played a limited but nuanced role in patients' intention to use mHealth application. While a minority of participants demonstrated strong innovativeness, characterized by proactive curiosity and early experimentation with digital health apps, this tendency was not widespread across the sample. Those who engaged actively with new apps often framed their use not strictly in response to clinical needs but as part of a broader personal interest in experimenting with technology. This aligns with previous research highlighting that individuals with higher innovativeness are more likely to explore novel health technologies (Ráti and Kemény, 2023). However, for most participants, innovativeness was expressed in more cautious, conditional forms. The majority exhibited a "wait-and-see" orientation, preferring to observe others' experiences or wait for recommendations from trusted sources before engaging with mHealth applications. This conditional openness suggests that innovativeness in health technology contexts is not merely a fixed personality trait but is strongly influenced by contextual factors such as perceived health need, social reinforcement, and emotional readiness. These findings extend prior quantitative studies utilising Technology Readiness and Acceptance Model (TRAM) (Zahed et al., 2023; Ráti and Kemény, 2023) by providing qualitative evidence that innovativeness is often situational, particularly in health domains where risk perception and personal vulnerability play a significant role in adoption behavior.

Discomfort was evident in participants' expressions of frustration with complex app in-

terfaces and a general sense of being overwhelmed by digital health tools, which in turn hindered their intention to use mHealth applications. Notably, this discomfort was not limited to older participants, it appeared across age groups and was often rooted in emotional readiness, prior negative experiences, or a lack of clear guidance. For some, the cognitive load required to navigate unfamiliar platforms conflicted with the desire for simple, low-effort routines in managing their condition. As one participant noted, *"At the end of the day, the app should make my life easier, not add another layer of stress."*. These findings align with previous research indicating that patients often experience emotional discomfort and cognitive burden when interacting with health technologies, particularly when confronted with complex interfaces (Or and Karsh, 2009). Such negative perceptions can significantly hinder technology acceptance. This highlights the need for mHealth applications that minimize perceived complexity and foster psychological ease from the outset.

Insecurity emerged as a key barrier, with most participants expressing concerns about data privacy and trust in mHealth applications. Many questioned how their health information would be stored, who could access it, and whether these tools were sufficiently safe, particularly in cases where apps lacked clear healthcare affiliations. Such concerns are consistent with prior studies identifying privacy risks as significant obstacles to adoption of digital health technologies (Zhou et al., 2019b), and highlight the importance of clinical endorsement in building trust and lowering resistance, echoing Dou et al. (2017)'s findings. Interestingly, this domain-specific insecurity coexisted with frequent smartphone use for non-health purposes such as communication or entertainment. This supports findings by de Camargo Catapan et al. (2025) on domain-specific trust, suggesting that general digital familiarity does not necessarily translate into confidence in using health-related digital tools. Insecurity driven by privacy concerns thus operated as both a technical and emotional barrier to adoption, underscoring the need for mHealth app designs that prioritize data transparency, medical legitimacy, and patient control over personal information.

Finally, across all traits, the presence or absence of external support emerged as a key moderating factor. Participants who experienced higher levels of discomfort or insecurity frequently indicated that guided support from healthcare professionals, family members, or technical tutorials would increase their willingness to engage with mHealth tools. These findings reinforce prior research indicating that social influence and external support play a significant role in increasing mHealth acceptance among cardiac patients, particularly for individuals experiencing discomfort or low confidence with digital tools (Bäuerle et al., 2023).

In sum, these findings directly address the second sub-question. Among the technology readiness traits, discomfort and insecurity emerged as the most salient trait influencing approach to mHealth applications, while innovativeness and optimism played more limited or conditional roles:

1. **Low optimism**, as patients showed limited belief that technology would enhance their health management, preferring familiar routines;
2. **Conditional innovativeness**, where few exhibited proactive exploration of mHealth apps, while most adopted a cautious "wait-and-see" approach dependent on exter-

nal validation;

3. **High discomfort**, reflected in frustration with complex interfaces, cognitive overload, and emotional overwhelm, hindering adoption;
4. **High insecurity**, marked by strong privacy concerns, skepticism about data sharing, and distrust in non-clinically affiliated digital tools.

These traits influence adoption primarily by shaping patients' intention to use mHealth applications. While low optimism and conditional innovativeness limit proactive exploration of mHealth applications, high discomfort and insecurity directly hinder engagement by increasing cognitive burden and privacy concerns. As a result, technology readiness traits largely operate as barriers to adoption in this patient population.

5.3. Sub-Question 3: Exploring Health Technology Perceptions (HBM & TRAM)

SQ3: How do chronic CVD patients perceive the usefulness, ease of use, and barriers related to their intention to use mHealth applications?

The findings from Theme 3, *Facilitators and Barriers Shaping mHealth Adoption Intention*, demonstrate that chronic CVD patients' perceptions of mHealth applications are shaped by an integrated evaluation of usefulness, ease of use, and barriers, influenced by both technology readiness traits (TRAM) and health beliefs (HBM) (Lin et al., 2007; Janz and Becker, 1984).

Perceived usefulness was closely tied to the extent to which mHealth applications simplified patients existing self-management routines. Participants valued features that integrated medication tracking, symptom monitoring, appointment scheduling, and communication with healthcare providers into a centralized, cohesive system. This integration was perceived as reducing the cognitive and organizational demands of managing chronic illness, thereby enhancing patients' confidence in maintaining therapeutic compliance. These findings align with prior research emphasizing that perceived usefulness increases when mHealth tools provide clear benefits by consolidating key functions, and directly support patients' daily care processes and real-world disease management routines (Zahed et al., 2023).

In this study, perceived ease of use emerged as a key factor influencing participants willingness to engage with mHealth applications. This aligns with previous research identifying ease of use as a central determinant for adoption of digital health technologies (Zhou et al., 2019b). Apps with simple, intuitive interfaces were viewed favorably, while cluttered design, excessive features, or advertisements quickly undermined engagement. Importantly, ease of use was not judged solely on technical design but was closely tied to emotional comfort and digital confidence. Participants described anxiety about "doing something wrong", frustration when applications disrupted familiar routines, and a desire for guided onboarding or low-pressure trial periods to build confidence. These findings align with prior studies emphasizing that emotional reassurance, and cognitive simplicity are central to perceived usability in digital health adoption (Blandford, 2019).

Perceived barriers extended beyond usability to include multiple obstacles:

- *Technical barriers:* Participants reported frustrations with overly complex features, poor design, and intrusive advertisements, which contributed to cognitive overload and digital fatigue. These findings resonate with prior studies identifying feature complexity, usability challenges, and interface design issues as significant deterrents to mHealth adoption (Searcy et al., 2019).
- *Cost barriers:* Subscription models and recurring fees were commonly viewed as unsuitable for chronic disease management, particularly among participants on fixed incomes, who expressed a preference for free or one-time payment models. Similar concerns about affordability and financial burden have been observed in prior research on mHealth applications (Zhou et al., 2019a; Searcy et al., 2019).
- *Psychological barriers:* Many participants demonstrated strong emotional attachment to established non-digital routines (e.g., handwritten notes, pillboxes), a preference for face-to-face interaction with healthcare professionals, and skepticism toward unverified or non-clinically endorsed apps. These patterns reflect broader concerns regarding trust, habit, and resistance to change that have been identified in previous studies on mHealth adoption (Zahed et al., 2023; Blandford, 2019).

Across these dimensions, trust emerged as a decisive moderator of mHealth adoption intentions. Participants expressed significantly greater openness to mHealth applications that were endorsed by healthcare providers or integrated into formal care systems. Such clinical affiliation provided reassurance regarding the accuracy, safety, and legitimacy of the digital tools, fostering confidence in their use for chronic disease management. Conversely, apps lacking clear clinical validation, were frequently viewed with skepticism and rejected due to concerns over misinformation, unverified claims, or general lack of credibility. These findings align with previous research emphasizing the critical role of healthcare provider endorsement and formal medical integration in establishing trust for digital health tools. Dou et al. (2017) highlights that clinical recommendation significantly enhances mHealth acceptance, particularly among patients managing chronic conditions. Similarly, Eapen et al. (2016) argue that healthcare providers remain trusted brokers of accurate medical knowledge, and that circumventing providers in direct-to-consumer digital health models may limit both patient confidence and technology adoption.

The findings directly address sub-question 3 by identifying the following key insights:

1. **Perceived usefulness is conditional**, based on whether mHealth applications simplify daily routines, centralize health data, integrate with care teams, and reduce cognitive demands, offering clear and personally relevant benefits.
2. **Perceived ease of use is emotionally grounded**, shaped by simplicity of design, intuitive navigation, emotional comfort, fear of errors, and the availability of guided onboarding or trial opportunities to build confidence.
3. **Perceived barriers are multi-dimensional**, including:
    - *Technical barriers:* feature complexity, poor design, advertisements, and digital fatigue;

- *Cost barriers:* subscription fatigue, financial burden, and lack of insurance coverage;
- *Psychological barriers:* emotional attachment to analog routines, preference for human interaction, and skepticism toward unverified or non-clinically endorsed apps.

4. **Trust serves as a critical moderator**, with clinical endorsement and healthcare provider recommendation significantly enhancing perceived credibility and willingness to adopt mHealth tools.

These findings highlight that patients' perceptions are shaped not only by technical features, but also by emotional safety, trust, social support, and alignment with personal care routines, reflecting an integrated influence of health beliefs and technology readiness.

5.4. Answering the Main Research Question

MRQ: How do health beliefs shape chronic CVD patients' intention to use mHealth applications for improving therapeutic compliance during the long-term management phase?

The findings of this study demonstrate that health beliefs play a central role in shaping chronic CVD patients' intention to engage with mHealth applications, but their influence is neither isolated nor static. Instead, health beliefs interact closely with patients' technology readiness traits, emotional confidence, and contextual factors, jointly influencing intention to adopt mHealth applications to support therapeutic compliance.

Perceived severity and susceptibility, two core constructs of the Health Belief Model (HBM), were found to strongly motivate patients' general commitment to managing their chronic condition. Patients who had experienced prior cardiac events or had a strong family history of cardiovascular disease expressed heightened awareness of the seriousness of their condition, which fostered a stronger sense of responsibility toward adhering to therapeutic regimens. This elevated health threat perception created a baseline openness to seeking supportive interventions, including mHealth applications, consistent with previous findings that heightened perceived risk strengthens behavioral intentions in chronic care contexts (Zahed et al., 2023; Al-Noumani et al., 2019).

However, this openness was filtered through patients' technology readiness traits (TRAM), which played a decisive role in shaping adoption intentions. For many participants, low optimism limited expectations that technology would improve health outcomes. Conditional innovativeness reflected a "wait-and-see" stance, where few were eager early adopters, and most required external reassurance or peer validation before engaging. High discomfort, driven by frustration with complex interfaces, cognitive burden, and emotional overwhelm made many participants hesitant to engage with digital platforms. Insecurity around data privacy, safety, and lack of clinical affiliation further diminished trust in mHealth tools (Zhou et al., 2019b; Eapen et al., 2016). Patients' health beliefs about the seriousness of their condition created motivation to seek support, but their technology readiness traits shaped whether mHealth application was perceived as a viable support mechanism.

Interestingly, this alone did not automatically translate into intention to adopt mHealth

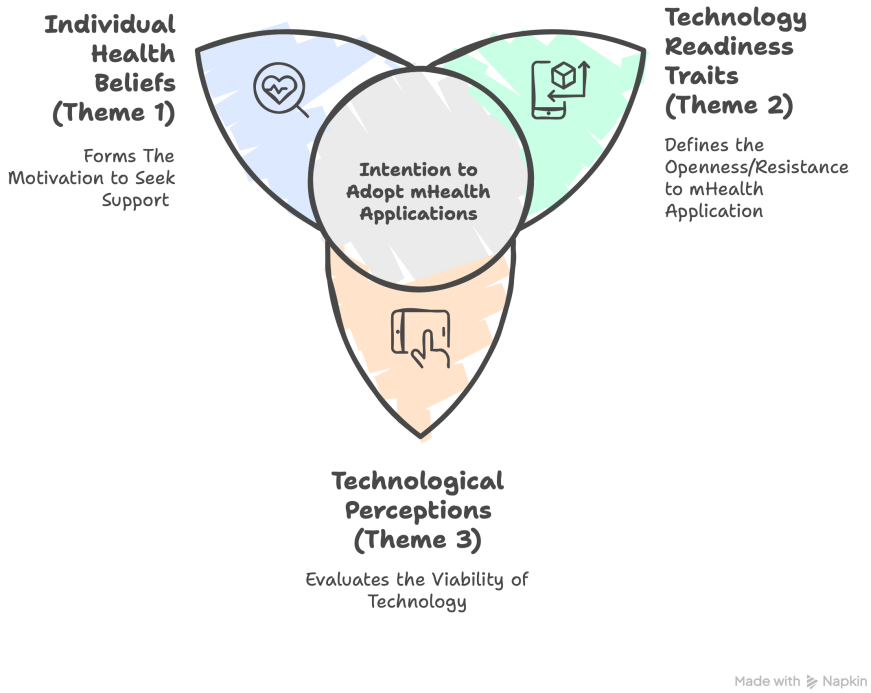

Figure 5.1: *Illustration of the factors influencing intention to adopt mHealth applications*

applications. Rather, as the findings from Sub-Question 3 revealed, patients filtered their intentions to engage with mHealth applications through evaluations of perceived usefulness, ease of use, and barriers. Perceived usefulness was contingent on whether mHealth application offered meaningful simplification of care routines, centralized health information, and directly reduced the cognitive and organizational burdens of disease management. Ease of use, meanwhile, was highly sensitive to emotional safety, fear of making mistakes, and confidence in navigating digital platforms, highlighting that usability is not purely a technical concern but deeply intertwined with emotional readiness and cognitive simplicity (Blandford, 2019; Zhou et al., 2019b).

Perceived barriers emerged as a significant point of friction where health beliefs and technology readiness intersected. Even when patients were highly motivated to manage their condition, discomfort with complex app interfaces, digital fatigue, financial constraints, and psychological attachment to non-digital routines often discouraged adoption. Furthermore, trust played a decisive moderating role across all stages of evaluation: clinical endorsement and healthcare provider recommendation were essential for legitimizing mHealth tools, especially for patients with lower digital confidence or higher risk aversion (Dou et al., 2017; Eapen et al., 2016).

Importantly, this study suggests that intention to adopt mHealth applications for therapeutic compliance is shaped not solely by individual health beliefs or technology readiness traits or technological perceptions in isolation, but by the dynamic interaction between them. Health beliefs create the underlying motivation to engage with support-

ive interventions, while technology readiness traits, perceived usefulness, ease of use, barriers, and trust factors determine whether mHealth applications are perceived as viable, trustworthy, and emotionally safe solutions. To successfully support therapeutic compliance through mHealth applications, interventions must address not only technical functionality but also patients' psychological needs that are consistent with their belief, emotional safety, and the broader social and clinical context in which technology adoption occurs.

These findings support prior calls for integrated frameworks that combine behavioral health models like HBM with technology acceptance and readiness models such as TRAM to fully capture the complexity of mHealth adoption in chronic care populations (Alpar and Driebe, 2021; Zahed et al., 2023).

5.5. Theoretical Implications

While this study is based on a limited qualitative sample, it offers some exploratory insights into the theoretical understanding of mHealth app adoption in the context of chronic cardiovascular disease (CVD) management. By combining elements of the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM), this research illustrates how an integrated approach may help to capture both health-related beliefs and technology-related perceptions that influence patients' intention to use mHealth applications.

The findings suggest that health beliefs, typically applied to explain traditional health behaviors such as medication adherence or lifestyle change, may also play an important role in shaping patients' perceptions of digital health tools. Constructs such as perceived severity, susceptibility, and cues to action appeared in participants' reflections on their needs and expectations for using mHealth applications. In this way, the study adds some qualitative depth to prior work that has proposed applying the HBM to digital health contexts (Ahadzadeh et al., 2015; Zahed et al., 2023).

At the same time, the findings highlight certain limitations of technology acceptance models that emphasize constructs like perceived usefulness or ease of use. Several participants expressed feelings of discomfort, insecurity, or ambivalence toward digital health tools, suggesting that emotional factors, previous experiences, and personal coping strategies also play a role. While these observations align with previous critiques of models such as TAM, this study offers some preliminary qualitative support for extending such models to better incorporate individual emotional dimensions.

In addition, the study indicates that technology readiness may not be a stable trait but rather shaped by personal health contexts and experiences. Participants' openness to using mHealth applications seemed influenced not only by their general digital fluency, but also by how well the technology aligned with their daily routines, emotional needs, and perceived vulnerabilities. This suggests that health-specific extensions of models like TRAM may be valuable for future research.

Finally, participants often described their engagement with digital health tools as part of a broader meaning-making process, shaped by their illness identity, sense of control, and trust in care systems. These narratives suggest that mHealth app adoption may

be more than a purely rational or utilitarian decision, emphasizing the importance of patient-centered and interpretive perspectives in future theoretical development.

Overall, while these findings are preliminary and based on a small sample, they suggest that integrating health behavior models like HBM with technology acceptance frameworks may offer a more holistic lens for understanding mHealth adoption, particularly in chronic care contexts.

5.6. Practical Implications

Based on a limited qualitative sample, this study offers several tentative implications for the design, delivery, and implementation of mHealth interventions targeting chronic CVD patients.

1. Design Simplicity and Emotional Clarity

Participants expressed a preference for mHealth applications that are simple, focused, and emotionally reassuring. Developers might consider prioritizing clear interfaces, minimizing cognitive demands, and ensuring that key features, such as medication tracking, reminders, and symptom logging, are intuitive and non-intrusive. The findings suggest that excessive complexity may create stress for some users, particularly those already managing high levels of health-related anxiety. Designing for emotional safety, predictability, and clarity may help promote sustained engagement.

2. Trust and Clinical Endorsement

Trust in the recommending source emerged as a potentially important factor influencing willingness to adopt mHealth tools. Healthcare providers, particularly general practitioners and specialists, were seen as key gatekeepers whose endorsement could increase patients' openness to using such tools. This highlights the potential value of closer collaboration between developers and clinicians to integrate mHealth applications into existing care pathways. In addition, policy-makers and insurers may support adoption by providing accreditation or integrating approved solutions into reimbursement frameworks.

3. Onboarding and Support Structures

For patients with limited digital confidence, initial guidance and support appeared to play an important role. Several participants noted the helpfulness of external support through family members, tutorials, or clinician-led introductions. mHealth applications may benefit from offering guided onboarding features such as video demonstrations or step-by-step coaching. Healthcare providers might also consider brief in-clinic sessions to help patients become familiar with these tools, potentially lowering initial barriers to use.

4. Aligning with Health Beliefs and Compliance Mindsets

Participants' willingness to engage with mHealth applications often reflected not only their technological readiness, but also their personal health beliefs. Those who perceived higher severity or susceptibility regarding their condition appeared more receptive to digital support, particularly when it aligned with their self-understanding and sense of con-

trol. Framing mHealth applications as aids for maintaining independence or preventing future complications may resonate more strongly with some patients than emphasizing compliance or monitoring alone.

In summary, these exploratory findings suggest that mHealth app adoption in chronic care may depend on factors extending beyond technological features alone. Solutions that are belief attuned, clinically credible, and aligned with patients' lived experiences may hold greater promise for sustained engagement. Further research with larger and more diverse samples could help to refine and validate these observations.

5.7. Limitations of the Study

While this study offers exploratory insights into how health beliefs and technology readiness may influence mHealth adoption among chronic CVD patients, several limitations should be acknowledged.

1. Small Sample Size and Limited Transferability

The study employed a small qualitative sample, prioritizing the exploration of participants' experiences over generalizability. Although thematic saturation was reached, the findings cannot be considered representative of the broader chronic CVD population. Instead, they offer preliminary, context-specific insights that should be interpreted with caution.

2. Demographic Skew and Sample Homogeneity

The participant group was skewed towards older, retired males, with limited variation in gender, age, employment status, or socioeconomic background. Most participants had Coronary Artery Disease, with few representing other CVD-related conditions. This sample homogeneity may limit the diversity of perspectives captured, particularly from younger patients, females, or those with different diagnoses.

3. Self-Selection and Sampling Bias

Participants were recruited primarily through convenience and self-selection, including outreach via a single homecare provider and personal networks. This may have introduced participation bias, favoring individuals who were more willing to engage, more reflective, or more comfortable discussing technology. Individuals who are more hesitant toward technology or less inclined to participate in research may be underrepresented.

4. Interview Duration and Depth of Inquiry

Considering the cognitive and emotional burden that extended interviews may place on chronic CVD patients, the interviews were deliberately kept within a 30-45 minute time frame. While this allowed participants to share meaningful perspectives, the limited duration may have constrained the depth of exploration, leaving certain topics less fully developed than might be achieved in longer or multiple interview sessions.

5. Reliance on Self-Reported, Retrospective Accounts

All data were based on self-reported experiences shared during semi-structured interviews. While this approach provided valuable narrative insights, it remains subject to

recall bias, social desirability bias, and subjective interpretation. No observational or behavioral data were collected to triangulate or verify participants' accounts.

6. Translation and Interpretation Challenges

Six interviews were conducted in Dutch, transcribed and translated collaboratively by a native dutch speaking colleague. Although care was taken to preserve accuracy, some nuance may have been lost or altered during translation, potentially influencing the interpretation of certain meanings or emphases in participants' responses.

7. Focus on Adoption Intentions Rather than Actual Behavior

The study examined participants' intentions to adopt mHealth applications rather than their actual behaviors. While intention can serve as a useful indicator of adoption potential, previous research has noted a gap between stated intentions and actual usage behavior in technology adoption contexts (Bhattacherjee and Sanford, 2009). Without longitudinal or behavioral follow-up, sustained adoption remains unexamined.

Despite these limitations, the study offers a useful exploratory foundation for further research into the behavioral, emotional, and psychological factors that may influence mHealth adoption in chronic care contexts.

5.8. Suggestions for Future Research

Building on the insights and limitations of this study, several avenues for future research are proposed to broaden and refine the understanding of mHealth app adoption in chronic care contexts, particularly among CVD patients.

1. Bridging the Intention-Behavior Gap Through Longitudinal Research

Future studies should examine the long-term behavioral outcomes of patients who express an intention to adopt mHealth applications. While this study explored intention, longitudinal designs incorporating usage tracking, app analytics, or follow-up interviews could shed light on the factors that facilitate or hinder sustained engagement over time. Such research would offer valuable insight into the translation of intention into actual, consistent use, especially for behaviorally anchored interventions in chronic disease management.

2. Expanding Sample Diversity

Further research should engage more culturally, linguistically, socioeconomically, and demographically diverse populations to examine how digital engagement is shaped by structural, educational, and cultural factors. In particular, including more female participants, younger patients, and individuals in full-time employment would help address the demographic skew observed in this study.

3. Comparative Model Testing

Quantitative or mixed-methods studies could test and compare the explanatory power of HBM, TRAM, and integrated models across different chronic conditions or demographic segments. Structural equation modeling (SEM) or path analysis could assess the relative

influence of both HBM and TRAM constructs, contributing to the further validation and refinement of theoretical frameworks in digital health adoption research.

4. Exploring Emotional and Relational Dimensions of Trust

Future research could further explore the emotional and relational foundations of digital health trust, particularly how patients' established comfort with traditional care routines influences their openness to mHealth applications. Several participants in this study expressed a preference for familiar, low-tech management strategies, such as handwritten logs, verbal instructions from healthcare providers, or physical pillboxes, which were perceived as sufficient, reliable, and emotionally reassuring. Studies could investigate how this anchoring in familiar routines affects perceptions of digital intrusiveness, legitimacy, or redundancy. Furthermore, examining the role of relational trust, e.g., trust in physicians, caregivers, or family members, as mediators of digital acceptance may offer insights into how digital onboarding can be more relationally and socially supported, guiding the design of hybrid care models that combine digital tools with trusted human interaction.

In summary, this study provides a foundation for a range of theoretically grounded and practically relevant future investigations.

5.9. Relevance to the Management of Technology (MoT) Program

This study aligns closely with the interdisciplinary scope and core principles of the Management of Technology (MoT) program at TU Delft. The MoT program emphasizes understanding technology as a corporate resource, managing innovation processes, and applying strategic insights to technological contexts, elements that are reflected throughout this thesis.

1. Technology as a Corporate and Health System Resource:

This research investigates mobile health (mHealth) applications not solely as consumer-facing digital tools, but as strategic resources for chronic disease management within healthcare systems. By examining patient adoption behavior through integrated psychological and technology readiness frameworks (HBM and TRAM), the study considers how mHealth technologies generate value when aligned with user beliefs, emotional readiness, and institutional trust, paralleling how technology resources are evaluated, adopted, and integrated in organizational contexts.

2. Innovation Process and User-Centric Design:

The thesis contributes to innovation management by identifying user-level factors that influence mHealth app adoption, including both enablers and barriers rooted in health beliefs and technology perceptions. These insights can inform patient-centered design approaches and guide stakeholder engagement processes, reflecting the MoT emphasis on managing innovation through user-informed design, iterative development, and contextual adaptability.

3. Strategic Implications for Digital Health Deployment:

The study outlines practical considerations for healthcare providers, policymakers, and developers to support mHealth adoption, including factors such as trust-building, clinical endorsement, and digital onboarding strategies. These recommendations illustrate how psychological and behavioral insights can inform managerial decision-making and strategic deployment of digital health technologies, directly addressing the MoT objective of connecting technology insights with organizational strategy.

4. Multidisciplinary and Socio-Technical Approach:

By integrating theoretical constructs from behavioral health psychology, technology management, and qualitative research, this study adopts a multidisciplinary perspective that reflects the socio-technical nature of innovation challenges. This approach is consistent with the MoT philosophy of addressing technological adoption as a function of both technical capability and social acceptance within complex systems.

In summary, this thesis contributes to the MoT field by illustrating how mHealth applications can be strategically evaluated and adopted through an integrated understanding of patient beliefs, and technological readiness.

6

Conclusion

This study set out to explore how health beliefs shape the intention of chronic cardiovascular disease (CVD) patients to adopt mHealth applications that support long-term therapeutic compliance. Recognizing the limitations of purely technology-focused adoption models, this research integrated the Health Belief Model (HBM) and the Technology Readiness and Acceptance Model (TRAM) to investigate both psychological health beliefs and technological factors that jointly influence mHealth app adoption. The guiding research question was: *How do health beliefs shape chronic CVD patients' intention to use mHealth applications for improving therapeutic compliance during the long-term management phase?*

The qualitative interviews revealed several important insights. From a health belief perspective, perceived severity and susceptibility were strong motivators for mHealth engagement, especially among participants with a family history of CVD or those who had already experienced serious health events. Cues to action, such as physician recommendations, structured reminders, and family support, facilitated engagement.

From a technology readiness perspective, traits such as discomfort and insecurity, especially related to data security and personal competence, hindered adoption. Digital literacy emerged as a crucial moderating factor, highlighting that general digital competence does not automatically translate to comfort with health-specific applications.

Participants' perceptions of mHealth apps, including perceived usefulness and ease of use, were central to forming behavioral intentions. Apps perceived as trustworthy, user-friendly, and valuable in supporting therapeutic compliance were more likely to be accepted. Confidence in using the app, often shaped by prior positive experiences with digital tools, also played a significant role. Perceived barriers emerged as a critical inhibitor of mHealth adoption. These barriers included concerns about data privacy, skepticism about the effectiveness of mHealth apps, cost concerns, and doubts about the apps' ability to address the complexity of chronic disease management.

The core insight generated from this research is that mHealth app adoption among chronic CVD patients is fundamentally shaped by the dynamic interplay between their subjective health beliefs, their readiness to engage with digital tools and their percep-

tion about mHealth applications. Health beliefs serve as a psychological lens through which patients assess the relevance and necessity of using mHealth applications, shaping their motivation to seek digital support, while technology readiness determines their confidence and comfort in operationalizing these tools in daily life. However, adoption intention depends on whether patients perceive the mHealth application as useful, easy to use, and free of significant barriers. Simply providing access to well-designed technology is insufficient; effective mHealth applications must simultaneously address patients' perceptions of health risk, their beliefs about personal control over health outcomes, their perceived barriers, and their emotional readiness to integrate technology into self-management routines. This explains why some patients who are otherwise digitally competent remain hesitant to adopt mHealth applications for health-specific purposes.

This study contributes to academic literature by demonstrating the relevance of health beliefs and the value of integrating health behavior theories in mHealth app adoption research. It extends existing knowledge by applying an integrated HBM and TRAM framework to chronic disease management. The findings illustrate that health beliefs and technology readiness are not isolated but dynamically interact to influence patients' decision-making processes. This dual-lens approach offers a holistic understanding of mHealth app adoption for chronic CVD management, addressing gaps previously unaddressed by standalone models.

The findings offer practical insights. For mHealth app developers, incorporating features that address both psychological and technological barriers can improve user adoption. These include easy-to-navigate interfaces, robust privacy safeguards, and built-in educational content that reinforces health benefits. For healthcare providers, recognizing individual differences in health beliefs and technology readiness can help tailor recommendations and patient education, increasing the likelihood of sustained app usage. Policymakers can promote digital literacy programs that build patient confidence in using mHealth tools for chronic disease management.

Future research can build upon this study by employing longitudinal designs to track actual mHealth app usage behaviors over time, particularly to explore how health beliefs evolve as patients continue managing their condition. Expanding the participant pool to include more diverse socio-demographic groups would enhance generalizability. Additionally, future models could incorporate constructs such as trust in technology, data privacy concerns, habit formation, and the role of caregivers in digital health engagement. Intervention studies that test belief-informed app design modifications could offer practical insights for developers and healthcare providers alike.

In conclusion, successful adoption of mHealth applications in chronic CVD care is not solely a technological challenge but equally a psychological one. Understanding patients' health beliefs and addressing their emotional, cognitive, and technological readiness are critical for designing effective digital health interventions. As digital health continues to evolve, incorporating belief-informed design principles holds promise for improving long-term therapeutic compliance and ultimately, patient outcomes in chronic disease management.

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A

Appendix A - Interview Guide

Interview Questions- CVD Patients (30 - 45 Minutes)

Introduction & Warm-Up

Thank you for agreeing to this interview. Id like to hear more about your experience managing your heart condition and your thoughts on using technology to support your treatment. There are no right or wrong answers, so feel free to share openly.

Before we continue, Id like to explain what I mean by a *mobile health app*. These are simple programs you can download on a smartphone or tablet, kind of like a tool or helper on your phone, that can support you in managing your health.

For example, these apps can:

- Remind you to take your medications on time.
- Help you write down how you're feeling or track things like your blood pressure or heart rate.
- Give advice on healthy eating or exercise.
- Send updates to your doctor or nurse if needed.
- Show you your progress in following your treatment plan.

Some people find these apps helpful, while others prefer not to use them and thats completely fine. Im just curious to hear your thoughts about these kinds of tools, whether youve used them before or not.

Could you briefly tell me a little about yourself? (For example, your age range, daily routine, and general experience with technology.)

Follow-Ups: How often do you use your smartphone or other digital devices in your daily life?

Experience with CVD:

- Can you tell me about your experience living with cardiovascular disease? For

example, taking medications, monitoring symptoms, or following lifestyle recommendations?

Follow-Ups:

- How regularly do you take your prescribed medication?
- Have you ever missed a dose? If so, what usually causes that?
- Do you follow any dietary or exercise recommendations from your doctor? Why or why not?
- What helps you stay consistent with your treatment plan?

Perceived Severity:

- How serious do you consider your heart condition to be?

Follow-Ups:

- Has your doctor talked to you about the long-term risks?
- Does this sense of seriousness affect how motivated you are to manage it?

Perceived Susceptibility:

- How likely do you feel it is that your condition could worsen if not managed carefully?

Follow-Ups:

- What makes you feel that way?
- Have you had past experienceseither yourself or someone closewhere the condition worsened?

Innovativeness:

- Are you usually one of the first people to try out new technologies, or do you prefer to wait?

Self-Efficacy/Optimism:

- How confident do you feel in your ability to manage your health, especially using digital tools like mobile apps?

Follow-Ups:

- What makes you feel confident or uncertain?
- Have you used mobile apps successfully for other things (e.g., banking, booking appointments)?
- If someone showed you how to use it, would you feel more in control?

Perceived Benefits

- Do you find mobile health apps to be useful?

- What benefits do you think mobile health apps could offer for someone managing a heart condition?
- Can you think of any ways these apps might make it easier to stay on track with your treatment?

Perceived Barriers

- What concerns or challenges might make you hesitant to use a health app?
- Would cost be a concern for you when considering a health app?
- Do you worry about how complex or difficult these apps might be to use?
- Do you have any concerns about how your personal health information is stored or shared through these apps?

Intention to Use:

If a mobile health app were available to help manage your heart condition, how likely would you be to try it?

Follow-Up Questions:

- What would make you more likely to give it a try?
- Would you prefer to test it out first before deciding to use it regularly?
- Have you thought about using such tools before?

Experience with mHealth Apps:

- Have you ever used a mobile health app to manage your condition or track your health?

(If **Yes**):

- What factors encouraged you to start and continue using a health app over time?
- Did your doctor or nurse recommend you to use health app?
- Did your doctor or nurses recommendation influence you to start using the apps?
- Can you tell me about your experience? What worked well, and what didnt?
- Do you get reminders, messages, or notifications that help you stay on track with your treatment?
- What types of reminders or events encourage you to take action regarding your health?
- How easy or difficult is it for you to use a mobile health app regularly?
- In your opinion, do you find mobile health app to be helpful for managing your heart condition?
- What would discourage you from continuing to use it over time?

(If **No**):

- What are the main reasons you havent used a mobile health app yet?

- Is there anything specific stopping you or worrying you about using such apps?
- Has your doctor or nurse recommended you to use health apps?
- Would you be more likely to use an app if your healthcare provider suggested it?
- How easy or difficult do you think it would be for you to use a mobile health app regularly?
- Do you have any concerns or worries about using mobile apps to manage your health?
- In your opinion, how helpful could a mobile health app be for managing your heart condition?
- What factors would encourage you to start and continue using a health app over time?

B

Appendix B - Visual Illustrations of Thematic Analysis

This appendix presents visual representations that supplement the thematic analysis discussed in the main findings chapter. It includes code tree, bubble chart and three word clouds, each corresponding to a core theme or theoretical construct derived from the interview data.

The code tree illustrates the thematic framework, bubble chart shows the distribution of sub-themes based on the number of mentions and number of participants, highlighting the relative salience of different topics within the data set. The word clouds offer an accessible summary of frequently used terms within each thematic category, capturing the language patterns and emphasis areas of participants.

Together, these visuals provide an additional layer of transparency and support the robustness of the qualitative analysis by showing how key themes emerged both in frequency and in participant diversity.

B.1. Thematic Framework

The thematic analysis generated three overarching themes that collectively reflect the interplay between patients' health beliefs, their technological readiness, and the facilitators and barriers shaping their intentions to adopt mHealth applications.

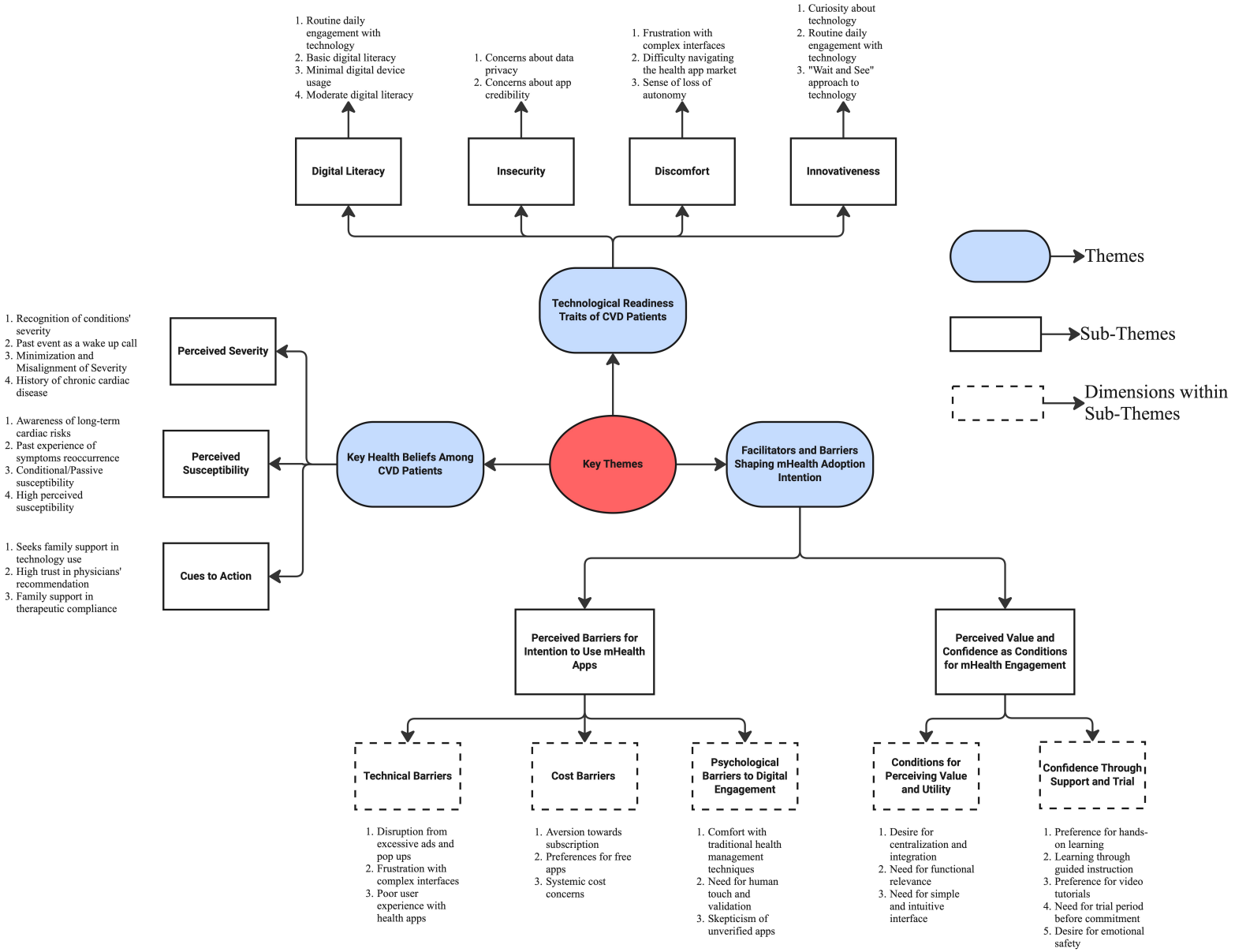

Figure B.1: *Code Tree of Thematic Analysis*

Key Health Beliefs Among CVD Patients

The first theme reflects how patients' underlying health beliefs influence their perceptions of cardiovascular disease (CVD) management and therapeutic compliance. Sub-themes include *Perceived Severity*, *Perceived Susceptibility*, and *Cues to Action*. Patients demonstrated varying levels of recognition regarding the seriousness of their condition, ranging from minimization of risks to heightened awareness following personal or familial health events. Many participants referenced family history, prior cardiac incidents, and physician recommendations as strong cues triggering adherence and behavioral change. These findings are consistent with the core constructs of the Health Belief Model (HBM), where perceptions of vulnerability and consequences play a critical role in motivating health behaviors.

Technological Readiness Traits of CVD Patients

The second theme highlights participants' individual traits related to technology adoption, aligning with key constructs from the Technology Readiness and Acceptance Model (TRAM). Four sub-themes were identified: *Digital Literacy*, *Insecurity*, *Discomfort*, and *Innovativeness*. Digital literacy levels varied widely across participants, with some reporting routine engagement with digital devices while others expressed limited confidence. Insecurity emerged around concerns regarding data privacy and app credibility, while discomfort was often linked to frustration with complex interfaces or loss of control when navigating digital tools. Innovativeness reflected participants' openness or hesitancy toward exploring new technologies, ranging from cautious trial to active curiosity.

Facilitators and Barriers Shaping mHealth Adoption Intention

The third theme captures the multidimensional factors that either promote or inhibit adoption of mHealth applications. This theme includes two broad categories: *Perceived Barriers for Intention to Use mHealth Apps* and *Perceived Value and Confidence as Conditions for mHealth Engagement*.

Perceived Barriers Three specific barrier types emerged:

- **Technical Barriers**: excessive notifications, app malfunctions, and poor interface design.
- **Cost Barriers**: subscription fees, commercialization concerns, and systemic financial considerations.
- **Psychological Barriers**: preference for traditional management approaches, a need for human validation, and skepticism towards unverified app content.

Facilitators Facilitators centered on conditions that enhance perceived value and confidence. These included:

- Desire for functional relevance, integration, and user-friendly interfaces.
- The importance of trial periods, guided support, and emotional safety before committing to long-term use.

Integrating Health Beliefs and Technological Factors

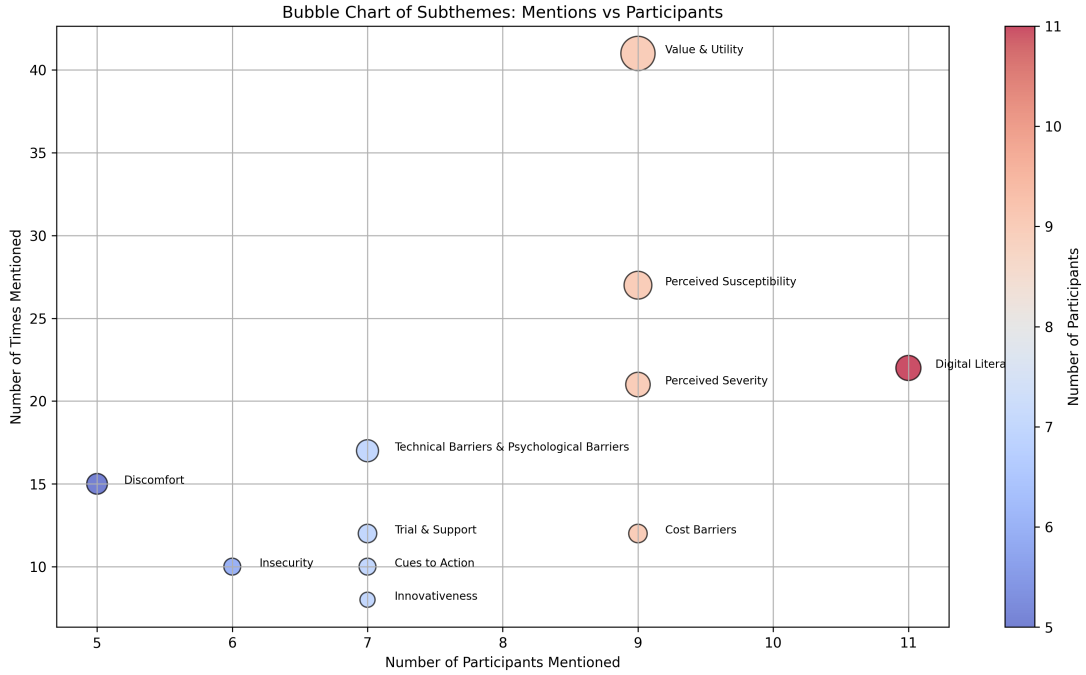

Figure B.2: *Bubble Chart Mentions vs Participants*

The combined framework illustrates how health beliefs and technological factors jointly shape patients' adoption decisions. While patients may recognize the severity of their condition and acknowledge the potential benefits of mHealth tools, individual readiness traits and external barriers often moderate actual adoption behaviors.

B.2. Sub-theme Distribution – Mentions vs Participants

To complement the qualitative findings, the bubble chart shown in figure B.2 visually represents the distribution of subthemes based on two dimensions:

- Number of participants who mentioned the subtheme (x-axis)
- Total number of times the subtheme was mentioned across all interviews (y-axis)

The size and color of each bubble indicate the number of participants contributing to that subtheme, with warmer tones (red) signifying higher participant involvement and cooler tones (blue) indicating lower involvement.

Key Observations:

- **Value & Utility** emerged as the most salient subtheme, mentioned over 40 times by 10 participants. This highlights the critical role of perceived usefulness in driving engagement with mHealth applications, aligning strongly with the TRAM model.
- **Digital Literacy**, and **Perceived Susceptibility** were also among the most frequently discussed subthemes, each mentioned by 9-11 participants. These reflect how both internal motivation (HBM) and technological capability (TRAM) shape compliance behavior.

- **Technical and Psychological Barriers** and **Cost Barriers** show moderate frequency and breadth, pointing to persistent systemic and individual obstacles to adoption.
- **Cues to Action**, **Trial & Support**, and **Innovativeness** were less frequently mentioned, possibly reflecting their supporting or contextual role rather than being central drivers of adoption.

B.3. Word Cloud

The word cloud presented below visualizes the most commonly used adjectives in interviews. This visualization was generated using frequency-based analysis of coded text segments, providing an intuitive representation of language patterns across participants.

Larger and more centrally placed words appeared more frequently in participant responses, reflecting dominant topics, concepts, and personal experiences. These words offer insight into the lived reality of patients managing chronic cardiovascular conditions. While not a substitute for in-depth qualitative coding, this visual serves as a supplementary tool to support and triangulate the thematic findings in the main analysis.

B.3.1. Theme 1 - Key Health Beliefs Among CVD Patients

Key Insights from Figure B.3:

- The frequent appearance of words such as serious, sick, careful, long, consistent, and chronic reflects a strong patient awareness of the ongoing nature and seriousness of cardiovascular disease. These terms demonstrate patients recognition of the long-term commitment required for managing their condition effectively.
- Words like careful, useful, aware, consistent, and motivated indicate a conscious understanding among patients regarding the importance of maintaining regular health behaviors, adherence to medication, and following professional medical advice to mitigate health risks.
- The presence of terms such as fatal, worse, high, pressure, and delicate emphasizes patients' perceived susceptibility to disease progression and serious health events, which directly relates to constructs of Perceived Severity and Perceived Susceptibility within the Health Belief Model (HBM).
- The inclusion of words such as young, invincible, and casual suggests that some patients, particularly younger individuals, may underestimate their personal risk, potentially leading to lower perceived vulnerability and inconsistent adherence to preventive measures.
- Additional terms such as active, healthy, overwhelming, and annoying capture the emotional and behavioral tension patients experience in balancing daily life with the demands of chronic disease management. This reflects the ongoing psychological burden associated with long-term therapeutic compliance.

B.3.2. Theme 2 - Technological Readiness Traits of CVD Patients

Key Insights from Figure B.4

Figure B.3: *Word Cloud of Keywords from Theme 1*

Figure B.4: *Word Cloud of Keywords from Theme 2*

Figure B.5: *Word Cloud of Keywords from Theme 3*

- Central words such as personal, medical, complex, complicated, new, hard, and many highlight that participants perceive mHealth technologies as highly personal yet often complex and challenging to navigate, reflecting mixed levels of comfort and readiness when engaging with digital health tools.
- Terms like hesitant, careful, cautious, uncertain, and uneasy illustrate varying levels of psychological hesitation and apprehension, corresponding to insecurity and discomfort dimensions of technological readiness. These traits influence participants willingness to adopt or trust mHealth solutions.
- Words such as confusing, experimental, complicated, untrustworthy, and wrong suggest perceived risks related to the stability, reliability, and safety of the technology further reinforcing discomfort and perceived technological vulnerability.

B.3.3. Theme 3 - Facilitators and Barriers Shaping mHealth App Adoption Intentions

Key Insights from Figure B.5

- Prominent words such as complicated, complex, confusing, wrong, annoying, and hard reflect widespread usability challenges and cognitive barriers that may discourage patients from adopting or continuing to use mHealth applications.
- Terms like expensive, financial, affordable, cheap, and free highlight strong concerns around the financial accessibility of mHealth tools, emphasizing that perceived cost plays a critical role in adoption decisions.

- Additional concerns emerge around commercial models and information overload, as seen through terms such as subscription, ads, commercial, busy, and cluttered, suggesting that some participants are wary of intrusive business practices and overwhelmed by excessive notifications or features.
- On the other hand, positive terms like helpful, useful, confident, clear, intuitive, and easy indicate that for some users, well-designed, supportive, and user-friendly mHealth apps serve as facilitators that enhance adoption intentions when these tools meet expectations of perceived ease of use and perceived usefulness.

C

Appendix C - Self Reflection On My Thesis Journey

This thesis journey has been one hell of a ride. There's a saying among TU Delft students: "If you didn't have any breakdown, did you even do your thesis?" This is so true. After so many breakdowns, phone calls back home to India, and questioning myself, I've finally finished my thesis.

Looking back on this whole experience, I have to say there were many times I regretted choosing this topic. The reasons were tough: trying to get everyone to agree on what my research should be about, keeping all the people involved happy with where my thesis was going, and finding patients who were willing to be interviewed for this research. The only thing that kept me going was one simple thought, this work might help at least one patient. Now that I look back, I don't regret any of it. It was a hard journey, but it taught me so much.

My Changing View on Using AI

My relationship with AI during this process has been complicated. As a teaching assistant for four TPM courses this year, I was very much against using AI in schoolwork. I thought it wasn't fair to students who did their assignments without AI help.

But when I started my thesis, I had a fear of missing out if I didn't use AI. This made me feel conflicted, so I talked to several professors about how to use AI the right way. Through these conversations, I figured out how to use AI responsibly.

I decided to use AI as someone who could review my work and not to generate content. I used ChatGPT with prompts like "Review the attached content critically and provide recommendations for improvements." This was really helpful, ChatGPT kept finding problems in my writing like issues with flow, transitions, and grammar, and gave me good suggestions. This really helped improve my writing.

But I learned something important: you have to know when to stop asking for feedback. ChatGPT will keep giving you suggestions forever, it never stops. I had to learn to stop when I felt like I had good work. I also used Grammarly to fix grammar mistakes. Since

I'm terrible at design and have no artistic skills, I had to use AI for visuals too. I used DALL-E and Napkin AI to create images for my thesis.

What I Learned

This thesis taught me that you grow through hard times, and that technology can really help you when you use it the right way. The important thing is to stay honest in your work while using tools that make your thinking better, not replace it.