Power Distance and Users Behavior Towards the Adoption of m-Government Services in Tanzania: A Web Analytics Study

Fredrick Ishengoma, Leonard Mselle, and Hector Mongi

***Abstract*— Citizens adoption of m-Government services can be achieved through voluntary or mandatory settings. In Tanzania, some government authorities have chosen mandatory adoption approach in order to increase adoption rate, efficiency, and reduce the costs of public administration. One of the crucial dimensions of mandatory adoption is power distance (PD). Literature review, mostly from developed countries, have shown contradicting results on the role of PD towards the adoption of m-Government services. Meanwhile, there is a lack of research studies from African developing countries. This research seeks to fill this gap by examining if PD is a success factor towards the adoption of m-Government services and model users behaviours. The study analyzed the 1-year transactions logs that cover before and after the mandatory electronic payment system is adopted. Furthermore, the study analyzed the 1-year traffic of data from government recruitment agency by using web analytics to understand users' pattern. Findings show that PD is a significant success factor in the adoption of m-Government services in Tanzania. The study also reveals the existence of flash effect (FE) pattern. Finally, the study proposes a Flash Event Mitigation Algorithm (FEMA) to mitigate the impact of the FEs on m-Government services.**

***Keywords*— Flash Event, m-Government, Power Distance, Web Analytics**

I. Introduction

The provision of government services through mobile technologies, mobile government (m-Government), is evolving in developing countries with great effort by governments. The society at large has started depending on m-Government services in their daily lives. The proposed prime notion of e-Government, to receive government service from anywhere and at any time is now fulfilled by m-Government. Various governments are transforming their public administration to improve government services through m-Government. The potential of m-Government services lies on its ubiquitous and the real-time value, such as news alerts, weather forecasts, employment opportunities, significant announcements such as upcoming shortage of electricity or water supply due to ongoing maintenance activities, land inspection, and the like [1].

However, the existing low adoption rate of m-Government services pushes the government to use the power distance cultural dimension in order to accelerate the initiatives [2]. Power Distance (PD) is the extent to which the less powerful members of institutions, organizations and citizens within a country expect and accept that power is distributed unequally [3]. Tanzania is rated as a high PD society [4]. In the high PD society, people widely accept a hierarchical order, where citizens and organization subordinates are looking to be told what to do.

In Tanzania, government authorities have mandated some of its service channels to be mandatory adopted. For instance, it is mandatory for citizens to have a national ID in order to open a company or get a passport. In Dodoma urban region, it is mandatory for the citizens to pay their water bill electronically. Despite these experiences in Tanzania, no research has examined the relationship between PD and the adoption of m-Government services.

Generic technology adoption models do not consider PD as a success factor, and they are not applicable within the environment where power distance is applied [5]. In trying to understand and overcome this paradox, we seek to determine if PD is a success factor towards the adoption of m-Government services or not. Moreover, we examine the behaviour patterns of the users adopting m-Government services.

This paper proceeds as follows: Section II presents an overview of power distance and technology adoption in Tanzania. Section III discusses works that are related to this study. Case studies used in this research are described in Section IV. Section V describes the methodology used in this study. Section VI presents results and discussion. Section VII describes the limitations of the study. The paper finalizes with conclusions and future work on section VIII.

II. POWER DISTANCE AND TECHNOLOGY ADOPTION IN TANZANIA

Tanzanian leadership style is characterized by controlling and directing employees with very close monitoring of subordinates. The study by [6], found that Tanzanian employees want a leader who will tell them what to do and who makes decisions for them. The study argued that "Upward communication is neither expected nor

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encouraged, in fact, a manager that needs feedback and consensus to make important decisions will not do well in Tanzania.” This top-down management approach is the accepted and preferred method within the Tanzanian culture.

High PD in Tanzania entails that, citizens expect and accept direction to come from those in powerful roles such as in government [5]. This includes decisions that impact technology adoption. In high PD culture, government agencies are the ones that mandate the decision to adopt a certain technology. For instance, on 31 December 2012, citizens were mandated to adopt the digital television signals as the government was switching off its analogue television signal. From then, the number of active decoder subscribers has been growing yearly [7].

Some m-Government services are still voluntarily mode with multiple options to access the service. For instance, you can retrieve the National Examinations Council of Tanzania (NECTA) form IV results through browsing the NECTA website, newspaper publication, or SMS query. Presently, with both modes (mandatory and voluntarily), it is crucial to understand if PD is a success factor towards the adoption of m-Government services or not. This will help in understanding what works and what does not work in the adoption of m-Government services in Tanzania. The success factors can be replicated in other sectors for the aim of improving adoption, efficiency, and revenues in the government services.

III. RELATED WORKS

Despite the empirical research progress on m-Government adoption in developing countries [8], there has been a lacuna of studies that examine the relationship between PD and the adoption of m-Government services. Some of the existing studies have explored the relationship between PD and other technology adoption like the Internet [9] and consumer products like cell phones [10].

The study by [9] conducted in Japan and the United States to examine the adoption of the Internet and understand the underlying factors influencing the diffusion process. The study argues that PD is negatively associated with Internet adoption.

While previous research regarding the penetration rates of new products did not include power distance as a predictor [11], the study by [10] on 56 countries found that this dimension to have a significant negative effect. To the contrary, [12] found evidence that PD had a positive influence on diffusion rates in a study of technological product innovation across 13 countries.

The study by [13] investigated the relationship between PD and traditional e-Government adoption and found that PD is more likely to affect e-Government adoption than other cultural dimensions. Thus, people in countries with high PD are more likely to adopt e-Government than people in countries with low PD.

However, the study by [19] argues vice-versa with the study by [13] that higher power distance countries tend to have a lower e-Government adoption rate. The recent study [8] conducted on 26 European countries support this by arguing that, countries with higher PD tend to have a lower e-Government adoption rate.

A study by [14] looked at the experience of introducing mandatory e-Government in Denmark. The government of Denmark approved a public digital post-law in 2012 which requires citizens to send and receive electronic messages which are treated with the same status as letters in paper form. The main finding was that the service was successfully adopted; however, staff were concerned about citizens who have no access to ICTs or who were unsure about how to use them, most often older people, people who were unwell and the unemployed.

These study findings call for more research on the relationship between PD and the adoption of m-Government services in different countries and context. Our study argues that in some settings, voluntary adoption is more successful [15], [16], [17], while in another situation mandatory policy is the only way to induce technology usage because it can encourage the initial behaviour to adopt technology [18], [2], [8]. In other words, both mandatory and voluntary adoption approaches can deliver the potential of successful technology adoption when applied in the relevant setting and condition. Therefore, this study fills the research gap on the influence of PD on the adoption of m-Government services in the Tanzanian context.

IV. CASE STUDIES

This study has employed two case studies. One from Dodoma Urban Water supply and Sewerage Authority (DUWASA) and the other from the National Examinations Council of Tanzania (NECTA).

A. DUWASA Water Bill Payment Service

Dodoma Urban Water supply and Sewerage Authority (DUWASA) was established under section 3(I) of Cap. 272 of 1997 as repealed by section 60 of Water Supply and Sanitation Act No. 12 of 2009. DUWASA is responsible for operations and management of water supply and sanitation services in Dodoma city, Tanzania.

Formerly, citizens used to pay their water bill manually by physically visiting the DUWASA offices with a cheque or cash. On March 2018, DUWASA introduced a new way of paying the water bill electronically. The water bill is paid by dialling the unique codes on a mobile phone whereby using a particularly given ID number that identifies your account; you can transfer the money to DUWASA account. DUWASA required all its clients to adopt this mode of payment with a grace period of four months for adoption. From August 2018 electronic payment mode became the only single payment mode for the water bill in Dodoma urban. This study seeks to examine the role of PD in the citizen adoption of water bill payment electronically before and after the mandatory directive is implemented.

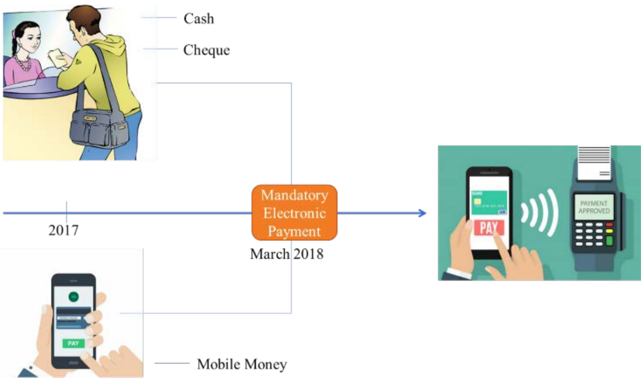

Fig 1: Trendline of DUWASA water bill payment methods before and after mandatory setting

B. *Necta.go.tz*

Necta.go.tz is a website for National Examinations Council of Tanzania (NECTA) which mainly deals with administering secondary examinations and publication of students' results in Tanzania. NECTA is the only legal primary and secondary level examination body in the country. Therefore, its mandate and services are enforced by law in both Tanzania mainland and Zanzibar. Students and citizens can access examination results ubiquitously through the site. Users can also access the examination results by sending a mobile coded message (<<matokeo*centre number*candidate number*exam type*exam year >>) to 15311. The reply message will send the results according to the query. Our study seeks to understand the user's behaviour of this m-Government service by studying the necta.go.tz web traffic.

V. MATERIALS AND METHODS

A. *Log File Analysis (LFA)*

Log File Analysis (LFA) refers to the analysis of transaction logs that automatically captures the type, content or time of the transaction made from the user to the system. In this study, LFA is used to gain an understanding of the interaction between m-Government users and the system.

We analyze the log files of all water payment transactions that have occurred in the period of more than one year (from June 2017 to September 2018) in Dodoma urban. The log files include the transactions undertaken, time and the payment mode used (manual or electronic). These details are first cleaned to ensure data is correct, and there is no inconsistency. The process includes removing duplicates, getting rid of extra spaces, changing text lower/upper case for consistency and spell-check. This log data is then imported into SQL for processing. The log file covers a total of 472,373 transactions. The phases involved in the LFA are depicted in Figure 2 which includes the input of a log file for processing, processing, discovering of user pattern, and results.

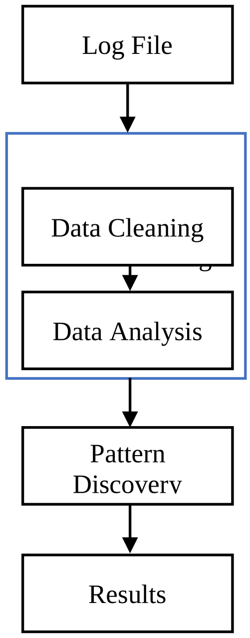

Fig 2: Phases in Log File Analysis (LFA)

B. *Web Analytics*

Web Analytics (WA) can be defined as the measurement, collection, analysis, and reporting of web-based data for understanding and optimizing web usage [20]. Web Analytics Tools (WATs) can be used to study and understand users' behaviour and navigation patterns in the web system. For instance, WATs can be used to realize the number of visitors to the system, where visitors come from, what section they visited, how long they stayed, how deep in the system they navigated, where their visits end and where they went from there [21]. Number footnotes separately in superscripts (Insert | Footnote).[1] Place the actual footnote at the bottom of the column in which it is cited; do not put footnotes in the reference list (endnotes). Use letters for table footnotes (see Table I).

The strength of web analytics lies on it is fast, low cost, able to produce unbiased results, cover the shortage of experts, it does not get tired, and it evades inconsistency results from experts [22]. In this study, we will use the Alexa WA tool [23] to examine 1-year web traffic data of users visiting NECTA site.

VI. RESULTS AND DISCUSSION

A. *DUWASA Payment Service*

We used logfile analysis to capture the number of users who have been using the electronic and non-electronic channel for water payment before and after the mandatory requirement for one year. We compare with the number of users who have been visiting the offices physically for water bill payment.

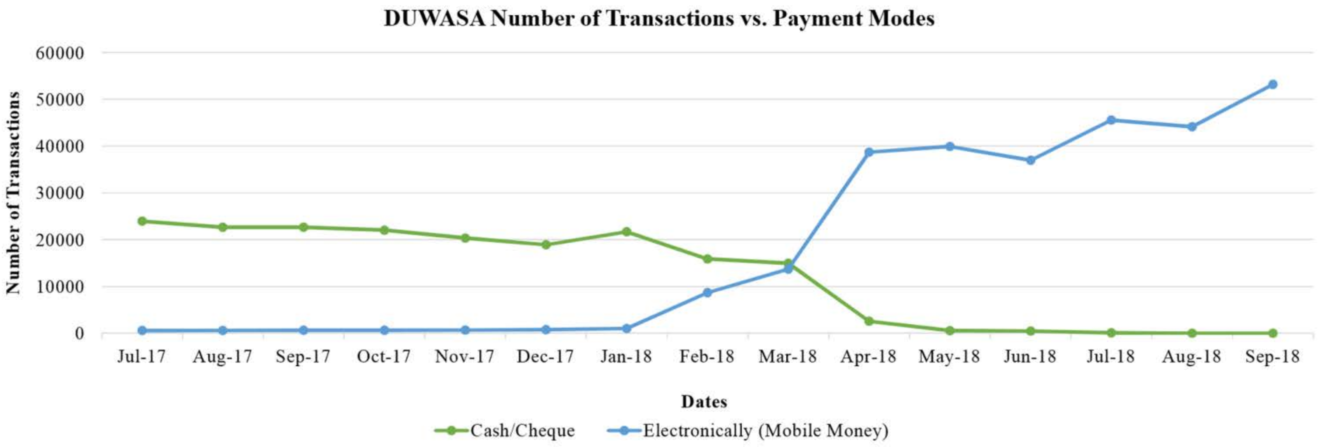

Fig 3: DUWASA number of transactions vs. payment modes for one year (2017- 2018)

Figure 3 shows the transactions of DUWASA water bill payment for a period of one year (June 2017 to September 2018). Our graph shows there were a higher number of citizens visiting the office physically for the water bill payment before March 2018 compared to the citizens who were paying electronically. The point of intersection in the graph indicates the time when DUWASA authority start implementing the mandatory electronic payment of the water bill (March 2018). The implementation began with a grace period of four months for people to fully adopt the electronic channel. From August 2018, DUWASA closed all other options, and the electronic channel only remained.

Figure 3 shows that there was a shallow level of water payment via electronic channel before the mandatory announcement (March 2018). The adoption level rises significantly after the implementation of mandatory setting. The number of transactions nearly doubled after the implementation of mandatory setting. These findings clearly show that the power distance (PD) is a significant success factor not only for the adoption but also for increasing the revenue of m-Government services.

B. Necta.go.tz

We observe the number of visits to a site based on the number of sessions per month (NSM). Figure 4 depicts the number of sessions per month for one year. Based on figure 4, the popularity of the site is on February 2018, November 2017 and August 2017. We explored the dates of these flash peaks to understand what happened during these dates. We found out that, during these flash peaks, there are significant events that involve users' interaction with the site on a very high frequency. These are called flash events (FE) or Flash Crowds [24].

The flash events (FE) happens due to the sudden increase in the popularity of a website triggered by any special events like breaking news, the release of popular products, the announcement of examination results, and so on. Figure 4 highlighted three flash events namely FE1, FE2 and FE3 which corresponds to the following key events.

From figure 4, FE1 is observed to be at the peak in August month. This high rise of users on this particular time is due to the release of NECTA Form Six Advanced Secondary Education Examinations (ACSEE) results on July 15. This is the cause of the flash effect observed throughout August month. On November 2017 and February 2018 similar case occurred.

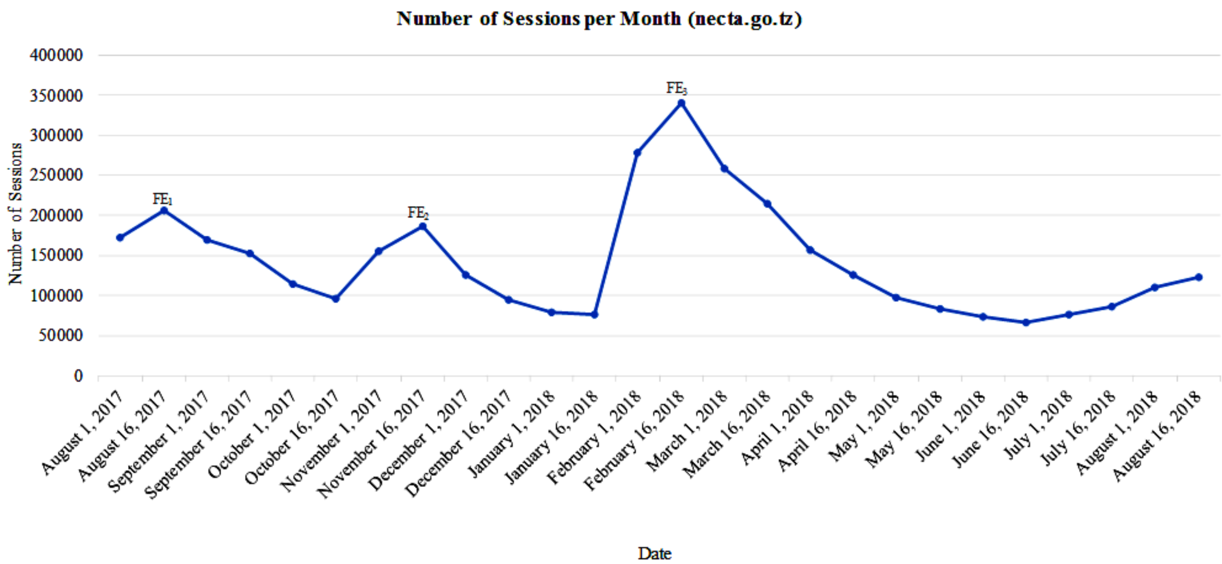

Fig 4: Average Number of Sessions per month for Necta.go.tz

The flash effect seen in November 2017, FE2 is a result of the NECTA releasing Primary School Leaving Examinations (PSLE) results for the year 2017 on October 20, 2017. FE3 was the result of the NECTA releasing the Form Four Secondary Education Examinations results on 30 January 2018.

Concerns were observed on the unavailability of the NECTA website during examinations results seasons, and this is due to the effect of FEs. The m-Government availability challenge due to the impact of FEs exists both in developing and developed countries. For instance, in Australia, 2016, millions of users simultaneously accessed the census website to fill their details. The lack of sufficient resources on the webserver caused the site to crash down [25].

Availability of the m-Government services is considered as a significant success factor towards the adoption of such services [26]. Availability is essential because the expected benefits of using m-Government services, such as gains in efficiency, effectiveness, cost-saving, and public value, cannot be realized if the availability of the service is limited.

Take, for instance; applicants are applying online for a degree programme X, which is available in Universities A, B and C. However, the online application site of University A keeps crashing all the time since it cannot handle the enormous traffic in a small amount of time (FEs). This situation will eventually disappoint the applicants, and they will move on applying to University B and C which are stable. Failure to resolve the issue may lead University site B and C to be fully adopted while University site A failing to be adopted. We have witnessed this scenario occurring in some University websites in Tanzania during the application period.

Studies have shown that when a user needs a particular service and that service is not available at the moment; it tends to discourage the user, where he/she will switch to alternative active service [27]. Such situations highlight the severity of the problem of Flash Events (FEs) towards the adoption of m-Government services. In the next section, we propose the Flash Event Mitigation Algorithm (FEMA) for m-Government services.

VII. PROPOSED FLASH EVENT MITIGATION ALGOLITM FOR M-GOVERNMENT SERVICES

Our study findings have shown the presence of a flash event behaviour in using m-Government services. We consider a condition where a server connects to the Internet and provides m-Government services to the citizen. Legitimate users do not harm the server or the service. However, as more requests come to the server in a limited time, the server becomes more and busier. The busy server suffers a flash event which is observed as a sudden high demand for service requests from users. In this scenario, a flash event overwhelms a server which results in either a delay of response or a complete crash. Regularly, the only overload control method is to return the HTTP server too busy message if the HTTP server queue passes a certain threshold. After that, the user may decide to retry and wait.

We propose a Flash Event Mitigation Algorithm (FEMA) to ensure high availability of m-Government services in the case of flash event occurrence. The proposed algorithm is adapted from sleep/wake-up scheduling technique commonly used in Wireless Sensor Networks (WSN) for extending the limited lifetime of sensors. According to the best of our knowledge, the sleep/wake-up scheduling technique has never been applied before in e/m-Government applications [8].

The proposed FEMA algorithm makes use of spare servers whenever the active server reaches the load capacity threshold (LCT). We calculate LTC by the following formula:

$$LCT = \left(\frac{Server\ capacity\ - Current\ Load}{Server\ capacity}\right) X\ 100\%$$

Whereby, server capacity the maximum number of simultaneous connections a server can handle at a time. Current load is the number of connections currently in use by the server.

We set the threshold lower boundary and upper boundary to be $(LCT)_{lo}$ and $(LCT)_{up}$ respectively. We consider a server to be under-load whenever its threshold is below "$(LCT)_{lo}$" value. We consider a server is in an average load whenever its threshold is between $(LCT)_{lo}$ and $(LCT)_{up}$. And we consider a server to be in the overload state when its threshold is above $(LCT)_{up}$.

FEMA assumes all servers are locally allocated to reduce the overhead of remote access. A load balancer (LB) sits between users and the servers accepting incoming traffic and distributing the traffic to the required server until it reaches a threshold. The task of the load balancer (LB) in the proposed algorithm is to maintain the load between the servers to prevent a single server being overloaded with requests and crash during FEs. A spare server will only be activated when the threshold of the previous server is reached. Moreover, working servers will be turned off whenever their current load (CL) reach zero.

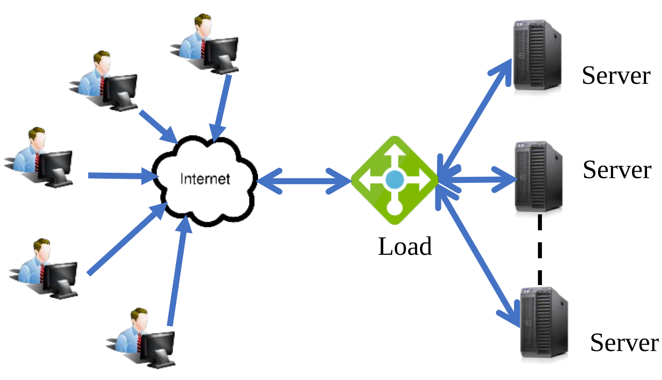

Fig 5: Proposed FEMA Architecture for m-Government Services

The architecture assumes n number of web servers, all which are considered initially to be under load level. When the load state of a server 1 exceeds a threshold limit, then it sends a message to the load balancer regarding its state. The load balancer (LB) will then activate the second server. All incoming requests will be sent to server two until the threshold limit is reached. The third server will be activated from sleeping mode. New requests will now be directed to server three until its threshold is reached. Each server will be sending its status to the LB whenever its state changes. When all the requests have been processed in server 1, the server will go into sleeping mode until its needed. The process repeats itself according to the server current load and server capacity. Figure 5 depicts the proposed FEMA Architecture for m-Government service. Figure 6 depicts the Flash Events Mitigation Algorithm (FEMA). Figure 7 depicts the phase transitions in FEMA.

Proposed Flash Event Mitigation Algorithm for m-Government Services

Input: S1, S2, S3, LB
Output: Load balanced on S1, S2, S3
//LB: Load Balancer
//CL: Current load
//S: Server
// S1: Server 1
// S2: Server 2
// S3: Server 3
//LCT: Load Capacity Threshold
//(LCT)u to the Upper boundary of Load Capacity Threshold
1: Initially, S1 is the main server for m-Government services
2: The LB checks the status of LCT value on n servers (S1, S2, S3) periodically.
3: The LCT values are sent back to the load balancer
4: If S1.LCT≡(LCT)up, then S1 sends a message to LB
5: LB wakes up S2
6: LB routes all the coming traffic to S2
7: end if
8: If S2.LCT≡(LCT)up, then S2 sends a message to LB
9: LB wakes up S3
10: LB routes all the coming traffic to S3
11: end if
12: If S3.LCT≡(LCT)up, then S3 sends a message to LB
13: LB routes all the coming traffic to S1 or S2
14: end if
15: If S1.CL≡0, then S1 sends a message to LB
16: LB sleeps S1
17: end if
18: If S2.CL≡0, then S2 sends a message to LB
19: LB sleeps S2
20: end if

Fig 6: Flash Events Mitigation Algorithm (FEMA)

VIII. Conclusion

The process of technology adoption may be voluntary or mandated by government authorities. In some settings, voluntary adoption is more successful adopted, while in another situation mandatory approach is the only way to induce technology. In this study, we examined (1) if power distance (PD) is the success factor towards the adoption of m-Government services in Tanzania and (2) the existing behaviour patterns of users of m-Government services in Tanzania. The study used log file analysis and web analytics approaches.

Our study offers several contributions to m-Government literature. First, we contribute to the relatively low number of studies that have investigated the relationship between PD and the adoption of m-Government services. Second, unlike previous studies which have focused on the adoption of m-Government services in voluntary use scenarios, we study a case of mandatory adoption. Third, methodologically, most of the previous studies have applied traditional quantitative and qualitative methodologies, whereas we apply log file analysis and web analytics approaches. The empirical findings of this paper provide significant evidence to support that power distance is a considerable success factor towards the adoption of m-Government services in Tanzania. Fourth, this paper reveals the user's behaviours patterns which are characterized by flash events (FEs) and propose an algorithm to mitigate its effects in m-Government services. The proposed FEMA is based on sleep-wake up the concept which has never been applied before in m-Government literature. Future research directions for this research lie in (1) understanding citizens' perception towards the use of power-distance in the adoption of m-Government services and (2) validation of proposed FEMA using real datasets.

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