

Factors Affecting M-Government Deployment and Adoption

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Abstract—Governments constantly seek to offer faster, more secure, efficient and effective services for their citizens. Recent changes and developments to communication services and technologies, mainly due the Internet, have led to immense improvements in the way governments of advanced countries carry out their interior operations. Therefore, advances in e-government services have been broadly adopted and used in various developed countries, as well as being adapted to developing countries. The implementation of advances depends on the utilization of the most innovative structures of data techniques, mainly in web dependent applications, to enhance the main functions of governments. These functions, in turn, have spread to mobile and wireless techniques, generating a new advanced direction called m-government.

This paper discusses a selection of available m-government applications and several business modules and frameworks in various fields. Practically, the m-government models, techniques and methods have become the improved version of e-government. M-government offers the potential for applications which will work better, providing citizens with services utilizing mobile communication and data models incorporating several government entities. Developing countries can benefit greatly from this innovation due to the fact that a large percentage of their population is young and can adapt to new technology and to the fact that mobile computing devices are more affordable. The use of models of mobile transactions encourages effective participation through the use of mobile portals by businesses, various organizations, and individual citizens.

Although the application of m-government has great potential, it does have major limitations. The limitations include: the implementation of wireless networks and relative communications, the encouragement of mobile diffusion, the administration of complicated tasks concerning the protection of security (including the ability to offer privacy for information), and the management of the legal issues concerning mobile applications and the utilization of services.

Keywords—E-government, m-government, system dependability, system security, trust.

I. INTRODUCTION

THE notion of national governments delivering various services to its citizenry through the Internet is not new. However, with the rapid expansion of Internet usage throughout the globe—including the developing world, the idea is increasingly gaining traction and relevance in many parts of the world. During mid 90s the Internet usage was limited to only 1% of the population [1], only twenty-four

years later this figure is fast approaching half the world population (the current figure in 2014 stands at 40% [2]). Moreover, mobile phone ownership is projected to be around 90% of the world population (above six years of age) by 2020 [2], out of these mobile phone users, a significant percentage of devices will be Internet enabled smart-phones (currently there are 800 million smart-phone users around the globe [3]). Just as many commercial entities have taken advantage of this easy connectivity, many governments too have realized the instant connectivity offered through these mobile devices has the potential to transform the way governments offer various services to citizens.

There are many advantages to both the governments and citizens that can be brought through the effective implementation and deployment of M-Government concepts i.e. providing government services—previously offered through a government official at an office via a mobile application. First, it enables services that previously required a visit to the relevant government office, to be done at a click of a button, saving both time and travel costs to its users. Second, many of the government processes that were traditionally carried-out manually can be semi or fully automated, making them more efficient, thus reducing costs. Furthermore, the government services' reach can be vastly expanded without opening offices in sparsely populated areas, saving costs further. Also, the instant bidirectional connectivity that is offered by m-government applications can be leveraged to establish better citizen participation in various decision making process. For example, it enables more citizens to conveniently and effectively express through feedback which improvements they would like to see in current services and even which new services that they would like governments to offer via m-government. Despite these potential benefits of m-government usage, it is widely accepted that many of the early deployments fell well short of these high expectations. One of the key issues that many countries faced was the lack of adaptation from stakeholders. However, the potential future benefits of these systems could far outweigh the cost of these early setbacks. Therefore, it is important to study and learn from these early deployments so that these issues can be fixed in future deployments.

This project aims to analyse the weaknesses that hinder the rapid adaptation of m-government applications. First, we aim to examine the most important benefits the m-government applications can provide to both the citizens and their respective governments. Then the shortfalls of current approaches to m-government deployments are examined with the view of identifying potential improvements.

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Apart from the various shortfalls that may come from the user perspective, there are also large technological challenges to m-government application deployments that must be addressed. When offering a form of government that technologically receives, stores, and manages private data belonging to potentially millions of citizens, extreme care must be taken in both the design and deployment. There are important issues about security and privacy as data stored in such services are extremely confidential in nature such as tax returns, medical data, state financial benefits, etc. Therefore, it is paramount that the system design guarantees system dependability and privacy. System dependability encompasses reliability of the system i.e. the data held by the system is never lost and is available at any time (despite system crashes). Security consideration should encompass the system's ability hold the data without compromising user data privacy.

II. BENEFITS OF M-GOVERNMENT SERVICES

Developing countries have two characteristics that make m-government services very attractive. First, a majority of their citizens are young (as opposed to developed countries where it is projected that deaths will exceed births by 2025) Younger citizens embrace and adapt to new technology quickly. Second, mobile phones and devices are much less expensive than desk based and notebook computers, as a result they are more widely used. The benefits of m-government services can be divided into two categories: a) potential benefits that can be experienced by the citizens and, b) various benefits that can be gained by the state through the deployment of M-government services. These two groups are examined separately below:

A. Benefits to Citizens

There are number of obvious benefits to be had by the citizens through m-government deployments. These include the instant accessibility of the services through the phone, saving travel cost and precious time. In addition to these direct benefits, there are also benefits that can be exploited through the direct link that m-government services provide between the citizen and their government, which can lead to more citizen engagement.

1. **Instant Accessibility:** In the past, receiving various government services required a visit to a particular government department. This is often inconvenient; citizens have to travel to government offices where the particular service is offered –often on a workday. Not only the cost and inconvenience of travel, such a trip may require time-off from their regular jobs. The situation is even worse in large countries with limited accessibility. In such places, it is not practically possible to have government offices that cover countries' geographical area uniformly, given the sparse population density patterns, thus requiring citizens to travel vast distances. For example, in countries such as Brazil there are places that are only accessible by boat. Citizens of these remote villages are hardly ever able to make the journey to government offices, instead, the government agents are

periodically sent to the villages. M-government service offers a much more convenient way to provide various government services in many of these scenarios.

2. **Citizen Engagement:** Nowadays citizens hardly participate in the decision making process of the government. This is mainly due to lack of effective method to enable the engagement of vast number of public in the decision-making on a continuous basis. Doing this with traditional means such as in-person discussions is impractical for obvious reasons. However, using various feedback mechanisms, through m-government applications, government can easily engage large percentage of the population in the process of governance.

B. Benefits to the Government

In addition to the various obvious benefits to the citizens, there are many benefits to the governments that can be gained through m-government service deployments. These mainly fall into two categories. First, there are potential efficiency savings that can be made through reduction of staff, offices, etc. Second, more importantly, government will be able easily access more data on various aspects of running of the state institutions and its citizens that were otherwise not available or incomplete prior to the m-government deployment. Such data can be analysed to offer better provisioning of resources and identify various issues.

1. **Cost Saving through Automation:** Many of the mundane tasks that are offered by government employees manually can be fully or semi-automated as the data is already available in digital form. Gradually as m-government services are adopted by the majority of the citizens of the state some of the government offices offering the analogous services can be reduced. Both reduction of staff and offices can lead to significant cost savings which can be reallocated to other government services.
2. **Increase Efficiency through exploiting Data Analysis Opportunities:** When vast majority of government services transform into m-government services a vast amount of electronically stored data will be available on each individual citizen, as well as the collective population. The electronic record on each citizen would certainly be much more complete than the record that exists today, prior to m-government deployments. As a result the government would be able to analyse the data to improve its services. To provide a concrete example, if the doctor's appointments at hospitals are booked through an m-government service, both the volume of appointments and wait-times for each appointment can be easily tracked. These can be mapped to different geographical areas of the country and compared. It is likely to show that some areas have extremely high wait-times compared to the average (or target) while other areas may be well below the average wait-times. In such situation, the administrators can re-evaluate the number of doctors that are allocated to these areas and necessary adjustments can be made easily. Such analysis will not be

possible, at least easily, unless all the data was available in digitized form in one place.

III. M-GOVERNMENT SERVICES

Reference [4] pointed out that e-government offers services which already exist in conventional government to its citizens, but utilizes e-services to carry them out. On the other hand m-government delivers the services by using advanced technology such as wireless technology, mobile phones and advanced applications to deliver the services more effectively. Also, the most effective point in m-government service delivery, is the ability to deliver anywhere in street, homes, parks, etc., instead of the citizen having to visit the concerned offices to access the services

M-government provides different services to the citizens such as medical services, education, health, emergency services, etc., Short Message Service (SMS), a text messaging service component of phone, Web, or mobile communication systems is particularly useful for these services. It uses standardized communications protocols to allow fixed line or mobile phone devices to exchange short text messages. Reference [5], [6] summarizes these services below:

- **Firefighting:** wireless technology and mobile phones allow the firefighters to know precise data about the fire such as the plans before the fire, the information about nearby areas of the fires, the recent actions in the area of fire, and any information which can help them in fighting the fire.
- **Education system:** m-government and wireless and mobile phones technologies improve the education system, and provide communications between the students, teachers and parents. The school administration can notify the parents about the performance of their children. The administration can notify the parent immediately if their children are late or miss a class, and the m-service gives students the ability to know the results of their exams. The deployment of m-government in the education system improves the overall efficiency of the education process.
- **Public health:** Preservation of public health aims to increase the performance of health care services, in addition to decreasing the cost. Using mobile phones and wireless technology allow the medical staff to save their time and effort. It also enables them to gain the correct data, to take the correct decision, to access the records of patients, to access the results from the labs, to ask for blood donation, to ask about Medical Consulting etc.,.
- **M-democracy and m-government:** the mobile phones give the government the ability to receive feedback from citizens. The government can provide citizens with forms to fill it with their opinions and their judgments about a new law, thus increasing the participation of citizens in governance. Also, wireless technology assists in virtual referendums, and in electronic voting.

IV. CASE STUDIES AND DEPLOYMENT IN VARIOUS COUNTRIES

The growing popularity and use of mobile phones with its relative technologies and applications paved the way for several m-government activities and initiatives in a number of countries. This section explores some of the presented projects concerning m-government activities [7].

A. Case Studies in Various Countries

The “CelloPhone” project was proposed by [8] in 2009 to provide a solution for the lack of equipment, which had made in the past small medical tasks infeasible. “CelloPhone” was based on offering a mobile dependent diagnostic technology. This technology is cheap and able to perform main diagnostics, such as blood counts. Its outcomes can be sent to a specific dataset using SMS. Thus, this project assists in enhancing healthcare services in several countries

“Simpill”: a refined pill container, which sends messages to a specific central server when it is opened. It reminds patients to take their medication on time. When messages are not received, a text message containing a reminder is delivered to the family of the patient. This application is currently in use in various countries [9].

“Ushahidi’s mapping application”: is a platform for gathering data, visualizing and attractive mapping. It permits persons to submit certain data using their mobiles. The submitted data can then be offered via mails or web-forms [10].

Bridgeit: is an advanced application developed by “Bridgitec Mobile Technology Program” to offer teachers in several underdeveloped areas to teach materials, in areas such as science, mathematics, life skills and English language. Digital videos for those materials are obtainable on a specific server that can be chosen for delivery with the use of mobiles [11].

“Telecom without borders”: depends on using mobile techniques in reestablishing vital communication networks. One of the most essential equipment used is a group of satellite phones, which offer successful communication lines regardless of the distortion of local infrastructures. This in turn highlights the significance of mobile applications in certain situations [12].

“Donations via SMS”: mainly donations are generated with the use of mobiles and SMS services. This application permits users to send a text message with a known keyword to a certain number to make a donation.

“SMS security alerts”: this application allows businesses registering at a messaging service to be notified and warned instantly via a text message in the case of external bomb alerts or security threats

“BuitenBeter”: this application provides a direct channel for communication among governments and their citizens. It allows citizens to report various issues concerning public space and broken or faulty infrastructure components. It was proposed for the first time in 2010 in Eindhoven, then, it was used in various other countries due to its success [13].

“Agroportal”: this application provides its users with up to date relative news, questions that are asked regularly and a list

of helpful links. Furthermore, it allows its users to submit applications using internet, which are then processed by the related public authority to deliver the response back to the users. Generally, this application aims to enhance and simplify communication among governmental authorities and users [14].

“TextaParent”: the purpose of this application is to enhance communication among schools and students’ parents. An account must be registered initially where the school teachers can send text messages for parents concerning certain events, such as closures, cancellations or visitations. In addition, it can be utilized to transmit frequent reminders and notifications or to simplify communication in some crisis cases [15].

“Bus Text Message Service”: is a messaging dependent data system, which provides citizens with information concerning bus stops and when next busses will come. With the use of this application, citizens can transmit messages with the identity of their target bus stop to the main service which can then send a text message to that citizen concerning the time of arrival of the next bus [16].

“Mobile parking fee payment system”: this application allows car drivers to pay for parking based on sending a text message only. It is widely being used in Sweden, Estonia and Austria [17].

“Job acquisition via SMS”: is a messaging dependent application that contains contact information for temporary workers. If temporary workers are needed, a text message is transmitted to recorded will-work-temps. The person that answers first will get that job [18].

“Alert DC”: this application offers fast text notifications and updated data for citizens based on sending messages via mails or mobiles throughout certain disaster areas. Those messages are transmitted via known “DC Homeland Security & Emergency Management personnel” [19].

“My Mobile Virginia”: this application provides users with several types of data such as selection notices, crisis weather conditions and legislative data. The data can be downloaded on mobiles easily [20].

“911 via SMS”: This application offers help for deaf people, allowing them to send text messages in emergency cases to communicate. In addition, this application can help in cases where a victim or victims is attempting to hide and request help without making any noise (such as in an armed robbery case.)

B. M-Government Deployment in Various Countries

“M-government deployment in Jordan”: Reference [21] conducted a study about how m-government can be of benefit to “developing countries” just like Jordan. He said that m-government helps the citizen to find a whole package of government information online, allowing him or her the ability to perform transactions. In addition, it gives the government the ability to communicate with citizens by using the mobile phone network and to provide them with services. The study also shows how the m-government recently has been used as a way to increase the influx of new information and services to the citizens, in addition to the information and services

provided by traditional e-government. For instance, in emergency cases or in natural disaster, the government needs to collect real time information for citizens, while in sudden emergency cases, the government can use m-government to send warnings to the citizens to enable them face the disaster. Furthermore, m-government can provide information and services such as simple financial transactions.

The services from m-government improves communication with the citizens and because of that, many developed countries are trying to provide more m-government services for citizens. The huge propagation of mobile phones, the recent development of the wireless infrastructure, and the development of m-government in the developed countries, give the developing countries just like Jordan, the ability to deploy m-government in their home countries [21].

A survey in Jordan show that majority of Jordanians use mobile phones, internet and support m-government by using government SMS services. These results provide incentive for the Jordanian government to use the SMS services as an initial way to deploy m-government in Jordan [21].

The challenges, which faced deployment of m-government in Jordan, involve the cost of possessing a mobile. In addition to the cost of mobile services, the cost of wireless internet connection is another challenge facing Jordanians. To solve this issue, competent authorities are working on decreasing the cost and increasing the penetration of the wireless internet in the Jordan [21].

“M-government deployment in the Sultanate of Oman”: Reference [22] conducted a study about m-government deployment in the Sultanate of Oman and found that in the past five years, the Sultanate of Oman was trying to apply e-government similar to other countries in the world. Because of the huge evolution of technology, the government in the Sultanate of Oman has failed to deploy the e-government in its country despite the huge investment in this department. The deployment of e-government faced a lot of challenges, but with the evolution of mobile phones and wireless internet connection, the Sultanate of Oman started to deploy m-government as a new way to provide effective services to the citizens and residents. The factors which increase the probability of successful deployment of m-government in the Sultanate of Oman is the huge evolution in mobile phones and its services, and the huge adoption of the mobile phones between the citizens and residents. More than the half of Omani population owns mobile phones with the number of mobile phone owners is increasing with the time.

Many of organizations in Oman are starting to use mobile as a way to provide its services to the clients, and the government is starting to provide its services to citizens by using mobile phone services i.e. (the m-government concept). One of m-government services in Oman, the m-parking for the citizen, gives drivers the ability to pay for parking in the Muscat area by using their mobile phones. The drivers have to send message-contained details of their car registration number, and the total time required to park their cars. The mobile network operator, which cooperates with the government, is responsible for adding the total fee to the

mobile phone bill, and then it sends a confirmation message with details about the interval time allocated to parking. The total fee is added to the mobile phone bill or will be deducted from the mobile phone's account [22].

The deployment of m-government in Oman faced a two part challenge. The first part is the technical challenge which involves poor communication infrastructure which is a common challenge of the developing countries. The poor cooperation between the ministries, the security problems and the difficulties in data recovery are among the obstacles. The other challenge is the technology itself. This involves a shortage in technology awareness amongst Omanis and lack of trust in IT systems, as most people do not feel comfortable making financial transactions over the internet [22].

"M-government deployment in the Malaysia" Reference [23] proposed a study about deployment of m-government in Malaysia and they found that m-government development in Malaysia is in the early stages. The citizen needs to be encouraged to use m-government in their transactions. A survey in Malaysia for various groups of Malaysians according to their interest in technology, found that, despite the fact that the level of knowledge about mobile government services among these groups is good, the number of Malaysians who actually deploy m-government services is very small. The researchers found that, the m-government offered has many valuable features such as ease of use and saving time and effort of the Malaysian.

In Malaysia, the citizen can use the short message service (SMS) to check their polling information. This service is done using mobile phones and a wireless internet connection. In addition to that, the m-government has the capability to provide the Malaysians real time information by sending email or SMS [24].

"The EKL initiative" is the Malaysian government initiative to support e-government Strategies. The aim of this initiative is increasing the performance of service delivery to accomplish the best benefit for Malaysians, organizations and companies who are in the Klang Valley (Klang Valley is a region in Malaysia and consist of Kuala Lumpur and its outskirts)." The EKL initiative" approach provides online services, which are interactive and work 24 hours throughout the whole year via different channels. The mobile phone is one of these channels. By using SMS, citizens and other interested parties are using a predefined number are able to get the government news, information and services such as traffic infractions, the application of payment and driving licenses renewal [23].

"M-government deployment in the Saudi Arabia" The huge penetration rate of using the mobile services in Saudi Arabia encourages the government to devise more ways to implement the m-government concept. Reference [25] found that, the penetration rate of mobile phones in Saudi Arabia is increasing. Based on the last survey in 2008, the number of mobile phones in Saudi Arabia is 36 million, which is a huge number, compared with just 7.7 million users who are using internet connection. Considering that the population of Saudi Arabia is about 26 million, the government sector tends to use

the mobile phones as a way to deliver its services to the citizens.

Mobile services in the Ministry of Education give students the ability to know the results of exams by sending SMS to their phones. As well, drivers are informed of fines through SMS which contains their car identification number. Currently, government is deploying m-government by using the SMS as a way to deliver services to citizens; other sectors are also using advanced mobile applications [25].

Reference [26] found that in 2007, the government of Saudi Arabia started to tackle the challenges of deploying m-government. One of these challenges was the poor infrastructure, so it allocated one billion US dollars to develop the infrastructure and the results of this development is expected to increase the performance of public sector, efficient service delivery, making transactions over the internet more efficient, and provide real-time information to the citizens.

V. CHALLENGES

There are a number of challenges in the design, deployment and management of applications that are required to handle the large potential user base. A large user base is the norm for many countries (except for very small countries) as government applications are required to be capable of serving all citizens. One potent example of issues faced by applications of such large scale services is demonstrated by the US government's HealthCare.gov service launched recently. The system was plagued by system crashes and security issues [27]-[29]. Although the service was supposed to serve nearly 7 million citizens, initially it was not able to handle couple of hundred thousand users at a time without crashing and bring the entire service to a grinding halt. Despite the initial fixes, the service continues to experience total outages and security issues on an ongoing basis [27]. The fact that the technologically-savvy US government was unable to launch a reliable e-government service amply demonstrates the technological challenges that underpin such services.

A. On-Demand System Scaling

Although m-government systems designs should have the ability to serve the entire population of the particular country, it is unlikely that all of its citizens would start using the newly deployed m-government service from its launch. It would take years of effort to slowly convert the users from the existing manual service to the equivalent m-government service offering. This prompts the question of "what is the right level of service provision". After-all, the governments would not want to make the large capital investment on the server infrastructure that can host an m-government application framework that is able to cater to its millions of potential future users, and ultimately find it is not being used by the citizens. Indeed, there is the risk that the deployed m-government service may not be widely adopted. The best-case scenario is that the users would gradually adopt the m-government service over the course of several years or even more. Therefore, ideally, the governments would like to design and deploy services that can be gradually scaled-up as

the user numbers grow. In such designs, the necessary server infrastructure would be added based on demand. This would allow the attractive option for the respective governments of making only modest investments on server/hosting infrastructure up-front, and gradually expand as the user-base grows.

In order for the applications infrastructure to be scaled-up in this manner, the system should be designed from the outset with this elasticity principal in mind. Although this would add costs to the initial development of the software infrastructure, it would certainly be worth it, as it would enable much reduced server resource provisioning at the start of the deployment.

One attractive option to consider on this key issue is whether the m-government back-end infrastructure should be hosted on dedicated government-managed server frames or would it be more advantageous to host the back-end infrastructure on commercial cloud infrastructure.

There are numerous commercial, reliable, and legal reasons for and against using commercial cloud infrastructure for hosting a government application. All the issues need to be evaluated holistically as the data held by the applications are extremely privacy-sensitive. Moreover, the government will be held accountable for any breaches of confidentiality and integrity, which could potentially result in serious consequences for the government. Furthermore, the decisions regarding hosting infrastructure cannot be easily changed midway through the deployments. For example, if one chooses to use a particular Cloud Infrastructure provider, the application is required to be built around the proprietary service echo system that is provided by that company. For example, the Amazon Web Services infrastructure that offers on-demand cloud hosting has its own service echo system which manages the various aspects of the application infrastructure such as load balancing, replication, system monitoring services, key management APIs, Database instances, etc. Once the application is built around such an echo system, switching to another Cloud Infrastructure provider would be almost impossible. Therefore, decisions regarding whether to host the application on dedicated in-house server infrastructure, or on-demand commercial cloud infrastructure, is a crucial decision that needs to be taken at the beginning of any large m-government project as it has many consequences later.

B. System Security and Data Privacy

Many of m-government services require the exchange of sensitive information. Take for example, the medical data. Currently many governments across the globe are streamlining their government "Heath Services". Countries such as the UK have spent billions of dollars digitizing and automating many aspects of the National Health Service (NHS) [30]. Offering various services, previously offered manually in-person, through the internet is an important aspect of this strategy (e.g. via e-government and m-government services). For example, the appointment booking services at hospitals, electronic prescription services and even full digitized medical records

for all patients that can accessed anywhere is planned. Not just in the UK, such modernization plans are underway in many developed countries around the world.

Regardless of the wide array of benefits to both citizens and their respective governments, it is not too hard to see the potential dangers (about data privacy) of such application if the security and privacy is not adequately addressed. To take a concrete example, let's examine the Electronic Patient Record (EPR) service that is being proposed in the UK. The system proposes an electronic service that makes an electronic version of each patient's Medical Record available through e-government service. Instead of having the Patient Medical Records in respective patients' doctors' filing cabinet, the ability to access it electronically from anywhere in the country and even potentially from anywhere in the world, is extremely useful. For example, if someone falls ill outside their own hometown and had to be admitted into a hospital, currently the medical records have to be sent via courier. If someone falls ill outside the UK, the process is even more lengthy and cumbersome. Some patients may have special conditions such as allergies or have undergone or are undergoing treatment that the new physician should be aware of straightaway. However, under the current system there is no guarantee that the new physician would get the required information in timely manner. With the introduction of e-government service, this situation could be much improved as the patient's record can be retrieved at the click of a button. Although extremely useful and potentially lifesaving, having medical records of an entire population through the click of a button could be potentially dangerous, especially if they were part of m-government. Unless necessary security measures are in place to ensure the system is not abused, and mechanisms to monitor and guarantee strict control data privacy of the patients – the implementation of m-government needs very close scrutiny.

The example described above is not unique, many of the government services require such sensitive information to be stored and managed. Therefore, security and data privacy is an extremely important design consideration for any m-government system. The security considerations fall into three different classes:

1. System Security –where the intruders gain direct access to infrastructure
2. Secure Authentication –System is able to identify the user based on some shared credentials
3. Access Control –the type of operation each user can perform on the system is controlled

Each of these issues needs to be addressed as primary goals of the system design is to secure the data stored within these applications.

"Authentication method": One of the important design considerations of any m-government application is the authentication method. Authentication is based on some shared credentials the system and the user (and the user alone) holds. Popular method of authentication is through user identification and a password. However for some of the more sensitive applications, the password option may be too insecure. Given that many of the government identification

documents such as passports and identification cards contain biometric data (e.g. iris pattern data, finger print information) such information can be used for authentication. Since the governments already hold these credentials on every citizen (who holds a passport/id card with biometric info) using such method would add minimal cost to the m-government deployment. One slight technical issue that may arise is that not all mobile devices currently have biometric data reading capability such as finger-print readers. These are widely available in current laptops, and they are appearing in the newer smart-phones. For example the new Samsung Galaxy 5 [31] contains a finger-print reader. Therefore one can only assume this trend will continue, thus, using such biometric authentication method would not pose much practical hurdle in the future.

The second design consideration in the security infrastructure is the authorization mechanisms in the system. Authorization mechanism dictates what operations each user is able to perform in the system. Once the authentication step is performed, the system can identify the user. Associated with each user id, there is list of operations that the particular user is allowed to perform in the system. Although it may appear to an outsider that all users of a certain Mobile Application are allowed to perform exactly the same operations, the reality is more complicated. For example, in the above example of Medical Record application, there are many types of users that fulfill various roles in the overall scheme. A doctor should only have access to the Electronic Medical Records of patients he/she is currently treating. A health department official who is planning future medical supply provisions should only have access to data summaries that are relevant and necessary for his duties. Individual patients should only have access to view their own records, but should not be able update or change their records, etc. Similar situations will arise in many m-government application scenarios. Therefore, all the system operations should be systematically identified and mechanisms should be implemented that will allow these operation to be assigned to various types of user groups that exist.

C. System Dependability and Reliability

The example described in the preceding section involving Electronic Medical Record system do have extremely stringent requirements, as the services provided through such applications can lead to lifesaving decisions. Although not all government services many not have such stringent reliability requirements, they all require high availability. Therefore, the system dependability and reliability becomes a key design requirement for m-government systems. There are number of techniques that can be used in the design methodology that can be used to improve system dependability. These steps can be broadly divided into two categories a) minimize and remove software bugs that may exists within the system code base and, b) minimize the disruption caused by infrastructure failures such as server infrastructure failure and network outages, etc.

First issue is a software engineering consideration and there

are many techniques and methods proposed in literature that aim to alleviate the software bugs in the systems or techniques to minimize the effects of critical bugs within the broader system.

Although the commercial Cloud Infrastructure providers offer attractive cost benefits, many of these cloud platforms suffer from reliability issues. This is evident in the string of high profile system outages that many commercial cloud services have suffered during the last couple of years [32], [33]. In some instances, there had been loss of data [34] causing severe disruption to the data owners. Even the largest Cloud Service providers such as Microsoft Azure and Amazon EC2 had not been immune to disruptive, partial or full service outages that lasted for many hours. Therefore, m-government application that provides vital services such as Patient Medical Records are required to overcome these service outages. M-government applications and the related software infrastructure need to be designed to maintain availability, – albeit at reduced quality of service—in the face of such infrastructure failures.

There are number of design techniques that can be used to address these hosting infrastructure failures. Although Cloud infrastructure will suffer from service outages of various severity, it is very unlikely Cloud infrastructure operated by two different vendors would crash simultaneously because they use vastly different technologies underneath. Thus, the software bug or operational error/situation is unlikely to occur at two different vendors concurrently. This is termed replication where two or more instances are run simultaneously. Therefore, a crash of one instance would not render the entire service inoperable. To facilitate such a mechanism the host name needs to be mapped to multiple IP addresses (using multiple DNS A-records). This technique can also be used for load balancing i.e. spread the request among many servers to improve request service times.

D. Legal Issues

M-government systems would be required to store and manage a large amount of citizens' private data for which ultimately the government is responsible. If the data is stored in commercial cloud infrastructure, there are important legal aspects that need to be considered, especially given the data will most likely be stored in a data-center situated in foreign territory. This issue is highlighted by the court-case between the US government and Microsoft regarding a search warrant issued on data that is actually held in Microsoft's Data-centers situated in Ireland. Microsoft claims the US search warrants are not applicable as the data in question is held in Ireland out of the jurisdiction of US [35], [36]. The court-case is currently unresolved and going through the appeals process. This raises the important questions regarding the implications of using commercial cloud infrastructure to store sensitive citizens' data, which the hosting companies may have to handover to foreign governments if a situation such as mentioned above arises. All these issues need to be considered in the design process of the m-government application. For example, situations such as above can be avoided if all the data stored in

the commercial data-center is encrypted, such encryption can be performed at gate-ways when the data is retrieved and stored. These gate-ways servers can be placed within the country and can be managed by the relevant government. Such a solution would enable the use of much more cost-effective commercial Cloud Infrastructure while avoiding any potential breach of privacy of the citizens. However, such decisions need to be taken at the outset of the design of such m-government applications, as the entire application infrastructure needs to be designed and built around these concepts and cannot be added as an afterthought.

Many governments, including the government of the Emirate of Abu Dhabi, realized the potential benefits m-government concepts could bring to both government and its citizens. Realizing these advantages, from early 2000s, various governments across the globe have tried to transform various traditional government services to m-government services. Although these early adopters have made genuine enthusiastic efforts in these m-government projects, including large financial investments, many projects across the spectrum have suffered from lack of interest from their stake-holders, leading to low adaptation rates. Therefore, given the potential future benefits of the overall goals of m-government to both the governments and their citizens across the globe, it is worthwhile investing effort into systematic analysis regarding the cause of these low adaptations in the previously deployed m-government services.

VI. CONCLUSION

The studies on these early m-government services reported in literature have identified a number of themes about the main cause for their failures. This research ultimately aims to formulate a new approach to m-government system deployment that will address any of the issues identified in literature. The new approach is aimed at increasing the adaptation rate of m-government services. While at the same time, through the evaluation of this new approach, we would gain more insights into the problem areas and issues pertaining to m-government system design and deployments.

It is worthwhile to further analyze the issues already identified. The main issues fall broadly into three themes which are listed below:

A. Lack of Information and Communication Technology Skills (ICT Skills)

There are still parts of the globe where a vast generational gap exists with regard to ICT skills. In these countries, there is a sizable percentage of the population lacking in the necessary computer skills to take advantage of these m-government services. Unless special training can be provided to them by their respective governments, no amount of improvements to the offered m-government services will be able to encourage this segment of the population to adopt these services.

B. Cultural Factors

There are diverse sets of cultural factors that are in play. For example, there are cultures where borrowing money is

frowned upon, in some cases even religiously prohibited. In such scenarios offering m-governments services that require online payments – which many of them do—is problematic as a credit-card is required for such services. Another example of a cultural barrier is the language. In many countries there are many regional languages and dialects where the rural population is only proficient in their local language, while the official government language is a different one. Unless the m-government services are accessible in all the regional languages, large swaths of the country's population are instantly cut-off from m-government services.

C. Perception and Lack of Trust

There are always parts of the population for whom the idea of receiving important government service that require the submission/exchange of confidential and personal information, such as applying for a passport, through the Internet will remain uncomfortable for the foreseeable future. The various issues of identity theft and various cyber-criminal activities have not helped to alleviate such perceptions. However, through the use of biometric identification documents which can be used to provide strong authentication, these m-government services may be able to address these issues in the future.

With the understanding of these issues, this research would subsequently propose a novel approach to m-government system deployment. In this new m-government deployment system, we will try to address many of the issues faced by current m-government systems outlined above and take into account all the important design considerations outlined in the previous sections.

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