Quality Evaluation of e-Government Digital Services

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ABSTRACT
In this paper we present a “quality estimation model” for
digital e-Government services suitable for quality evaluation,
monitoring, discovery, selection and composition.

Categories and Subject Descriptors
D.2.8 [Software Engineering]: Metrics; D.2.9 [Software
Engineering]: Managements

Keywords
e-Government, Quality of Service, quality model

1. INTRODUCTION
The promotion of e-Government by Public Administrations
(PA) encourages the development of digital services. To
provide an approach to quantify Quality of Service in e-
Government digital service we must take into consideration
the following components: (a) study of parameters to be in-
cluded in the model; (b) introduction of a mathematic model
to define utility function; (c) representation of parameters
and metrics using a shared representation.

In this paper we take in consideration the second step. We
present a “quality evaluation model” for digital e-Government
services. This is useful for services quality evaluation, mon-
itoring, discovery[1], selection[3] and composition [4].

2. MODEL FOR QOS ESTIMATION
Quality model for QoS quantification of e-Government dig-
tal services take into consideration the work in [2]. This
paper describes how to formally discriminate between n dis-
tinct Web Services in input and for all services they associate
m evaluation parameters. For every service an overall qual-
ity value is defined from these inputs. Our study introduces
further elements that aren’t provided in literature but that
must be considered in the e-Government domain. We study
input data homogenization to handle inconsistency on met-
rics on e-Government parameters. Also, we must introduce
the interaction between them. It measures dynamic relation
between service parameters in such way to indicate how a
parameter behaviour condition each other.

Proposed model considers an unique service for evaluation
based on quality parameters that represent it. Discovery
concept in e-Government is still premature. Indeed, in this
domain we don’t speak about offer market but there is an
unique offer to satisfy demands of specific users target. Ev-
ery parameter is combined with a weight related to interac-
tion level reached by parameter in respect to the other. QoS
computation considers every parameter in a group that are
able to associate similar criteria. It is more rational refering
to cost than execution cost and transmission cost in a sepa-
rate way. Every group is weighting related to group feature
importance to final QoS value. To evaluate overall service
quality is necessary to consider the steps in Figure 1 and
experimental results from the model. This is exposed in the
following subsections.

2.1 Model Phases
Phase 1: Data Homogenization
At first we analyze data homogenization of array \(Q\) that
contains \(n\) quality parameter observed during measurement
process \((Q = \{q_1, q_2, \ldots, q_n\})\). Through a normalization
process we report parameter value on an increasing gradu-
ation when min is 0 and max is 100. For this purpose we
foresee two arrays, \(N\) e \(C\). Array \(N\) assumes discreet value 0
and 1 to differentiate proportional growing and inverse pro-
portional growing of quality parameter in respect to overall
quality. The second vector indicated by \(C\) represents max

![Figure 1: QoS evaluation model stack](image-url)
value that $q_i$ parameter in $Q$ vector may assume. Value associated to this vector are binded to the study on single parameter and it depends by specific metrics used to express parameter other than methodology applied to measurement. For homogenization purpose we define function 1 such that for each element $q_i$ in vector $Q$ we obtain a new element in vector $Q'$. 

$$f_1(q_i, n_i, c_i) = n_i \left( \frac{q_i \times 100}{c_i} \right) + (1 - n_i) \left( 100 - \frac{q_i \times 100}{c_i} \right)$$

(1)

**Phase 2: Parameter Interaction**

In the second phase we consider interaction among different quality indicators. To this purpose we provide $MI$ matrix that describes in detail relative interaction between parameters. This matrix consider interaction $\varepsilon(q_j, q_k)$ for every pair $(q_j, q_k)$ of elements in vector $Q$. $\varepsilon(q_j, q_k)$ value is comprised between 0 and 1 and it measures interaction reported in $MI$ according to (2).

$$m_{j,k} = \begin{cases} 
\varepsilon(q_j, q_k) & \text{se } \varepsilon(q_j, q_k) > 0 \\
0 & \text{se } \varepsilon(q_j, q_k) \leq 0 
\end{cases}$$

(2)

Clearly, $\varepsilon(q_j, q_k) > 0$ shows a positive interaction, while $\varepsilon(q_j, q_k) \leq 0$ shows absence of interaction. We have interaction matrix $MI$ with diagonal value equal to 0 to represent insignificant interaction of parameter with itself.

Starting from $MI$ matrix we define a new vector $P$ that measures interaction weight between quality parameters. We suppose, for example, that cost interacts positively with the user’s perceived trust, these two parameters may be associated to interaction factor that considers this observation. From this vector we extract interaction factor $\varphi_j$ of parameter $q_j$.

$$\varphi_j = \frac{p_j}{n - 1}$$

(3)

In (3) we show the parameter interaction level respect to the max number of interactions and it doesn’t consider recursive phenomenon on parameter legitimate by null value on matrix diagonal. Indeed, it is not admissible a situation when cost parameter interact with itself. Analysis between distinct services may be different because cost parameter of one service may interact with cost of other services. Considering interaction factor vector, every element of vector $Q'$ must be normalized to obtain a new vector $Q''$ based on function in (4).

$$f_2(\varphi, q'_j) = \varphi_i \ast q'_j$$

(4)

**Phase 3: Grouping and Group Weight**

At this point we consider that in the model the parameters can be grouped and managed like group of features with different importance. For this reason we introduce matrix $D$ and vector $G$. $D$ shows parameter that can be considered together because it refers to similar features, while $G$ represents element importance in respect to the others. Moreover, with $l$ we refer to total number of groups of quality criteria. Applying matrix $D$ to $Q''$, with $D \ast Q''$ we obtain vector $G$. To this point it is necessary to know groups cardinality displayed by $h_i$.

In the next step we present an array $F$ of weight associated to every group. In this manner we can specify user preferences or developer preference over group $i$ or over single parameter. In this case we have groups formed only by a single parameter.

Finally, it is possible to evaluate an overall quality value for a service considering QoS function showed in (5).

$$QoSLevel = \frac{\sum_{i=1}^{n} h_i \ast f_i}{\sum_{i=1}^{n} f_i}$$

(5)

3. CONCLUSION

QoS in e-Government domain covers a fundamental role. Either service provider or service user can differentiate, estimate and reuse services with the same ability. In this work we present a model for quality estimation and guideline to take into consideration quality aspects.

The most important experimental results show that $QoSLevel$ is a linear function, it increases or decreases steadily in respect of the parameters. From analysis of frequency distribution we can see that it follows a normal trend. Moreover, the approximation steadily improves as the number of observations increases. Finally, we notice that the upper bound for quality depends on the interactions between the parameters. If the interaction decreases the quality level has low values, while if the interaction and the interaction factor increase also the $QoSLevel$ increases. All this things are legitimated by the fact that frequency distribution, in case of considering minimal interactions, are attested near low values, while stretch to normal with the highest interaction.

The increase of the interaction among parameters supports the quality of the proposed model because the e-Government process stimulates different depending factors.

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4. REFERENCES


