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Investigating Service Characteristics as Determinants of User Performance and Satisfaction in Saudi Arabia's Mobile Government Context

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Abstract. This study examined the effects of key characteristics of m-government services on realizing two highly desired adoption outcomes, user performance improvement and satisfaction, in the Saudi Arabian context. Based on a literature gap in understanding these effects, a research model was developed incorporating five service characteristics (ubiquity, technical sustainability, responsiveness, intensiveness, and information soundness) as determinants of the two outcomes. To validate the developed model, a closed-ended survey questionnaire was administered through the convenience sampling method to Saudi citizens and residents having experience with m-government services. The collected data (i.e., 226 valid responses) were analyzed using the structural equation modeling approach. The findings revealed significant positive effects of responsiveness, intensiveness, and information soundness on performance improvement, while only responsiveness and intensiveness impacted satisfaction. Furthermore, indirect effects (i.e., through performance improvement) on satisfaction were explored for these characteristics. This study contributes by introducing new service characteristics overlooked in past m-government research and investigating under-examined outcomes in the considered context, thereby providing novel theoretical and practical insights.

Keywords: mobile government, ubiquity, technical sustainability, service intensiveness, user performance, user satisfaction

1. Introduction

One of the most prominent digital transformations of the public services worldwide in the current century is shifting the government service offerings and processes to the mobile computing platform. This transformation has been facilitated by many enablers, including the increasing number of mobile subscriptions worldwide, the growing utilization of mobile technologies for accessing information and services by a wide variety of people categories (Al-Hubaishi et al., 2017), and the continuous price decrease of these technologies (Al Najjar et al., 2019). The outcome of this transformation is a class of innovative service offering methods called mobile government (m-government). This government is widely denoted as an advanced service delivery innovation and a phenomenal trend in reforming and reengineering public services that has potential to introduce diverse service improvements (Shareef et al., 2014), as well as to prominently strengthen the level of government agencies' interactions with their stakeholders (Alsaadi et al., 2019), such as citizens, businesses, and employees. Accordingly, it has been increasingly adopted by a variety of government agencies around the world to realize such improvements for their public service offerings. It was early given a broad definition denoting it as "government's efforts to provide information and services to public employees, citizens, businesses, and nonprofit organizations through wireless commu-nication networks and mobile devices such as pagers, PDAs, cellular phones, and their supporting systems" (Moon, 2004). More recently, it has been assigned simple descriptions, such as the public sector's utilization of mobile technologies to enable the offering of information and services via mobile devices to citizens without time and location limitations (Mensah & Mwakapesa, 2022).

Relying on mobile technologies in public service offerings increases the m-government prospect to enhance the efficiency, effectiveness, and overall quality of government services and processes (Alsaadi et al., 2019; Fadelelmoula, 2022a; Wang et al., 2020). This improvement is accompanied with a variety of potential benefits, including offering real-time information (Shareef et al., 2014), decreasing government expenditure, extending service offering to a wider population (Alshammari et al., 2022), enhancing government transparency and public governance (Alonazi, 2019), reducing corruption, and promoting democracy (Wang et al., 2020). However, there are challenges associated with the m-government adoption, including ensuring effective offering of services and attaining desired outcomes, such as increasing citizen satisfaction and loyalty (Al-Hubaishi et al., 2017). Addressing these challenges involves exploring the factors that improve both m-government service provision and its desirable consequences. Among these factors, the characteristics of m-government services can have significant roles in realizing a substantial part of such improvement.

In addition to its unique characteristics (e.g., ubiquity and portability), m-government services can also have those broadly identified for e-services quality, such as ease of use, reliability, customization, information accuracy and relevancy, interactivity, and responsiveness (Al-Hubaishi et al., 2017; Aloudat et al., 2014; Shareef et al., 2014). This is mainly due to the lack of agreed-upon quality characteristics for m-government services (Chanana et al., 2016) as well as for the other types of e-services (Aloudat et al., 2014). However, the effects of most of these characteristics on achieving the desirable outcomes of m-government adoption have not received substantial attention in the extant m-services literature. The majority of past studies focused on only the influences of these characteristics at the adoption stage of m-government services, such as their direct/indirect impacts on the user intention to adopt these services (e.g., Mensah & Mwakapesa (2022), Aloudat et al. (2014), and Eid et al. (2020)). Accordingly, little research was conducted to assess the roles of m-government service characteristics in producing the anticipated outcomes (e.g., user satisfaction) of these services upon their successful adoption (Al-Hubaishi et al., 2018). This confirms a notable literature gap that the antecedents contributing to the successful adoption's outcomes and their precise roles in advancing such consequences have not been extensively examined in the m-services context.

As a research effort to narrow such gap, this study examines the effects of crucial service characteristics as antecedents of key desired user-related outcomes of m-government services

adoption, which are performance improvement and satisfaction. These characteristics are ubiquity, technical sustainability, responsiveness, service intensiveness, and information soundness. Some of these characteristics are identified as service quality features in the m-services domain (i.e., responsiveness as well as the accuracy, currency, and completeness sub-dimensions of the information soundness characteristic) (Al-Hubaishi et al., 2018; Aloudat et al., 2014; Eid et al., 2020) and software area (i.e., technical sustainability) (Razavian et al., 2014). The rest of these characteristics include a unique feature of m-services that contributes to overall perceptions of the mobile service quality (i.e., ubiquity) (Kaatz, 2020) and a highly desirable attribute in the services provision field (i.e., intensiveness). Although these characteristics have a potential to greatly impact the outcomes of m-government adoption, their influences have not been given due consideration in the extant literature, especially technical sustainability and intensiveness, which have not even been evaluated as influential antecedents affecting the adoption of m-government in the past researches. Accordingly, these five characteristics have been included here to examine their roles as determinants of such desired outcomes. The two desired outcomes (i.e., performance improvement and satisfaction) have been selected here because they are among the most promised adoption benefits in the IT/IS innovations area. Moreover, they have rarely been included in the existing research frameworks of m-government, signifying a lack of in-depth knowledge about their predictors in such an innovative service field, as well as difficulties in understanding user expectations (Desmal et al., 2022) and performance gains. Consequently, a research model postulating the effects of these characteristics on the two desired outcomes has been developed in the present study.

The developed model has been empirically examined in a context that is increasingly focusing on implementing the most innovative technologies and business models for public services delivery, which is the Saudi one. This context has witnessed a great diffusion of m-government services in the recent years with the aim to realize crucial government-specific gains (e.g., larger service coverage, speedy transition to green government, and faster flow of information) and user-specific ones (e.g., enhanced service accessibility, ease of use of public services, and improved reception of notifications and alerts) (GOV.SA.; https:// www.my.gov.sa). The major facilitators driving this diffusion include the high spread rate of the enabling technologies usage, which is evidenced by the tremendous utilization of smartphone technology and fast growth degree of internet usage in Saudi Arabia (Alharbi et al., 2020). It has been expected that there have been more than 40 million mobile subscriptions in Saudi Arabia and most of them (95%) are having internet accessibility (Alharbi et al., 2022). Additional drivers of such diffusion comprise pivotal administrative causes, such as specifying m-government implementation as a priority for all Saudi government agencies (Alharbi et al., 2020) and enforcing preventive procedures and lockdowns to combat the spread of covid-19 virus. Accordingly, a wide range of m-government services have been actively provided by Saudi government agencies. Most of these services are encompassed in mobile apps, such as Tawakkalna app developed by the National Information Center, Mawid and Sehhaty apps offered by Ministry of Health, Absher app provided by Ministry of Interior, and Eatmarna app sponsored by Ministry of Hajj and Umrah. The popular public services provided by these apps include those related to the prevention of the Covid-19 virus spread, patient appointments management and medical reporting, passport and driving license related transactions, and Two Holy Mosques entry permissions, respectively.

Nevertheless, there is a scarcity of empirical research studies focusing explicitly on exploring the factors that influence the adoption of m-government services in the Saudi context (Alonazi, 2019). This lack extremely extends to the post adoption stage in terms of identifying the determinants of the anticipated outcomes of using these services. As a step towards eliminating such lack, the present study has concentrated on producing empirical evidences on how the abovementioned five characteristics of m-government act as antecedents affecting the realization of user performance improvement and satisfaction, as highly desirable usage outcomes, in the Saudi m-services

environment. Besides contributing to the elimination of this lack, the exploration of these effects is also essential to enhance the offering of public services in the considered context. This is because identifying service characteristics leading to useful usage outcomes as well as those do not have such a role is clearly a necessary effort to decide the improvement facets of these services.

To conclude, the above illumination indicates that the major concentration of this study is on the empirical examination of the following key research question: "What are the effects of the characteristics of m-government services on achieving two desirable adoption outcomes of these services (i.e., user performance improvement and satisfaction)?". The addressing of this question emphasizes that the present study has great potential to enrich the body of knowledge in the m-services domain by exploring these effects in a massive mobile public services environment (i.e., m-government).

2. Theoretical Background

This section provides a background to the service characteristics and desirable outcomes of m-government adoption.

2.1. Service Characteristics

As other crucial objects in the public and private sectors (e.g., products and human resources), services are commonly described by diverse properties called characteristics. Some of these characteristics are unique attributes that distinguish services from tangible products, including intangibility (they cannot be perceived with human senses), inseparability (having simultaneous production and consumption), variability (vary with respect to their quality and standards), and perishability (impossibility to store them) (Dohmen et al., 2012; Fahy & Jobber, 2015, Wahyudi et al., 2022). In addition to these distinctive characteristics, services can be characterized by those identified for other objects (e.g., physical products and technical systems), such as reliability and usability. These characteristics are denoted here as "inherited".

Most of the inherited characteristics are used as criteria that aid service providers in understanding users' perception and judgment about the quality of their service offerings. This usage stems from the essence of the service quality as a multi-attribute construct. Accordingly, such characteristics are frequently included as quality attributes in the quality models proposed for the services sector. Among these models, SERVQUAL and SERVPERF are the most prominent scales that have been frequently used to evaluate service quality in various service sectors. SERVQUAL, originally conceptualized by Parasuraman et al. (1985) and subsequently adjusted by Parasuraman et al. (1988), revealed that five generic attributes are used as criteria in assessing service quality through measuring the service expectations and perceptions of consumers. These attributes are tangibility, reliability, responsiveness, assurance, and empathy. Each of these attributes is indicated by certain desirable service delivery features, such as the visual appeal of the proider's physical facilities, accurate offering of promised services, prompt service provision, trust in the provider's employees, and individual attention reception, respectively (Parasuraman et al., 1988). SERVPERF, proposed by Cronin and Taylor (1992), adopts the same five quality attributes of SERVQUAL to measure only the consumer perceptions of service performance (i.e., excluding their expectations).

2.2. M-service Characteristics

Besides the service characteristics included in these two global quality scales (i.e., SERVQUAL and SERVPERF), a wide range of other ones have been encompassed as quality attributes in context-specific models. Concentrating on the m-services domain, instances of these models are presented as follows. M-S-QUAL, developed by Huang et al. (2015), focused on identifying the factors that constitute m-service quality in an m-commerce environment. It showed that four common attributes (i.e., contact, responsiveness, fulfillment, and efficiency) make such constitution for distinct types of shopping. Considering a different area of m-services, Akter et al. (2013) developed a hierarchical

multidimensional model that specifies multiple attributes as determinants of key dimensions of service quality in the m-health setting. These attributes include efficiency, cooperation, confidence, and care.

By paying attention to m-government, Shareef et al. (2014) identified the characteristics of connectivity, interactivity, understandability, and authenticity as quality attributes of m-government services. In the same vein, the multidimensional model investigated by Al-Hubaishi et al. (2018) incorporated multiple attributes as sub-dimensions of the factors predicting m-government service quality, including accuracy and currency of information, interface design, compatibility, and functional benefit. Chanana et al. (2016) showed that the characteristics representing privacy, ease of use, availability, provision of a wide range of services, and transparency are among the most important quality parameters for mobile government services. Eid et al. (2020) categorized m-government characteristics into service and technology attributes. The service attributes are responsiveness, currency, and accuracy, while those of technology include security, trust, and risk.

In addition to the characteristics identified by such m-government quality models, more ones have been included in several studies as motivational factors affecting m-government adoption and its anticipated outcomes. For instance, Wang et al. (2020) examined four m-government characteristics (i.e., mobility, localizability, personalization, and security) as relative advantage constructs predicting the user's perceived value. Wang et al. (2021) considered the characteristics of convenience and transparency as social benefits of m-government use in their evaluation of the factors enhancing citizen satisfaction from the social perspective. Al Najjar et al. (2019) assessed the characteristics that would impact the efficiency and effectiveness of m-government, including timeliness, accessibility, accuracy, and usability. Concentrating on value proposition for m-government, Yu (2013) identified the characteristics of portability, adaptability, ubiquity, and multi-functional among those representing functional features of m-government.

2.3. Desirable Adoption Outcomes

A broad range of desirable outcomes on the user level have been examined in the extant literature of the service innovations adoption, such as engagement and loyalty (Alalwan et al., 2020), perceived value and continuance intention (Fadelelmoula, 2022b; Wang et al, 2020), satisfaction (Khan et al., 2021), performance gains (Tam & Oliveira, 2019), trust (Alomari, 2022; Zhou, 2012), and net benefits (Sura & Ahn, 2019). Among these outcomes, improving user's performance and realizing his/her satisfaction are ones of the prominent anticipated adoption's consequences that can contribute to evaluating the effectiveness of the adopted innovation. Performance improvement encompasses positive impacts on certain key indicators, including the productivity, effectiveness, and performance of the individual user in his/her job (Goodhue & Thompson, 1995). As such, a considerable number of previous studies assessed these performance impacts using multiple improvement parameters, which comprise enhanced productivity, increased effectiveness, improved job performance, and augmented problem identification capabilities (Sanzogni, 2014). Investigating such performance impacts has been the focus of substantial research efforts aimed at gaining a sufficient understanding of the user performance resulting from the adopted systems (Sedera & Lokuge, 2019) as well as the factors improving this performance. Some of these research efforts represent empirical studies that reported contradictory results about the resulting performance effects at the user level (Sanzogni, 2014). This indicates the need for further studies to investigate and verify the exact motivational drivers affecting users' performance, especially in the area of recent technological innovations (e.g., m-government).

The second desirable outcome (i.e., user satisfaction) represents a prevalent indicator of the user's positive feeling and response (Liao, 2015) as well as the fulfilment of his/her expectations (Marinkovic & Kalinic, 2017). It has been extensively examined in a variety of service innovation contexts, such as m-commerce (Marinkovic & Kalinic, 2017) and m-health (Oppong et al., 2021). This wide examination is due to several factors, including the importance of user satisfaction as a

source of success in diverse sectors (Desmal et al., 2022) and the major challenge of maintaining it in many service industries (Oppong et al., 2021). Although user satisfaction has been a dominant dependent construct in several innovation adoption theories, it has rarely been included in the research models devoted to m-government services, signifying a lack of in-depth knowledge about its predictors in such innovative service field as well as a difficulty in understanding users' expectations (Desmal et al., 2022).

In sum, despite of the critical importance of both user performance and satisfaction, they have not received a considerable focus in the m-government context. Accordingly, examining them in the present study is essential to provide new insights about their influential predictors in such a context.

3. Research Model and Hypotheses

The developed research model (see Figure 1) comprises highly overlooked associations in the innovative services delivery context. These associations represent the roles of five service characteristics (i.e., ubiquity, technical sustainability, responsiveness, intensiveness, and information soundness) in achieving two desirable adoption outcomes of m-government services, which are user performance improvement and satisfaction. The description of these characteristics and their postulated links with the achievement of the two desired adoption outcomes is presented in the following sub-sections. Additionally, the model encompasses the effect of performance improvement as a mediator of the relationship between these characteristics and user satisfaction.

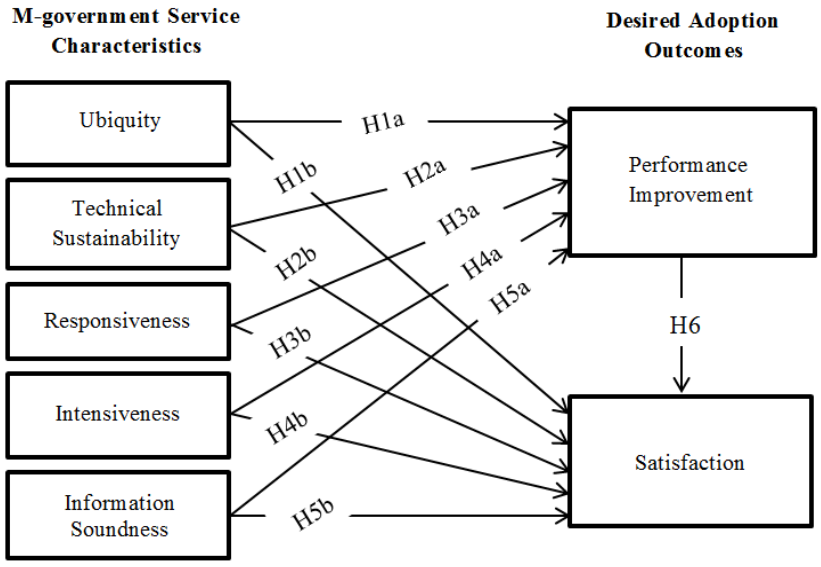


Fig. 1: The hypothesized research model

3.1. Ubiquity

Ubiquity is one of the most prominent unique characteristics of m-services (Okazaki & Mendez, 2013). It indicates the convenient access to offered services and content anytime and anywhere through mobile technologies (i.e., asserting time-space flexibility) (Ma et al., 2021). The crucial benefits that stem from this characteristic include immediacy (quickness of an action), continuity (continuous access to services), and mobility (independence from physical constraints) (Mensah & Mwakapesa, 2022; Okazaki & Mendez, 2013). In the context of innovative government services, ubiquity represents a key distinguishing feature that establishes the merit of m-government in advancing public service offerings and interactions with stakeholders compared to e-government. In this context, ubiquity emphasizes that government services can be accessed by stakeholders at

anytime and from anywhere by exploiting mobile technologies in these offerings (Mensah & Mwakapesa, 2022), indicating greater accessibility to provided content and performance of transactions on a real-time basis. As such, ubiquity is regarded in this study as the degree to which users are able to use m-government services whenever and wherever they need them.

3.1.1. Relationship between Ubiquity and the Desired Adoption Outcomes

Several studies have reported positive influences of ubiquity on key indicators of user performance improvement in a variety of m-service environments. Among these studies, the results of Arpaci (2016) suggested ubiquity enabled by the mobile cloud storage services as one of the factors that improve the productivity, effectiveness, and academic performance of students. Sandhu (2022) explored a significant positive effect of ubiquity on the benefits perceived by mobile users, which comprise key performance improvement aspects, including enhancing users effectiveness and enabling them to accomplish tasks more quickly. Such association between ubiquity and performance improvement was not given focus in the extant m-government research. However, the ability of users to conduct ubiquitous government transactions as well as issue quick and immediate requests is greatly anticipated to improve their performance in the vital public interactions with government agencies. Accordingly, the following relationship is postulated.

H1a: Ubiquity positively affects user performance improvement in the m-government context.

Ubiquity was revealed by several researches in the m-services domain as a significant determinant of highly needed adoption gains, including utilitarian and hedonic values perceived by mobile users (Ltifi, 2018), overall perceived value (Anwar et al., 2021), trust, and experience enhancement (Zhou, 2012). Such gains were highlighted by several researches as influential factors impacting user satisfaction (e.g., Anwar et al., 2021; Park et al., 2011), indicating that ubiquity is among the factors that lead to achieving users' pleasure with their experience of m-services usage as well as meeting their expectations. Consequently, the ubiquity of m-government services have the potential to maintain and improve users' satisfaction with their interactions with government agencies, as well as their pleasure with the execution of transactions and requests involved in these interactions. Hence, the following effect is posited:

H1b: Ubiquity positively affects user satisfaction in the m-government context.

3.2. Technical Sustainability

Technical sustainability is a key dimension of the quality of software systems and services that involves dealing properly with changes and evolution by making relevant adaptation and improvement. It specifically revolves around attaining the long-term utilization of such systems and their appropriate evolution in an ever-changing implementation environment (i.e., having constantly varying conditions and associated requirements) (Lago et al., 2015; Penzenstadler & Femmer, 2012). As such, it refers to the longevity of systems and services (Penzenstadler & Femmer, 2012), and comprises two pivotal aspects: the long-term use and the capability to evolve (Hygerth, 2016). It has been assigned numerous definitions and conceptual descriptions. Among these, it is defined as "the ability of a software service network to cope with change and evolution, while providing the requested features and capabilities" (Razavian et al., 2014). Penzenstadler & Femmer (2012) expressed it shortly in terms of ease of adapting software to future changes. Besides such adaptation to future changes, some definitions included user needs as a basis for carrying out modifications on a software system for the sake of its sustainability (Venters et al., 2014). According to these definitions, the technical sustainability of technological solutions is mainly indicated by their longevity and adaptability to future changes, requirements, and advancements in their environments.

Like many other IT/IS innovations deployed in wide environments, realizing the technical sustainability of m-government services is of great importance due to the massive amounts of time,

efforts, and funds dedicated to the implementation of these services. Thus, it is necessary to ensure that these services are continually provided and improved in accordance with the most recent developments in the areas of IT (e.g., mobile technologies and communications) and service delivery as well as the changing needs of stakeholders. Relying on the above definitions, the technical sustainability of m-government services is viewed here as the extent to which these services are easily adapted and improved according to the changes and evolutions that occur in the IT and business domains, such as those taking place in mobile technologies and practices, business rules and requirements, and stakeholder needs.

3.2.1. Relationship between Technical Sustainability and the Desired Adoption Outcomes

The empirical examination of the effects of technical sustainability on performance improvement and satisfaction was not taken into account in the m-government literature. To the best of our knowledge, this gap also extends to the entire service innovations domain, emphasizing a significant lack of understanding of how these constructs are associated with each other in such a domain. However, focusing specifically on m-government services, achieving their technical sustainability is anticipated to be essential to constantly attain their desired adoption outcomes, including improved user performance and satisfaction. Accordingly, the evolution of these services on the basis of future changes, stakeholder needs, and service provision advancements has a great possibility to continuously provide users with needed functionalities, features, and improved interactions with government entities. This can mostly result in enhancing the key dimensions of users' performance improvement (e.g., reaching higher levels of user effectiveness and productivity) and increasing user satisfaction with the offered services. Accordingly, the following links are hypothesized.

H2a: Technical sustainability positively affects user performance improvement in the m-government context.

H2b: Technical sustainability positively affects user satisfaction in the m-government context.

3.3. Responsiveness

Responsiveness is among the five distinct dimensions identified by SERVQUAL to evaluate customer perceptions of service quality by service and retail businesses. It involves timeliness of service in terms of providing prompt service and help to customers (e.g., immediate fulfillment of customer requests) (Parasuraman et al., 1988; Parasuraman et al., 1985). Thereby, it basically serves as an indication of shortening the length of time that customers have to wait to receive a response from the service provider and the latter's willingness to help them. Hence, it signifies compliance with the user's time requirements (i.e., meeting time deadlines) (Johnson, 2014). Such speedy reaction to customer requests and needs highlights responsiveness as a key objective for both ordinary and electronic service offerings towards realizing high quality service delivery.

In this sense, responsiveness has been suggested as one of the most applicable SERVQUAL dimensions to assess service quality in the broad electronic government area (Alonazi, 2019). Accordingly, it has been included in many studies as a service quality feature of m-government (e.g., Alonazi, 2019; Aloudat et al., 2014; Eid et al., 2020). Furthermore, it has been indicated as a driver motivating the development and adoption of m-government services (Al Najjar et al., 2019). In prior m-government researches, responsiveness received almost similar definitions and interpretations with those assigned to it in other service offering fields (e.g., ordinary e-services). Among these researches, Yu (2013) included responsiveness as "the ability to quickly respond to user requests and transactions". Accordingly, responsiveness is conceptualized here as the extent to which user requests and transactions receive prompt response and handled in a timely manner when using m-government services.

3.3.1. Relationship between Responsiveness and the Desired Adoption Outcomes

Numerous studies have shown that responsiveness is critical to user satisfaction and performance improvement (Johnson, 2014). It is among the characteristics that substantially impact the time and effort that users devote to interacting with a system or service. Kar (2021) included that reducing user time and effort is associated with higher levels of system responsiveness. Focusing on the performance improvement aspects, such reduction is likely to enhance user performance in terms of increased productivity and effectiveness in tasks accomplishment. On the other hand, low levels of responsiveness are very probable to make it more difficult to carry out tasks, which negatively affects user productivity and effectiveness. Many empirical studies in the electronic services domain have revealed significant positive associations between responsiveness and constructs incorporating performance improvement aspects. For instance, Almaiah et al. (2016) found that responsiveness is having a significant positive effect on perceived usefulness of m-learning, which was assessed in terms of multiple performance improvements for users, including quick accomplishment of tasks, increased productivity, and enhanced effectiveness. A similar effect was explored by Sura & Ahn (2019) in the context of social commerce. However, such relationship between responsiveness and aspects of user performance improvement did not receive a considerable attention to be verified empirically for m-government services. This is despite of the high possibility of this relationship to exist in the m-government context. Hence, the following hypothesis is posited:

H3a: Responsiveness positively affects user performance improvement in the m-government context.

With respect to the effect of responsiveness on user satisfaction, significant associations between these constructs have been empirically pointed out in diverse m-services contexts. For example, Khan et al. (2021) observed that responsiveness has the strongest influence, among the examined service attributes, on user satisfaction with m-banking. Likewise, Liu et al. (2018) explored responsiveness as the most important factor affecting user satisfaction with another class of m-services, which is m-learning. Such effects of responsiveness on user satisfaction were not empirically confirmed in the m-government context as evidenced by the scarcity of studies addressing them in such a broad m-services environment. However, these effects also apply to m-government services because reliance on mobile technologies elevates the responsiveness provided by these services to higher levels than those of the ordinary e-government services, which in turn is likely to lead to improved satisfaction. Accordingly, the following relationship is suggested:

H3b: Responsiveness positively affects user satisfaction in the m-government context.

3.4. Intensiveness

Intensiveness is conceptualized in this study as a composite characteristic consisting of three intensities pertaining to major components of the services domain (i.e., service's provider, user, and needs). These intensities are service intensity, usage intensity, and fulfillment intensity. Each of these intensities is driven by the user needs and can thus act as an indicator of the quality of care provided to service users. Service intensity is a concept often used in many ordinary services sectors (e.g., healthcare and transportation services) to primarily indicate the quantity of services provided to users (Sosin, 2001) and the variety of these services (Arnold, 1985). Accordingly, it can mainly serve as an indicator of the capacity of the service provider in terms of the number and variability of services provided.

Usage intensity refers to the frequency with which the user accesses the provided services to issue requests or perform transactions. As such, it can effectively act as measure of the amount of user interactions with these services. It received several indications in diverse contexts, such as the number

and frequency of mobile purchases (Hou & Elliott, 2021) and amount of time devoted to using a social network (Ellison et al., 2007).

Fulfillment intensity signifies that service offerings satisfy a wide diversity of user needs (e.g., obtaining certain information, paying bills, renewing a passport, getting a visa, etc.). Accordingly, it reflects the capability of service providers to intensively incorporate the content and business processes that sufficiently meet user needs in the development of their services.

Relying on the aforesaid description of the three intensities, the present study concisely interprets the intensiveness of m-government as the degree to which the government is able to provide a wide range of services that are frequently accessed by end users through mobile technologies to fulfill a variety of needs.

3.4.1. Relationship between Intensiveness and the Desired Adoption Outcomes

The three intensities constituting the intensiveness characteristic were not given sufficient attention to explicitly address their effects in the area of electronic services adoption. This research gap also extends to the post-adoption stage of these services as evidenced by the paucity of studies examining the effects of each of these intensities on attaining desired adoption outcomes. Among the rare studies that addressed some aspects of these intensities, Wendland et al. (2019) observed that the degree of use of a mobile application is positively associated with the performance of diverse categories of stakeholders. They used usage intensity as one of the measures of the degree of use construct. Despite the scarcity of such empirical findings, it is reasonable to suggest that the more intensiveness of m-government, as represented by its service, usage, and fulfillment intensities, the higher the possibility of building constructive usage experience leading to improved performance, as well as increased satisfaction with the services offered. This suggestion stems from the high capabilities of m-government enabling technologies (e.g., mobile devices and communications) to facilitate and drive the continuous increment of these three intensities in several facets, such as increasing the government agency ability to regularly offer more wide variety of services, as well as raising the frequency of user interactions with the services provided. Hence, the following hypotheses are postulated:

H4a: Intensiveness positively affects user performance improvement in the m-government context.

H4b: Intensiveness positively affects user satisfaction in the m-government context.

3.5. Information Soundness

Information soundness is the second construct, besides intensiveness, that has been viewed in the present study as a composite characteristic. It is made up of three major quality attributes of one of the most important content of service offerings, which is information. These attributes are accuracy, currency, and completeness. They indicate that the offered service provides its users with accurate, up to date, and all necessary information to meet certain needs (Al-Hubaishi et al., 2018; Lin, 2013). Each one of these attributes contributes to reaching the sound condition of information, which is identified here for m-government as the condition in which the information provided by such service innovation is precise, up-to-date, and complete, so that it is credible for decision-making or judgment. Accordingly, they collectively establish the validity of information to be effectively used by the intended users for crucial purposes, such as planning, decision making, and conducting transactions. In this sense, they can be described as the information quality attributes that best constitute the power of information in providing significant value to end users. This conceptualization of information soundness is largely consistent with the sound information category identified by Kahn et al. (2002) which encompasses that the information meets the criteria for accuracy, completeness, and error-freeness.

3.5.1. Relationship between Information Soundness and the Desired Adoption Outcomes

The three attributes forming the soundness of information were found by some studies as determinants of user's performance improvement aspects in a variety of IT/IS environments. For instance, the analysis of Ali & Younes (2013) revealed that these attributes are among those that significantly contribute to improving user performance, which was measured using indicators of effectiveness, efficiency, and creativity. They considered a generic information systems context to analyze the roles of these attributes. Among the rare studies that examined such a relationship in the m-government context, Eid et al. (2020) noticed that the accuracy of the provided information positively affects the usefulness of m-government, which includes user performance improvements in terms of getting things done more rapidly and increasing productivity. Building upon such findings of former studies, it can be considered that when end users of m-government services are provided with information having the three attributes of information soundness, multiple performance gains are attained, such as enhanced effectiveness in accomplishing tasks and increased productivity. Consequently, the following link is postulated:

H5a: Information soundness positively affects user performance improvement in the m-government context.

By concentrating on the second desired adoption outcome (i.e., satisfaction), Al-Hubaishi et al. (2018) considered the three attributes of information soundness (i.e., accuracy, currency, and completeness) as dimensions of information quality and explored that this quality is among the factors contributing towards realizing user satisfaction in the m-government context. Likewise, Wang & Teo (2020) included these attributes as indicators of information quality and found a positive association between this quality and users' satisfaction with m-government services. Accordingly, it is reasonable to suggest that information soundness, as composed of accuracy, currency, and completeness attributes, is an influential factor in increasing user satisfaction with provided services, given that users often desire to receive precise, up-to-date, and complete information. Therefore, the following effect is posited:

H5b: Information soundness positively affects user satisfaction in the m-government context.

4. Research Methodology

Achieving the target of the current study (i.e., the empirical assessment of the effects of m-government service characteristics on improving user performance and satisfaction) implied the use of the quantitative research approach, which is a dominant methodology for examining the relationship between variables in the field of empirical research. This approach mainly involves the following essential steps: (a) collecting numerical data based on precise measurement of the variables being examined, (b) implementing relevant statistical techniques to analyze the collected data, and (c) interpreting the analysis results. To conduct the data collection step, a closed-ended survey questionnaire (i.e., containing a predefined set of response options) was constructed, whereas the data analysis was carried out using the structural equation modeling framework, which encompasses a family of statistical analysis methods.

The contents of the constructed questionnaire were divided into two parts. The first part consisted of demographic attributes of the potential respondents, including gender, age, educational level, nationality, and experience in using m-government services. The second part contained 21 statements that reflect the measurement items assessing the respondent's perceptions of both independent and dependent constructs included in the developed model (i.e., m-government service characteristics, performance improvement, and satisfaction). Most of these items were derived from questionnaires validated by prior studies in the area of IT/IS adoption. Only commonly used items in such studies

were included in the formulated questionnaire. Slight modifications were made to these items to better suit the context of the present study (i.e., m-government services). These items were used to evaluate three characteristics of m-government services (i.e., ubiquity, responsiveness, and information soundness) as well as the considered desirable adoption outcomes (performance improvement and satisfaction). The items measuring two service characteristics (i.e., technical sustainability and intensiveness) were developed in this study based on relevant literature on service offerings and IT innovations adoption. This is due to the lack of studies that empirically assessed these two characteristics in the electronic services domain.

The content validity of the questionnaire was evaluated by five academic researchers, having experience in developing survey instruments, to ensure the adequacy, comprehensiveness, and clarity of all the items considered to measure the model's constructs. According to their suggestions, 7 items were rephrased and 4 were excluded. The list of final items included in the questionnaire is shown in Appendix A. The items measuring ubiquity (UBI) were adopted from Mensah & Mwakapesa (2022) and Tojib & Tsarenko (2012). Responsiveness (RES) was measured using items taken from Aloudat et al. (2014) and Eid et al. (2020). Information Soundness (INSO) was assessed using items extracted from Al-Hubaishi et al. (2018) and Lin (2013). To evaluate technical sustainability (TESU), items were developed based on Razavian et al. (2014), Penzenstadler & Femmer (2012), and Venters et al. (2014). Likewise, the items measuring intensiveness (INT) were developed based on prior studies, including Sosin (2001), Arnold (1985), Hou & Elliott (2021), and Ellison et al. (2007). Measuring performance improvement (PEIM) was conducted based on items derived from Urbach et al. (2010). Satisfaction (SAT) was evaluated using items adopted from Al Najjar et al. (2019) and Marinkovic & Kalinic (2017). To capture the responses of the prospective respondents to each of these items, a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) was applied.

The considered population for this study consisted of Saudi citizens and residents who have used the mobile services provided by major Saudi government agencies, such as Ministry of Interior, Ministry of Health, and Saudi Data and Artificial Intelligence Authority. To choose the potential respondents from this population, a commonly used sampling technique in the IT/IS literature was implemented, which is convenience sampling. This technique involves selecting the most conveniently available members of the intended population to serve as study participants. As such, it is easier to implement and more cost-effective than other methods, thereby it was chosen here for data collection. Following this technique, the constructed questionnaire was self-administered to a sample of 340 participants in the target population, considering those located in the Riyadh region (i.e., situated in the middle of Saudi Arabia). The number of received responses from this sample was 261, stating an adequate response percentage of 76.8%. Out of these responses, 19 were incomplete and 16 were inaccurately provided (e.g., choosing the same option to respond to all items). After excluding these invalid responses, the final sample (i.e., considered for analysis) consisted of 226 respondents. Most of the respondents were Saudis (79%), were in the age range from 25 to 44 years (84%), had at least a bachelor's degree (64.7%), and had a minimum one year of experience in using m-government services (95%). The detailed values of the demographic attributes of the respondents are listed in Table 1.

4.1. Detecting Common Method Bias & Collinearity

Common Method Bias (CMB) and collinearity are phenomena that negatively influence the accuracy of data analysis results, and thus lead to untrue interpretations and inferences. CMB is a phenomenon that mainly arises from considering the same set of respondents as a source for providing responses to the measurement items of both independent and dependent constructs (Podsakoff et al., 2003). These responses can be impacted by numerous factors,

such as the design, complexity, ambiguity, and length of the instrument used to collect the data as well as the respondent's knowledge of the subject, which may influence the respondent's motivation to provide accurate answers (Eichhorn, 2014). As such, CMB reflects a major source of measurement errors that threaten the validity of the findings and conclusions about the postulated associations among the variables of a research model (Podsakoff et al., 2003).

Table 1. Demographic attributes of the sample (n=226)

Attribute	Value	Frequency	%
Gender	Male	187	83%
	Female	39	17%
Age	< 25	7	3%
	25-34	103	46%
	35-44	87	38%
	45–54	23	10%
	≥ 55	6	3%
Academic degree	Diploma	68	30%
	Bachelor	89	39.4%
	Postgraduate	57	25.3%
	Other	12	5.3%
Nationality	Saudi	179	79%
	Non-Saudi	47	21%
Experience in using m-government services	Less than 1 year	11	5%
	One year and above	215	95%

The commonly implemented tests for CMB include Harman's single factor test (Podsakoff et al., 2003) and full collinearity variance inflation factor (FCVIF) test (Kock, 2015). Harman's single factor test involved carrying out an exploratory factor analysis to check whether one factor accounts for the majority of the total variance or a single factor is produced (i.e., CMB occurrence conditions) (Podsakoff et al., 2003). The factor analysis included all the measurement items of the developed model constructs (i.e., 21 items) and was conducted using the Statistical Package for the Social Sciences (SPSS). The results showed that the single factor explained 38.69% of the total variance, which is less than the threshold of 50%. This provides evidence that CMB was not a concerning issue in this study.

In addition, the FCVIF test was also conducted to validate the result produced by Harman's single factor test. The FCVIF test, as proposed by Kock & Lynn (2012), involved generating the variance inflation factors (VIFs) for all independent and dependent constructs in the developed research model. SPSS was used to produce these VIFs. All model constructs were included in a regression analysis as predictors of a single outcome construct and the collinearity diagnostics option was selected to generate the VIFs of these constructs. All obtained VIFs (shown in Table 2) were below the cut-off value of 3.3 (Kock, 2015), confirming that CMB did not represent an issue affecting the conclusions of this study.

Also, the presence of VIFs < 3.3 for all examined constructs demonstrated evidence for the absence of the collinearity situation. Collinearity signifies that independent constructs may be collinear with each other (vertical collinearity) or with a dependent construct (lateral collinearity) (Kock & Lynn, 2012). Hence, the developed model was devoid from interrelationships that make it difficult to assert the influence of any single construct as well as to interpret the analysis results (Hair et al., 2019).

Table 2. Produced VIFs of the full collinearity test

Construct	UBI	TESU	RES	SEIN	INRO	PER	SAT
VIF	1.042	1.302	1.921	1.883	2.162	3.118	2.697

5. Analysis and Results

The data obtained through the administered questionnaire were analyzed using the structural equation modeling (SEM) approach. SEM is a set of statistical techniques used to examine associations between multiple variables (Hair et al., 2019). Compared to traditional analysis methods (e.g., regression analysis), SEM provides the capability to assess an entire model rather than concentrating only on individual associations. It also enables simultaneous examination of the impacts of independent constructs on many dependent ones (Collier, 2020). Accordingly, it was chosen to test all the hypothesized relationships in the current study. Implementing the SEM approach involves assessing two types of models, namely the measurement model and the structural model. The measurement model encompasses the potential links between the examined constructs and their measurement items, while the structural model specifies the possible associations between the independent and dependent constructs (Hair et al., 2019). Two widely used statistical tools in the area of IT/IS innovations adoption were considered to conduct the data analysis, which are SPSS and Analysis of a Moment Structures (AMOS) statistical software.

5.1. Measurement Model Evaluation

The measurement model in the present study comprised the links between the latent constructs (i.e., examined m-government characteristics, performance improvement, and satisfaction) and their measurement items. The evaluation of this model involved assessing both construct validity and internal consistency to determine whether the considered measurement items for each construct strongly measure it. Construct validity was assessed in terms of two sub-dimensions of it, which are convergent validity and discriminant validity. Convergent validity is demonstrated by high correlations among items measuring the same construct, whereas discriminant validity is indicated by low correlations between items assessing different constructs (Sallis et al., 2021).

The assessment of convergent validity was implemented through examining three widely used metrics: item loadings, average variance extracted (AVE), and composite reliability. Item loadings are used to determine the strength of the relationships between the measurement items and their associated model's constructs (i.e. the factors). Factor analysis was conducted to produce the loading of each item on its corresponding construct. The obtained results (Table 3) showed that the loadings of all items, ranging from 0.775 to 0.969, exceeded the ideal value of 0.7 (Hair et al., 2019), thereby the items measuring each construct were highly related to it. The AVE (i.e., a measure of convergence among the construct's items) was calculated for each construct based on the produced loadings of its items. The calculated AVEs, ranging from 0.75 to 0.87 (Table 3), were greater the cut-off value of 0.5 (Hair et al., 2019), revealing an adequate convergence. The values of the third measure of convergent validity (i.e., composite reliability - Fornell & Larcker, 1981) were also calculated for all constructs based on item loadings. The computed values of this measure (Table 3) were in the satisfactory range (i.e., 0.70–0.95), depicting acceptable reliability. In sum, satisfactory convergent validity was evidenced by the values of item loadings, AVE, and composite reliability.

The discriminant validity (i.e., the second sub-dimension of construct validity) of the model's constructs was evaluated on the basis of the Fornell–Larcker criterion (Fornell & Larcker, 1981). According to this criterion, discriminant validity is achieved when the square root of the AVE of each construct is higher than the construct's correlations with the other constructs in the model. Table 4

presents that the square roots of the AVE values (i.e., shown on the diagonal) were greater than the values of the correlations between the constructs (i.e., off-diagonal elements). Thus, discriminant validity was satisfied for all constructs, indicating that each construct is distinct from the other constructs in the model.

The internal consistency (i.e., an indication of the extent to which each construct is consistently represented by its associated measurement items (Hair et al., 2019) was inspected using a measure widely applied in quantitative research, which is Cronbach's alpha (Cronbach, 1951). As shown in Table 3, the obtained values of Cronbach's alpha for all model's constructs, ranged between 0.829 and 0.921, were above the rule of thumb value of 0.7 (Nunnally & Bernstein, 1994), confirming a satisfactory level of internal consistency.

5.2. Structural Model Evaluation

The evaluation of the structural model comprised examining the posited relationships among its constructs, which represented the effects of the considered m-government characteristics on performance improvement and satisfaction. A necessary step before conducting this examination was to inspect how well the model fits the data obtained through the administered questionnaire. To perform this step, a set of widely used fit indices were assessed based on their recommended threshold values. These indices are normed chi-square (χ^2/df), Root Mean Square Error of Approximation (RMSEA), Goodness-of-Fit Index (GFI), Comparative Fit Index (CFI), and Non-Normed Fit Index (NNFI). Using such a variety of indices is essential to accurately determine the model adequacy (Schermelleh-Engel et al., 2003; Smith and McMillan, 2001). Table 5 shows that the obtained values of χ^2/df (1.576) and RMSEA (0.051) met the condition that they should be less than their threshold values (Schermelleh-Engel et al., 2003), whereas the values of GFI (0.912), CFI (0.978), and NNFI (0.969) were above their minimum recommended values (Smith and McMillan, 2001). As such, a satisfactory fit of the hypothesized model to the collected data was evidenced, indicating the adequacy of this model for further evaluation, which was the examination of the postulated associations among its constructs.

Examining these postulated relationships was carried out based on the standardized path coefficients (i.e., *ß* values) for all paths from the considered m-government characteristics to the dependent constructs (i.e., performance improvement and satisfaction). The evaluation of the produced values of these coefficients as well as the significance of their associated t-values (see Table 6 and Figure 2) demonstrated the significance of only five paths in the hypothesized model. These paths represent the associations H3a (RES → PEIM), H4a (INT → PEIM), H5a (INSO → PEIM), H3b (RES → SAT), and H4b (INT → SAT). Consequently, each of responsiveness (*ß* = 0.185, $t = 2.347$, $p < 0.05$), intensiveness (*ß* = 0.441, $t = 5.708$, $p < 0.001$), information soundness (*ß* = 0.273, $t = 3.603$, $p < 0.001$) positively affects performance improvement, whereas only responsiveness (*ß* = 0.394, $t = 4.633$, $p < 0.001$) and intensiveness (*ß* = 0.432, $t = 5.395$, $p < 0.001$) have significant positive influences on satisfaction.

Table 3. The measurement model evaluation results

Construct	Items	loadings	Cronbach's Alpha	Composite Reliability	AVE
Ubiquity (UBI)	UBI1	0.967	0.913	0.952	0.87
	UBI2	0.969			
	UBI3	0.857			
Technical Sustainability (TESU)	TESU1	0.916	0.836	0.903	0.76
	TESU2	0.912			
	TESU3	0.775			

Responsiveness (RES)	RES1	0.893	0.829	0.900	0.75
	RES2	0.884			
	RES3	0.821			
Intensiveness (INT)	INT1	0.905	0.907	0.942	0.84
	INT2	0.945			
	INT3	0.905			
Information Soundness (INSO)	INSO1	0.951	0.921	0.952	0.87
	INSO2	0.950			
	INSO3	0.893			
Performance Improvement (PEIM)	PEIM1	0.928	0.894	0.934	0.83
	PEIM2	0.902			
	PEIM3	0.895			
Satisfaction (SAT)	SAT1	0.891	0.862	0.917	0.79
	SAT2	0.902			
	SAT3	0.869			

Table 4. Discriminant validity inspection

	UBI	TESU	RES	INT	INSO	PEIM	SAT
Ubiquity (UBI)	**0.933**						
Technical Sustainability (TESU)	0.115	**0.872**					
Responsiveness (RES)	0.067	0.413	**0.866**				
Intensiveness (INT)	0.099	0.297	0.453	**0.917**			
Information Soundness (INSO)	0.032	0.389	0.622	0.532	**0.933**		
Performance Improvement (PEIM)	0.065	0.350	0.503	0.632	0.616	**0.911**	
Satisfaction (SAT)	0.058	0.307	0.523	0.600	0.486	0.762	**0.889**

Note: The square roots of AVE values are shown on the diagonal, whereas the off-diagonal elements represent the values of the correlations between the model's constructs.

Table 5. Assessment of the obtained values of the fit Indices

Fit Indices	χ^2/df	GFI	CFI	NNFI	RMSEA
Obtained value	1.576	0.912	0.978	0.969	0.051
Recommended value	< 3.00	> 0.90	> 0.90	> 0.90	< 0.08

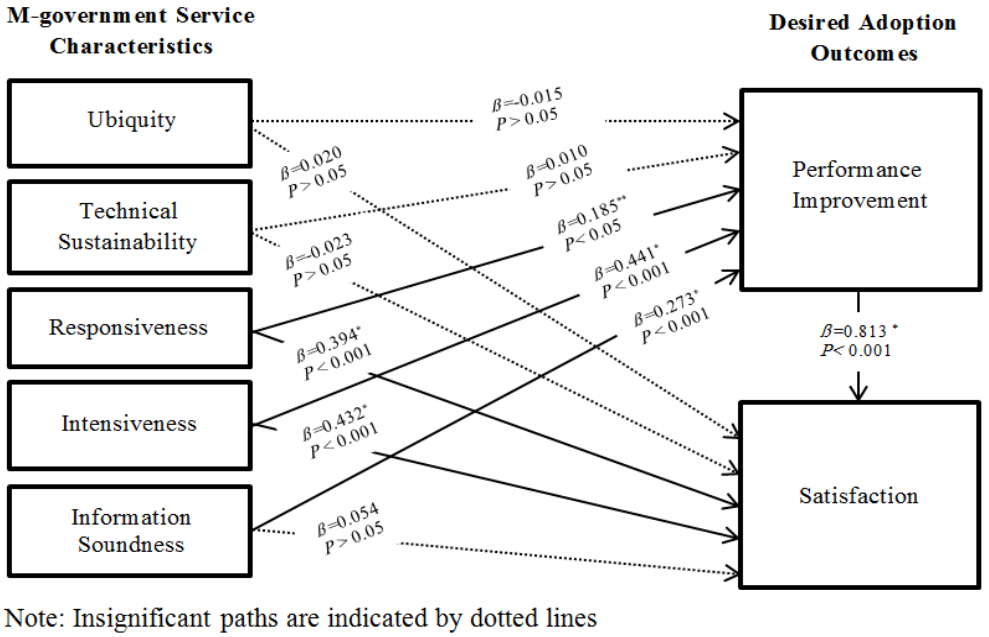
In contrast, the paths related to the associations H1a (UBI → PEIM), H2a (TESU → PEIM), H1b (UBI → SAT), H2b (TESU → SAT), and H5b (INSO → SAT) were not supported, implying that both ubiquity (*ß* = -0.015, *t* = -0.443, *p* > 0.05) and technical sustainability (*ß* = 0.010, *t* = 0.171, *p > 0.05*) did not have significant influences on performance improvement, as well as each of ubiquity (*ß* = 0.020, *t* = 0.552, *p* > 0.05), technical sustainability (*ß* = -0.023, *t* = -0.358, *p* > 0.05), and information soundness (*ß* = 0.054, *t* = 0.669, *p* > 0.05) had no significant impact on satisfaction.

An additional examination was conducted to explore whether the considered characteristics are having indirect effects on satisfaction through performance improvement. This examination first

involved testing the direct effect of performance improvement on satisfaction (i.e., H6), which was found significant with ß = 0.813 ($p < 0.001$). Afterwards, testing the indirect effects on satisfaction revealed that of the considered characteristics only responsiveness (ß = 0.171, $p < 0.05$), intensiveness (ß = 0.355, $p < 0.001$), and information soundness (ß = 0.241, $p < 0.001$) indirectly associated with this construct through performance improvement. As such, there were two characteristics had both direct and indirect effects on satisfaction (i.e., partial mediation through performance improvement), which are responsiveness and intensiveness, while one characteristic had only an indirect effect on satisfaction (i.e., information soundness), indicating a fully mediated association.

Table 6. Results of the postulated paths examination

Hypothesized path	Standardized path coefficient (ß)	t-Value	Result
H1a: UBI → PEIM	-0.015	-0.443	Not Supported
H2a: TESU → PEIM	0.010	0.171	Not Supported
H3a: RES → PEIM	0.185	2.347**	Supported
H4a: INT → PEIM	0.441	5.708*	Supported
H5a: INSO → PEIM	0.273	3.603*	Supported
H1b: UBI → SAT	0.020	0.552	Not Supported
H2b: TESU → SAT	-0.023	-0.358	Not Supported
H3b: RES → SAT	0.394	4.633*	Supported
H4b: INT → SAT	0.432	5.395*	Supported
H5b: INSO → SAT	0.054	0.669	Not Supported
* Significant for $p < 0.001$ ** Significant for $p < 0.05$			



Note: Insignificant paths are indicated by dotted lines

Fig. 2: Results of testing the hypothesized paths

6. Discussion

This research concentrated on examining how certain service characteristics (i.e., ubiquity, technical sustainability, responsiveness, intensiveness, and information soundness) contribute to the achievement of two desirable adoption outcomes in the m-government context, which are user performance improvement and satisfaction. The obtained results demonstrated that only three of the examined characteristics (i.e., responsiveness, intensiveness, and information soundness) are significant direct determinants of performance improvement, whereas only two of these three characteristics (i.e., responsiveness and intensiveness) contribute significantly to achieving satisfaction. Furthermore, indirect effects of these three characteristics on satisfaction (i.e., through performance improvement) were detected.

The produced results pertaining to responsiveness and intensiveness signify that the provision of a broad variety of services characterized by high accessibility and fast response rates is a substantial driver for improving both user performance and satisfaction in the m-government context. Thus, among the examined characteristics, only increased intensiveness and responsiveness can directly contribute to the collective enhancement of the users' productivity, effectiveness, pleasure, and expectations fulfillment. This raises the potential of these two characteristics to have more significant contributions because the factors that positively affect performance and satisfaction are more likely to motivate more desirable adoption consequences, including continuance usage intention and loyalty. Besides such direct effects of both responsiveness and intensiveness, the revealed significant indirect associations between these characteristics and satisfaction shed light on their roles in augmenting the indicators of performance improvement (e.g., increased productivity) that can lead ultimately to user satisfaction.

The explored positive effect of responsiveness on performance improvement is in line with that reported by the studies that examined the association between this characteristic and perceived usefulness (e.g., Almaiah et al., 2016; Sura & Ahn, 2019). These studies included perceived usefulness as a construct encompassing several user performance improvements, such as quick tasks accomplishment and enhanced effectiveness. Likewise, the revealed significant impact of this characteristic on satisfaction confirms the findings of multiple prior studies, particularly those conducted in the m-services domain (e.g., Kar, 2021; Khan et al., 2021; Liu et al., 2018). Regarding the influences of intensiveness, the produced findings are consistent with those of the rare studies that addressed effects of individual dimensions of this characteristic on attaining desired outcomes of technology usage and found significant links, such as the positive effect of intensity of use on users' performance (e.g., Wendland et al., 2019).

With respect to the impacts of information soundness, the findings indicate that ensuring the sub-dimensions of this characteristic (i.e., accuracy, currency, and completeness of informational content delivered through m-government) can only contribute directly to performance improvement and indirectly to satisfaction. The direct effect on performance improvement is consistent with the findings of multiple prior studies that included these sub-dimensions (e.g., Ali & Younes, 2013). Regarding the effect on satisfaction, the analyzed respondents' perception of the assessed characteristics declared that information soundness cannot be a direct determinant of this construct in the context of this study. This is unlike several previous findings showing significant direct links between characteristics encompassing these sub-dimensions (e.g., information quality) and satisfaction in diverse contexts, including m-government (Wang & Teo, 2020). One probable interpretation of this contradiction is that the three sub-dimensions of information soundness were only viewed in the context of the present study as essential attributes that information must have in any offering of innovative government services, and thus their roles in raising satisfaction are vastly inconsiderable. Moreover, the mandatory usage of a considerable portion of such services may also

reduce the contribution of these sub-dimensions as drivers of the users' pleasure with the service utilization experience.

Comparing the contributions of the significant characteristics based on the produced standardized path coefficients demonstrated that intensiveness had the largest influence on performance improvement (ß = 0.441), followed by information soundness (ß = 0.273) and responsiveness (ß = 0.185). Also, intensiveness owned the greatest impact on satisfaction (ß = 0.432), followed by responsiveness (ß = 0.394). Moreover, intensiveness had the strongest indirect effect (ß = 0.355), through performance improvement, on satisfaction, followed by information soundness (ß = 0.241) and responsiveness (ß = 0.171). This emphasizes the merit of intensiveness, as composed of service, usage, and fulfillment intensities, in substantially driving the aspects of both performance improvement and satisfaction in the context of m-government services, such as increased productivity, enhanced effectiveness in accomplishing tasks, and fulfillment of user's expectations.

Although ubiquity and technical sustainability have been highly anticipated to have crucial roles in driving useful adoption outcomes, the findings showed that these characteristics cannot act as significant direct predictors of performance improvement and satisfaction. Consequently, they cannot even indirectly relate to satisfaction, considering performance improvement as a mediator. This highlights the possibility that their effects are more limited to motivating the use of m-government services rather than promoting desired adoption benefits of these services, given that prior studies suggested the importance of one of them (i.e., ubiquity) in influencing the user's decision to adopt certain m-services (Huang, 2014). These findings are consistent with those of Mensah & Mwakapesa (2022) regarding the insignificant impact of ubiquity on the achievement of better performance in an m-government setting. However, they contradict the roles of ubiquity elements (e.g., time saving and flexibility), highlighted by Aslam et al. (2021), in realizing the usefulness of other m-service applications (i.e., than m-government) and motivating their users' engagement. Also, they are inconsistent with the great possibility of the evolution of m-government services over time, as reflected by technical sustainability, to continuously provide users with the needed functionalities and features that can highly result in improved performance and satisfaction. As such, increasing the potential of both ubiquity and technical sustainability to drive useful outcomes of the m-government services adoption needs to get the necessary focus from both policy makers and providers of these services.

7. Theoretical and Practical Implications

From a theoretical perspective, the present study has introduced two underlying characteristics for m-government services (i.e., technical sustainability and intensiveness) that have not been explicitly considered, to our best knowledge, in the entire m-services area. Hence, the study has gained the potential to extend the extant research models and theories that incorporate m-service characteristics. Furthermore, it has provided a distinct view for information soundness characteristic in the m-government context by regarding it as a sound state of information that is reached upon satisfying three conditions (i.e., accuracy, currency, and completeness). Consequently, the empirically obtained findings pertaining to the roles of these characteristics in achieving two desired adoption consequences (i.e., performance improvement and satisfaction) provide new useful insights to both scholars and practitioners about the antecedents that drive such outcomes in the m-services domain. These insights are also beneficial to the key stakeholders of m-government (e.g., government agencies and service developers) seeking a broader understanding of the determinants that raise user performance and satisfaction. Regarding the other examined characteristics (i.e., ubiquity and responsiveness), the lack of sufficient research evaluating their roles in the m-government context declares that the explored effects of both of them in this study enrich the knowledge and understanding of the influential determinants impacting the realization of those adoption's outcomes. In addition, our empirical assessment has produced new clarifications concerning the role of

performance improvement as a mediator factor for the associations between the considered characteristics and satisfaction.

From a practical standpoint, as has been explored, the only antecedents increasing both user performance and satisfaction are responsiveness and intensiveness, thereby the aspects that maintain such significant value of these characteristics should receive a considerable focus from m-government providers and developers when developing such public services. Instances of these aspects include the continuous offering of a wide diversity of highly accessible services and needed transactions, frequent incorporation of innovative services, as well as steady assurance of quick responses to user requests. In addition to these characteristics, it is also necessary to pay attention to improving the sub-dimensions of information soundness (i.e., accuracy, currency, and completeness) in designing such services in order to augment the desired consequences. This is because the findings have demonstrated significant associations between information soundness and performance improvement (i.e., direct effect) and satisfaction (i.e., indirect influence).

The assessment of the produced standardized path coefficients for all examined relationships designated intensiveness as the most influential characteristic in predicting the two desired usage outcomes of m-government services (i.e., performance improvement and satisfaction). Accordingly, increasing the levels of the components of m-government intensiveness (i.e., service, usage, and fulfilment intensities) should continually receive attention in the advancement endeavours of the public service offerings to maintain higher levels of such desired usage outcomes as well as the factors mediating these levels. Such increase is mainly directed to the facets reflecting the extent of care provided to public service users, including the amount and diversity of services needed, frequency of accesses to these services, fulfilment of a broad range of stakeholder needs, and involvement of various government agencies in service provisions.

For insignificant characteristics (i.e., ubiquity and technical sustainability - those did not directly or indirectly influence the two desired consequences), effective service design and deployment methods are advised to be incorporated in the government's IT strategy to promote the contributions of such features upon the successful adoption of m-government services. These methods should ensure efficient advancements of service offerings according to diverse future changes (e.g., technological, environmental, organizational, and user-needs evolutions) as well as guarantee maximized ubiquitous access to the delivered services. This involves satisfying multiple technical requirements, including the assurance of high diffusion of mobile infrastructure and communications across all populated areas, as well as devising flexible service design that accommodates the future evolutions, functional needs, and user expectations of the public services delivery.

8. Conclusion

This study has examined the impacts of five crucial m-government service characteristics on two vital, yet under-researched desired adoption outcomes, performance improvement and satisfaction, within the context of Saudi Arabia. The findings provide novel evidence that responsiveness, intensiveness, and information soundness positively influence user performance, whereas responsiveness and intensiveness drive satisfaction. From a theoretical perspective, incorporating new characteristics like technical sustainability and intensiveness not previously considered in m-government research contributes to advancing technology adoption models in this domain. The revelation of significant predictors of under-examined outcomes also enriches understanding of how to realize the promised benefits of m-government adoption. Practically, the results emphasize the need for m-government providers globally to focus on enhancing responsiveness, intensiveness and information quality to improve user performance and satisfaction. While this study focused only on Saudi Arabia, the findings have implications for other emerging m-government environments by demonstrating the important roles of these key characteristics. Further research can build upon these contributions by

verifying the impacts of additional characteristics and outcomes across diverse cultural and developmental contexts.

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Appendix A. Measurement Items of the Examined Constructs

Ubiquity (UBI)
UBI1: I can use the m-government services anywhere UBI2: I can use the m-government services anytime UBI3: I can use the m-government services when I need
Technical Sustainability (TESU)
TESU1: The m-government services are easily adapted according to the changes taking place in the information technology and business domains TESU2: The m-government services are easily improved according to the evolutions taking place in the information technology and business domains TESU3: The features and functions of the mobile government services are constantly fulfilling my needs
Responsiveness (RES)
When using m-government services, my … RES1: Requests receive a prompt response RES2: Transactions are carried out quickly RES3: Needed information is provided to me in a timely manner
Intensiveness (INT)
INT1: A broad range of m-government services are provided to us INT2: A broad range of m-government services are frequently used by me INT3: A wide variety of my needs are fulfilled by m-government services
Information Soundness (INSO)
The m-government services provide me with … INSO1: Accurate information INSO2: Up-to-date information INSO3: All necessary information
Performance Improvement (PEIM)
PEIM1: The m-government services increase my productivity in accomplishing tasks PEIM2: The m-government services enhance my effectiveness in accomplishing tasks PEIM3: The m-government services make it easier to accomplish tasks
Satisfaction (SAT)
SAT1: I am satisfied with the outcomes of the transactions supported by the m-government services SAT2: I am pleased with the experience of using m-government services SAT3: The m-government services meet my expectations