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Mobile applications for COVID19: A review and exploratory analysis of their roles in health, financial technology, and public services

Thamer Alshammari

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Abstract

Introduction. The COVID-19 pandemic accelerated the use of mobile applications to maintain access to essential services. Governments worldwide adopted mobile technologies to support healthcare, financial, and public service delivery during lockdowns. This review examines the adoption, effectiveness, and challenges of these applications across sectors and regions.

Method. Using a systematic literature review combined with thematic exploratory analysis**,** this study identifies mobile applications developed in response to COVID-19, categorised by healthcare, financial technology (fintech), and public service domains. It analyses adoption drivers, technological trends, and regional implementation differences.

Analysis. The review reveals that while mobile apps enabled rapid service continuity, they also raised concerns regarding data privacy, digital equity, and system interoperability. Key themes include trust, usability, and institutional support, with variations in effectiveness based on infrastructure and governance.

Results. Mobile applications significantly contributed to healthcare delivery, financial transactions, and public services during COVID-19. While they enhanced accessibility and service continuity, major challenges emerged around data privacy, infrastructure, and user adoption. The study highlights the need for user-friendly, secure, and interoperable mobile systems to improve resilience in future crises.

Conclusion. The findings highlight the need for resilient, secure, and inclusive mobile systems. Cross-sector collaboration, privacy regulations, and context-aware design are essential for enhancing digital preparedness in future crises.

Introduction

The COVID-19 pandemic transformed the methods used by governments and institutions in service delivery by accelerating the adoption of mobile applications. Mobile platforms in areas including healthcare, finance, and the sphere of government played a critical role as the means of remote access and operation throughout lockdowns. Though the process of transition towards the digital platform in most countries had already started, the crisis speed things up significantly and demonstrated its efficiency as well as the major constraints.

With the rise of mobile money, governments worldwide embrace m-Gov services to access government operations. Allow citizens access to services via mobile devices, eliminating the need for physical office visits. This trend of mobile-friendly design increased before COVID-19 H. Salman et al. (2022), and R. Peiris et al. (2021), with governments enforcing mobile platforms to improve services. The pandemic in March 2020 increased the deployment of mobile apps in healthcare, fintech, and public services. Figure 1 illustrates the growth in mobile application usage from 2019 to 2022 across the health, fintech, and public service sectors, with a notable surge during the pandemic years. This sector-wise increase reflects how governments expanded digital service delivery to manage health crises, sustain financial access, and maintain public services remotely.

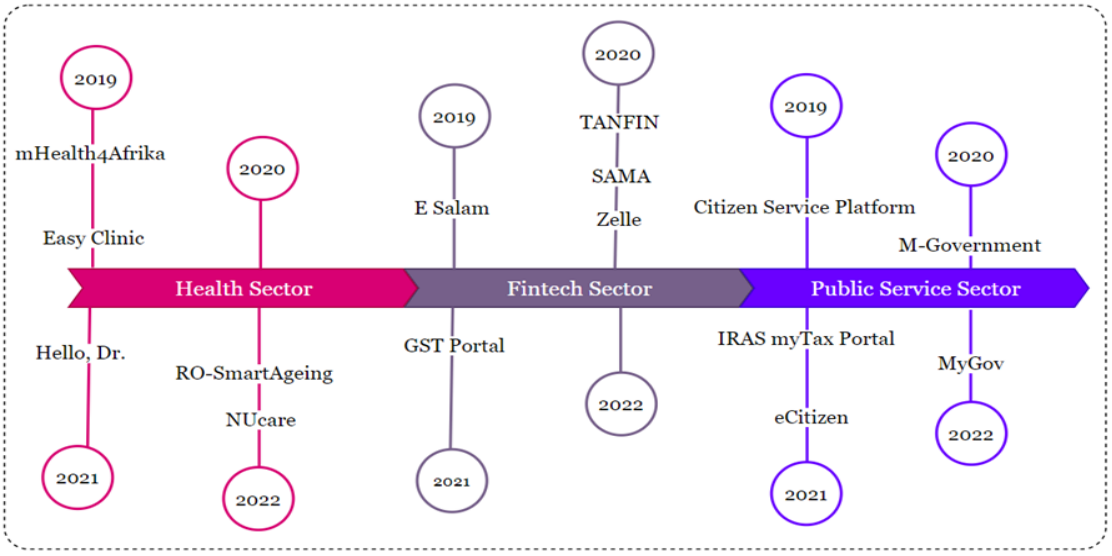

Figure 1. m-Government applications in different domains.

Mobile apps like *mHealth4Afrika*, *Easy Clinic*, and *Hello, Dr.* enabled remote consultations, health monitoring, and personalised medical advice. In Saudi Arabia, the apps *Seha* and *Tawakkalna* provided telemedicine, contact tracing, and vaccination records. Public platforms like *MyGov*, *eCitizen Platform* offered digital services, while *Absher* facilitated ID renewal, visa applications, and traffic fine payments. These apps supported daily life during crises.

In the pandemic, lockdowns and social distancing led to office shutdowns, causing traditional service delivery to be insufficient. Governments respond quickly using user-friendly applications in major sectors. These apps provide service during an era of unprecedented socio-economic transformation.

In this connection, mobile applications became essential aspects of social life, healthcare, and financial stability. They enabled telemedicine, contact tracing, digital wallets, and ensured public service continuity during lockdown. The pandemic highlighted mobile technologies that facilitate resilience while also exposing the opportunities and vulnerabilities of technologies.

This paper examines mobile applications deployed since COVID-19, focusing on healthcare, fintech, and public services. It highlights research findings on the effectiveness, adoption, and challenges of mobile government services to identify areas for enhancement. The goal is to strengthen digital applications to prepare for future global crises.

Objective and scope

This paper provides an overview of mobile applications developed during COVID-19 across healthcare, finance, and service provision. It examines their impact on adoption trends and associated issues, offering insights into optimising mobile governance for global crises.

Through a socio-technical lens, this research analyses the features, adoption rates, and efficacy of mobile applications created between January 2019 and December 2022. In order to evaluate global reactions and differences in their usefulness, it integrates data from other regions. Below are the research questions that are mainly focused on.

Research questions

To guide this comprehensive review, the following research questions have been formulated:

- RQ1: What has been the role of mobile applications in healthcare, fintech, and public services during the COVID-19 pandemic, specifically regarding their adoption, effectiveness, associated challenges, and implications for future crises?
- RQ2: What is the extent to which pandemic-related problems could be solved by mobile applications in particular areas of their application, such as healthcare, fintech, and public services?
- RQ3: Regarding the usage of mobile applications during and due to the pandemic, what particular challenges and drawbacks did the stakeholders face, mainly in terms of privacy, accessibility, and provided technological features?
- RQ4: Considering the mentioned challenges, is it possible to recommend the following actions that will help improve the efficiency of mobile applications in future world crises?

Literature search approach

Bibliographic research was done, and the databases used included PubMed, IEEE Xplore, Google Scholar, and Scopus. During the research, the following search terms were used: COVID-19 mobile applications, m-Government COVID-19, Healthcare apps COVID-19, Fintech COVID-19, Public service delivery COVID-19. The selected studies were also reviewed thematically, that is, repeatedly with a focus on the themes, success, and barriers of the three sectors.

While the study follows a systematic process for selecting and categorising literature, the analysis is also exploratory in nature. Through thematic synthesis, it identifies cross-cutting patterns, emerging challenges, and sector-specific insights that go beyond predefined categories. This approach allows for a more nuanced understanding of how mobile applications functioned during the COVID-19 crisis across healthcare, fintech, and public services.

Inclusion criteria

- Relevance: Those applications that have been developed or revamped largely due to the COVID-19 outbreak.
- Sector-specific: The applications that can be categorised as healthcare, financial technology, or public service-oriented.
- Geographic diversity: Submissions in a variety of countries to obtain a broad spectrum of reactions and usage.

- Publication date: Articles published in research journals, composite, biographies, encyclopaedias, and documentaries produced or published between January 2020 and December 2023.
- Language: Publication of only English-language research articles to make the author's work easily.
- Related papers count: Almost 50 of the most relevant papers were selected.

Exclusion criteria

- Non-COVID-related Applications: Mobile applications that were not created or redesigned due to the pandemic.
- Irrelevant sectors: Use business cases other than healthcare services, payments, and financial platforms, as well as the public sector.
- Insufficient data: Research works that do not offer the necessary information or evaluation on the use of the application and its successes or difficulties. Figure 2 shows the study selection criteria.
- Mobile Ecosystem Services (MES): Papers that are not relevant to MES during COVID-19 are excluded.
- Excluded papers count: Almost 450 papers were excluded due to irrelevancy.

Figure 2 illustrates the inclusion-exclusion criteria for this research.

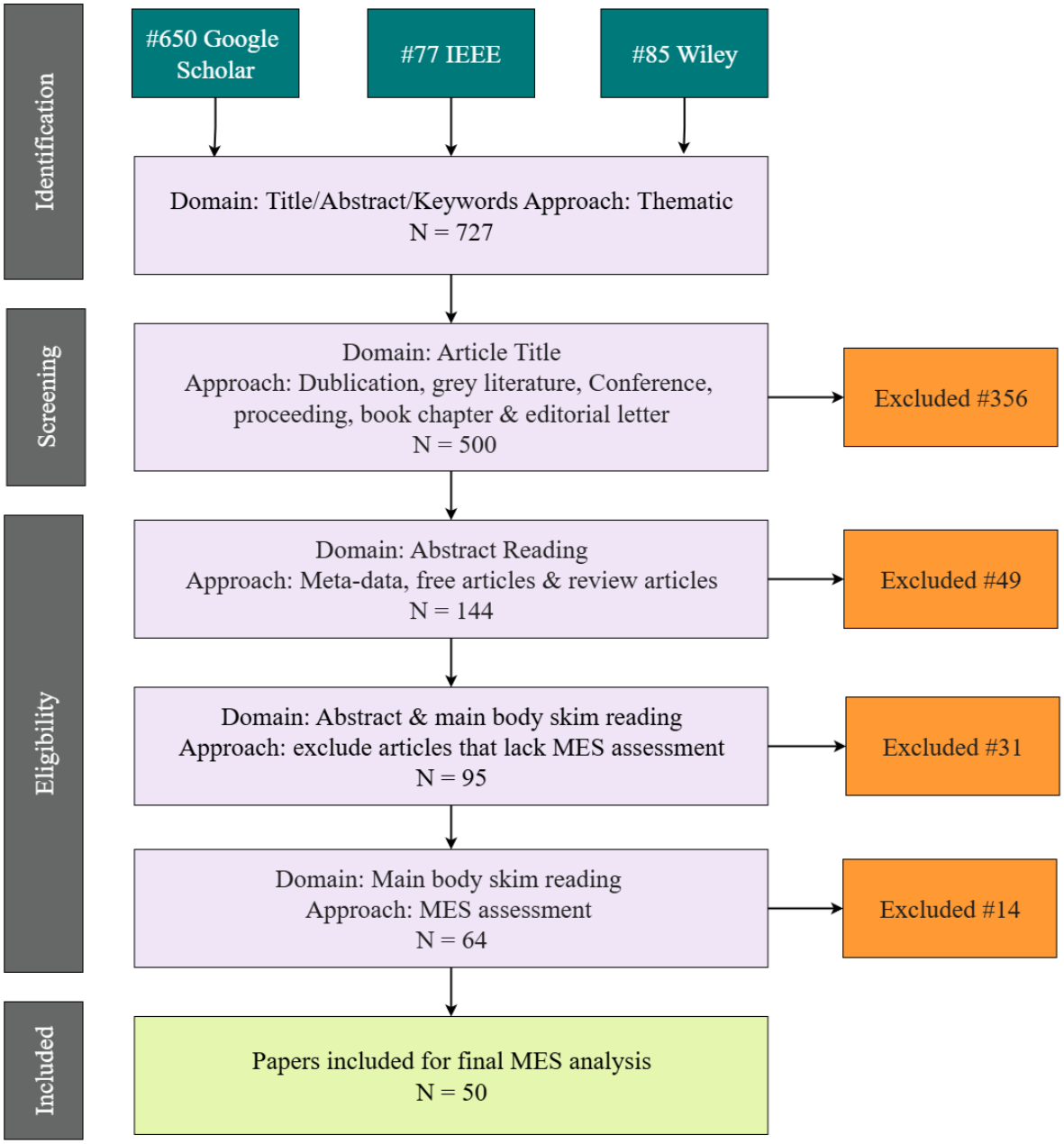

Figure 2. Studies selection criteria

Related work

The outbreak of COVID-19 put into sharply focus the role that digital innovation plays in crisis management. Mobile applications play an important role in improving health access, public service delivery, and user engagement. Recent studies highlight aspects of the contributions and limitations of these solutions by underlining challenges concerning security, user adoption, and infrastructure.

H. Salman et al. (2022) applied the *Technology Acceptance Model* to the adoption of m-government services and integrated factors like social influence and trust derived from the use of technology

in Bahrain. Perceived utility and the aspect of trust were found to be critical drivers for such adoptions. This provided valuable insight into user experience, where trust and perceived usefulness play a major role. Another approach discussed by R. Peiris et al. (2022) to increase user confidence during COVID-19, safety in the taxi sector by including user education and safety tracking features. Their approach of using tracking and data analytics to monitor the COVID-19 status of drivers and passengers has something in common with the relevant tracking and reporting of symptoms and exposures used by healthcare apps.

The usability of Saudi mobile health applications (SMHA) during the pandemic using SMART heuristics targeted at mobile devices was evaluated by M. Booday et al. (2021). This was a heuristic assessment, unmasked various usability issues that restricted user experience, emphasising the need for user-friendly design and functionality.

Furthermore, the study by N. Darapaneni et al. (2021) looked at the COVID-19 confinement strategies and stages of lockdowns in Karnataka, India, through the first two waves of the pandemic. By using an EDA with hypothesis testing and statistical measures like p-values and t-statistics, strict lockdowns, lower infection rate, and breaking the chains of transmission. The pandemic of COVID-19 forced rapid adaptations in the delivery of public services, underlining the flexibility of digital applications in responding to unforeseen challenges. In the cultural and tourism sectors, R. Thirupathieswaran et al. (2022) presented a system of *Mobile Application-based Secured Smart Museum*, which addressed sharp declines in museum visits and revenue while ensuring safety and building trust.

Inayatulloh et al. (2021) proposed an e-government model in the public service sector to resolve access and quality of service issues affected by the pandemic. This research, through qualitative analysis of stakeholder and citizen involvement, developed a framework for better engagement with citizens and ensuring the accessibility of basic services during lockdowns. The increased digital activity while working from home during the pandemic, as explored by J. Ahmed et al.(2020) is the reason for cybersecurity concern. From this research, the sudden increase in internet usage made people and organisations more likely to become targets; cybercriminals have leveraged loopholes in data protection.

Lastly, the work of I. Syafarina et al. (2021) took Indonesia's Large-scale Social Restrictions as a containment measure. A linear regression analysis showed that human mobility reduction was effective in the spread of COVID-19 for an initial period, though it waned during the peak times of traveling. This study critically represents a contribution of mobility data to pandemic response planning, suggesting that data-driven insights from digital applications may support the optimisation of lockdown strategies.

The above studies show how mobile applications have played a vital role during the COVID-19 pandemic in many sectors, including healthcare, fintech, and public services. Based on this review, through all phases of the lockdown, these applications facilitated necessary services such as telemedicine, contact tracing, digital payments, and e-government. Focusing on these sectors, the following review focuses on key contributions and challenges experienced, therefore based on further understanding of the domains in which the roles of mobile applications were involved in pandemic response.

Health sector

Mobile applications played a central role in addressing healthcare challenges during the COVID-19 pandemic. Mobile health technologies enabled several critical functions, including symptom tracking, contact tracing, telemedicine, and vaccination coordination. For instance, India's *Aarogya Setu*, Indonesia's *PeduliLindungi*, and Malaysia's *MySejahtera* were developed and implemented to track infection rates, identify potential contacts, and provide timely updates on the status of the

pandemic (Yasir et al., 2020; Mansoor et al., 2021). These applications empowered governments and public health departments to enhance their response strategies and improve public communication.

Research conducted by Yasir et al. (2020) examined the influence of e-government and COVID-19 word-of-mouth (WOM) on online social presence during the pandemic. Their findings underline that e-government affects social media interactions, promotes compliance with protective measures, and affects public opinion. While e-government trust is crucial for pandemic management, positive COVID-19 WOM boosts the public's desire to adopt safety actions.

Similarly, Mansoor et al. (2021) examined how governance practices, responsiveness, accountability, and transparency affect public trust in government during the COVID-19 pandemic. The study focused on concepts like trust in government and perceived government response to COVID-19 (PGRC). Composite reliability, average variance extracted, the heterotrait-monotrait ratio, and the coefficient of determination are the metrics assessed in the analysis using SmartPLS 3.3.0.

Furthermore, the work by Alharbi et al. (2022) investigated public knowledge, use, and acceptance of mobile health apps *Sehha*, Mawid, and *Tetamman* during the COVID-19 pandemic. The study gathers demographic information on data on age, gender, education level, and occupation while evaluating usability, perceived usefulness, cognitive load, security and privacy concerns, and reliability. The findings reveal that 85.7% of participants were aware of at least one app.

In order to identify the need for future initiatives, Sujarwoto et al. (2022) examine COVID-19-related mobile health applications in Indonesia. It evaluates usability, usefulness, integration, infrastructure, and data security through user feedback based on WHO guidelines and the mHealth technology fit framework. Findings show that while the apps focus on information dissemination, self-risk assessments, online forums, and telemedicine, they lack contact tracing and health management features.

The goal of the study by Alkhwaldi et al. (2022) was to develop a framework to analyse the factors affecting the adoption of mobile government services in Jordan during the COVID-19 pandemic. The study focuses on factors, including performance expectancy, effort expectancy, social influence, facilitating conditions, trust, corruption avoidance, and fear of COVID-19. It emphasises that incorporating trust, corruption avoidance, and fear of COVID-19 into the UTAUT model deepened the understanding of m-government adoption in Jordan.

Factors affecting the adoption of Indonesia's *Peduli Lindungi* app, an essential m-government tool during COVID-19, were examined in the study by Kurniasih et al. (2024), it analysed perceived usefulness, ease of use, service quality, system quality, and information quality. A survey of three months consisting of 26 items with a Likert scale. Results indicated that perceived usefulness, ease of use, and service quality significantly drive app adoption, while system and information quality play a lesser role.

According to Caetano et al. (2020), during COVID-19, investigating government initiatives accelerated the implementation of telemedicine in Brazil's healthcare system. The study emphasised telehealth as a vital instrument in Brazil's pandemic response, facilitating remote care monitoring and treatment, and it did so by drawing on government initiatives and literature assessments. Bassi et al. (2020) investigated how mobile applications can enhance the governance and delivery of public health services in India during COVID-19. Awareness, accessibility, healthcare needs, and training support were the main topics of the study. Participants included the general population or technical specialists, and healthcare professionals using both qualitative and quantitative techniques as surveys and interviews.

Furthermore, Alsyouf et al. (2020) explored the deployment of mobile health apps in Saudi Arabia to enhance public health surveillance during COVID-19. The study focused on technology integration, user engagement, and data privacy and security. Instead of utilising specific questionnaires or surveys it conducted qualitative reviews of various Saudi mHealth applications. The success of these initiatives underscores the potential of smartphone technology to revolutionise healthcare in the country.

In Indonesia, Lu et al. (2023) examined the connection between health stress and the desire to use mobile health apps during the pandemic. The research explored perceived utility, satisfaction, convenience, and health stress. The results showed that intention to keep using these apps is influenced by perceived satisfaction and usefulness. The author Prathap et al. (2020) introduced the use of combining the *Health Belief Model* and the *Expectation Confirmation Model* to explain the adoption and continued use of mobile payment services during COVID-19. The study explored factors of perceived severity, susceptibility, self-efficacy, perceived usefulness, and satisfaction. Data from 654 participants in India. Findings showed perceived health threats, especially severity and susceptibility, significantly influence mobile payment adoption.

According to Nie et al. (2023), perceived service quality and information quality were the main elements that determined the continued desire to use mobile health services. A questionnaire was used to gather data from 334 mHealth users. To increase user engagement and guarantee the continued use of mHealth apps, the results emphasised the significance of improving e-health literacy and service quality.

Nathan et al. (2022) explored factors affecting public acceptance of location-based mobile government services for emergency management. Perceived utility, trust, and privacy concerns were identified as the main determinants of attitudes and intentions to use these services during emergencies through a survey and Partial Least Squares analysis. To improve government services during emergencies, H.S. Oztaskin et al. (2024) presented the use of a Mobile-based Emergency Response System that uses mobile technology. Emphasising reliability, trust, security, and privacy, the study details the development and testing of system components, including an ontology-supported case-based reasoning system and a text information extraction and aggregation algorithm.

An ontology-supported case-based reasoning framework for m-Government emergency response services was presented by Haili Li et al. (2024), offering decision support to government agencies and mobile users in times of emergency. A survey with 24 questions across 20 subjects assessed ease of use, usefulness, disaster information presentation, and satisfaction. Results reveal user satisfaction regarding ease of use, usefulness, and clarity of disaster information.

Across the health sector, common themes emerge, particularly the consistent influence of trust, usability, and perceived usefulness on mobile health app adoption (Alharbi et al., 2022; Yasir et al., 2020; Lu et al., 2023). Several studies emphasise the importance of government responsiveness and transparent communication in building public trust (Mansoor et al., 2021; Nathan et al., 2022). However, the degree of technological sophistication and integration varies: some apps like *Hello, Dr.* Farah Wahida et al. (2021) and *RO-SmartAgeing* Paraschiv et al. (2022) incorporated AI and IoT for advanced monitoring, while others focused solely on contact tracing and symptom reporting Sujarwoto et al. (2022). Despite rapid deployment, interoperability with national health systems and long-term sustainability remain critical, showing gaps, especially in lower-income settings (Cunningham et al., 2019). In addition, the ethics of data sharing during emergencies are underexplored, with some platforms collecting and sharing user data without clear consent mechanisms (Wahida et al., 2021; Nie et al., 2023). These findings highlight the need for sustainable, privacy-conscious, and cross-compatible digital health systems for future public health resilience.

Application in the health sector

In the context of Saudi Arabia, the *Easy Clinic* application, discussed by A. Almazroa et al. (2019), uses Body Area Network technology to wirelessly connect sensors that monitor vital signs, temperature, blood pressure, and heart rate. The application provided users with emergency alert recommendations and user user-friendly mobile interface. The challenges for effective implementation included ensuring data privacy, achieving device interoperability, and managing high deployment costs.

The RO-S*martAgeing* mobile app, discussed by E.A. Paraschiv et al. (2022), used IoT, Big Data, and AI for real-time health monitoring and early disease detection to support elderly patients at home. Key features include continuous health tracking, data collection, AI-driven insights, customisable alerts and user-friendly visualisation tools. Challenges such as data privacy, interoperability, user adoption, and regulatory compliance need to be addressed for effective implementation.

The *Hello, Dr.* app, discussed by Farah Wahida et al. (2021), used AI, GPS, and wearable devices to improve patient healthcare access in Southeast Asia. Features include AI-powered self-diagnosis, emergency care, home visit tracking, telemedicine, and cloud-based data sharing with encrypted connections for privacy. Challenges include privacy protection, interoperability, emergency handling, legal requirements, user engagement, and development costs.

The *mHealth4Afrika* platform, discussed by P. M. Cunningham et al. (2019), is a multilingual healthcare solution for resource-constrained environments in Ethiopia, Kenya, Malawi, and South Africa. Funded by the European Commission under Horizon 2020, it integrates medical sensors and decision support systems with HL7 FHIR-based EMRs and EHRs. Challenges include limited infrastructure, data security, and ensuring long-term sustainability in remote, low-resource settings.

In the context of the Philippines, the N*Ucare* application, discussed by Shelly Camille Ancheta et al., (2022), is a web and mobile platform that enhances virtual healthcare consultations via text, voice and video. Aimed to improve access to medical treatment for college students and others with financial or physical limitations including electronic prescriptions and chatbot integration for COVID-19 and system FAQs.

The review on the health sector indicates that the themes remain the same in various regions. Trust, usability and perceived usefulness were the main drivers of adoption of mobile health applications that were rapidly adopted in contact tracing, consultations, as well as health monitoring. Although national-scale apps improved centralised health responses, several had a low degree of long-term pairing with health infrastructure and robust privacy protection. The technological capabilities, such as AI and IoT enhanced functionality, yet low connectivity in low-resource environments and overall unavailability in the digital divide, hindered access. Such results highlight the necessity to create safe, cross-compatible health platforms that will be able to retain end-user confidence and system stability during future emergencies.

Table 1 summarises key mobile health applications deployed during COVID-19, highlighting their functions, target users, and country-specific implementations.

Title, Author, year	Region	Purpose	Technologies besides smartphones	Maturity level	Features
IoT advances in Big Data for healthcare AI. (Almazroa et al., 2019)	Saudi Arabia	Easy Clinic offers real-time health monitoring with wireless sensors.	BAN,Scientific algorithms and cloud-based infrastructure	18 and above	Real-time alerts, tips, monitoring, and a user-friendly app.
IoT for remote healthcare and AI in Big Data. Elena-Anca (Paraschiv et al., 2022)	Ploiești, Romania	RO-Smart Ageing uses IoT for elderly home monitoring.	IoT, Big Data, Artificial Intelligence.	60 and above	Health tracking, AI insights, custom alerts, and easy visualisation.
Hello, Dr: A Healthcare Mobile Application (F. Mohd et al., 2021).	Malaysia	Improve access through telemedicine.	AL, ML,GPS Technology and Cloud base data sharing	18 and above	AI diagnosis, GPS care, secure records, and scheduling.
mHealth4Afrika: Co-designing a standards-based healthcare solution (Cunningham et al., 2019).	South Africa	Improve automated reporting in resource-limited settings.	HL7 FHIR, medical sensors	all age groups	Multilingual platform with real-time care, reporting.
NUCare: Web Framework for Online Consultations in Manila. (S. Ancheta et al., 2022).	Philippines	Enhance virtual healthcare for students and those with barriers.	Web application, chatbot	all age groups	Text, voice, video consultations, and chatbot.

Table 1. Comparison of remote healthcare technologies

Effectiveness of healthcare applications:

mHealth applications enhance communication and real-time data collection. The accurate structured data provided by these applications enabled effective management of public health crises through policy and interventions.

Challenges in healthcare applications:

Medical data contributed to these applications was occasionally shared with authorities, regardless of patients' preferences, triggering discussions on the role of people's confidentiality versus the necessity of containing the coronavirus.

Fintech sector

The pandemic increased the use of mobile fintech applications as a mode of making contactless payments and financial inclusion mechanisms. This study reveals that stocks in the fintech industry experienced a sharp rise in the usage of mobile applications during the pandemic. Due to lockdown

measures that limited physical contact Al Nawayseh et al. (2020) there was a shift towards digital wallets to avoid any contact through cash. Mobile wallets such as *MadaPay* in Saudi Arabia, *WeChat Pay* in China, *Paytm* in India, and *GoPay* in Southeast Asia have become essential for financial transactions.

Application in the fintech sector

SAMA: The SAMA application, created by the Saudi Arabian Monetary Authority, aims to improve financial efficiency and transparency. It was vital during COVID-19, helping businesses navigate economic upheavals, ensuring compliance with new rules, providing remote access to essential services, and maintaining financial stability.

E Salam: E-Salam mobile app uses cloud infrastructure, mobile development, and geolocation to provide Islamic banking services in rural Sakheer, Bahrain. Electronic salam contracts improve access to financial services, crucial during the pandemic when mobility restrictions hinder in-person transactions.

Zelle: With just an email address or phone number, Zelle allows users to instantly conduct peer-to-peer (P2P) transactions through bank platforms. It was crucial during pandemic, enabling contactless payments as a safe alternative to cash and checks when in-person transactions were prohibited.

TANFIN: TANFIN is an Asia-Pacific company that uses digital payment systems to improve financial inclusion in nations. Its services became vital during COVID-19, offering digital financial solutions for saving, investing, and transacting in disadvantaged groups. The pandemic increases the need for accessible financial services, especially in areas with poor internet connectivity.

GST portal: The GST portal in India ensures transparency in tax administration and enables online registration return filing and tax payment. The functionality was crucial during lockdown allowing businesses and tax-payers to manage tax activities remotely. Table 2 presents key fintech applications introduced during COVID-19, emphasising their roles in digital payments, financial inclusion, and service accessibility.

Application	Region	Purpose	Technology	Features
SAMA Mobile	Saudi Arabia	Boost financial transparency and efficiency.	Cloud computing, data analytics, AI.	Real-time monitoring, budgeting, reporting.
E-Salam	Sakheer, Bahrain	Offers Islamic financial services to rural areas via mobile.	Cloud infrastructure, mobile app development.	Financing calculators, Islamic compliance.
Zelle	United States	Enable instant P2P transfers via email.	Integrated with bank apps, and direct payments.	Instant transfer, supports 1,000+ institutions.
TANFIN	Asia-Pacific	Boost financial inclusion via digital payments.	Blockchain, AI, data analytics.	Mobile banking, payments, micro-loans, financial tools.
GST portal	India	Streamline GST management for taxpayers.	Cloud computing, databases, web development, analytics.	Easy registration, tax filing, reports, support, tracking.

Table 2. Comparison of financial applications

Yan et al. (2021) investigated variables that influence Bangladesh's adoption of Mobile Financial Services during COVID-19 and highlight FinTech's role in economic resilience. The study focused on performance expectancy, effort expectancy, perceived value, perceived trust, and social influence. Data from 227 potential MFS users were collected through a structured questionnaire.

With a focus on their contribution to economic resilience through mobile financial services connected to government initiatives, a study by Al Nawayseh et al. (2020) examined the factors that influence consumers' choices of FinTech applications during COVID-19. The study polled 500 potential users in Jordan. Findings highlight the importance of trust and perceived benefits in adopting FinTech for financial inclusion during crises.

The work by Amaglobeli et al. (2023) examined how GovTech can improve public finance by using digital technologies to boost revenue collection and improve financial management in the public sector. However, successful implementation depends on overcoming challenges related to digital infrastructure, the digital divide, and cybersecurity risks. The contribution by Al Amin et al. (2024) explores factors that affect e-satisfaction, continuance intention, and e-loyalty toward mobile payment applications during the COVID-19 pandemic in Bangladesh. Focus on perceived usefulness, information quality, service quality, system quality, anxiety, and threats. Results show that information, service, and system quality significantly enhance the intention to continue using MPAs during the pandemic.

Phung et al. (2023) examined the role of government support in shaping Vietnam's FinTech industry during and after COVID-19. Factors include attitudes toward FinTech, perceived

behavioural control, subjective norms, and government support. Data collected through web-based surveys from 1,180 university students in Vietnam and analysed.

Small businesses' functions are completely changed by fintech advancements. The study by Sharma et al. (2024) reviewed 103 journal articles (2008–2023) examining the relationship between small businesses and FinTech. It addressed technological, personal, and external factors without using specific analytical tools. Abdillah et al. (2020) investigated the user experience of the Go-Pay service within the *Gojek* app during COVID-19. The study assessed several aspects, including attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty. Using an online User Experience Questionnaire distributed to computer science students, mainly from millennial and Gen Z demographics, findings reveal users had an above-average experience with the application.

Furthermore, a study by Laksamana et al. (2022) explored factors driving consumer continued use of mobile payments in the FinTech sector during COVID-19. Elements examined include trust, perceived usefulness, ease of use, risk, and security. Data from an online survey of 673 participants were analysed. Findings reveal trust, perceived usefulness, ease of use, and security significantly shape positive consumer attitudes toward mobile payments.

Following the pandemic outbreak, Halim et al. (2021) investigated the intention of using e-wallet services in Indonesia. Examines factors, attitude, subjective norm, and trust. Between October and November 2020, data were collected via online survey from 415 respondents. The study reveals attitude, inertia, subjective norm, and trust significantly influence the continued use of e-wallets post-pandemic.

The theoretical framework was examined by Althunibat et al. (2021) to find the relationship between mobile government services and the digital economy, especially during COVID-19. The digital gap, public policy, trust, privacy and security, ICT infrastructure, and accountability are all identified. The study proposed that successful m-government services and digital economy growth depend on addressing challenges to enhancing security.

Dumanska et al. (2021) examined how COVID-19 shifts traditional commerce to e-commerce and m-commerce. It identifies factors driving this transition, pandemic-related restrictions, technological advancements, and shifts in consumer behaviour. By detailed analysis of existing data, the author forecasts future trends using global sales data, concluding that the pandemic accelerated the adoption of e-commerce and m-commerce platforms.

The research by Hasnain et al. (2024) explored factors that affect the adoption of government mobile commerce applications in Odisha, India. The study highlights factors of trust, perceived awareness, and perceived value. Data was collected by a questionnaire, which they distributed to 315 respondents. The findings suggest that improving perceived value and increasing awareness are critical strategies to improve the adoption of government mobile applications in Odisha.

A study by Sardjono et al. (2021), examins the transformative impact of the pandemic and how COVID-19 drove the global adoption of e-commerce and m-commerce platforms. It highlights social distancing measures and technological advancements. By reviewing existing literature, the authors conclude that the pandemic has significantly accelerated m-commerce adoption, with these platforms serving as critical tools for sustaining economic activity during lockdowns.

Amid the challenges of the COVID-19 pandemic, a study by Nani et al. (2021) investigates elements that influence users to continue using mobile commerce in Indonesia. The study identifies reliability, information quality, and system quality as important factors. One hundred and ninety-six m-commerce consumers who completed purchases between April and June 2020 provided

information via a structured online survey. Results indicate system dependability and quality impact on the user, which influences the desire to continue.

Research by Xinh et al. (2022) investigates the rapid digital shift during COVID-19, showing the factors affecting consumers in continuing mobile shopping during COVID-19. Factors include perceived usefulness, confirmation, and satisfaction. They conducted a survey of individuals aged 18 to 35 in Ho Chi Minh City. Findings show that perceived usefulness, confirmation, and satisfaction drove the intention to continue mobile shopping during the pandemic.

In the evolving digital landscape by the pandemic, research by Tan et al. (2022) looks at factors influencing the use of mobile commerce apps in Malaysia during COVID-19. The study highlights performance expectancy, social influence, effort expectancy, and trust. Data was collected with an online survey distributed on social media, collecting responses from 150 people. Findings indicate that performance expectancy and social influence lead users to continue using mobile commerce apps during the pandemic.

In an exploration of post-pandemic consumer behaviour, the research by Ashoer et al. (2022) provides insights into factors driving the continued use of mobile commerce applications in Indonesia using the UTAUT2 model. It analyses constructs such as performance expectancy, social influence, competence, and relatedness. Data from an online survey of 202 Tokopedia users was analysed by (PLS-SEM). Results show UTAUT2, SDT constructs, habits, and social influence affect m-commerce app usage.

In a compelling exploration of rural banking, a study by Al Amin et al. (2022) looked at factors that affect rural customers to continue using mobile banking services during COVID-19 in Bangladesh. A questionnaire was distributed to 250 rural customers. Findings reveal that perceived ease of use and institutional support impact rural customers' attitudes to continue using mobile banking services.

Demonstrating the growing reliance on digital platforms, a study by Bouaynaya et al. (2022) looked at the role of trust in the adoption and use of mobile commerce during the pandemic. Researchers in France and the UK employed (PLS-SEM) using XLSTAT to poll Generation Z aged 18 to 34. Findings show how trust affects user behaviour and loyalty in e-commerce.

Adoption and impact:

Mobile wallets ensure the continuity of financial transactions and the effective distribution of government subsidies. For example, in India the *Paytm* app plays a role in delivering DBTs to millions, impacting fiscal stability during the pandemic economic disruption.

Opportunities for fintech:

Mobile financial services help control the virus spread. Additionally, distance-based payment solutions became a hallmark of the virus economy, with governments and banks promoting digital transactions for financial security and effectiveness.

In the fintech sector, studies reveal how perceived usefulness, ease of use, and trust are central to adoption across diverse populations (Yan et al., 2021; Laksamana et al., 2022; Halim et al., 2021). Government-backed platforms like Paytm and the GST Portal (Al Nawayseh et al., 2020; Phung et al., 2023) were especially effective in maintaining fiscal stability and enabling remote transactions. However, digital inequality remains a persistent challenge, particularly in rural areas with limited access or financial literacy Al Amin et al. (2022). There is also a divergence between public and private sector-led innovations, with private players often driving rapid adoption but facing challenges related to cybersecurity, user retention, and regulatory oversight (Amaglobeli et al., 2023; Abdillah et al., 2020). Notably, very few studies addressed long-term fintech engagement or post-pandemic behavioural shifts, signalling a research gap in evaluating enduring digital financial

behaviours. These insights call for inclusive fintech ecosystems that balance innovation with security, and support vulnerable groups through digital infrastructure, consumer protection, and education.

Public services sector

The pandemic public service, with a focus on social distancing, has transformed the services that were delivered. Mobile applications maintained the continued availability of critical public services as governments' physical offices were closed and face-to-face encounters minimised Karetsos et al. (2014). Furthermore, Table 3 outlines major public sector mobile applications used during COVID-19, focusing on governance, emergency response, and citizen engagement.

Application	Region	Purpose	Technology	Feature
eCitizen	East Africa	Boosting efficiency via digital access.	Web portals, mobile apps	Easy online access to healthcare, taxes
IRAS myTax Portal	Singapore	Simplify tax filing.	Integrated payment systems,online services.	Online tax filing, and access to taxes.
Citizen Service Platform (CSP)	Europe and Asia	Enhance involvement and government transparency.	Web apps, mobile platforms	Centralised online access to government services
M-Government	Africa	Improve access to services via mobile devices.	Mobile apps, SMS services, mobile web platforms	Anytime, anywhere access to government services.
MyGov	India	Enhance participation in governance.	Web and mobile apps, data analytics	Enables citizen feedback in decision-making.

Table 3. Comparison of digital government platforms

Application in the public sector

Ntalian et al. (2008) explored how m-Government can improve agriculture by addressing inefficiencies and delivering services to producers, improving productivity and competitiveness. Factors are mobility, location-based services, timesaving, and ease of use. A questionnaire on personal information and potential m-Government offerings, like product information and weather alerts, revealed producers preferred receiving information via SMS for weather alerts and disease notifications.

Furthermore, the research by Maumbe et al. (2010) aimed to improve agricultural development in rural South Africa. Factors included trust, information accessibility, and economic viability. The

study shows how frameworks for mobile agriculture apps help rural communities become more efficient. Issues like low literacy rates and high device costs need addressing to increase benefits.

To improve agriculture practices, the study by Karetsos et al. (2014) explored smartphone apps for m-government in agriculture to improve information delivery between government agencies and farmers. It focuses on ease of use, trust, and cost-effectiveness. Techno-economic analysis and pilot testing showed significant potential for real-time updates on market prices and weather. However, connectivity issues in remote areas need addressing.

Implementation of public service apps:
Public service apps like Saudi Arabia's *Tawakkalna* allowed requests for lockdown permissions and emergency services. Similarly, Singapore's Trace Together and South Korea's Corona 100 are vital in delivering public services and providing access to government information during the pandemic Ntalian et al. (2008).

Impact on governance:
These mobile platforms enhance government accountability and facilitate interactions with officials. During COVID-19, governments ensure services were available at all citizen contact points to help reduce virus spread.

Social connectivity and information dissemination:
These apps mobilised knowledge, offering health measures and government instructions, providing citizens with vital information for quarantine and awareness of societal and health changes.

A cross-sectional analysis of public service mobile applications reveals a unifying theme: digital platforms were indispensable in ensuring service continuity and civic engagement during lockdowns (Ntalian et al., 2008; Karetsos et al., 2014). Despite technological advances, effectiveness varied by region, with basic SMS-based services often outperforming more complex mobile apps in rural areas with limited digital literacy and infrastructure Maumbe et al., (2010); Ntalian et al., (2008). This reflects that simplicity and accessibility often outweigh technical sophistication in marginalised contexts. Furthermore, while platforms like *MyGov* (India) and *TraceTogether* (Singapore) facilitated rapid information dissemination and citizen engagement, privacy and data governance concerns were inconsistently addressed across implementations. Several studies failed to examine the long-term institutionalisation of m-government tools post-pandemic, raising important questions about sustainability and public trust. Collectively, these insights point to the urgent need for adaptable, interoperable, and inclusive governance frameworks capable of serving diverse populations under both normal and crisis conditions.

Analysis and discussion

Conventional factors affecting technology adoption

Performance expectancy:
N. Darapaneni et al.'s (2021) work is influenced by the effectiveness of Karnataka's Indian region COVID-19 shutdown measures to reduce case counts during waves 1 and 2. Key factors include successful lockdown strategies, public compliance, and data analysis demonstrating their impact. The findings show that the shutdown significantly reduced virus transmission, emphasising the importance of effective government interventions in public health crises.

Trust:
R. Thirupathieswaran et al. (2022) and Yan et al. (2021). Trust in government initiatives during the COVID-19 pandemic is vital for both the Mobile Application-based Secured Smart Museum (MSSM) system and FinTech applications. For the MSSM, trust is built through safety measures and

transparent communication, while the perceived usefulness of FinTech hinges on financial inclusion and government support

Perceived usefulness:
Studies by Alsyouf et al. (2020) and Lu et al. (2023) show that Perceived usefulness emphasises mobile technology's impact on government public health initiatives during COVID-19. Alsyouf et al. (2020) highlighted improved data collection and communication, while Lu et al. (2023) focused on mHealth applications for effective surveillance. These insights stress the importance of user engagement and data privacy for strengthening health system resilience.

Ease of use:
The studies by Oztaskin et al. (2024) and Althunibat et al. (2021) emphasise ease of use in mobile emergency response systems during COVID-19. Oztaskin et al. (2024) highlighted that a user-friendly interface in the Mobile-based Emergency Response System (MERS) enhances interaction among government agencies and citizens. Similarly, Althunibat et al. (2021) stress that intuitive design in location-based warning systems is crucial for public trust and effective adoption.

Social influence:
Research by Sharma et al. (2024) and Abdillah et al. (2020) showed that during the COVID-19 pandemic, FinTech innovations influenced governmental policies. Sharma et al. (2024) point out that using FinTech increases economic resilience, and a study by Abdillah et al. (2020) demonstrated how Go-Pay's satisfied customers influence digital payment tactics.

System quality:
According to research by Halim et al. (2021) and Oztaskin et al. (2024) system quality is essential for using digital services during COVID-19. While Halim et al. (2021) highlighted the importance of e-government service quality in increasing user engagement, Oztaskin et al. (2024) discovered that dependable e-wallet services increase customer confidence.

Perceived risk:
Dumanska et al. (2021) and Hasnain et al. (2024) emphasised that perceived risk is vital for increasing e-commerce and government mobile apps. Users switch to digital solutions due to increased hazards caused by the pandemic, but Odisha's adoption of government apps concerns privacy and security.

Facilitating conditions:
Bouaynaya et al. (2022) pointed out the factors that made the adoption of mobile commerce easier during COVID-19. The study highlights the importance of perceived simplicity of use, quality, and technology acceptance in fostering consumer happiness and trust. These elements are essential for government initiatives to be successful during emergencies. Figure 3 shows the factors affecting during COVID-19 in previous studies.

As illustrated in Figure 3**,** these factors collectively impacted the adoption of mobile government applications during COVID-19, as highlighted in previous studies.

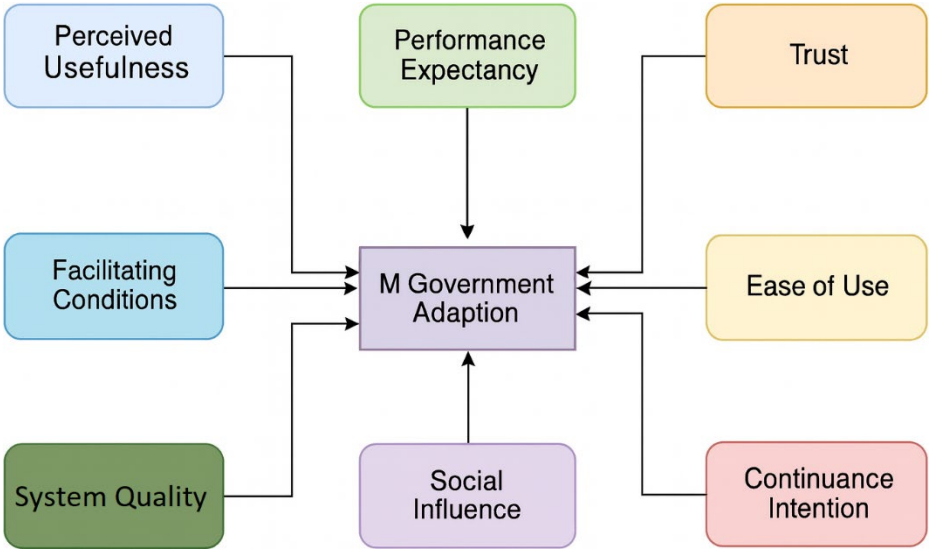

Figure 3. Factors affecting during COVID-19 in previous studies

COVID-19 emerging factors affecting technology adoption

Mobile government during COVID-19 successfully integrated five factors, as shown in Figure 4, to ensure public health compliance.

Fear

The rapid spread of viruses created fear worldwide. Governments established mobile applications that delivered immediate updates on virus infection data, combined with health warning signs, along with safety protocol recommendations. Users received trustworthy data through mobile applications during the most critical periods.

Awareness

Governments provide awareness via mobile platforms. These platforms share preventive measures and health updates to promote safe practices. By providing access to real-time notifications and official guidelines, the apps helped boost the overall understanding of COVID-19 risks and contribute to informed citizens.

Localisation

Mobile apps were customised to fit in users' cultural and regional needs, ensuring clarity in public health messages. The application improves the user involvement through content modification with unique social norms and standards. For instance, health information within Saudi Arabia became accessible and practical through localised terminology choices. Figure 4 shows Emerging Factors Affecting M-Government During COVID-19.

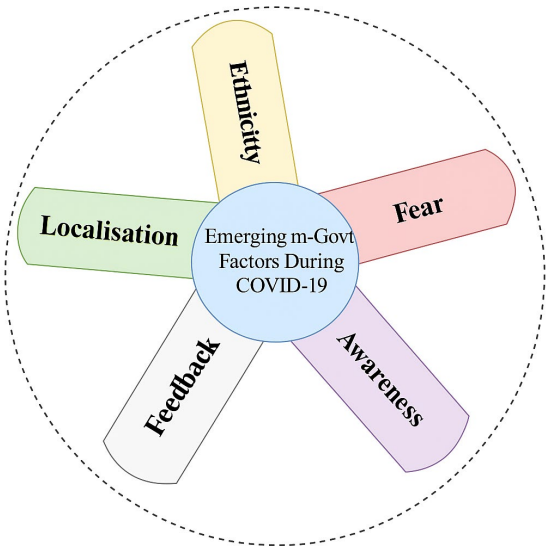

Figure 4. Emerging factors affecting m-government during COVID-19

Ethnicity

Many countries have a diverse population, including expatriates from various backgrounds. To ensure everyone had access to vital information, the governments offered app content in multiple languages. This multilingual approach promoted inclusivity, allowing non-native speakers to follow health guidelines and helping reduce the spread of the virus across communities.

Feedback

Governments allow citizens to share feedback. This feature allows users to share concerns and suggestions, enabling the government to address issues, adjust policies, and respond quickly. For example, Saudi Arabia's T*awakkalna* app includes feedback features to help authorities to strengthen trust and improve the effectiveness of Saudi Arabia's COVID-19 response efforts.

These strategies helped to tackle the pandemic by fostering trust, communication, and compliance through accessible, culturally relevant mobile platforms.

Recent challenges

The study explored how mobile apps, based on Argenti's (2013) crisis communication principles, impacted COVID-19 management. While effective in addressing urgent needs, their rapid development introduced challenges that affected their efficiency and user acceptance.

Data privacy and security

Data privacy and protection emerged as a key concern with the rapid deployment of mobile apps. Many lacked proper data protection standards, raising issues like safeguarding users' health information. For instance, India's A*arogya Setu* faced criticism over unclear data usage policies, sparking debates on secure data practices (Bassi et al., 2020; Alyousf et al., 2020).

Technological infrastructure limitations

In developing countries, limited internet access restricts mobile app usage. Issues like unstable connections, low smartphone ownership, and low digital literacy worsened existing inequalities in service access. These infrastructure challenges made it hard for governments to implement mobile solutions consistently across populations.

System stability and longevity

The pressure to roll out mobile apps led to stability issues and challenges with long-term use. Many apps faced some technical problems and struggled to adapt to the users' needs. For example, early contact tracing apps in some countries were ineffective because of low adoption and inaccurate data.

User adoption barriers

Despite the availability of mobile apps, user activity barriers like lack of awareness and resistance to change issues play a role. Some apps are complex and with specialised interfaces failed to reach a broader audience.

Future recommendations and suggestions

The rapid development of connected mobile apps created challenges and also opened up new opportunities for innovation, policy development, and cross-industry collaboration.

Innovation in mobile technologies

The pandemic increased innovation in mobile apps worldwide. IT stakeholders focus on creating secure, user-friendly, and scalable solutions to meet growing demands. This period of investment led to advancements like end-to-end encryption, real-time data, and improving future app development Kurniasih et al. (2024).

Policy and regulatory frameworks

The pandemic exposes gaps in data privacy, security, and ethical tech use. Governments now see the need for policies balancing app utility with rights protection. Such frameworks can guide responsible app development and deployment during future crises, ensuring preparedness.

Enhanced cross-sector collaboration

The pandemic encourages collaboration across sectors like healthcare, fintech, and public administration, resulting in apps to address crises. This collaboration opens the door to integrated solutions to handle problems.

Strengthening digital infrastructure

COVID-19 emphasises the need for digital platforms to support mobile app adoption. Governments and private sectors are now investing in internet expansion, smartphone access, and digital literacy programs. With the initiative to improve app efficiency in future crises.

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About the author

Thamer Alshammari is an Assistant Professor in the College of Computing and Informatics, Saudi Electronic University, Saudi Arabia. He received his Ph.D. from Monash University, and his research interests include the adoption of emerging technologies, usability, and artificial intelligence. He can be contacted at t.alshammari@seu.edu.sa

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