

## Measuring for Knowledge: A Data-Driven Research Approach for E-Government

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**Abstract:** E-government still faces many challenges as it continues to develop. The current status of electronic services delivery opens up a lot of questions, both for practitioners and researchers. Therefore, further progress of e-government needs a profound knowledge base. E-government policy has focused several years on bringing online public services and on benchmarking their availability and sophistication. Simultaneously, e-government measurement activities are often based on the so-called supply-side benchmarking. This is important knowledge, however, it is under criticism because it lacks a user-centric viewpoint of e-government development. In this paper a bottom-up and data-driven approach is presented how research could help to manage (user-centric) e-government strategies. Based on statistical testing (techniques of Structural Equation Modeling, SEM) of large sample data from the Belgian government, we have investigated which relations do exist between contextual variables and the availability and/or satisfaction of electronic public services. This paper presents an illustration of this data-driven approach and explains how this can support and enrich the management and evaluation of e-government policy.

**Keywords:** e-government, methodology, management, benchmarking, evaluation, framework.

### 1. Introduction

Since the mid-90s the rise of information and communication technologies (ICT) has started. The public sector could not ignore the new developments and was forced to implement innovations and to explore new possibilities, just as the private sector (Heeks, 2003). In the middle of this 'e-evolution' e-government became the buzzword and was believed to be the driving force behind the modernization of public administration (Bekkers & Homburg, 2007). After more than a decade, all Western countries have developed an e-government policy enabling the offering of services by hand of different channels. Although internet still is the main channel for electronic service provision, some governments are experimenting with a so-called multichannel delivery (OECD, 2005). In addition, the sophistication of electronic public services is continuously increasing: electronic full case handling and advanced identification methods become more common in e-government.

Despite the promising expectations, e-government still faces many challenges as it continues to develop (Jaeger & Thompson, 2003; Traunmüller & Wimmer, 2004). One of the main pitfalls of e-government is its relative low uptake: in most Western countries the usage of e-services is no longer increasing in the last years (Eurostat, 2009). Therefore, the current status of electronic service delivery opens up a lot of questions, both for practitioners and for researchers. In this regard, e-government development needs a profound knowledge base: knowledge is needed about user needs, ICT literacy levels, satisfaction of e-services, impact of online public services, etc.

In this paper we discuss how a data-driven research approach can help in e-government policy. Efforts are needed to bring together knowledge concerning both technical developments and evolutions in user needs. In addition, several scholars have emphasized the need of investigating the demand side of e-government, instead of a purely supply-oriented approach (van Dijk, Peters, & Ebbers, 2008; Kunstelj, Jukic, & Vintar, 2007; Verdegem & Verleye, 2009). This approach entails the centralization of different sources of information that have an influence on e-government progress. Simultaneously, it needs to be decided what and how to measure e-government development.

First of all, we argue in this paper why e-government measurement is increasingly put in the foreground. We explain why there seems to be a shift from efficiency to effectiveness in the evaluation of public e-services delivery. Starting from the conceptual viewpoint, we move to the daily-based activities in e-government measurement in Belgium. We discuss research results on the development of a Belgian e-government monitor and how a data-driven approach is helpful in this.

## **2.Rethinking e-government policy and its measurement**

### **2.1.E-government policy: the shift from efficiency to effectiveness**

There are many definitions of e-government and the term itself is not universally used. The differences are not just semantic and may reflect priorities in government strategies (Heeks & Bailur, 2007; Yildiz, 2007; Relyea, 2002). Moreover, definitions and terms adopted by individual countries have shifted, as priorities have changed and as progress was made towards particular objectives. This is as it should be: the area is a dynamic one and policies as well as definitions need to remain relevant. The Organisation for Economic Co-operation and Development (OECD) defines e-government as: “*The use of information and communication technologies, and particularly the Internet, as a tool to achieve better government* (p. 23)” (OECD, 2003). It can be stated that this is a more ‘traditional’ definition of e-government in which the focus is mainly on the government itself.

In line with the definition of above, e-government policy in Europe have focused several years on bringing online electronic public services and on benchmarking their availability and sophistication (Codagnone, 2008). This is important knowledge, however, it is not free of criticism stating that too much attention is given to the supply-side of e-government (Reddick, 2005; Kunstelj, et al., 2007; van Dijk, et al., 2008). Given the relatively low uptake of e-government – one of the main arguments to rethink the electronic service delivery – several authors made a plea for more user-centric development of e-government (Bertot & Jaeger, 2006; 2008).

Closely related with the shift from a government orientation to a citizen orientation is the paradigm shift from efficiency to effectiveness. The latter refers to goals of government policy in general and e-government in particular. Millard (2008) distinguishes three types of goals concerning public policy: efficiency, that can be seen as the search for savings. Consequently, efficiency mainly deals with value for government. Effectiveness has more to do with the search for quality services and, as a result, the emphasis is on the value for the users (both citizens and businesses). Lastly, and more in general, governance is about the search for good governance, in which value for society is the key word.

The paradigm shift, i.e. equal attention for both efficiency and effectiveness, has partly originated from the rethinking of e-services policy as well as the strategies concerning the evaluation of e-government (measurement activities). Not only the supply-oriented approaches of e-government have come under criticism, critiques also exist towards the so-called supply side benchmarking (Bannister, 2007; Peters, Janssen, & van Engers, 2005; Janssen, Rotthier, & Snijkers, 2004). Codagnone & Undheim (2008) summarized the main lines of criticism of this: the overall relevance and validity of purely supply-side approaches and the reliability, comparability and transparency of the methodologies used are strongly questioned. In addition, the model of stages in development as well as the 20 basic online public services seem to be no longer sufficient for accurately evaluating e-government progress.

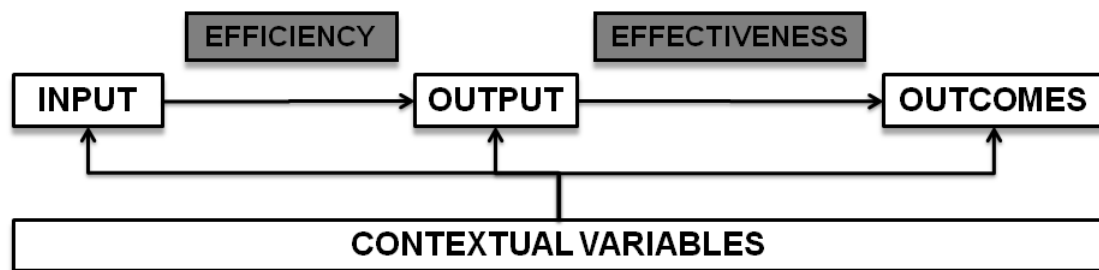
### **2.2.Measurement for knowledge**

Policymakers increasingly use electronic channels to deliver a wide range of information, interaction and transaction services at a growing level of sophistication. Consequently, the measurement of progress of e-government development has become a hot topic in e-services policy (Heeks, 2006; Kunstelj & Vintar, 2004; Peters, et al. 2005). It can be stated that these evaluation activities can serve

a double goal: first of all, in the light of rethinking e-government and moving towards a more user-centric approach, not only the current provision of services should be evaluated. A thorough understanding of demand side is also important (van Dijk, et al., 2008; Kunstelj, et al., 2007). This relates to the question of effectiveness of e-government strategies. Secondly, governments are also under pressure to offer more and better services while spending less at the same time. This way, e-government is seen as a catalyst for a productivity-driven way of working (Millard, 2008).

It must be clear that the electronic service delivery as well as underlying businesses processes and information are quite complex whereby it is difficult for governments to determine adequate measures for evaluating efficiency and effectiveness of the spending of their public money (Peters, et al., 2005; Kunstelj & Vintar, 2004). Measurement for knowledge is thus an important but difficult to achieve challenge. Therefore, it must be based on a holistic framework of different information sources. The framework should be comprehensive on the one hand, but flexible to adapt to new trends and evolutions on the other hand (Centeno, van Bavel, & Burgelman, 2004). Another point of attention is that e-government measurement strategies should be integrated in daily based activities. Once-only screenings of spending of government on IT or assessment of user needs and expectations prevent to develop long term e-government strategies (Kunstelj & Vintar, 2004; Bertot & Jaeger, 2006). Therefore, robust methodologies and measurement frameworks are needed.

Question remains what to measure and how to develop a holistic framework? Figure 1 depicts the classical conceptual framework for the measurement of efficiency and effectiveness of public sector policies and services (Codagnone & Undheim, 2008).



**Figure 1:** Basic framework – efficiency versus effectiveness

This framework distinguishes three elements in the public service value chain: input, output and outcomes. According to Codagnone & Undheim (2008) input are all the monetary and non-monetary costs that go into the production of an output and in the achievement of outcomes. Output can be seen as the final product of processes and activities that is less influenced by external variables and more under the control of the producing unit. This way, efficiency can be seen as the input/output ratio. In addition, outcomes can be seen as the result of the input & output activities, or, in other words, outcomes can be measured by the degree to which input and output are capable of achieving the intended results for different groups of stakeholders (citizens, businesses as well as governments).

The ‘input-output-outcomes’ relation does not exist within a vacuum. Other variables may have an influence on input, output and outcomes as well as on efficiency and effectiveness. In general these variables can be aspects of regulation, public sector functioning, economic and social factors, cultural attitudes, politics, etc. (Codagnone & Undheim, 2008). Especially with regard to e-government, these variables also may be related with (e-)readiness and other external variables (Millard, 2008; van Deursen & van Dijk, 2009).

### 3. Evaluating e-government development in Belgium

#### 3.1. Context and general framework

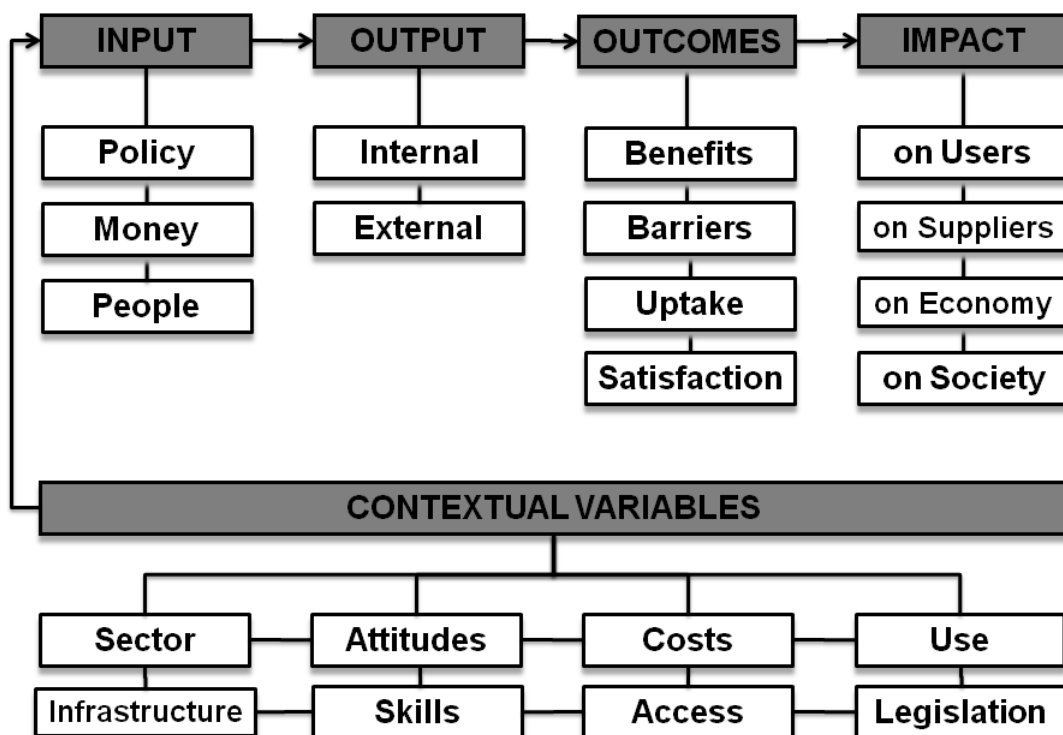
E-government in Belgium is an important driver for public modernization. However, like in the neighbouring countries, a lot of work remains to be done. In the OECD Peer Review Report of Belgium (OECD, 2008) it is stated that: “*Belgian governments could consider acquiring a systematic basis on knowledge of user needs and channel this knowledge into the design and development of targeted e-government services, with the purpose of making these services more attractive to users and more adapted to their true needs* (p. 19).” This is a clear call for more user-centric strategies. Other points of attention are the intergovernmental co-operation management strategies of integrated e-government (regarding the complex state structure) as well as reducing the digital divide (stimulating ICT access and use is necessary to make up arrears in comparison with other OECD countries), and are thus important challenges for Belgian e-government policy (OECD, 2008).

The OECD Peer Review report highlights e-government monitoring activities as an important plan for action in Belgium. Some first initiatives are already started in the last few years. The Federal Government has monitored user needs (Fed-e-View/Citizen) as well as the computerization of administrative departments (Fed-e-View/Administration) since 2004 (OECD, 2008). Another Fed-e-View study (focusing on e-government for businesses) is planned for the near future. The Fed-e-View studies are good initiatives, however, a systematic framework for monitoring and evaluating e-government is currently lacking. Hence, the need for setting up an e-government monitor. Although this monitor can build on the experience of the Fed-e-View studies a holistic framework still needs to be developed.

More in particular, this framework should provide a complete overview of e-government progress. Therefore, the measurement initiatives regarding to citizens’ needs and expectations should be combined with a continuous assessment of the administration back-office development, as well as other aspects related to the provision of electronic public services. In a nutshell, the measurement of e-government should pay attention to information containing the different aspects of the e-government value chain.

#### 3.2. What to measure?

One of the most important questions regarding the measurement of e-government is the strategic decision what to measure, or, in other words, which domains can be distinguished? And how adequate measurement indicators (as the basis of concrete data collection) can be formulated? Based on prior research in this field (Codagnone & Undheim, 2008; Millard, 2008; Kunstelj & Vintar, 2004) a general framework has been developed. Figure 2 provides an overview of this framework. The five key domains are: contextual variables, input, output, outcomes and impact.



**Figure 2:** General framework for measuring e-government in Belgium

On the figure it is illustrated how each domain can be subdivided in underlying blocks of indicators that will consist of different (key) indicators. In our research project, a total of 830 e-government measurement and evaluation indicators are formulated, corresponding with 160 key indicators. The indicators originate from different sources such as Eurostat, eUser, SIBIS, eGEP, etc. as well as the national statistics department (ADSEI – FOD Economie).

‘Contextual variables’ consist of different categories of indicators that have an indirect influence on e-government progress. It contains information about the ICT sector (e.g. employment and turnover, investment in ICT research, etc.), infrastructural variables (e.g. availability of internet access points, geographical coverage of Internet or GSM/DTV by access platform, etc.), attitudes of users towards ICT (e.g. intentions to purchase ICT infrastructure, reasons for not having access to Internet, reasons for not using a computer, etc.), skills of users (e.g. levels of computer and Internet skills), costs (e.g. price of cheapest Internet access by access platform), levels of access to ICT of both citizens and businesses (e.g. level of internet access at home by access device, level of internet access in enterprises by type of connection, availability of ICT-equipped workstations in public administrations, etc.), use of ICT (e.g. computer use by individuals, Internet use in enterprises, use of ICT devices in public administrations, etc.) and legislation matters (e.g. the legal framework to regulate ICT). In sum, these contextual variables mainly correspond with e-readiness and related issues.

The block ‘input’ deals with investments of government (monetary and non-monetary) with regard to e-government provision. Under the category ‘policy’ key indicators are listed such as ‘the acceptance and implementation of strategic e-government elements’ or ‘strategic policies regarding ICT’. The categories ‘money’ and ‘people’ are self-explanatory.

‘Output’ corresponds with two groups of indicators: ‘internal’ and ‘external’. The first group assembles key indicators such as ‘the implementation of joined up service delivery’ or ‘the use of monitoring tools or the use of technical e-government components’. Under the second group, we have listed variables such as ‘accessibility of government websites’, ‘availability of electronic public services by channel’, ‘online availability of basic public services for businesses by type of service’, etc.

The blocks 'outcomes' versus 'impact' are less self-evident. Especially, it is the question which indicators should fall under outcomes and which under impact. We decided to see outcomes as the collective term for both issues preceding e-government acceptance (benefits and barriers), the uptake of electronic public services itself and the direct results of e-government usage (satisfaction). Examples of indicators measuring benefits are 'the ease of use of online public services', 'the perceived benefits for enterprises of using online public services', etc. 'Barriers' is the opposite category of benefits, containing indicators such as 'the perceived barriers for citizens to uptake e-government' or 'the perceived cost of e-government for enterprises', etc. The uptake of e-government can be measured using variables such as 'channels used by citizens for interaction with public authorities' or 'the use of basic online public services for enterprises by type of service', etc. Satisfaction is also a sub domain of outcomes and assembles key indicators such as 'citizens' evaluation of government websites' or 'satisfaction of enterprises using the Internet for interaction with public authorities', etc. Other projects such as eGEP (Codagnone & Boccadelli, 2006) view user satisfaction as a part of the impact of e-government. This contrasts with our perception of 'outcomes' versus 'impact'.

In this framework 'impact' is perceived as the (direct or indirect) results of e-government uptake. Therefore, four categories can be distinguished: impact on users, impact on suppliers, impact on economy and impact on society.

### 3.3. How to decide what to measure?

Regarding the development of a measurement framework, two issues need to be clarified: first of all, the frameworks consist of different types of variables. Some are quantitative while others are more qualitative of nature. We also have to be aware of the distinction between different types of indicators: key indicators, indicators, sub indicators and composite indicators. Secondly, it is important to decide what to include in the monitor and what not. Particularly, various indicators concerning e-government exist. The research database consists of more than 800 indicators. Therefore, in order to keep the monitor manageable it is important to explore strategies to give prioritization to indicators. Different approaches and techniques could help on this.

A first approach is a top-down approach, meaning that (key) indicators could be selected by hand of input of experts. Via Delphi-analysis for instance, it becomes possible to move to consensus about which indicators (and underlying data) can or should be measured. A second approach is a bottom-up approach. This way of working is data-driven as statistical techniques can be used in order to detect which (key) indicators having the most impact while they are simultaneously covering the overall model. In the next part, we reflect on research activities as part of a quantitative approach in e-government measurement.

## 4. A data-driven research approach

### 4.1. Methodology

The second method that is elaborated in this part, was a bottom-up approach. Structural Equation Modeling (SEM) was applied to the data in order to determine whether a set of sub indicators all measuring the same underlying construct, being the indicator they are supposed to measure. The models that are developed within this analysis also give an indication of which sub indicator performs best in measuring this construct.

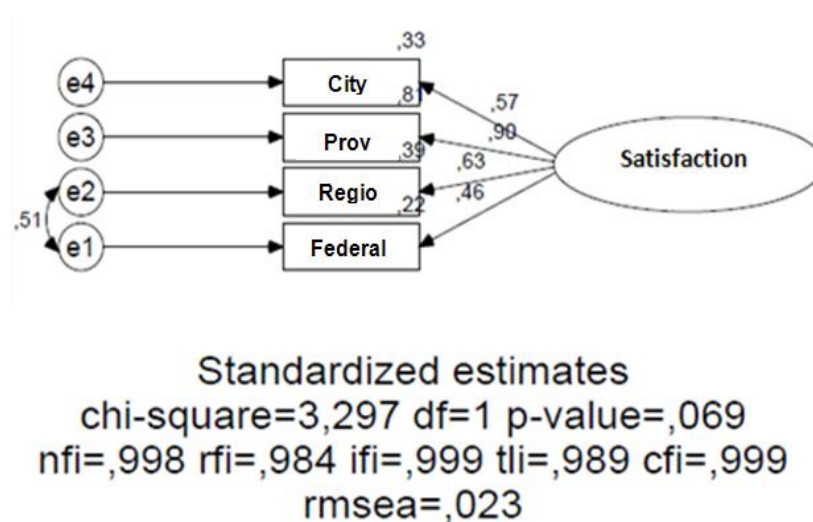
The applied statistical technique (SEM) allows for estimation of the goodness of fit of a hypothetical model given the data at hand. Estimating measurement models to validate conceptual (theoretical) models have a long tradition in marketing and consumer research (Bagozzi, 1980). SEM offers a sub model (measurement model) to test assumptions regarding the strength of the relationships between

indicators (items in the questionnaire) and the latent variables (the concepts), with simultaneous estimation of the correlations/co-variation between the concepts.

Two series of sample data were used in the application of the bottom-up approach. The first set of data originates from a longitudinal panel research, consisting of three data waves, carried out among both internet users and non-internet users. This set of data was collected by a commercial internet research company, commissioned by the Federal Public Service for ICT (Fedict). The second set of data was collected by the national statistics department of Belgium (ADSEI).

#### 4.2.Results

During the analysis we collected sub indicators in the data corresponding to several indicators within the conceptual model. Where this was possible, a SEM model was built to test the assumption that the sub indicators do a good job in measuring the same underlying indicator. In figure 3 an example is shown of one of these models that were developed. In this case, several questions measuring the same construct were analyzed.



**Figure 3:** example of a Structural Equation Model

This SEM model is based on four variables (squares). These four variables are supposed to be sub indicators for the indicator "Citizens' evaluation of government websites". The question that was used to measure this was: "how satisfied are you with the website of your ...":

- City (City);
- Province (Prov);
- Regional government (Regio);
- Federal government (Federal).

For each of these websites the respondents were asked to give their evaluation on a scale ranging from 1 to 10, in which 1 corresponds with 'not satisfied at all' and 10 with 'very satisfied'.

The ellipse in the model is the latent variable (which means that it is not directly measured in the questionnaire) that is supposed to be measured by the four manifest variables (which means that they are directly measured in the questionnaire). The four small circles represent the measurement errors for each of the variables. The effect of the construct 'Satisfaction' on its four indicators is represented by the single arrows. The numbers on these arrows are the standardized regression coefficients. These coefficients have a value between -1 and 1. The higher their absolute value, the more important the corresponding variable is as a source of information about the underlying concept ('Satisfaction'). The number in the right upper corner of the manifest variables gives us the amount of variance

explained by the latent variable. The double arrow between error e1 and e2 represents a correlation between these measurement errors. An error correlation can only be added if a meaningful explanation can be found for it. The hypothesis in the example of Figure 3 is that citizens do not see any difference between the Federal and Regional government level, as they are both perceived as part of the national (central) government.

Besides the detailed parameters on the model there are also a number of goodness of fit parameters that give a global evaluation of the model have to be assessed. For any model, the Chi-square ( $\chi^2$ ) should not be significant, the fit indices (NFI, RFI, IFI, TLI and CFI) should have a value of at least 0.90 and the RMSEA should be lower than 0.05.

The model presented in figure 3 confirms that the four manifest variables measure the concept of satisfaction with government websites in a reliable way. The same methodology was applied for a range of indicators and corresponding data (when available) as was illustrated in the conceptual model of figure 2, including 'contextual variables', 'input', 'output' and 'outcomes'. For the category 'impact' no existing indicators and data were available yet.

## **5. By means of conclusion**

In this paper it is demonstrated why e-government measurement is increasingly important. After a long period of (pure) supply-oriented measurement approaches, a strong plea is made for a more comprehensive way in analyzing e-government development. The presented research is part of a larger research project that is carried out in order to develop an e-government monitor in profit of the Belgian government.

During the research a conceptual model was developed covering the full e-government value chain. This conceptual model corresponds with a database containing 160 key indicators and more than 800 indicators. For some of the indicators data is already collected while for other indicators no information is currently measured. In order to keep the e-government measurement activities (and the e-government monitor) manageable, an approach is needed to select indicators and data that are more important in comparison with the others. During the research project, both a qualitative (top-down) and a quantitative (bottom-up) approach was applied. In this paper the methodology of a data-driven approach is illustrated.

Based on Structural Equation Modeling (SEM) it was possible to validate indicators based on several sub indicators using statistics. This statistical validation technique of the models (groups of indicators) also allows to give indication of which sub indicator is more suitable in measuring the proposed variable. This data-driven approach is one method to develop a measurement framework that needs to be comprehensive and flexible regarding new developments at the same time. The first aspect refers to the goal to cover the overall e-government value chain while the latter refers to new types of services and channels that will become available in the future.

The statistical testing must be seen as an approach offering valuable knowledge for policymakers. Firstly, an evaluation can be made whether the indicators employed in the questionnaire do a good job in measuring the proposed variables. In other words, SEM (or other validation techniques) is helpful in testing validity of the measurement instruments. Secondly, as there exist a lot of indicators that can be used for the assessment of e-government progress, an approach is needed to decide what to measure. A bottom-up and data-driven approach is at least important as a top-down approach. Thirdly, when evaluating the current measurement activities based on existing data, several recommendations can be formulated in profit of e-government practitioners. More specifically, feedback can be provided on methodology (data collection, answer categories, sample size, etc.) and related aspects. This knowledge is necessary when developing a comprehensive framework for measuring e-government development. A robust instrument is needed for setting up assessments over the time: only when we



are capable of using validated frameworks for measurements in the long term, we will be able to build reliable knowledge on e-government impact.

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