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Digital Health: The Critical Value of Mobile Technology for the Health Sector, Different Application Examples from the World and Current Trends

Muhammet DAMAR
Dokuz Eylul University
İzmir, Türkiye
Upstream Lab, MAP, Li Ka Shing Knowledge Institute, Unity Health Toronto, Ontario, Canada
muhammet.damar@deu.edu.tr
0000-0002-3985-3073
(Corresponding Author)

Oguzhan KOP
Izmir University Of Economics
İzmir, Türkiye
oguzhankop@hotmail.com
0009-0006-8976-6820

Ömer Faruk ŞAYLAN
Ege University
İzmir, Türkiye
saylan.omer.faruk@gmail.com
0009-0005-3735-9337

Ahmet ÖZEN
Dokuz Eylul University
Faculty of Economics and Administrative Sciences
İzmir, Türkiye
ahmet.ozen@deu.edu.tr
0000-0002-9635-5134

Ülkü Ece ÇAKMAK
Dokuz Eylul University
İzmir, Türkiye
cakmak.ulkuece@ogr.deu.edu.tr
0009-0007-5993-8692

Fatih Safa ERENAY
University of Waterloo
Faculty of Engineering
Management Science and Engineering
Waterloo, Ontario, Canada
ferenay@uwaterloo.ca
0000-0002-3408-0366

Abstract*— The internet technology, which began to integrate into our lives rapidly by the end of the 1990s, underwent significant transformations with the advent of mobile technology in the 2000s. Initially accessible through desktop or notebook computers, the internet has evolved to become an integral part of virtually every aspect of our lives as mobile technology advanced throughout the 2000s. The purpose of this study is to examine the role of mobile technologies within current health technologies, investigate the necessary competencies, evaluate mobile technology developments both in Türkiye and globally, and assess the information technology infrastructure, competencies, and skills required by the sector. Our research details various and specific mobile applications from numerous countries. Findings indicate that mobile technology has established itself much more rapidly and effectively in countries with strong internet infrastructure. Mobile health services are perceived as highly valuable by citizens. The real quality and effectiveness of mobile technology depend on its acceptance and swift implementation by users. Gamification is an important tool in the adoption of mobile health applications. These applications can enhance motivation by enabling both doctors to monitor patient care services and patients to track their own health. A good mobile health system should be accepted by both patients and doctors. In countries like Türkiye, where the health system is largely supported by the state, it is seen as necessary for the Ministry of Health to prioritize mobile services to establish a robust mobile health system. Furthermore, to effectively structure mobile services, it is essential to focus on the right problems and identify issues in order of priority. Literature review reveals that various mobile applications have been implemented in fields such as dermatology, orthopedics, ophthalmology, neurosurgery, and clinical pathology. Mobile technologies offer significant cost advantages in the delivery of health services. As the population ages in European Union countries, national governments are seeking ways to reduce healthcare costs. Mobile health is considered a solution to transform the delivery of health services and reduce costs through viable new care models for both industrialized and developing countries. Moreover, it has been observed that mobile applications provide significant benefits for the elderly, particularly in developed countries such as Germany and Sweden. Our study provides a comprehensive assessment of mobile technology in the healthcare sector, highlights prominent applications from Türkiye and around the world, and offers an extensive evaluation for field readers.

Keywords*— *Health sector, digital health, digital transformation, mobile technology, current trends

I. INTRODUCTION

The primary social responsibility of states, regardless of their position or social status, is to provide their citizens with the opportunity to receive timely, high-quality medical care at affordable prices. The advancements in health technologies and their successful implementation in health services in many countries have accelerated the development of fundamentally new medical care organization methods and techniques for society [1]. Ensuring that every individual in need of health services can access these services promptly and equitably, without time and location constraints, and maintaining the efficiency and effectiveness of these services is crucial for both individuals and public authorities [2]. Electronic health (e-health) is defined as "the use of information and communication technologies in health services for the prevention, diagnosis, and treatment of diseases, monitoring, and management of health." The "e" in e-health symbolizes that health services are "electronic, digital, internet-based, efficient, fast, information-focused, and technological" [2]. Recently, as the hardware capacities of smartphones and other mobile devices have advanced, e-health functionalities have become increasingly available on mobile platforms, making

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mobile health (m-health) applications a significant subset of e-health applications [3]. The power and reach of mobile communication offer considerable versatility and benefits for delivering high-quality, low-cost health services [4]. Mobile health services are among these. Mobile health applications are seen as a preferred approach to encouraging individuals in self-care skills, reducing complications and health costs, and improving individual well-being. The effectiveness of mobile health in managing chronic conditions, as well as in interventions like disease adaptation and self-monitoring ability, has been demonstrated. In this context, mobile health shows promise in the care and management of diseases [5].

Mobile applications serve as strategic tools in correcting and improving the health-threatening erroneous behaviors developed by individuals due to their habits [6,7,8]. Examples of mobile health applications include fitness and health [9; 10], quit smoking [11,12], live healthy [13], nutrition [8;14], instant heart rate monitor [15,16], e-pulse/pulse tracking [17, 18], and the central hospital appointment system [19]. This study focuses on mobile technologies and mobile applications, providing comprehensive discussions and research on mobile technology within the health sector, highlighting interesting and noteworthy applications from Türkiye and around the world that can offer readers a different perspective on the field. Currie & Seddon [20] suggested that for the European Union to achieve its goal of increasing citizen engagement in health services, mobile technology should be part of a broader social innovation. They also argued that public health culture would only change by developing a health infrastructure supported by these applications. As researchers, we aimed to present a comprehensive mobile technology perspective for state institutions, recognizing this reality. The following sections detail the health sector, digital health, and mobile technology conceptually, with comprehensive literature information and compilation on examples of mobile technology applications in the health sector in Türkiye and globally. The discussion and conclusion sections elaborate on the key topics highlighted in the literature concerning the health sector. Upon reviewing the literature, it is noted that there has been no research of this scope and dimension on mobile technologies in the health sector, and our study is expected to fill this significant gap.

II. MATERIALS AND METHOD

This study is a comprehensive review study carried out with traditional methods. It centers on the healthcare sector, illustrating how the development of mobile technology and the diversification of mobile technology products and applications over time have transformed our ways of working. The study examines the role of mobile technologies within current healthcare technologies, investigates the required competencies, evaluates mobile technology developments in the sector in both Türkiye and globally, and addresses the necessary competencies and capabilities alongside the information technology infrastructure needed by the sector. In this context, over 900 research articles, review papers, institutional reports, and book chapters were assessed via Google Scholar.

To access research and reports on mobile applications in Türkiye via Google Scholar, initial searches were conducted using the terms “mobil teknoloji ve sağlık sektörü”, “mobil teknoloji ve Türkiye” and “mobil sağlık uygulamaları”. Further searches were performed using the English terms “mobile technology and digital health” and “mobile applications in health sector.” Additionally, health applications were examined through Google Android Market and Apple Store on a country-specific basis, and institutional applications were included in the paper. This approach aimed to provide policymakers with insights into mobile applications developed by various health institutions across different countries. Applications and best practices that could enrich the study were incorporated into the overall context, thereby offering a comprehensive view.

III. HEALTHCARE SECTOR, DIGITAL HEALTH, AND MOBILE TECHNOLOGY

Technology is rapidly advancing today. The healthcare field is also benefiting from these advancements and moving some services to virtual platforms [21]. The use of informatics in healthcare increases efficiency and quality of service while reducing medication, data, and medical errors [8,22]. In this context, digital technologies are gaining importance every day. Digital health enables unprecedented changes throughout the entire healthcare system by redefining and expanding the boundaries between patients, consumers, citizens, healthcare workers, investors, organizations, and similar structures [23,24]. Mobile technologies have become one of the most crucial and critical technologies enabling the digitalization of the healthcare sector. In recent years, mobile technologies have also found a place in the healthcare sector through wearable technologies. The use of mobile and wearable health technologies highlights the temporal, spatial, and interpersonal nature of health monitoring. Health-related data can be easily and frequently collected from users' mobile devices when they log into the relevant application. These devices offer a unique opportunity not only for users but also for health and public health workers to monitor and measure individuals' health-related habits [19,25]. Additionally, mobile technology provides unique opportunities to increase patient engagement, reduce healthcare costs, and improve outcomes [26].

Mobile technology is advancing in countless directions, and particularly in medicine, it has become an attractive area for mobile technology innovators [27]. The benefits of adapting mobile technologies to healthcare institution processes are broad, ranging from communication and cost to patient care and error reduction [28]. With the developments in information technologies used in healthcare services, especially portable devices, digital video broadcasts, database technologies, and interaction with electronic health records and health information systems have been facilitated [29]. In addition, today, mobile technology, IoT, artificial intelligence, wearable sensors, big data, blockchain and cloud computing have become prominent technologies in the healthcare sector [30,31,32]. These developments have influenced the delivery of healthcare services

In their study, Banderker & Van Belle [33] expressed the adoption factors for mobile technologies as follows: job relevance, usefulness, perceived user resources, and device features, and additionally, patient impact, support from the

national government, and hospital management. Digital, mobile, and telecommunication technologies differentiate the way people communicate in daily life. Various applications allow patients to communicate with physicians, access test results, and schedule medical appointments. More interestingly, with the advancing technology, physicians can now diagnose and even treat patients remotely [34]. Metaverse technology has also become prominent in fields such as medicine, nursing, public health, midwifery, and dentistry [35,36].

E-health reduces dependency on hospitals and decreases the in-person use of hospitals through mobile applications that can provide 24/7 service and are easily accessible to everyone [2]. According to Eysenbach [37], e-health is a new field where medical informatics, public health, and business converge through the internet and related technologies to deliver or improve healthcare services and information. In a broader sense, the term not only refers to a technical development but also characterizes a mindset, an approach, a commitment to networked, global thinking, and the use of information and communication technologies to improve healthcare locally, regionally, and worldwide. Additionally, he outlined the 10 Es of e-health: Efficiency, enhancing quality of care, evidence-based, empowerment of consumers and patients, encouragement, education, enabling information, extending the scope of healthcare, ethics, and equity.

Mobile health applications, ranging from simple SMS messages used to raise awareness and provide guidance on diseases to video teleconsultation and tele-visit applications, scheduling appointments via mobile phone or website, sending medical data from portable or wearable devices, conducting color blindness tests through smartphone applications, and remote chronic disease management, are increasingly prevalent in both developing and developed countries [38]. Mobile technologies, which refer to wireless devices and sensors that are accessible, wearable, and portable by consumers in daily activities, are defined as cost-effective tools [39]. Today, with the advent of wireless and mobile technologies, individuals and organizations can perform their activities anytime and anywhere [40]. Mobile services have also transformed the delivery of government services, bringing us face-to-face with the concept of mobile government (m-government). Mobile government refers to a series of public applications and services delivered to citizens through wireless and mobile technologies [41]. Mobile government is also referred to as mobile governance (m-governance) in the literature and represents a new channel or access method to deliver electronic government services to all citizens. M-governance provides an additional access tool for e-government and processes by using wireless and mobile technologies to deliver services via mobile devices [42].

Mobile government changes the way information is exchanged between the state and citizens, creating a new communication channel by delivering government services transparently anytime and anywhere, and eliminating the traditional organizational structure of the state [43]. In recent years, m-government has gained increasing interest, particularly among developed countries, as a mechanism to reduce costs, increase efficiency, and improve public access to government services [44]. Especially in rural areas, access to electronic government services has a significant impact [42].

Today, through smartphone applications, we can measure physiological values such as blood pressure [45, 46], blood glucose levels [47, 48], and heart rate [49, 50], and even view conditions such as skin cancer [51, 52] and middle ear infections (otitis) [53, 54, 55]. Sensors developed for hundreds of medical values, such as lung functions [56, 57, 58], mood [59, 60], eye pressure [61, 62], movement disorders [63, 64], and brain waves [65, 66], are being used or tested in clinical measurements. The remarkable technological progress observed in hardware development and innovation processes in just the past few years is astonishing. Blood pressure, heart rhythm and rate, blood oxygen saturation, respiratory rate, and body temperature can now be monitored continuously and non-invasively [67, 68, 69, 70, 71, 72]. This capability allows many patients not only to measure their own values but also to perform appropriate activities related to their diseases, adhere to their diets, and avoid harmful things at home, work, and during travel [7, 8, 73, 74]. They can easily do this by simply pressing the "measure" or "start" button on their smartphone screens. Continuous measurement during sleep or in stressful environments will provide us with highly valuable medical data [38].

IV. Application Examples of Mobile Technology in the Healthcare Sector in Türkiye

Among the significant policy implementations conducted by the Ministry of Health in Türkiye from 2002 to the present, the Health Transformation Program holds a prominent position. Various pilot applications conducted nationwide until 2013 paved the way for the full implementation of these initiatives under this program title. Structural and functional changes have been experienced across the entire healthcare system, primarily benefiting healthcare workers and all stakeholders in the community. The primary goal of this program is to maintain the overall health of patients through preventive measures, sustain a healthy population, ensure improved recovery conditions for patients, and maximize access to healthcare services under equitable conditions for all citizens [75].

The widespread adoption of mobile technologies today is helping pave the way for a new paradigm where individuals can access their health information at all times. Portable and wearable technologies are increasingly utilized to collect data on individuals' physiology, psychology, and behaviors. This valuable information can be used to reduce health risks, optimize disease complications, raise awareness about self-care, understand health determinants, or gain new perspectives on factors contributing to illness [5]. Mobile phones have proven useful as instant communication channels for transmitting demographic, clinical, research, and advancement data to healthcare providers and providing timely, reliable advice to healthcare seekers [76].

In Türkiye, efforts in the field of e-health systems have also begun. The Ministry of Health initiated infrastructure and system establishment efforts related to telemedicine in 2007 and, as of 2016, has been implementing practical applications

such as "e-nabız (e-Pulse), e-randevu (e-Appointment), electronic health records, doctor information database, online appointment system, and digital hospitals"[2]. Additionally, the Ministry of Health's strategic plan for 2013-2017 includes goals related to the use of "telemedicine and electronic information systems" in healthcare services[2].

Mobile communication technologies are effectively utilized in the field of telemedicine [77]. For example, in Türkiye, mobile technology has facilitated access to critical areas for patients such as hospital appointments, medication schedule tracking, and allergy control. For citizens with limited or difficult access to the internet, the development of the 182 Central Physician Appointment System has provided a direct communication channel for them to consult and specify their desired area of treatment at hospitals via voice communication with an advisor. Despite still being a new technology area for our country, these innovations in the healthcare sector have benefited from advancements made in other countries [43].

Various studies have been conducted in collaboration with different units to explore potential mobile application ideas, some of which are listed below [38, 78]:

- *Aile Hekimim Kim (Who is My Family Physician? With Map Support)*: An intelligent smartphone application that allows individuals to find their family physicians.
- *enVision Mobile*: Healthcare professionals can perform their tasks within the Electronic Document Management System (EBYS) software using the enVision Mobile application on their mobile phones.
- *Ministry of Health Mobile Application*: A mobile device application that allows users to read current Ministry news and calculate their body mass index by entering their weight and height to raise awareness about obesity.
- *Personal Electronic Health Record*: An application that enables individuals to access their medical data via smartphones, tablets, and the web, and authorize visits to their doctors.
- *Nearest Hospital and Nearest Pharmacy*: An intelligent smartphone application that helps individuals locate nearby pharmacies and hospitals.
- *Emergency Pharmacy*: An application that shows the nearest emergency pharmacies on a map.
- *General Information Mobile Health Application about Diseases and Symptoms*: A mobile health application that provides general information about diseases and their symptoms.
- *Application Regarding Drug Indications*: An application that provides information about drug indications.
- *E-Nabız (E-Pulse)*: A personal health record system created by the Ministry of Health in early 2015, allowing citizens to access their medical data, authorize doctor visits, and manage their health records through smartphones, tablets, and the web.

Social Security Institution (SGK) Mobile Applications:

- *SGK Mobile Library*: A mobile application providing access to SGK publications.
- *SGK Children's Application*: An informative application about SGK and its activities.
- *SGK TV Application*: An informative application about SGK and its activities.
- *Service Statement 4/A*: A mobile application for querying 4A services.
- *When Can I Retire?*: A mobile application for querying retirement conditions.

Tezcan [38] emphasized that the widespread adoption of mobile health applications in Türkiye would benefit the country due to its positive impact on both health preservation and healthcare expenditures. He listed the benefits as follows:

- Through SMS notifications, informative campaigns can be conducted in rural areas, focusing on epidemic prevention, maternal and child health, pregnancy monitoring, vaccination, and raising awareness.
- Locally developed user-friendly smartphone applications and gamification software can educate future generations, especially children and youth, to become more health-conscious individuals with higher awareness. This could contribute to improving the general health literacy index, which is currently measured at 30.4 out of 50, with 64.6% of the population falling into inadequate or problematic health literacy categories in Türkiye.
- Remote disease management applications can provide continuous, higher-quality healthcare services to the 22 million chronic patients living in Türkiye.
- Portable and wearable devices/sensors developed in Türkiye can significantly contribute to employment and production goals aligned with Türkiye's 2023 objectives.

One of the significant steps towards digitalizing the healthcare system in Türkiye was the emphasis on e-health applications in the 2013-2017 Strategic Plan to enhance citizen satisfaction and efficiency. Within this program framework, numerous e-health applications have been implemented under various headings. With the increasing use of technological devices, the Ministry of Health monitors the development of applications for mobile devices through the Mobile Applications Unit of the General Directorate of Health Information Systems and coordinates this process with the unit for wearable technological health products. Citizens can access the applications developed for them through the Apple Store and Google Play Store mobile markets, while Ministry of Health-affiliated users can access these applications via the T.C. Ministry of Health Mobile Market using their health user addresses [79].

Looking at e-health applications in Türkiye, the following systems stand out:

- The Drug Tracking System, created to prevent counterfeit drug coupons and ensure the effective and affordable distribution of drugs to all citizens.
- The electronic prescription (e-prescription) application, implemented for similar purposes.
- The MEDULA system managed by the Social Security Institution (SGK), which electronically manages all information flow regarding hospitals, pharmacies, and individuals.
- The Organ Transplant Information System.
- The Family Medicine Information System.
- The Central Hospital Appointment System, known colloquially as "Alo182".
- The core resource management system where all Ministry of Health resources are recorded and used for planning and management.
- The Health-Net platform, an electronic data storage system that forms the basis for all these e-health applications in Türkiye [80].

V. MOBILE TECHNOLOGY APPLICATION EXAMPLES IN THE EUROPEAN CONTINENT FOCUSING ON THE HEALTH SECTOR

Health systems are concerned with disease prevention, early diagnosis, diagnosis, research, and timely, affordable, and safe treatment. Communication is key to delivering services in the healthcare sector, establishing connections between service providers and patients. In the recent past, mobile technology has provided various communication platforms for the healthcare system [81]. Similar efforts are also underway in the European Union. The increased use of mobile phones is expected to save over 100 billion euros in healthcare services across Europe by 2017 and increase gross domestic product by 93 billion euros. Mobile health is expected to reduce annual healthcare spending in the European Union by 18%, as well as reduce care costs for chronic conditions by 30% to 35% through improved treatment compliance and remote patient monitoring [20].

The European Union's Horizon 2020 research and innovation program, which began in 2014, is a program where many mobile health projects can be funded. One of the focus areas of Horizon 2020 is 'Personalized Health and Care'. It supports the concept of "empowering citizens" based on taking responsibility for health and disease and improving health. Below are explained four projects benefiting from mobile health funds [82]:

- *Nephron Plus/Artificial Kidney:* Chronic kidney disease is a condition observed in one out of every ten people at a certain age. Life is difficult and treatment is complex for patients suffering from kidney failure. The NephronPlus project has received 5 million euros from the European Union funds. The project aims to develop a wearable artificial kidney to remotely monitor symptoms related to the disease via smartphones and to facilitate the lives of patients.
- *GlukoTab/Easier Work, Better Care:* In hospital settings, issues can arise during shifts between doctors and nurses in terms of information flow. Supported by EU funding, the REACTION project has developed GlucoTab, a mobile system that enhances medical information flow in hospitals. The system monitors values such as blood glucose levels, nutrient intake, administered medications, and insulin sensitivity through sensors, providing treatment recommendations. The collected data is stored on a server and shared on tablets of healthcare providers.
- *MobiGuide/Guiding Chronic Patients:* Supported by EU funding, the MobiGuide project has developed an intelligent mobile system that guides chronic patients. The research focuses on heart patients (those with atrial fibrillation) and women who have experienced problems during pregnancy (such as hypertension and diabetes). The patient wears sensors that monitor biosignals (such as heart rate, blood pressure), which are sent to a smartphone and then transmitted to a robust database. The collected data is analyzed by the MobiGuide decision support device according to the patient's clinical data history. The device alerts the patient to what needs to be done or asks questions when additional information is needed. The system then provides recommendations for lifestyle changes or contacts caregivers. All treatment recommendations are sent to the caregiver. Ultimately, the system will be suitable for all chronic and acute conditions.
- *Interstress/Dealing with Stress:* Developed to escape to a tropical island in a three-dimensional virtual reality environment, Interstress is a program designed to learn and apply effective relaxation techniques via smartphones or tablets. The main objective is to reduce stress and improve health using appropriate biosensors.

To give another example from the mobile technology networks used in the field of healthcare in European Union countries, many applications called "myskinpal and firstderm", compatible with smartphones, have been developed in the Netherlands to diagnose and treat skin diseases. For example, after you take a photo of your skin problem where you notice a difference in your body, you can write down the area in which it is, its symptoms, how long it has existed and your personal information and send it to the dermatologists in the system through the application. Experts can analyze based on the photos and information you send and give you feedback such as "There is a serious situation, visit the nearest hospital" or "There is no serious situation, use these medications and continue your life." Some of these applications are paid (around $20) and some are completely free. The Dutch government, which received positive feedback from this application, developed the application and created some new applications. These applications can analyze and diagnose your skin problems before presenting your skin problem to a doctor. Put this into practice; wound, blemish, skin tone change, irritated area, etc. He does so by uploading his photo. In this way, the Dutch government both provided public services to citizens and reduced the workload of healthcare professionals [2].

When we examine mobile technologies through the Apple Store and Android Market, focusing on the UK, we come across the following applications:

- *NHS App:* Usage: The NHS App provides basic healthcare services such as obtaining medical assistance, scheduling appointments, and renewing prescriptions for users. Services: Access to health records, updating patient information, easy access to healthcare services, emergency guide. Purpose: To enhance digital access to NHS services, improve patient experience, and make healthcare more accessible [83].
- *NHS COVID-19 (inactive):* Usage: Used during the COVID-19 pandemic for users to monitor symptoms, track contacts, and receive test results. Services: Symptom monitoring, COVID-19 contact tracing, access to test results, current health information and guidance. Purpose: Pandemic management, controlling transmission by alerting those in contact with infected individuals, safeguarding public health [84].
- *NHS Couch to 5K:* Usage: Encourages users to increase their physical activity levels through running. Services: Running training from beginner level, motivational content, progress tracking. Purpose: To reduce health issues like obesity and cardiovascular diseases, improve public health, promote physical activity [85].
- *Smokefree:* Usage: Supports users in quitting smoking. Services: Smoking cessation plans, progress tracking, information on the health effects of smoking. Purpose: To reduce smoking addiction, decrease smoking prevalence in society, improve public health [86].
- *Drink Free Days:* Usage: Encourages reducing alcohol consumption. Services: Monitoring alcohol intake, promoting healthy drinking habits, motivational content. Purpose: To reduce alcohol addiction, mitigate the negative health effects of alcohol, promote healthy lifestyles [87].
- *Mindfulness UK:* Usage: Offers meditation and mindfulness exercises for stress management and mental health. Services: Daily mindfulness exercises, stress reduction techniques, mental health resources. Purpose: To improve users' mental health, enhance coping skills for stress, increase overall well-being [88].
- *Everymind:* Usage: Provides information on mental health topics and directs users to supportive resources. Services: Mental health tips, stress coping strategies, mental health assessments. Purpose: To raise awareness of mental health in society, help users maintain and improve their mental health [89].
- *GoodSAM Responder:* Usage: Matches first aid providers with those in need during emergencies. Services: CPR training, emergency guide, participation in local emergency teams. Purpose: To expedite emergency assistance, enhance community emergency response capabilities, save lives [90].
- *Blood Donor:* Usage: Promotes blood donation campaigns and directs users to nearby donation centers. Services: Blood donation appointments, information and guidance on blood donation, donor appreciation program. Purpose: To raise awareness about blood donation, strengthen blood stocks, meet blood demand during emergencies [91].

When we examine mobile technologies through Apple Store and Android Market focusing on Sweden, the following applications emerge:

- *1177 Vårdguiden:* Usage: Provides access to healthcare services and offers consultation for health issues. Services: Symptom control, healthcare guidance, appointment scheduling, medical advice. Purpose: To facilitate easy access to healthcare services for the public, provide guidance in emergencies [92].
- *Kry - Erfaren vårdpersonal:* Usage: Offers online doctor appointments and healthcare consultation via a telemedicine platform. Services: Telemedical examinations, prescription renewal, medical reporting. Purpose: To facilitate access to healthcare services, enhance patient satisfaction, digitize healthcare [93].
- *Min Doktor – Vård & vaccin:* Usage: Provides telemedicine services and allows users to have online doctor consultations. Services: Remote medical examinations, patient management, healthcare information. Purpose: To facilitate access to healthcare services, optimize healthcare delivery, improve patient experience [94].

Another application developed alongside these applications is Adrenals.eu, a portal created for mHealth purposes by the non-profit organization BijinierNET based in the Netherlands, which provides information and products online for adrenal gland patients, caregivers, and healthcare professionals [2]. In the Netherlands, the AdrenalNET/BijnierNET portal offers basic information on adrenal disorders such as adrenal insufficiency, Cushing's syndrome, congenital adrenal hyperplasia, primary aldosteronism, pheochromocytoma, and adrenocortical carcinoma [82].

In Germany, a pioneering country in the healthcare sector, telemedicine applications began earlier compared to many other countries. The operation of telemedicine is defined as the use of modern information and communication technologies in medical diagnosis, treatment, and consultation across a wide geographical area. The gradual development of telemedicine is hindered in Germany due to concerns such as data protection/security, resulting in insufficient representation in reimbursement and application lists. Mobile governance is transforming the exchange of information between the state, government, and citizens, providing transparent access to government services anytime and anywhere, thereby establishing a new communication channel between the state and its citizens and disrupting the traditional organizational structure of the state [43]. With the advancement of telemedicine, innovations and research and development continue in this field due to the convenience of digital services.

Mobile government has garnered increasing interest as a mechanism to reduce costs, enhance effectiveness, and improve public access to government services, especially among advanced countries in recent years [44]. It is acknowledged that each country uses mobile technology as a tool to provide services, depending on the accessibility levels to these services based on the welfare levels of their own citizens. There are significant differences among Member States of the European Union, with some countries being highly advanced in health information technologies (e.g., Denmark, Sweden, and the Netherlands), while many Central and Eastern European countries lag behind [95]. Mobile broadband has grown faster in developing countries, with economic growth expected to have a positive impact, experiencing a compound annual growth rate of over 200% since 2009 [96]. The introduction of new products and services by large firms and startups serves as another driving force, yet filling the healthcare market with mobile applications requires effective adoption and dissemination strategies, where health organizations and consumers recognize the importance and benefits of transitioning to mHealth [20, 97].

VI. Mobile Technology Application Examples Focusing on the Health Sector in Other Countries in the World

New technologies have enabled users to access information they need at an unprecedented rate in human history. This reality has encouraged major healthcare organizations to promote thinking, change, and restructuring in their traditional management styles. Additionally, organizations have been prompted to incorporate more flexible and interactive elements into their business models in line with current health trends [98]. This transformation and evolution is a phenomenon occurring across all countries worldwide. In the field of health, mobile technology has significantly contributed to time management and cost reduction for healthcare services at every level, from hospital visits to individual appointments with doctors, thereby greatly enhancing convenience [81]. Mobile health examples have been diverse and increasing in variety since their inception in 2003 globally. According to a report on mobile health published by the World Health Organization in 2011, 83% of member countries had implemented at least one mobile health initiative/project, whereas 19 countries had not implemented any mobile health projects. Moreover, over the past approximately 20 years and currently, mobile health has been used for various purposes in both developed and developing countries. In developed countries, it is predominantly used for remote disease management, wellness/fitness activities, and electronic patient data transfer, focusing more on technology use. In contrast, in developing countries (African countries, India, and Far East countries), it is used more for mobile phone-based information dissemination, raising awareness about diseases, and disease prevention [38].

On average, individuals spend 3 hours and 15 minutes on their phones daily. They check their phones approximately 58 times per day on average. Filipinos spend the most time on their phones daily. Japanese citizens spend less than half of the global average time on their smartphones. It is claimed that three-quarters of Generation Z spend a lot of time on their smartphones. According to recent data, an average person spends 4 hours and 37 minutes on their phone daily. This equates to more than one day per week or six days per month. Over the course of a year, this amounts to approximately 70 days spent looking at a phone. There is a correlation between generation and screen time: Generation Z (Average Daily Screen Time: 6 hours 5 minutes, Percentage Feeling Dependent: 56%), Generation Y (Average Daily Screen Time: 4 hours 36 minutes, Percentage Feeling Dependent: 48%), Generation X (Average Daily Screen Time: 4 hours 9 minutes, Percentage Feeling Dependent: 44%), Baby Boomers (Average Daily Screen Time: 3 hours 31 minutes, Percentage Feeling Dependent: 29%) [99].

We are at a turning point in health policies in this era. It is becoming increasingly clear that changes in the current healthcare system will not be sufficient to maintain and improve our health at this historic juncture. Many reasons can be cited for this, including rising rates of chronic diseases, obesity, and mental health problems. This situation proves the need for a fundamentally new mindset in health policies [100]. Many countries support these developments in different ways. Mobile health technology or mHealth, according to a study, is currently used by 83% of doctors in the United States to provide patient care. Mobile health is an emerging technology rapidly transforming healthcare services, enhancing the quality and efficiency of healthcare. mHealth encompasses various health technologies of vital importance [101]. Additionally, the deployment of mobile applications in the healthcare sector through gamification has become increasingly popular. Gamification provides users with an active experiential process, encouraging greater participation in the application. This process is tailored to the user's choices and preferences. It is observed in the literature that motivating individuals plays a significant role in gamification. Designers play a crucial role in ensuring that individuals do not become bored with the process and complete tasks. Examples of mobile health applications offered through gamification design include [3,78]:

- *Abbott Pharmaceuticals* has developed an application in the field of pediatrics for healthcare professionals, which utilizes gamification methods to present three primary approaches. The first is conditional progression, where users cannot advance to other modules without fulfilling a specific condition within the system. The second approach involves displaying movements.
- *Change Talk, Childhood Obesity, and Overweight:* This application has been developed to facilitate more effective communication between patients diagnosed with childhood obesity and their families. Its aim is to enhance patient motivation and promote behavioral changes in health. The application is structured around interactions between a virtual pediatrician (healthcare worker), the child obesity patient, and the mother, with behaviors varying based on the pediatrician's questions.
- *Google's Smart Contact Lens:* This technological innovation by Google measures glucose levels from tears and sends them to doctors around the clock.

- *CogCubed - Cognitive Games for Health*: This application is designed to assist in diagnosing attention deficit hyperactivity disorder (ADHD) in children and adults. A professional analyzes the user's behavior while playing games to determine their susceptibility to ADHD.
- *MangoHealth:* This application helps patients taking medication to manage their own health. Features include medication reminders, drug information, and health history. Users can earn points by adhering to their medication schedules, which can be converted into donations or gift cards if desired.
- *Project Evo*: Developed jointly by Akili Interactive Labs and Pfizer, this project is designed for Alzheimer's patients. Its goal is to detect susceptibility to Alzheimer's disease, and the application is developed based on clinical research.
- *Spread the Message Stop the Virus*: Implemented by the Royal Netherlands University in 2008 and 2009 in Uganda, this project targeted 15,000 active mobile users in the Mbarara region. Its aim was to raise awareness about HIV/AIDS and encourage counseling. Thousands of mobile phone users responded to an HIV/AIDS test via SMS and received messages to educate them on the topic.
- *SMS to Monitor Malaria in Remote Areas*: A pilot project organized by the Uganda Ministry of Health and Innovative New Diagnostics Foundation. Its objective is to enable health workers to report malaria results to each other via SMS, facilitating rapid disease monitoring in the field.
- *X out TB Project:* Conducted by the Massachusetts Institute of Technology in Nicaragua, this project aims to increase treatment chances for tuberculosis patients by monitoring medication adherence and requiring patients to report the code written on their urine analysis box via mobile phone.
- *Wired Mothers*: A project initiated by the University of Copenhagen in collaboration with the Ministry of Health and Social Welfare in Tanzania. It aims to reduce maternal and newborn deaths by encouraging pregnant women to attend routine prenatal care appointments, fulfill qualified birthing attendants, and access postnatal care through SMS reminders.
- *Real-Time Biosurveillance Program*: An early warning system based in India and Sri Lanka to prevent epidemic outbreaks, where village nurses enter disease statuses into a software via mobile phones.
- *Text4 Baby*: Developed to support Hispanic American pregnant and expectant mothers regarding pregnancy. The application sends messages to pregnant women regarding pregnancy details such as month and age, providing pregnancy-related tips at least three times a week.
- *Skin Scan*: A nevus analysis program that categorizes moles into low, medium, or high-risk categories. A photo of the nevus is taken and uploaded to a mobile phone. If atypical features are detected in the photo analysis, the user is directed to a dermatologist.

When we examine mobile technologies through the Apple Store and Android Market, focusing on the United States, we encounter the following applications:

- *CDC (Centers for Disease Control and Prevention):* Usage: Provides a wide range of health services including disease control, epidemiological data monitoring, health education and information dissemination, and emergency response management. Purpose: Established to control diseases in the United States and globally, gather epidemiological data, develop health policies, and educate the public on health issues. Service Areas: Government, healthcare professionals, researchers, and the general public [102].
- *VA: Health and Benefits:* Usage: Offers specialized services for veterans in the United States, including access to healthcare services, medical records, appointment management, and medication management. Purpose: Aimed at improving access to healthcare services for VA patients, enhancing medical care, and meeting the health needs of veterans. Service Areas: Veterans, VA healthcare service providers [103].
- *MyChart:* Usage: Provides patient portal services facilitating communication between healthcare providers and patients, with features such as access to medical records, appointment management, and prescription renewals.Purpose: Designed to streamline communication between healthcare providers and patients, improve patient management, and increase access to healthcare services. Service Areas: Healthcare providers, caregivers, patients [104].
- *HealthTap:* Usage: Offers online health consultation services including instant doctor consultations, asking health questions, access to health information, and messaging with doctors. Purpose: Facilitates online communication between users and doctors, raises health awareness, and enhances access to healthcare services. Service Areas: General public, health advisors, doctors, healthcare providers [105].

When we examine mobile technologies through the Apple Store and Android Market, focusing on Australia, the following applications appear:

- *COVIDSafe (inactive):* Usage: Used for contact tracing and pandemic management during the COVID-19 pandemic. Services: Tracks user contacts with infected individuals, provides information to health authorities. Purpose: Controls the spread of the pandemic, protects community health, prevents disease transmission through contact tracing [106].
- *My Health Records:* Usage: Allows users electronic access to their health records. Services: Access to medical history, prescription information, access to laboratory results, coordination of healthcare services.

Purpose: Facilitates access to healthcare services, centralizes and shares health information in a centralized database [107].

- *HealthDirect:* Usage: Provides access to health information and directs users to healthcare services. Services:Symptom checking, searching for healthcare services, guidance for emergencies. Purpose: Ensures public access to accurate health information, directs to healthcare services, provides emergency guidance [108].
- *QuitNow:* Usage: Supports users in the process of quitting smoking. Services: Smoking cessation plans, progress monitoring, motivational content. Purpose: Reduces smoking addiction, promotes healthy lifestyles, improves public health [109].
- *MyQuitBuddy:* Usage: Supportive application for smoking cessation. Services: Smoking cessation plans, progress monitoring, access to health information and support groups. Purpose: Provides support for smoking cessation, enhances motivation, raises awareness about health effects [110].

When we examine mobile technologies through the Apple Store and Android Market, focusing on Canada, the following applications appear:

- *Maple – Online Doctors 24/7:* Description: Maple, a mobile application supported by the Canadian government, enables users to communicate with healthcare providers via voice or text messaging and video calls at any time of the day. Users can schedule virtual health appointments, obtain illness reports, prescriptions, medical advice, request laboratory tests, and much more [111].
- *CANImmunize:* Description: ImmunizeCA, supported by the Canadian Ministry of Health, helps users update their vaccination records, track vaccination schedules, and receive vaccination reminders [112].

Mobile technology creates value across three fundamental pillars: productivity, coordination, and transformation. Mobile applications are becoming increasingly important in education in many countries, not only proving beneficial but also offering students an enjoyable and interactive learning experience. For a successful mobile product launch, a well-established systematic process that is controlled, efficient, and precise is essential [113]. Governments in developing countries are making increasing efforts to provide citizens, businesses, and public officials with greater access to information and services via wireless devices [114].

The digital health technology market is a continuously growing sector attracting significant investment. Investors naturally gravitate towards this field, with companies like Apple, Google, and Samsung focusing on the development of mobile medical applications, particularly those measuring blood sugar levels. IBM is increasing its research and development investments in image recognition and medical assistants/robots. Google is creating data collection and analytics pools to support medical solutions, while Microsoft is conducting feasibility studies in areas such as speech recognition and cloud technologies. The Russian company MegaFon has launched the video consultation service "MegaFon.Health," positioning itself as a partner in organizing health services within the healthcare system [115].

Health and safety inspectors can now file reports in real-time from the field using handheld computers or terminals, eliminating the need to re-enter data collected on paper forms when returning to the office. Meanwhile, citizens can save time and energy by accessing the Internet and government networks more easily via mobile phones and other wireless devices. For example, in Malaysia, citizens can verify voting information such as parliamentary and state electoral districts using SMS (Short Message Service). Alternatively, citizens can request real-time information to be sent to their mobile phones, PDAs, or pager devices via email or SMS. Another example is the California state government, which has established a webpage where citizens can register to receive wireless PDA and mobile phone notification services for energy alerts, lottery results, traffic updates, and articles from the Governor's press office. m-Government not only enhances efficiency but also facilitates citizen activism. In the Philippines, citizens can report smoke-emitting public buses and other vehicles via SMS to aid in the enforcement of anti-pollution laws. SMS is also used to involve citizens in crime and drug control efforts [42]. All these examples can be interpreted and diversified for the healthcare sector as well.

VII. Discussion and Conclusion

In our study, we identified the importance of a robust mobile health system, particularly for countries like Türkiye where the healthcare system is heavily supported by the state. Therefore, discussing mobile health under the concept of e-government within mobile government services was deemed to be a correct approach. Additionally, it was observed that for mobile services to be structured most effectively, they must address the right problems. The acceptance of a good mobile health system by both patients and doctors is crucial [33]. They pointed out that mobile information and communication technologies in the public health sector promise to improve the quality of health services, but this potential can only be realized if individuals decide to adopt new technologies.

During the development of mobile applications, we also found that information security and personal data privacy must be considered, and user roles must be well-defined. One of the most critical aspects to consider in mobile health projects is that technology alone is not sufficient in applications and solutions. Mobile health projects are equally complex as other healthcare projects. The significant difference lies in their ability to be largely accessed remotely and heavily utilize communication and information technologies. Therefore, a well-trained human resource is critical in this regard. Individuals who are aware of current information technology trends and anticipate how technology will affect their profession can play a key role in effectively utilizing relevant technologies [116, 117]. It is also considered highly beneficial to add at least one or two courses related to current health technologies and information technologies to programs in fields related to the healthcare sector such as medicine, dentistry, pharmacy, and nursing.

The effectiveness of the technology used is limited to the system you are affiliated with and the people you connect. While mobile applications and tools are developed for specific purposes, their adoption and acceptance by doctors are essential. Without sufficient doctor support and usage, there is no chance for any information technology (neither electronic health records nor mobility) to succeed [38]. Mobile health applications can enable both doctors to monitor patient care services and patients to monitor their own health, thereby increasing motivation. Gamification can be effectively used as a tool in mobile health applications [3]. The attitudes of doctors and patients towards mobile applications will provide important insights for hospital administrators, policymakers, and public health regulators regarding the impact and value of mobile tools in healthcare services.

Like in all fields, the use of information systems in healthcare is becoming widespread. Hospital information systems are used in public hospitals to securely maintain records related to patients and hospitals, improve appointment scheduling, hospital management, decision support, and workflow processes, thereby increasing efficiency and productivity, minimizing error rates, enhancing service quality, reducing service costs, and ensuring patient satisfaction[118]. Mobile information and communication technologies can help bridge these gaps due to the minimal and even zero operational costs in the mobile environment [119]. Healthcare services hold significant potential in this regard. Therefore, developing applications at this point can provide important cost advantages to institutions in the delivery of healthcare services. It is considered that health policy makers showing effective management at this point and paying attention to mobile technology will be an important input to increase patient satisfaction.

Various mobile applications have been implemented in many fields such as dermatology, orthopedics, ophthalmology, neurosurgery, and clinical pathology. Applications are comprehensive in increasing patient participation through mobile technology, self-monitoring by patients, facilitating clinical algorithm calculations, and bridging resource-poor environments with experts [120]. Moreover, it has been observed that mobile applications are of great advantage for the elderly in developed countries, especially in European Union countries such as Germany and Sweden. Bhavnani et al. [121] stated that perceptions of medical, governmental, and financial institutions support the concept that mobile health can meet increasing demands from an aging population and rising healthcare costs. Our interest in mobile health focuses on potential benefits to society and citizens when information and communication technology is used to change health culture. With an aging population across European Union countries, national governments are seeking ways to reduce healthcare costs. Mobile health is introduced as a solution to change the delivery of healthcare services through new care models applicable to industrialized and developing countries [122]. Mobilizing citizens in the innovation process, with adequate capacity to scale innovation, will accelerate economic growth and social equality [123]. Examples include mobile health technologies such as telemedicine, health applications for mobile phones, and remotely monitored medical devices, which show how citizens or patients can be more involved in healthcare services [20].

In the public sector, whether for healthcare services, education, or other services, when there is a need for mobile technology and your institution does not have the opportunity to develop such an application internally, particular attention should be paid to the procurement process. If your own software development team does not have sufficient expertise in developing such tools, outsourcing can also be pursued to avoid potential security issues in subsequent stages. It is essential to enter into a very good contract with relevant companies during the procurement process of such software. The contract must explicitly safeguard data privacy and the use of personal data under special laws and regulations. In addition, responsibilities arising from service interruptions or data manipulation must be clearly stipulated. Of course, mobile services are mostly presented as part of public health services by the government. However, in countries like Türkiye where private and public hospitals operate within the healthcare system together, obtaining such services through outsourcing via private hospitals in mobile application areas can lead to many problems or compensation issues for the institution.

Public institutions generally have established processes governed by laws and regulations, making it difficult to actively respond to current technologies. In this regard, especially for systems where public hospitals have a significant share in the healthcare system like Türkiye, it is considered highly beneficial to issue project calls through supporting institutions similar to TÜBİTAK for scientific research activities. Alongside this, creating special funds for project calls involving universities, healthcare institutions, and the private sector by healthcare policy makers and regulators is also considered highly beneficial for the rapid development of information technologies in healthcare.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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