Advanced Quality Tools for eGovernment Services*

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ABSTRACT
eGovernment QoS can be investigated either indirectly, by inspecting citizens satisfaction, or directly, by monitoring appropriate technical indicators. To this extent, we based our developments on the eGovernment Inquiry Framework for the management of questionnaire campaigns, which is now a standard component in the Regione Veneto eGovernment platform. We then completed the QoS picture through an eGovernment Technical Monitor, which provides administrators a close and flexible control to key performance indicators. Both tools are Java-based, make use of open source libraries and native XML-dbms and are exposed as standard WSDL-defined web services. They adopt an extensible architecture with an associative memory core connecting to higher level statistical variables and can be seen as the first components of an eGovernment QoS architecture with semantic capabilities.

Keywords
eGovernment, QoS, Semantic Web, Key Performance Indicators, Citizen Satisfaction

Introduction
Quality, along with its several instances, *quality control*, *quality assurance*, *quality management*, *total quality*, shows a long and successful history, started in the production, organization and engineering fields. Subsequently, quality models for process improvement were defined, like *lean production* [34], *six sigma* [16], *total quality* [11]; this evolution was consolidated with the 2000 edition of the widely adopted ISO 9001 standard [19]. These quality models are increasingly applied also to *immaterial* services, where *Quality of Service* (QoS) has to be measured and established contractually through *Service Level Agreements* (SLA). Given the eGovernment service focus, there is a significant interest for the application of quality methodologies to (*e*-)Government, as a coherent adoption of QoS methodologies can help Public Bodies to better satisfy citizens needs.

As eGovernment services are knowledge-intensive and operating over complex processes and organizations, *semantic web* technology can also be an useful element to add in order to improve the offered QoS. Semantic Web has been defined as [6] "an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation". The baseline data model for the semantic web architecture has been identified as the *Resource Description Framework* (RDF) [21, 25], an highly flexible XML language where statements are *triples* composed of *subject*, *predicate*, *object*, represented graphically as two nodes connected by an edge. Languages like RDFS [7] and OWL [26, 1] offer even more expressivity allowing for a better knowledge exchange in eGovernment environments [24].

QoS for the specific domain of eGovernment has been investigated in [22], where has been defined a specific *Quality of eGovernment Service* (QeGS) ontology. A structured analysis of eGovernment experiences can be found in [28], while a thoughtful list of requirements for a comprehensive semantic web architecture has been identified in [31], where also are listed several eGovernment projects, like German SAGA [13] and UK eGIF [33]. It has to be noted that the application of quality models to eGovernment is part of a definite Italian strategy [23].

As suggested in [20], processes are to be defined according to the different user roles; ruling out the "electronic agents" case (which is supposed to operate in a mature semantic web services scenario like the one analyzed in [14]), we can map their two other processes to *front-* and *back*-side of eGovernment.

The front-side is the *government-to-citizen* (G2C) domain, where web publishing is used to give information to citizens, to report news regarding tax procedures, laws as well as local informations about events; citizens browse the web searching for specific information but have to know in advance the government *context* where the information is located. Following National guidelines for the eGovernment support in small municipalities [32], the Italian Regione Veneto *myPortal* project, launched in 2003, addressed this field by offering local (province, comuni, comunità montane) governments

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free use of a common portal platform. By using the characteristic location-independence of web, it has been possible to active a single technological center (managed by the regional staff and providers) where portals are technically maintained, leaving the content management to the local government. The myPortal platform unifies at the moment a hundred local public administrations (in Veneto there are seven "province", 19 "comunità montane", 581 "comuni").

The back-side is the *government-to-government* (G2G) domain, where up-to-date information is circulated internally for service requirements and structured information is transferred/processed between employees; an extension of this case occurs with cross-agency group collaborations that involve complex multi-level government processes. The Regione Veneto *myIntranet* project addressed this field by selecting the appropriate technology (web services and semantic web) in a service oriented architecture to better support internal collaborations.

The myPortal/myIntranet (dual) framework represents an interesting applied research environment for semantic web technologies. Comparable research experiences can be found in [4] (Germany, Schleswig-Holstein), [5] (The Netherlands), in [10] (Italy, Regione Marche) and [17] (Finland). A review of applicable quality models for eGovernment can be found in [29], where a classification for quality measurements has been also identified: a) customer satisfaction, b) eGovernment portal quality and c) "technical" QoS.

Leaving out eGovernment portal quality (to be addressed in future projects aiming to further improve online services, more considerations near the end of the article), in our research we mapped the remaining classes to *eGif*, for multi-channel citizen satisfaction surveys and to *eMon*, for technical- and performance-related portal measurements.

These Quality Tools represent our strategy cornerstones to introduce objective measurements in eGovernment projects, giving also the opportunity to introduce semantic web technology capabilities to better address citizen's needs. The tool *eGovernment Inquiry Framework* (eGif) has been realized [8] to create survey campaigns, submit through different media channels, retrieve the answers, elaborate and report the results.[1] The second tool we present, still under development, is eMon, which follows eGif for collecting, monitoring and reporting a wide set of key technical, user-related and performance indicators to enhance eGovernment technical staff quality control in G2C portal services.

The paper is organized as follows. In the next section we present the eGif framework, its relation with quality-related models, the advantages offered by an appropriate use of statistical variables and the semantic web model for questionnaires. In the following section, the eMon model is explained and the implications of the extensive plug-in architecture for the system are shown. The integration between the tools is then deepened, and in the last section an outline of our vision for the semantic web QoS eGovernment architecture is presented.

[1] Documentation and source code for eGif is available at `http://grifo.dsi.unive.it/egif/`.

A QoS Inquiry Framework

User satisfaction analysis is a required ingredient in service quality management, where there is the need to compare *internal* measurements with *external* measurements. Structured methodologies exist:

a) quality-related models like SERVQUAL [30] and subsequents, mainly applied in the business domain to measure *customer satisfaction* through the use of suggested indicator classes and an analytical comparison of perceived Vs believed quality;

b) social research [27], where more emphasis is given to a right survey definition and to the social models of interaction, with questionnaires based on quantitative as well as *qualitative* variables.

Surveys emerged in an historical context where questionnaires were designed to fit in paper forms and computers were mainly used for (post-)elaboration purposes; submission of questionnaires through the web/email channels rendered then surveys popular and easy to manage. New interaction channels, like digital TV handsets, cellular phone interfaces, instant messengers (IM), are currently experimented, and asymmetric combinations of different channels for submission of questionnaires and for acquisition of the responses from the users help to raise the percentage of returns.

Technology interfaces can indeed facilitate the users and simplify the collection of data, reducing the costs of surveys and improving the whole effectiveness of the process. On the other side, not all the citizens can be reached via the technology channels, even with the simpler web & email, and identification/authentication processes has to be considered with attention.

With these considerations in mind, an effort was done to design a more "intelligent" survey tool by linking the statistical knowledge of the variables inspected with the questionnaire design process – mainly working on answer *constraints* and submission channels *capabilities*. By knowing *in advance* the statistical properties of the variables (being *nominal*, *ordinal*, *cardinal*, in ranges, etc), the survey tool is able to constrain its user acquisition, has a better control on the submission channels and can coherently elaborate/report the results.

Semantic-web techniques were then experimented to ease the sharing of the surveys between the social researchers: an associative memory of common [question + predefined answers] blocks is built on-top of a variables library containing their statistical properties, social semantics, and its relations with other variables.

An Extensible and Service Oriented Architecture

eGif exhibits a dual interface towards (a) the G2C local eGovernment Portal *myPortal* and (b) the G2G local eGovernment web-based collaboration tool *myIntranet*. Written

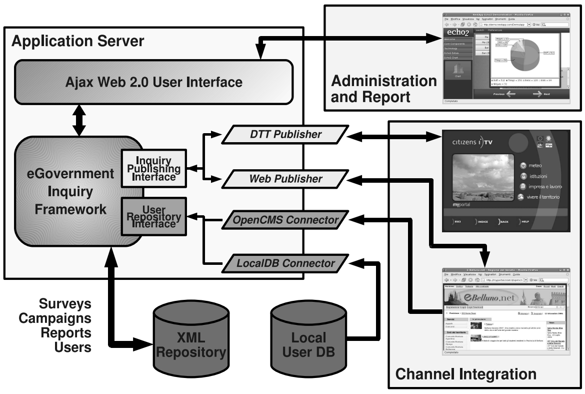

Figure 1: The eGif architecture.

in Java, it has been based upon a *web service* (WS) architecture: eGif exposes a WSDL-compliant interface, communicates through SOAP envelopes and can be listed through UDDI compliant registry. Given the guarantee role assumed by Regione Veneto for local government portals, the UDDI register model could indeed find fully appropriate use in this framework; adoption of semantic annotation standards (the simpler WSDL-S and the more complete OWL-S) are currently under evaluation; with this respect, in [31] there are some interesting hints about the model to be identified.

Several key requirements, both technical and practical, have been taken into account during the design of the eGif tool. As one of the main goals of the system is to serve as an abstract survey platform to many and diverse frontends, a standard service interface and a plugin-oriented architecture are both mandatory features. The service interface is used by a wide number of external applications, such as the analysis and reporting tools and the presentation layer of each of the several channel frontends and user interfaces (see Fig. 1).

According to the best practices about services oriented architectures, the services can be exposed through an UDDI registry and their semantic is explained through WSDL descriptors. In this way, third party applications or eGif extensions are able to connect to the eGif backend and take advantage of the function they require in a fully decoupled and well documented fashion. The services exposed belong to the domain of user authentication, survey repository access (both for publication or analysis purposes), survey campaign creation and so on.

The service oriented interface exposed by eGif can be used in order to exploit all the functions of the system, including the uploading and retrieval of surveys. Nevertheless, for the sake of ease of use, a fully working web-based frontend has been included in the system. This frontend offers a modern and practical interface to perform tasks such as user access profiles creation, plugin management and system monitoring. An effort was also done to make eGif capable of managing complex multi-indented questionnaire forms. Standard social research commonly uses dependency links between questions to be activated upon specific answers of the interviewed, posing serious difficulties to standard survey tools.

Operational Classes		Property States	Operating Procedure	Admissible Operations	Central Trend Measure	Dispersion Measures
qualitative ("mutables")	nominal	*separated*	*classification*	= ≠	mode	homogeneity index
	ordinal	*ordered*	*ordering*	> <	median	interquartile difference
quantitative ("variables")	cardinal	*discrete*	*counting*	+ -	mean	standard deviation
		continuous	*measurement*	x :		

Figure 2: Operational (variable) classes.

A full-fledged *survey editor* has been developed, allowing designers to build an arbitrary complex survey structure, including multiple choices, indented questions and different choices for statistical variables. eGif exploits a web *user interface* to allow survey designers to manage questionnaires with ease and flexibility. A graphics interface where the symbols "**?**" for *questions* and "**!**" for *answers* allows a dense and clear packing of the information on the screen and facilitates the users in the creation of questionnaires. The interface is based on server-side Echo2 Open Source (OS) GUI libraries.

A plugin-based multichannel engine makes eGif also capable to deal with a wide array of different media channels; different plugin types are available for the different tasks needed to reach true independence from the publication media. Plugins for web, email, digital TV set-top boxes and mobile phones were experimented. Authentication plugins are also provided to ease interoperability with the media channels by exchanging demographic variables, such as the age or sex of the respondents.

The Data Model

The questionnaires are built as sequences of *questions* to be submitted to the users in order to have an instance of the variables inspected; depending on the designer's choice, we can have open- or closed-format *answers*, the latter being preferred for quantitative research; depending on the choice, a variable can be inspected in different ways through different sets of answers. Descriptive statistics is used to (pre-)classify the variables in: a) *nominal*, classifiable, b) *ordinal*, ordinable, c) *cardinal*, computable. This operational variable classification has effects on the subsequent manipulations by restricting the allowed statistical computations and on the graphics representations that can be used (see Fig. 2).

Depending on the properties they describe, three semantical classes of variables are defined in social research (see Fig. 3):

1. *demographic/census data*, like age, sex, name, location and other fixed attributes of the respondent. These are standard independent variables required for classification purposes;

2. *objective data* (variables linked to actions), like common habits or information about past events/experiences, where variability is narrower, being data related to

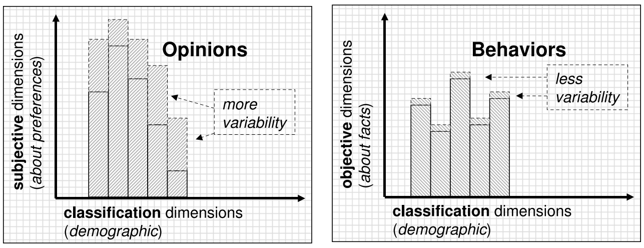

Figure 3: Different (dimension) roles assumed by the different semantical classes of variables.

facts. These can be used as (model-specific) independent variables;

3. *subjective data* (variables linked to preferences), like religious or political preferences, taste, interests, motivations, judgements, where variability is wider, being data related to *opinions*. These are commonly the (model-specific) dependent variables.

This high-level classification and the previous, more operational, is at the base of variable ontologies. Commonly used variables can then be defined and their relations stored in appropriate ontologies easing to questionnaire designers the task of identifying the appropriate dimensions of the surveys through the independent variables and the dimensions of the searched dependent variables. Further ontology attributions can be applied by using higher-level domain-related information pertaining to Local Government areas like Education, Health, Transports, Administration and so on.

eGif stores all its data in XML files through the eXist Open Source XML-native database. The role of XML is not limited to the surveys serialization: user profiles, configurations and all the other data are also stored in hierarchical structured repositories. The flexible *data structure* in XML, that can be validated and remains consistent between changes, is fully consistent with the semantic data models adopted.

A Technical-level Monitor for QoS Portal Measurements

In order to address our quality of service program, a different kind of measurement is needed to keep key performance indicators under close control. Our choice has been to design a comprehensive architecture around the atomic eMon “indicator unit” by giving eGovernment technical staff full knowledge for operation, performance and responsiveness of portal services and applications. To reach this goal, the quality tool eMon was designed (see Fig. 4):

- by identifying a set of strategies to insert low level key performance indicators in eGovernment portals and applications,

- by structuring a real time information flux feed model of the resulting indicators for system administrators via a messaging subsystem (using email, sms, IM and portlets),

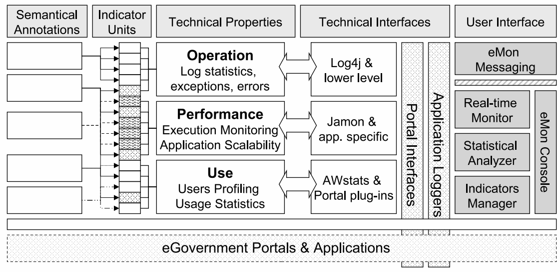

Figure 4: The eMon model.

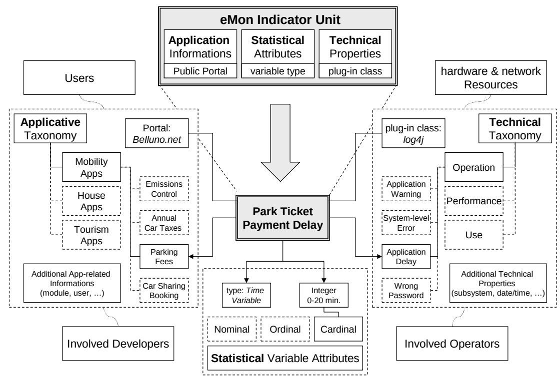

Figure 5: Indicators in the eMon model: an example for the indicator “Park Ticket Payment Delay”.

- by including a statistical analyzer to elaborate and report the evolution of the indicators and the correlation between them; finally,

- by making indicators manageable via a dedicated user interface.

The eMon technology innovation is the semantical coupling of the indicator technical interfaces and sensors with structured information about the related applicative, statistical and technical taxonomies. For example, a “Park Ticket Payment Delay” indicator warning, along with the technical facts behind the event, will bring knowledge about the parking fees application, about the “application delay” indicator classes and the statistical attributes needed by the eMon statistical engine for the computation of appropriate indexes and correlators (see Fig. 5). The gained eGovernment monitoring self-assessment could help in the realization of smarter, more careful and reactive G2C models.

The technical-level plug-in interface model is created as an abstraction layered out on-top of well known, widely used Open Source tools for monitoring, helping to further decouple the model from language- or system-level details, as well as over more portal- and system-specific interfaces. Three main areas for the deployment of the technical sensors were identified (see again Fig. 4):

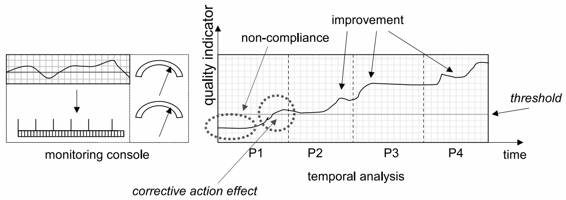

Figure 6: eMon visual interface – quality improvement implications for a specific indicator.

- the *operation* area, to maintain information about the state of the services. In addition to other lower-level interfaces, the OS tool log4j [3, 15] has been identified as a useful and flexible tool to feed eMon (through *appenders*) with informations at various levels of severity (debug, info, warn, error and fatal) that the *loggers* can transmit – a form of generalization for language-specific exceptions. Java[2] application developers only have to place in key positions of the source code these loggers; the level of logging can be then easily managed outside the application, by instructing log4j to ignore messages with lower level of severity;

- the *performance* area, to maintain information about the performance in production, to identify possible execution bottlenecks and to verify service scalability and application user responsivity. For this task, the OS tool Java Application Monitor (Jamon) [18] was identified; appropriate methods are invoked in the applications to start, measure, then stop the monitors, without the need to manage eGovernment administrative rights for distributed multi-portal services. Like log4j, Jamon limits by design the impact of the monitors on the application performance and can be externally configured;

- the *user-related* area, to collect informations about users accessing the portals: hits, views, robots and worms accesses, search keywords to reach the sites, etc. Again, a mature OS tool was identified, AWStats [12], capable of interacting with the main web-, mail- and ftp-server platforms and with the relative log files, by decoupling the model from the server technology.

These listed are the selected information sources. The resulting data flow is then enclosed in semantically annotated eMon indicator units, sent when required over the messaging subsystem and stored in a main XML repository for statistical and evolution analysis. The eMon user interface exposes a management console for eGovernment technical staff that can inspect the indicators sensed (see Fig. 6). eMon shares with eGif the same technology choices: the eXist OS XML-native dbms for the eMon repository and the server-side Echo2 web GUI framework for the eMon management console.

[2]Similar tools are available for other development frameworks, see [2].

Integration with eGif

Apart from the common technology choices, the performance and technical monitoring tool eMon shares with the inquiry framework eGif some parts of its higher-level features. In particular, the statistical approach is the same for both tools, bringing to a knowledge library for commonly used variables and their statistical properties. Also, (eGif managed) citizen feedbacks on specific online services can be supplemented by corresponding (eMon managed) effective performance information, supporting technical staff in their service improvement tasks. eMon trails can be acknowledged to belong to known users profiles by allowing deeper analysis on citizen classes application usage frequency. Like eGif, eMon exhibits a dual interface, collecting data from the G2C *myPortal* and exposing it to authorized staff through the internal G2G *myIntranet*. The UDDI register model should then provide eMon with additional sources of higher level information for surveyed services; semantic web service annotations would even better match with the semantic model of the eMon unit indicators.

The quality tools eGif and eMon have a key role in the Regione Veneto service oriented eGovernment architecture – they are a forefront for its progressive semantic web technology adoptions. A planned third tool to directly manage citizen feedbacks *inside* eGovernment services and processes should then follow to complete the whole picture of the Advanced Quality Tools for eGovernment Services.

Conclusions

A quality-oriented eGovernment research program involving also ontology- and semantic-based technologies has been conducted. The project has been developed on-top of a common web platform named “myPortal” based on Open Source technologies. The Inquiry Tool eGif is now available in all *myPortal*-served local administrations in Veneto. The Technical-level Monitor eMon will soon follow. Both are part of a wider quality measurement strategy for Local Government Portals in Regione Veneto.

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