

A Comparative Analysis of E-Government Quality Models

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Abstract—Many quality models have been used to measure e-government portals quality. However, the absence of an international consensus for e-government portals quality models results in many differences in terms of quality attributes and measures. The aim of this paper is to compare and analyze the existing e-government quality models proposed in literature (those that are based on ISO standards and those that are not) in order to propose guidelines to build a good and useful e-government portals quality model. Our findings show that, there is no e-government portal quality model based on the new international standard ISO 25010. Besides that, the quality models are not based on a best practice model to allow agencies to both; measure e-government portals quality and identify missing best practices for those portals.

Keywords—E-government, portal, best practices, quality model, ISO, standard, ISO 25010, ISO 9126.

I. INTRODUCTION

QUALITY models are important since they allow us to figure out the main characteristics of a software product, especially for software that are useful for citizens such as e-government. In such context, several researchers have proposed their own e-government quality models by either, adapting the ISO standards such as ISO 9126 [1] or ISO 25010 [2], or proposing their own quality models based on their experience in the domain. Those quality models are in general proposed to measure quality of e-government services [3]-[8], quality of e-government [9] and eventually quality of e-government portals [10]-[12].

In this paper we are going to compare the existing e-government quality models in literature, namely [3]-[13]. The analysis is based on the following criteria: year when the paper was published, ISO standard used related to software quality (such as ISO 9126, ISO 25000, etc.), whether the quality model introduces new quality characteristics or uses the existing ones from ISO standards, quality focus (for instance, supply side or demand side), quality domain (such as, service quality or Website quality, etc.), availability of the quality model's metrics, whether the quality model is using a best practice model or not, quality dimensions and whether the model is conceptual or has been empirically tested. The purpose is to figure out the main pillars to build a new quality model for e-government portals.

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This paper is structured as follow: Section II provides an overview and comparison on the existing quality models in literature, whereas, Section III provides a discussion and guidelines to build a new quality model for e-government portals based on the new international standard ISO 25010 [2]. Finally, Section IV concludes the paper and gives directions for future work.

II. E-GOVERNMENT QUALITY MODELS

In this section we are going to present, compare and analyze the existing e-government quality models in literature. We classify those quality models into the two following categories: ISO based e-government quality models and non ISO based e-government quality models.

A. Comparison of ISO Based E-Government Quality Models

From a quality in-use perspective, [4] provided a quality model for evaluating the quality of agricultural electronic services using the ISO 25010 quality in-use model. This focuses on the user perception of e-government services' quality. The authors proposed a quality model composed of the same quality characteristics of the ISO 25010 quality in-use model but with different sub-characteristics, as the following: effectiveness (effectiveness), efficiency (efficiency), satisfaction (usefulness, trust, pleasure and comfort), freedom from risk (economic risk mitigation, health and safety risk mitigation, and environmental risk mitigation) and context coverage (context completeness and flexibility).

From a service quality perspective, [3] provided a quality model for e-government services based on the ISO 9126 model. The model used all the quality sub-characteristics of the ISO 9126 quality model. The authors identified that privacy is not included in the ISO model and is in fact important for e-government. The model consists of 19 quality characteristics divided into two categories: supply side and demand side.

From an e-government quality perspective, [9] divided e-government quality into three aspects as the following:

- 1) Process quality: This is the quality of work and activities under e-government systems. This may refer also to system quality. They used the ISO 9126 quality characteristics to measure the process quality.
- 2) Information Quality: This refers to the quality of information.
- 3) Service quality: This refers of the quality of e-government services.

From an e-government portal quality perspective, [10] used

the ISO 9126 as a base model to identify the quality factors to assess the quality of e-government portals. After many reviews and feedbacks from experts, the authors decided to add more characteristics and sub-characteristics to the ISO 9126 model. In particular, six quality characteristics were added as main factors; those are: security (privacy, authentication and access control), availability (24/7 readiness and cross browser support), readability (clarity, language correctness and style uniformity), content (correctness, updated, completeness, relevancy, user-oriented, concise content and intelligibility), navigation (navigation structure, absence of navigation errors, links visibility, minimal path, external and internal links) and trustworthiness (correctness and completeness).

Table I shows a comparison between those quality models in terms of many criteria including: year when the paper was published, ISO standard used related to software quality (such as ISO 9126, ISO 25000, etc.), whether the quality model introduces new quality characteristics or uses the existing ones from ISO standards, quality focus (for instance, supply side or demand side), quality domain (such as, service quality or Website quality, etc.), availability of the quality model's metrics, and finally whether the quality model is using a best practice model or not.

From this table, we can notice the following:

- 1) Three models including [3], [9] and [10] are using the old ISO standard 9126, whereas only Ulman et al. model [4]

is using the new ISO standard 25010.

- 2) Three models included new quality characteristics or sub-characteristics to the ISO standards, namely, [4], [3] and [10] models, with the exception of Chutimaskul et al. model [9] which did not introduce any quality characteristic to the ISO standard.
- 3) Only one model provided definitions of the quality characteristics which is the Quirchmayr et al. model [3].
- 4) Two quality models are taking the citizens' perspective into consideration including Ulman et al. [4] and Chutimaskul et al. [9] models, while Quirchmayr et al. [3] model focuses on supply and demand side, and Osama et al. [10] model focuses on supply side.
- 5) Two models focus on service quality, which, are Ulman et al. [4] and Quirchmayr et al. [3] models, while Chutimaskul et al. [9] model is holistic and Osama et al. [10] model focuses on e-government Websites.
- 6) Only two models provided metrics for their quality models, namely, Ulman et al. [4] and Quirchmayr et al. [3] models. However the authors only provided a short list of metrics.
- 7) No model is based on a best practice model.

To conclude, only Osama et al. [10] model is focusing on e-government portals. However, this quality model is not based on a best practice model and is not using the new generation of ISO standards of software quality (ISO 25000).

TABLE I
COMPARISON BETWEEN THE ISO BASED QUALITY MODELS

Dimensions	Models Ulman et al. [4]	Quirchmayr et al [3]	Chutimaskul et al [9]	Osama et al [10]
Year	2013	2007	2008	2013
ISO Standards	ISO 25010	ISO 9126	ISO 9126	ISO 9126
Introduced new quality characteristics/sub-characteristics	New quality sub-characteristics	Added one quality dimension (privacy)	No	Added six quality characteristics
Provided definitions of quality characteristics	No definitions even for the newly added sub-characteristics	Provided definitions	No definitions	No definitions even for the newly added characteristics.
Quality focus	Citizen perspective quality (Quality in use)	Supply side and demand side	Importance of quality dimensions is taking citizen perspective into consideration	Supply side
Quality domain	Service quality	Service quality	Holistic (system quality, service quality and information quality)	E-government Websites
Provided metrics	Only short list of metrics (1 per quality sub-characteristic)	Only short list of metrics (1 per quality sub-characteristic)	No metrics	No metrics
Based on a best practice model	No	No	No	No

B. Comparison of Non ISO Based E-Government Quality Models

Hien [13] provided a theoretical model that focuses on e-government e-service quality. Unlike other studies, the author considers organization quality as an important key to evaluate e-service quality. According to the author e-service quality can be divided into three quality aspects as the following [13]:

- 1) Information quality: It can be defined as information that meets specifications or requirements from an information perspective and is suitable for use by information consumers from users' perspective.
- 2) Service quality: It can be defined as how a service

matches the customers' expectations.

- 3) Organization quality: It can be defined as the internal processes of an organization.

Besides that, [11] presented a theoretical model to evaluate the quality of e-government Websites. The model is called WEQ (Website Evaluation Questionnaire). The model proved to be a valid and reliable questionnaire after an empirical study [11]. WEQ is divided into three quality aspects as the following [11]:

- 1) Navigation: This measures the opinions of users on information seeking process. This includes ease of use, hyperlinks and structure.

- 2) Content: This measures the quality of the Website's information. This includes relevance, comprehension and completeness.
- 3) Layout: This is related to the "look and feel" of the Website.

Moreover, after an extensive literature review, [5], [6] classified 33 e-government quality attributes under six main quality dimensions to evaluate e-government service quality from a citizen's perspective. The model was validated by a citizen questionnaire which resulted in 21 quality attributes classified under four quality dimensions [5], [6] as follows:

- 1) Reliability: This can be defined as the feasibility and speed of using and receiving the services of the site and includes six evaluation criteria.
- 2) Efficiency: This can be defined as the ease of using the site and the quality of its information and includes seven evaluation criteria.
- 3) Citizen support: This can be defined as the ability to get help when needed and includes four evaluation criteria.
- 4) Trust: This can be defined as the extent to which the citizens believe the site protects their personal information and is safe from intrusion. It includes four evaluation criteria.

Furthermore, [7] developed an instrument for evaluating e-government e-service quality. The model is called 'e-GovSqual'. It was validated based on citizens' interviews and surveys. The final instrument includes six e-service quality dimensions as the following: Website design, navigation, Website aesthetics, information quality, security, and communication. According to the authors, those items are not new, but they are already present in other studies. However what make this unique is that those e-service quality dimensions were empirically validated.

Moreover, [12] developed an evaluation instrument for evaluating the quality of e-government Websites. The instrument is called E-Government Website Evaluation Tool (EGWET) and is composed of 106 questions derived from literature along with interviews with developers of the Australian e-government portals. The authors grouped the factors influencing the quality of e-government Websites into the following: security and privacy, usability, content, services, citizen participation and features.

Eventually, [8] proposed a theoretical model for assessing the e-service quality of e-government portals. The model was built after an extensive review of research. The quality model is composed of seven constructs as the following: citizen centricity, transaction transparency, technical adequacy, usability, complete information, privacy and security, and usefulness of information. However, after an empirical study using citizens' questionnaires, the authors concluded that the factors influencing the e-service quality can be categorized into three categories as the following:

- 1) Security/privacy and transparency of transaction.
- 2) Completeness of information about the service.
- 3) Citizen centric features and usability of the portal.

Table II shows the comparison between those quality

models in terms of the same criteria as for section A, with the exception of the ISO standards criteria, since none of them is based on those international standards. Besides that, we have introduced two new criteria that are relevant only for non ISO based quality models as the following: quality dimensions (which can be expressed in terms of quality characteristics as for the ISO based quality models or other quality aspects), and theoretical (for instance, whether the model is conceptual or has been empirically tested).

From this table, we can notice the following:

- 1) One model did not provide any explanations or definitions of the quality dimensions, which is the Elling et al. [11] model.
- 2) All the models focus on quality from a user's perspective with the exception of the Henriksson et al. [12] model which focuses on quality from a supply side perspective.
- 3) The quality dimensions of all the models differ widely, however some dimensions are shared between some models such as: information or content, service, security, privacy and navigation.
- 4) Four models were empirically tested, which are: [11], [5]-[8], while Hien [13] and Henriksson et al. [12] models are theoretical.
- 5) Four models focus on service quality which are: [13], [5]-[8], while Elling et al. [11] and Henriksson et al. [12] models focus on e-government Website quality.
- 6) Two models did not provide metrics of their quality models which are: Hien [13] and Bhattacharya et al. [8] models.
- 7) None of the models is based on a best practice model.

III. DISCUSSION

This paper has presented and provided a comparative analysis of the existing models and/or quality models for e-government in literature from different criteria, namely: year when the paper was published, ISO standard used related to software quality (such as ISO 9126, ISO 25000, etc.), whether the quality model introduces new quality characteristics or uses the existing ones from ISO standards, quality focus (for instance, supply side or demand side), quality domain (such as, service quality or Website quality, etc.), availability of the quality model's metrics, whether the quality model is using a best practice model or not, quality dimensions and whether the model is conceptual or has been empirically tested.

From our analysis of these models, we have first classified the models into ISO based quality models, namely, [4], [3], [9] and [10] and non ISO based quality models, namely, [11]-[13], [5]-[8].

From the ISO based quality models, what can be concluded is that there is only one model focusing on e-government portals' quality and it is using the ISO standard 9126 [1]. However, it is not based on a best practice model and it is not using the new generation of ISO standards on software quality (ISO 25000).

TABLE II
COMPARISON BETWEEN THE NON ISO BASED QUALITY MODELS

Dimensions Models	Year	Provided definitions	Quality focus	Quality dimensions	Theoretical	Quality domain	Provided metrics	Based on a best practice model
Hien [13]	2014	Yes	Customer expectations	<ul style="list-style-type: none"> Information quality Service quality Organization quality 	Theoretical + To be verified in the future by a survey to CIO + factors will be verified by a questionnaire	E-government E-service quality	No	No
Elling et al. (WEQ) [11]	2012	No	Citizen's perspective	<ul style="list-style-type: none"> Navigation Content Layout 	Theoretical and then proved after an empirical study	E-government Websites	Yes	No
Papadomichela ki and Mentzas (e-GovQual) [5], [6]	2012, 2009	Yes	Citizen's perspective	<ul style="list-style-type: none"> Reliability Efficiency Citizen support Trust 	Theoretical and then proved after an empirical study	E-government Service Quality	Yes	No
Kaisara and Pather (e-GovSqual) [7]	2011	Explanations without clear definitions	User perspective (questionnaire for e-government users)	<ul style="list-style-type: none"> Website design Navigation Website aesthetics Information quality Security Communication 	Theoretical and then proved after an empirical study	E-government E-service	Yes	No
Henriksson et al. (EGWET) [12]	2007	Yes	Supply side (interviews with developers)	<ul style="list-style-type: none"> Security and privacy Usability Content Services Citizen participation Features 	Conceptual model - A systematic review of contemporary research + Review of best practices in Website design + Interviews with internet services managers	E-government Website	Not found in paper	No
Bhattacharya et al. [8]	2012	Explanations without clear definitions	Citizen's perspective	<ul style="list-style-type: none"> Security/privacy and transparency of transaction Completeness of information about the service Citizen centric features and usability of portal 	Theoretical and then proved after an empirical study	E-service of e-government portals	No	No

Whereas, from the non ISO based quality models, what can be noticed is that there are two quality models focusing on e-government portals' quality. However, each model has a different set of quality dimensions.

Therefore, bringing a convergence and international consensus on quality models would facilitate both the measurement and the use of the quality models on the one hand and would guarantee the reliability and validity of the quality models on the other hand.

Besides that, those models are not based on a best practice model. Such a best practice model and ISO based quality model will allow agencies to use a normalized way to evaluate and benchmark their e-government portals. This will allow agencies not only to measure the quality of their e-government portals, but also to provide best practices that can be implemented to improve such portals' quality.

IV. CONCLUSION

In this paper we have presented and compared many e-government quality models that we grouped into two categories: ISO based quality models and non ISO based quality models. The ISO based e-government quality models are the ones of [4], [3], [9] and [10], while, the non ISO based quality models are the ones of [11]-[13], [5]-[8]. From our comparative analysis of those quality models we have concluded that:

1) Only one ISO based model is focusing on e-government

portals quality and is using the old ISO standard 9126 [1].

2) Two non ISO based quality models are focusing on e-government portals quality. However, each model has a different set of quality dimensions.

3) All the models are not based on a best practice model. Therefore, there is a need for a quality model for e-government portals, based on both; the new generation of ISO standards (ISO 25000) for software quality and an e-government portals best practice model.

To meet this need for such a quality model, a study was conducted in which the authors have collected e-government portals best practices from literature to build an e-government best practice model [14].

As a future work, the next step is to propose a new e-government quality model based on the ISO 25010 international standard for software quality [2] and a best practice model [14]. The model can also make use of the existing quality models. Such work includes defining: quality characteristics and sub-characteristics based on the best practice model, and metrics to evaluate each quality sub-characteristic. This way, agencies would be able to use this quality model to measure their e-government portals quality and identify the missing best practices to be implemented to improve their quality level.

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