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Towards a Better Understanding of Efficiency in mGovernment Services

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Abstract: - The benefits, which can also be considered as incentives or drivers, of implementing mGovernment services, include increasing efficiency of government processing (back office) and services (front office). The focus of this study is on efficiency evaluation of mobile services (mServices) rendered by mGovernment, regardless of the type of the end-user, aimed at producing a simplified methodology that will assist in analysing and assessing efficiency. The paper outlines the authors' methodology that aims to evaluate the efficiency of the services rendered by mGovernment entities. It has been developed as a follow-on to the generic management framework developed by the researchers to guide government in managing the adoption of wireless and mobile technologies for the implementation of mGovernment services.

Key-words: - mGovernment, efficiency, evaluation, mobile, services, management.

1 Introduction

The generic meaning of efficiency is that degree to which the goals have been reached, in relation to the means that have been applied. A process is considered 'efficient' if it requires relatively few inputs to produce a certain number of outputs. Efficiency in the public sector involves making best use of the resources available for the provision of public services [1]. The efficient government uses functions in such a way to minimise or avoid financial losses as well as time and resource wastage.

As with eGovernment, mGovernment helps improve efficiency in government. Information and communication technologies (ICTs) are a necessary enabler of reforms to the ways in which public administrations work. Improving internal operating systems – financial systems, purchasing and payment arrangements, internal communications and sharing of information – and programme processing and delivery arrangements can generate operating efficiencies and improve performance [2].

The focus of this study is on efficiency evaluation of mobile services (mServices) rendered by mGovernment, regardless of the type of the end-user, aimed at producing a simplified methodology that will assist in analysing and assessing efficiency. The authors have concentrated on mPayments as an example of an mGovernment service in light of the prediction by Wireless World Forum that by 2006 there will be more than 200 million regular mobile payment users spending a total of 47.2 billion euros worldwide [3].

2 Problem Formulation

2.1 Evaluating Efficiency in Mobile Government

In order to evaluate efficiency, both of the inputs and outputs have to be calculated as accurately as possible. Inputs are the resources that are provided by the mGovernment. Implementing these resources creates both opportunities and challenges. For example each instance of a monetary amount, human capital or tax deferral is considered an input once it is provided as a resource by the government. Although each input would, or could help to, create certain opportunities (such as more employment or the establishment of a small or medium size business (SME)) certain challenges would still be confronting such as the lack of institutional guidance or strategic thinking. On the other hand,

outputs are the direct effects of mGovernment management processing such as an increased number of activities or services, or a better-educated workforce. Increasing the number of services or introducing a new service is viewed as the response to the processing which can take the shape of change and/or innovation [4].

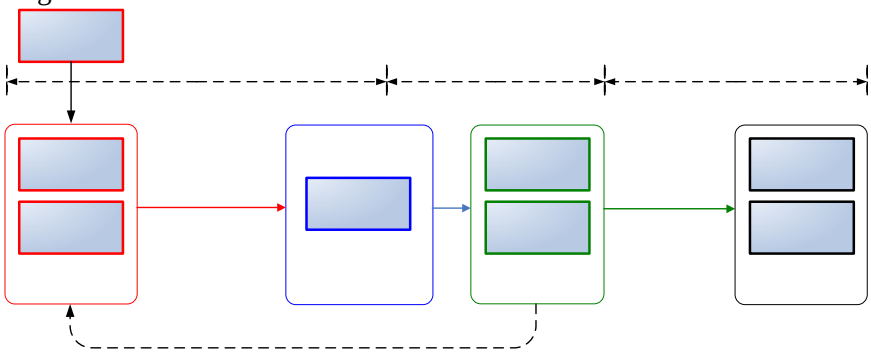

Fig.1: Efficiency as a relation between inputs and outputs. Source: Adapted from authors 2005

Inputs of the mGovernment are practically manipulated at the 'back office', whilst outputs are presented by the 'front office'. The mGovernment back office undertakes all the activities and processes in order to produce a service, such as finance, human resources, Information Technology (IT) support, facilities management, marketing and communications. Front office activities and processes cover the supply of a service to the end-user, who can be any of the mGovernment constituents, i.e. citizens, businesses or other government agencies.

Efficiency evaluation, as one of the elements used to measure–performance, covers all of the activities performed by both back and front offices to produce a service. Efficiency in service processing and service delivery should lead to cost benefits for both the administration and the end-user [5]. In their technical report, Centeno et al [6] state three trends in public needs for government services, namely needs related to:

- service provision,
- service delivery, and
- service access.

Examples of needs types for each trend are shown in the following table:

Back Office		Front Office
Service Provision	Service Delivery	Service Access
Personalized	Reliable	Easier
Pro-active	Simple	Faster
Cross-border	One-stop shop	Better

Table 1: Three trends in public needs of government services

2.2 The Problem Definition

While both service provision and delivery are managed by the back office activities, service access is one of the tasks of the front office. These service needs yield benefits, such as personalized, reliable and easier service, which the end-user seeks and desires. A real challenge emerges when taking a benefit component such as service access, as an example, to derive outputs indicators and metrics. The difficulty is how to measure a 'better' or a 'faster' service, especially when outputs depend on collaborative input efforts, as discussed below.

In addition, for the sake of simplifying the idea of this study, not all the inputs or outputs, which contribute to the impact on the mService, are considered. Accordingly, the efficiency assessment product aims to provide an initial indication rather than an authoritative evaluation. Part 2 of the paper provides a background overview of measuring efficiency and part 3 outlines the methodology of the paper. Part 4 describes the mGovernment Efficiency Evaluation Methodology while the conclusion and future directions are contained in Part 5.

2.3 Background on Efficiency Measurement techniques

Measuring efficiency is one of the principal tools for improving mGovernment performance. Efficiency measurement has been handled from different perspectives and applied on many areas of the corporate and government activities. Economic, production, systemic, technical and administrative efficiencies are examples of the areas to which such measurements have been applied. Accordingly, different methods for efficiency measurement were

created, adopted and adapted. Examples include the parametric method, which relies on econometric techniques, represented in Stochastic Frontier Analysis (SFA), and the non-parametric method, which uses mathematical programming techniques, to estimate distance functions known as Data Envelopment Analysis (DEA).

Many researchers, such as Cornwell, Schmidt and Sickles [7], and Coelli, Rao & Battese [8], have enhanced the theoretical and practical application of SFA model which sets up a frontier by taking in all the available data to estimate the cost function of a reasonably efficient firm. The function is then assumed to be common to all firms to assist in the finding of inefficiency measures. The SFA model can be written as follows in Table 2 [9]:

Formula	Explanation		
$c_i = f(y_i;\beta) + w$	c_i represents the actual cost which can never be lower than the frontier cost in the absence of data errors.	w_i is the total observed residual,	where $f(y_i;\beta)$ represents the cost frontier
$w_i = v_i + u_i$	v_i is the statistical noise		u_i is the inefficiency term

Table 2: SFA Formulae and Explanation [9]

As this method uses maximum likelihood estimation, there is no guarantee that the final estimators will hold any desirable statistical properties (unbiasedness, efficiency, consistency) in small samples [9], which is currently the case of mGovernment services from the perspective of the government management. Practically, a few mobile services are rendered by the government and this may lie under the required sample size where inferences will become problematic as they are directly affected by the quality and nature of data, the number of explanatory variables and the estimation procedure used. Theoretically, SFA uses the half-normal and the exponential distributions which assume a large number of efficient units (mServices) and only a few of them are relatively inefficient, and this adds another objection for implementing this model [9].

Studies of service quality that adopted the Data Envelopment Analysis (DEA) method used both single-stage and two stage empirical approaches. The single-stage approach was implemented by Soteriou & Stavrinides [10] to analyse the service quality of bank branches so theoretically it could be applied to mGovernment services such as mobile payments. Athanassopoulos [11] used the two-stage approach as an enhancement for the single-stage to provide more explanation about why services are efficient. DEA computes a scalar measure of efficiency and determines efficient levels of inputs and outputs for the organizations under evaluation [12]. One major issue with DEA is that a unit can appear efficient simply because of its pattern of inputs and outputs and not because of any inherent efficiency [13].

Both the above measurement tools have drawbacks as described above. In Section three the authors outline the measurement tool called Goal/Question/Metric or GQM which is used to measure the quality improvement of software development that they believe is particularly suited to the measure of the efficiency of the provision of mServices by mGovernment.

2.4 Study Methodology

This paper represents the next step in our study of the potential of mGovernment to provide efficient services to constituents of a state or country [4]. The focus of our initial literature review concentrated on existing response models for mGovernment. Academic databases, mainly Proquest and Computer and Information Systems Abstracts (CSA), were consulted to search for papers that dealt with the impact and response of either ICT or wireless and mobile technologies on government. Kushchu and Borucki [14] devised the Mobility Response Model; another useful framework for mobile government was developed by Goldstuck [15] and the authors developed a generic framework in author [4].

As mGovernment is a new area of research, there are very few completed studies so exploratory research is a legitimate methodology [16]. Such exploratory research assists in establishing the theoretical foundation for further examination and has been vital in developing a viable, theoretical framework as set out in our previous paper [17] and which is further expanded in this paper.

It became apparent to the researchers that the measurement of efficiency for mGovernment services such as mobile payment [18], would be of vital importance if the delivery of such services is to be handled by mobile devices which currently face such technical challenges as handover, roaming, dropout, lack of technical standards and security issues.

Our investigations revealed a third method called Goal/Question/Metric or GQM which is used to measure the quality improvement of software development. GQM defines a certain goal, refines this goal into questions, and defines metrics that

should provide the information to answer these questions. By answering the questions, the measured data defines the goals operationally, and can be analysed to identify whether or not the goals are attained. This GQM defines metrics from a top-down perspective and analyses and interprets the measurement data bottom-up [19]. The researchers found that this method would be suitable for adaptation for the measurement of efficiency of mGovernment services. Accordingly, in order to derive proper indicators and metrics we have developed an approach which is defined on the basis of GQM paradigm by Basili & Weiss [20], as explained in part 4.

3 Problem Solution

3.1 Efficiency Evaluation Methodology for mGovernment Services

The researchers propose the following as suggested steps for a complete efficiency evaluation process for the supply of mGovernment services. Firstly, it is necessary to precisely define the evaluation objectives and the authors use, as an example, the provision of mobile payment for a government service as a typical mGovernment service. Table 3 sets out specific objective examples for this mGovernment service which can be strategic, managerial or operational as outlined in author [4].

Strategic	Managerial	Operational
Determining the most feasible mix of the three ways to developing mobile payment infrastructure: bank-driven methods, mobile operator driven methods, and third-party driven methods [21].	Integrating mobile payment service as an additional facility with other mServices.	Implementing a mechanism that constitutes prima facie evidence of authorization (e.g., a dialled call) and authentication [22].
Increasing cooperation between the government and the banks to generate more traffic for government mobile networks.	Addressing the regulations for mobile payments.	Improving quality of mobile payment service.
Developing scalable mobile applications that can absorb new standards and support models.	Revising the rules of mobile services charges to reduce costs to administration.	Improving security.

Table 3: Examples of Efficiency Evaluation Objectives

The next step involves building indicators and metrics and this necessitates realizing and fulfilling the four requirements as set out in Table 3. If there is an over proliferation of indicators, measurement has passed the point of diminishing return thereby negating its usefulness and becoming counter-productive. Measures should ideally be clear, focused and manageable within the capacities of those administering and using them [23]. A structured process for selecting inputs for government mobile payment service and outputs indicators and metrics is essential, for ensuring that those selected will answer the questions that have been posed to fulfil the desired objectives at the previous step. Table 4 summarizes some properties mentioned by Hatry [24].

Indicator's Property	Meaning	Mobile Payment Service Indicator Examples
Representativeness	Indicator should address the scope of the objective question	As an example take the case of a person paying a parking fine to the local government authority (a mobile government service) via a mobile device – a reasonably common request by a constituent. A reliable output: after paying via SMS the constituent receives a receipt number on the mobile device. Feasible – yes. (Operational in Singapore) Uniqueness – unique receipt number.
Reliability	Indicator should not affect the final results for which it was used to deliver or extract	
Feasibility	Indicator should be practical, readily available, and cost effective within a specified time frame	
Uniqueness	Indicator should not be duplicated or overlaps with other indicators	

Table 4: Indicators & Metrics Properties

Deriving efficiency indicators can be affected by certain constraints that may exist in the mGovernment three-organisational levels; strategic, managerial and operational. Table 5 highlights some of these factors which have been adapted from CDLR [25]:

Constraint	Explanation	mGovernment Service Implementation
Inadequate skills:	Specific skills are required for building efficiency indicators	Five essential skills are required as per LaVigne [26]: 1. analytical skills 2. information management skills 3. technical skills 4. communication and presentation skills 5. project management skills

Unsatisfactory goal-setting:	Strategic goals are not broken down to managerial objectives and operational tactics	Developing scalable mobile applications that can absorb new standards and support models are not satisfactorily detailed into the needed resources and how they will be managed.
Lack of cost information:	Costs (as inputs) in relation to outputs for certain mServices are difficult to establish as a result to miscommunication between different management departments	Maintenance cost per a constituent account in a mobile payment service may not be as accurate as it should be because of the unavailability of correct figures for the staff costs due to the application of a certain policy such as internal privacy.
Lack of interest from political assemblies:	Certain efficiency measurements could cause political problems when indicators show "undesirable" results	If mobile payment efficiency proved "low", this may lead to certain conflicts between the politicians and the managers of this public service.
Existing regulations:	Accounting, statistic regulations and established procedures for reports and control can be constraints to building indicators	Standards Australia has developed the mCommerce Committee: Responsible for Australian representation on international m-Commerce standards setting bodies Contact point for other Standards Association committees on m-Commerce issues Oversees the work of its subcommittees

Table 5: Factors Affecting building Efficiency Indicators Source: CDLR [25]

In this step the authors devise Inputs and Outputs Indicators and Metrics Formation: Depending on the evaluation objectives at the previous step, indicators and metrics are decided for both inputs and outputs of an mService.

Producing an mService necessitates collaborative efforts, such as labour, information infrastructure and stakeholder inputs to the numerous government planning activities. These inputs are processed by mGovernment management and its contractors producing the mServices, which yield the benefits to their end-users.

3.1.1. Inputs

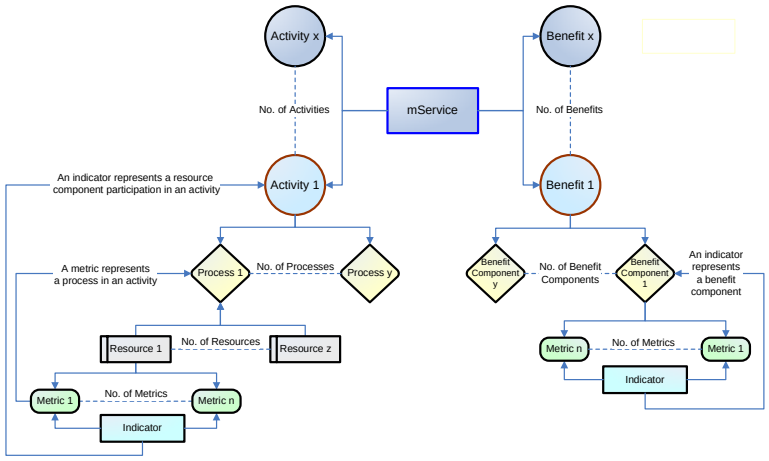

Fig.2: Indicators and metrics of inputs and outputs of an mService

Hence, each mService is decomposed to a number of activities, each activity is considered a collection of processes which, if completed, accomplish the activity. For a process to be completed, a combination of resources is necessary. As shown in Figure 2, for one activity each resource is considered an indicator which consists of a number of metrics representing different values of that resource. The result of using indicators and metrics will represent the cost variable of the inputs.

For example, if mobile payment service (mService *s*) consists of a number of activities $(a_1..a_{n-1})$, then for one activity such as activity a_1 to be completed, a number of resources is to be utilized and this may implement human, software, hardware and other resources as shown in table 6 . Each or all of these resources are used to achieve a number of processes $(p_1..p_{n-1})$ in activity a_1.

Resource Component	Indicator	Metric	Metric Meaning	Resource Component Cost
Human resources for	$c^H_{a_1}$	$n^H_{p_1 a_1}$	Number of human resources of process p_1 in activity a_1	

activity a_1		$c^{H}_{p_1a_1}$	Cost of human resources of process p_1 working in activity a_1	$c^{H}_{a_1} = \sum_{p_1}^{n^{H}_{a_1}} n^{H}_{p_1a_1} c^{H}_{p_1a_1} t^{H}_{p_1a_1}$
		$t^{H}_{p_1a_1}$	Human resources allocated time for process p_1 in activity a_1	
Software resources for activity a_1	$c^{SW}_{a_1}$	$n^{SW}_{p_1a_1}$	Number of software resources utilised for process p_1 in activity a_1	$c^{SW}_{a_1} = \sum_{p_1}^{n^{SW}_{a_1}} n^{SW}_{p_1a_1} c^{SW}_{p_1a_1} t^{SW}_{p_1a_1}$
		$c^{SW}_{p_1a_1}$	Cost of software resources utilised for process p_1 in activity a_1	
		$t^{SW}_{p_1a_1}$	Software resources allocated time for process p_1 in activity a_1	
Hardware resources for activity a_1	$c^{HW}_{a_1}$	$n^{HW}_{p_1a_1}$	Number of hardware resources utilised for process p_1 in activity a_1	$c^{HW}_{a_1} = \sum_{p_1}^{n^{HW}_{a_1}} n^{HW}_{p_1a_1} c^{HW}_{p_1a_1} t^{HW}_{p_1a_1}$
		$c^{HW}_{p_1a_1}$	Cost of hardware resources utilised for process p_1 in activity a_1	
		$t^{HW}_{p_1a_1}$	Software resources allocated time for process p_1 in activity a_1	
Other resources for activity a_1	$c^{OT}_{a_1}$	$n^{OR}_{p_1a_1}$	Number of other resources utilised for process p_1 in activity a_1	$c^{OT}_{a_1} = \sum_{p_1}^{n^{OT}_{a_1}} n^{OT}_{p_1a_1} c^{OT}_{p_1a_1} t^{OT}_{p_1a_1}$
		$c^{OR}_{p_1a_1}$	Cost of other resources utilised for process p_1 in activity a_1	
		$t^{OR}_{p_1a_1}$	Other resources allocated time for process p_1 in activity a_1	

Table 6: Derived inputs indicators and metrics for mServices s

Considering $v^A = a_1..a_{n-1}$ then the following equation will represent the total inputs cost of mService *s*:

$$c_s = \sum_{a=1}^{v^A} \left(c^{H}_{a} + c^{SW}_{a} + c^{HW}_{a} + c^{OT}_{a} \right)$$

3.1.2. Outputs

Indicators and metrics are derived from the benefits that the end-user gains from an mService. Gouscos et al [27] analyse benefits to their building components and consider this the first step in deciding which indicators and metrics are to be used. Benefits components are those values that the constituents expect from using an mService. As illustrated in figure 3, each benefit component has a number of metrics. Each metric measures a certain value in that component. One indicator represents one benefit component, and also groups a number of metrics under its heading.

Accordingly, in order to find out how "easier", "faster", or "better" the mobile payment service (mService s) is, the benefits of this service are analysed into their components. Effort of Acquisition (EoA), Effort of Familiarization (EoF), and Technical Support Necessity (TCN) are the three components making an "easier" service, and so on as shown at table 7.

Benefit	Benefit Component / Indicator	Metric	Metric Meaning	Benefit Component Response Weight	Benefit Impact
Easier Service (ES)	Effort of Acquisition (EoA)	t^{A}_{s}	Effort of Location (the number of minutes required for accessing an mService)	$EoA = \sum \left(t^{A}_{s} + t^{R}_{s} + t^{O}_{s} \right)$	$ES = \sum (EoA + EoF + TCN)$
		t^{R}_{s}	Effort of Request (the number of minutes required for making a request for an mService)		
		t^{O}_{s}	Effort of Delivery (the number of minutes required for obtaining the		

			results of an mService)		
	Effort of Familiarization (EoF)	t_s^{LN}	Effort to Learn (the amount of training time in minutes needed for new users in order to find features, perform common tasks and acquire an mService)	$EoF = \Sigma\left(t_s^{LN} + t_s^{RM}\right)$	
		t_s^{RM}	Effort to Remember (the number of minutes needed to perform an operation or feature that has not been used for a while)		
	Technical Support Necessity (TCN)	n_s^{TSR}	Number of Technical Support Requests (how many times users ask for help)	$TCN = \Sigma\left(n_s^{TSR} + n\_val_s^{TSR} + t_s^{RC}\right)$	
		$n\_val_s^{TSR}$	Content of Technical Support Requests (a significant value assigned to the content of users' requests)		
		t_s^{RC}	Time to Recover (the number of minutes needed to retrieve)		
Faster Service (FS)	Time of Acquisition (ToA)	t_s^{DI}	Time of Data Input (the number of minutes required for the user to enter needed information for each mService)	$ToA = \Sigma\left(t_s^{DI} + t_s^{D} + t_s^{LOC}\right)$	$FS = ToA$
		t_s^{D}	Time of Delivery (the number of minutes required for obtaining the results of an mService request)		
		t_s^{LOC}	Time to Locate (the number of minutes required to locate the required mService)		
Better Service (BS)	Quality of Experience (QoE)	n_s^{ER}	Number of Errors (the number of errors made by the user while performing an operation)	$QoE = \Sigma\left(n_s^{ER} + n\_val_s^{TRN}\right)$	$BS = QoE$
		$n\_val_s^{TRN}$	Transparency of mService (users' satisfaction as a significant value assigned from assessing the entire mService access cycle)		

Table 7: Derived outputs indicators and metrics for mService *s*

The total benefit impact m_s is then the calculated outputs of mService *s*, which is represented by:

$$m_s = \Sigma(ES + ES + BS)$$

3.1.3. Design Data Collection Approach

In order to pinpoint an mService benefit, end-user's needs (customer care) have to be initially investigated. In the mPayment scenario end users must be consulted initially and during the implementation. Customer support, relationships and service enhancements must be investigated using both quantitative (objectives) and qualitative (subjective) methods. Log files and statistics are examples of the quantitative methods, whilst questionnaires, best practices and historical analyses are examples of the qualitative methods, which also tend to be cognitive.

3.1.4. Assessment

Efficiency assessment is the quantitative relation between outputs and inputs of the same mService. In mobile payment service example, efficiency is investigated from three aspects: how easier, faster and better this service is than via conventional payment methods as depicted in Table 7 above. Accordingly, Table 8 shows the final value of efficiency criteria which is to be used as indices for future assessments.

Efficiency Criteria / Future Indices	Calculation
eff_{ES}	$\frac{ES}{c_s}$
eff_{FS}	$\frac{FS}{c_s}$
eff_{BS}	$\frac{BS}{c_s}$
eff_{m_s}	$\frac{m_S}{c_s}$

Table 8: Final Calculations for Efficiency Criteria

3.1.5. Recommendations

Depending on the efficiency assessment of mServices such as a mPayment implementation, recommendations for improvement are made. Recommendations will affect some or all of the goals, strategies, objectives and initiatives of mGovernment management, as shown in Figure 3. A prioritizing methodology is essential for optimum implementation of recommendations throughout a set period of time. Nonetheless, recommendations need to be delivered to decision makers at the right time, as there will inevitably be a compromise between rigorous recommendations on one hand and practical realities on the other [2].

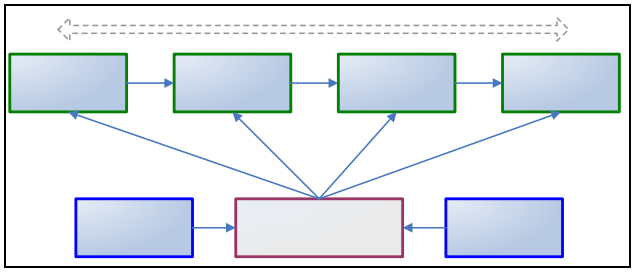

Fig.3: Efficiency Assessment Recommendations Effect on mGovernment Management

The following Table 9 expands the goals, strategies, objectives and initiatives of mGovernment management. Many countries such as Norway, Finland, Malta, India and Singapore are leading the charge for implementing mGovernment services, examples of which are seen in the table below.

Goals	Examples
Adopting a new comprehensive or holistic solutions rather than separate departmental services. Satisfying citizen's needs through diversified and multiple channels and platforms. Removing certain organisational or internal barriers between the government and citizens.	In the mPayment example as an mGovernment service consider the following: For parking infringements in Sydney for example citizens could pay via SMS, via Cosmos CardPay (Australia), CardAccess (Australia). www.cardpay.com.au www.cardaccess.com.au for example MobEPay, Teleterminal Singaporeans: receive SMS alerts for a variety of e-services such as: renewal of road tax, medical examinations for domestic workers, passport renewal notifications, season parking reminders, and parliament notices Malta residents can register to receive SMS notifications of court sitting/hearing deferrals, license-renewal, exam results, and direct credit payments from the Department of Social Security [3].
Strategies [28]	
Permanent monitoring of users' demands. Effective complaint management. Ubiquitous services with multilingual support.	For the above example, FAQs are normally provided on web pages, free calls to help operators when transactions go wrong.
Objectives [29]	
mGovernment applications are designed to interface with a wide variety of mobile devices. Citizens are to be educated about how to use and participate in an mGovernment initiative. Enabling citizens to have a common and seamless entry point to mGovernment services.	In Finland, SMS tickets can be used for Helsinki's public transport system. These tickets can be ordered by sending a text message and the user is billed through his or her regular mobile phone bill. The ticket itself is also delivered to the commuter by SMS [3]
Initiatives [30]	

Facilitating citizen access to government information. Facilitating compliance with rules. Citizen access to personal benefits. Government to government information and service integration.	Norway's tax collectors have introduced SMS tax returns. Taxpayers who have no changes to make to the form they receive in the post can now simply send a text message with a code word, their identity number and a pin code instead of returning the form by mail [3]

Table 9: Examples of Recommendations

4 Conclusions

This study proposed a methodology to assist in the evaluation of the efficiency of mGovernment services. By analysing both of the inputs and outputs in relation to their building components, indicators and metrics are derived. Simple and sequential mathematical equations are used to measure the cost of inputs, and the impact of outputs. To illustrate the principles of the method the authors have used an mPayment example of the type of mGovernment service throughout the paper. Quantitative and qualitative methods should be used to gather data for both inputs and outputs. As efficiency measurement means criteria that result from dividing outputs value over inputs value, these criteria will also used as future indices and benchmarks.

Further research will focus on conditions of applying the efficiency evaluation methodology discussed in this study, and how the performance of mGovernment, in general, can be affected once this element (efficiency) is adjusted to a certain rate. Our next step will be to apply the methodology to an existing mPayment, mGovernment service to test its viability.

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