Quality and impact monitoring for local eGovernment services

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Abstract

Purpose – The purpose of this paper is to introduce a layered, comprehensive model of quality of service (QoS) for local eGovernment, and discuss its feasibility on a regional eGovernment case study. The eGovernment online services are becoming a key infrastructure for advanced countries. They allow significant efficiency gains in different sectors of society, offering benefits for individual citizens and for the community as a whole. The deployment of online services alone is not sufficient in order to qualify an eGovernment strategy. The *intrinsic* and *perceived* quality of services offered, as well as the actual impact of new functionalities, should be properly measured and taken into account.

Design/methodology/approach – This paper presents an applied research study for a quality-focused evolution of a service-oriented architecture for local eGovernment portals. This investigation was based on three main layers: the perceived quality and effective impact of services (G2C layer), the effectiveness of the deployed processes (WFM layer) and finally, the system-level efficiency (G2G layer).

Findings – The measurement of quality with respect to eGovernment services is a complex task which requires appropriate tools to tackle the different aspects of the problem. Specifically, active and passive tools (respectively surveys and usage analysis) should be used to evaluate the quality perceived by the users as well as the utility of the service itself. The efficiency of the back office workflow must be estimated measuring statistical and dynamical indicators. Finally, technical measures should be used to monitor the responsiveness and scalability of software implementations and deployment systems.

Social implications – A better knowledge regarding (*e*-)Government service delivery processes, their QoS and their impact on the society can empower both citizens and local administrators, and can help them to better improve the effectiveness of local government.

Originality/value – The multi-layered quality measurement architecture proposed in this paper offers local governments the capability to systematically monitor and analyse the quality of their online services. The business process management technologies allow citizens to get a better knowledge of the service delivery processes; the QoS measurements allow to improve control on them; and the eGovernment Intelligence model allows to better quantify their actual social impact.

Keywords Local government, E-government, Performance measures, Quality of service, Metrics, Business process management, webbots

Paper type Research paper

1. Introduction

Local eGovernment online services dedicated to the citizens enjoy an increasing social impact. This yields a demand for the design and assessment of better quality of service (QoS) monitoring tools and strategies. The political pressure to improve the services provided to citizens forces each public administration to care about the quality levels reached by their online services via a comprehensive quality management strategy.

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There is also a significant interest in the local administrations for the application of quality and business process management (BPM) models to (*e*-)Government, as a coherent adoption of QoS methodologies could help public bodies to better satisfy citizen needs.

A structured analysis of eGovernment experiences can be found in Osimo (2008), while a thoughtful list of requirements for a comprehensive semantic web architecture has been identified in Sabucedo and Rifón (2005); a focus on local (municipal) eGovernment within the USA, the UK, Finland, France, Germany, The Netherlands and Japan is the subject of Drüke (2005), whereas in Sorrentino and Ferro (2008), the specific case of inter-municipal eGovernment collaboration within Italy was analyzed.

In Europe, eGovernment is annually assessed around four main clusters of services: income generating, service returns, permits and licences. The benchmark is performed at the granularity of the country, as the goal of these studies is typically to make a comparison between different national policies, and thus the availability of data at a more detailed scale is usually not needed. However, government should perform *locally* a more advanced analysis in order to evaluate how the offered services are appreciated and their effective consequences on the citizens' social and economic life.

We are adapting well-known QoS models and tools mainly developed in manufacture contexts (Parasuraman *et al.*, 1985) to properly address the issue of quality management of eGovernment services (Papadomichelaki *et al.*, 2006).

Our approach to QoS measurement aims at combining both *perceived* quality and measured *impact* of eGovernment services. Impact analysis of both general information and communication technologies (ICT) availability and of publicly funded ICT initiatives is a difficult task. Dedicated studies have been conducted with respect to the topics of education (Balanskat *et al.*, 2006), local area (Ciarli and Rabellotti, 2003) and long-term economy (Venturini, 2008), social capital/quality of life (Gaved and Anderson, 2006) and democracy (Wiklund, 2005).

The goal of our research is to model the management and measurement of QoS for eGovernment services in terms of *both effectiveness and efficiency*. Effectiveness, for public administrations, means not only positive returns of citizen satisfaction but also a positive impact of the offered services towards specific innovation indicators. Efficiency, on the other hand, can be modelled and measured with the help of BPM tools and, thanks for this capability, can be potentially improved via a substantial reformulation of local government service management processes. The main innovation in our research, as compared with common approaches in QoS, is the integration of the three layers (citizen satisfaction, impact analysis and BPM) in a unique platform and the capability to automatically gather data available in the web.

Our reference eGovernment architecture (Figure 1) is based on a dual model with an *external* interface towards citizens and a complementary *internal* interface dedicated to local (municipal) government staff, both interconnected and supporting a constellation of web services (WSs)-based tools and applications. Semantic web techniques are mainly used to accumulate relevance and classify information regarding online services in rdf databases.

The external, front-side of eGovernment is the *government-to-citizen* (G2C) domain, where web portals are used to give information to citizens, to report news regarding tax procedures, laws as well as local information about events. In this domain citizens are exposed to a growing set of online services that are aimed to support (or even substitute) the existing municipal public services. According to the national guidelines

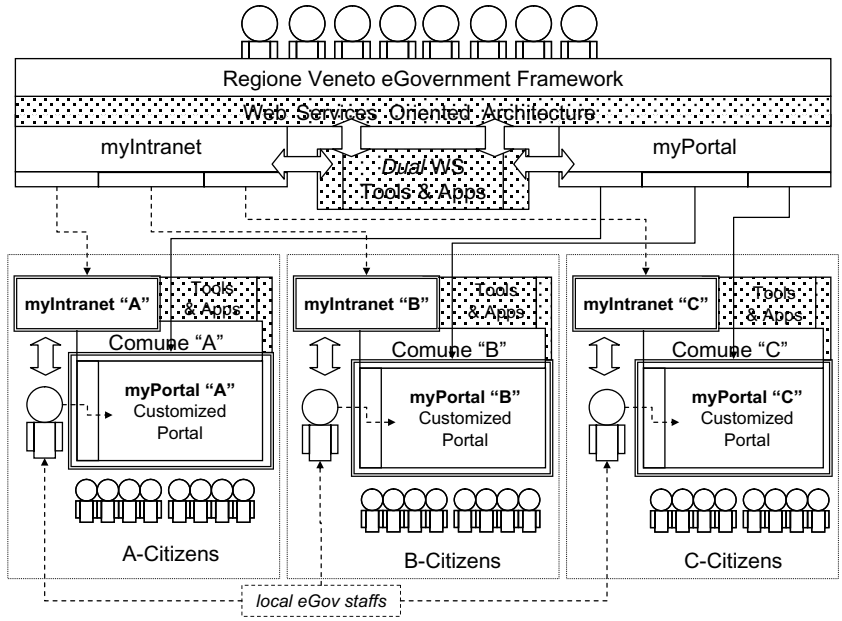

Figure 1.
Our reference service-oriented dual G2G/G2C architecture

for the eGovernment support in small municipalities, the *myPortal* project, launched in 2003 by Regione Veneto, offered local governments a common portal platform for free. The myPortal platform is currently adopted by a hundred local public administrations (municipalities, districts, etc.).

The internal, back-end of an eGovernment infrastructure is the *government-to-government* (G2G) domain, where up-to-date information flow is needed internally for service delivery and structured information, is transferred/processed among employees. An extension of this scenario occurs with cross-agency group collaborations that involve complex multi-level government processes. The *myIntranet* project addressed this field by selecting the appropriate technology in a service-oriented architecture (SOA) to better support internal collaborations. The myPortal/myIntranet framework has then been consolidated in a web SOA, open to specific dual-sided tools and applications.

A specific initial requirement of the government institutions imposes the integration in the architecture of a set of quality tools for the systematic evaluation of the online services (Candiello *et al.*, 2009). Coherently with this QoS-grounded research strategy a third workflow-based element, *myWorkflow*, was added in an attempt to increase the re-use of software by exploiting the standard-based definition and easy composition of processes (via BPEL), their process exchange (via XPDL) and finally the customization of their execution (via specific workflow management platforms). Another key requirement was the capability to ease communications on process flows. This goal induced us to apply BPM techniques to eGovernment. The BPM adoption is being facilitated by the recent availability of new interoperability standards and mature open source workflow management frameworks. For a recent survey on the diffusion of BPM culture in public administrations, see Niehaves and Malsch (2009).

The myPortal/myIntranet/myWorkflow framework represents the research environment where we structured a quality-centered approach, built onto a stack of systems, from the system layer to the workflow layer. Our approach follows the review of applicable quality models for eGovernment found in Papadomichelaki *et al.* (2006), where quality measurement models are classified in:

- customer satisfaction;
- eGovernment "core" quality; and
- "technical" QoS.

We mapped these three models, respectively, to *eGef* for multi-channel citizen satisfaction surveys, *eQual* for process evaluation and measurement and *eMon* for technical- and performance-related portal measurements.

These layered quality tools represent our cornerstones to operate objective measurements in eGovernment projects. The eGef inquiry tool (Candiello *et al.*, 2008) was designed to create survey campaigns, submit them through different media channels, retrieve the answers, elaborate and report the results. The BPM-based eQual QoS model is built upon the workflow process management architecture and is designed to measure static and dynamic quality indicators of eGovernment services. Finally, eMon (Candiello *et al.*, 2009) is aimed at collecting, monitoring and reporting a wide set of key technical usage and performance-related indicators to enable technical staff quality control in G2C portal services.

The remainder of this paper is organized as follows. In Section 2 the reference architecture is presented. In Section 3, the layered QoS model is outlined. In Section 4 some conclusive considerations are reported.

2. A process-oriented architecture for egovernment

The myPortal/myIntranet projects were launched in Veneto with the aim to first help geographical isolated municipalities located in mountain areas that can dramatically benefit from online eGovernment services. In particular, a technical and cultural coaching was needed for small, fringe municipalities (being sometimes as small as some hundred citizens worth) that rarely have financial and human resources to adequately project, realize and manage online services.

Municipality portals need basic *content management system* (CMS) functionalities and search facilities to manage institutional pages, bylaws, resolutions, acts, news and service information. Such topics were the first focus of myPortal, soon followed by online tax payment services and building-related authorization online processes. The specific features of the municipal communities induced from the beginning a key multi-channel requirement. This requirement is due both to the need to overcome the intrinsic geographical bounds for high-speed internet connections and to ease access to myPortal for the differently aged classes of citizens. To this extent, in addition to the use of traditional web and email interfaces, communication capabilities were provided via sms, fax, phone and digital TV set-top boxes.

After the initial adoption stage, the project was extended from its initial community to all other local (municipal) communities willing to take advantage of it. This led to the definition of a *de facto* standard for eGovernment portals and intranets for small and medium administrations in the Veneto region.

The G2C myPortal was initially developed around a closed source middleware. After a few months of usage, it was modified and enhanced to exploit the open source OpenCMS framework. However, the online services realized as java applications interacting via WSs interfaces, and the G2G myIntranet environment, both required a more extensible framework in order to express their full potential and ease the interface. The current technological environment for both myPortal and myIntranet is based on the open source JSR286-compliant portlet container Liferay.

The eGovernment architecture operating in Regione Veneto is built on an enterprise open source portal and a constellation of WSs and JSR-286 compliant portlets. myPortal was the first (G2C) framework developed, with the goal to offer at no cost to small and medium municipalities standard institutional web portal. myIntranet is the corresponding (G2G) framework designed to support the interactions needed by the government staffs.

The applications developed inside this architecture exhibit a *dual interface*, with highly configurable console editors exposed in the G2G/myIntranet side for government staffs and flexible, easy-to-use applications available in the G2C/myPortal side for citizens. The online services expose a WSDL-compliant interface, communicate via SOAP envelopes and can be listed through a UDDI-compliant registry. This way, applications are able to interconnect and to take advantage of the functions they require in a fully decoupled and well-documented fashion. Given the coordination role assumed by Regione Veneto for local government portals, the UDDI register model finds fully appropriate use in this framework. Currently an effort is being done in creating a set of regional standards to let local municipalities and third parties add directly new applications, documenting and exposing them in the regional registry. Information services, news and tax-payment were the first applications developed. Subsequently, those applications were supplemented by specific quality-oriented tools, in order to obtain a better insight about the citizen needs (Section 3).

We are also experimenting more advanced WS technologies to extend our framework, like WS semantic annotation standards (Sabucedo and Rifón, 2005) to improve the architecture extensibility, and WS orchestration models to allow application composition. A WS BPEL-based strategy is brought forward in coherence with our efforts in workflow-based and XPDL-compliant technologies (Figure 2).

Government services are backed by complex and continuously changing processes. This of course leads to a considerable effort for management, documentation and optimization. As a straightforward transition to eGovernment services has the risk to increase the complexity and the needed effort loosing the required flexibility, an effective communication circuit – as a foundation layer for quality management – was established with the citizens in order to closely follow their needs.

There are indeed two key features of the Italian local administration to be noticed in this context. First, there is a high potential for process reuse, as over eight thousand local municipalities have many commonalities: very often they offer the same services using *similar* (albeit not identical) processes. By contrast, local specializations of the main government processes are fairly common. This makes perhaps unsuitable a straightforward central-managed eGovernment development approach based on the design of specific applications for the municipalities.

Given the potential opportunities related to increased flexibility, easier maintenance and added transparency of the processes managed, a key role can be played

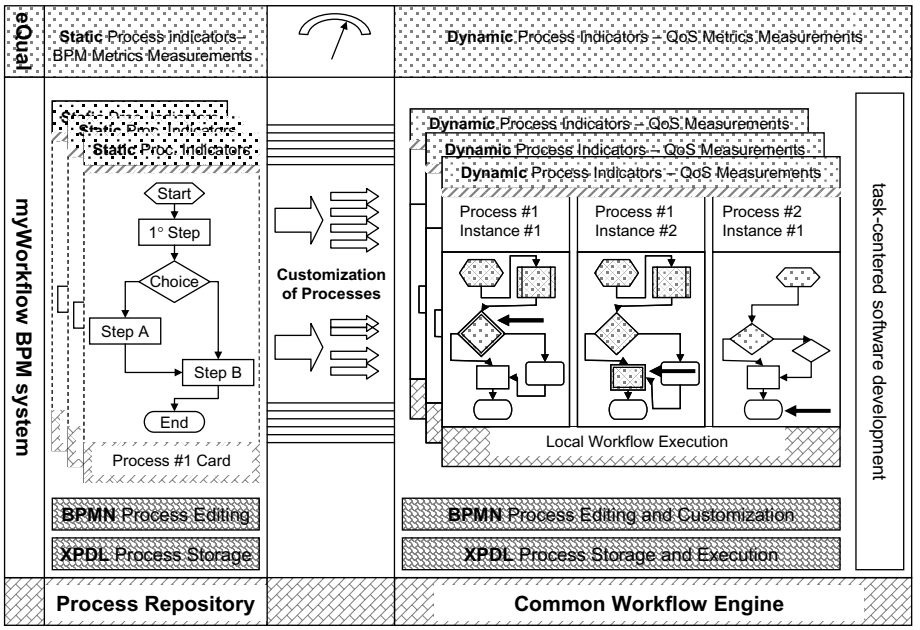

Figure 2. The workflow-based model for process execution and measurement

by BPM systems. The diffusion of BPM culture in public organizations devoted to offer services to the citizens could ease the mutual comprehension and legitimacy between local government and citizens (Niehaves and Malsch, 2009).

Thanks to the maturity of standards like XPDL (for process definition, interchange and storage) and BPMN (for process representation and editing) and the increased availability of related open source frameworks, we are experimenting a comprehensive strategy for eGovernment services to be layered upon a set of main processes managed by a workflow manager (WFM) platform by extending the current eGovernment service-oriented dual G2G/G2C framework.

The workflow layer matches coherently with the dual myPortal/myIntranet architecture, by offering via the G2G/myIntranet interface a specific process editing/inspecting interface for government staff and for exposing via the G2C/myPortal interface service (and connected processes) information for citizens, with the capability to collect their opinions regarding the services used.

In an effort to achieve "intrinsic" transparency about services and processes, the adoption of the XPDL standard could allow interoperability (Merino and Elguezabal, 2005) (Peristeras *et al.*, 2009), inheritance (van der Aalst, 2003) and comparison of similar processes present in different municipalities. An XPDL main *process repository*, being built at a regional level, is the key element in this strategy, where processes are managed by workflow and implemented via BPEL-coordinated SOA interfaces satisfying XPDL-compliant interoperability standards. (Hornung *et al.*, 2006; Danciu, 2006). The maintenance activity is easier and consumes less effort thanks to the gained processes abstraction. This fact also helps in requirements analysis for new application

development. The required specializations can be managed as a development layer to be added to the "core" process stored in the common regional repository.

3. A framework for egovernment QoS management

In order to maintain an adequate control level on QoS, we designed a three-layered quality model (Figure 3) with the goal to measure:

(1) *perceived quality* and *impact* of online services, via questionnaire submissions and webbot-based web data gathering;

(2) *service effectiveness*, via static metrics and dynamic indicators control; and

(3) *service efficiency*, via direct, low-level interaction with portals and systems.

To this extent, we developed a set of tools to satisfy the measurement needs of each quality layer:

- *eGef*, an inquiry/impact extended framework to design, submit and report *survey campaigns* to citizens about quality of (e-)Government services and to measure the *impact* of eGovernment projects and services;
- *eQual*, a workflow management-based model to set, monitor and measure *process indicators*; and
- *eMon*, a tool to monitor operations, performance and usage of eGovernment systems and services via *key performance indicators*.

The corresponding QoS metrics are:

- impact analysis measured indicators and citizens opinions, both concerning ICT government projects;

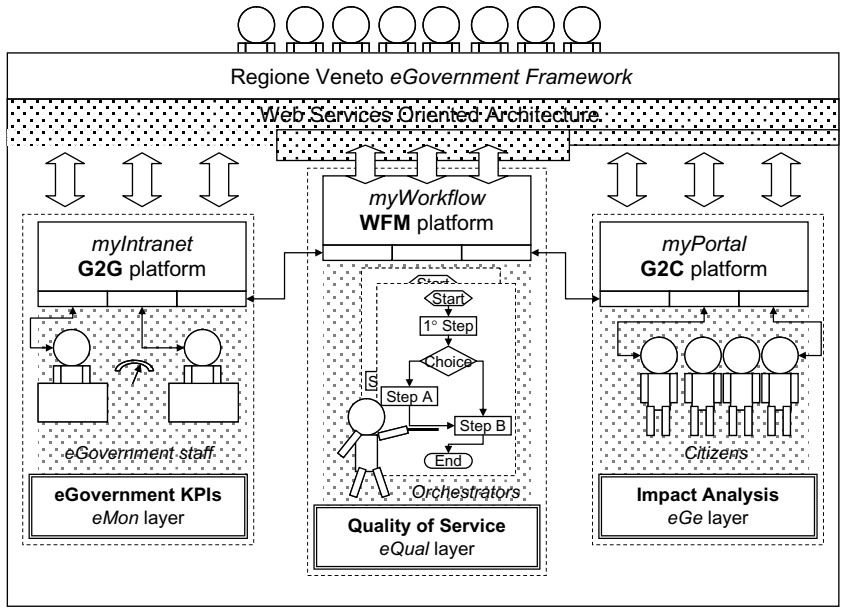

Figure 3.
The three-layered tools for QoS and their match with the corresponding G2G/WFM/G2C framework

- *static* process metrics, like cyclomatic or similar complexity measures, see for instance Cardoso *et al.* (2006), and *dynamic* process effectiveness measures, mainly time of transactions and successful completion of inspected processes; and
- system-, network- and software-level key performance indicators.

The following subsections will give an outline of each layer.

3.1 A framework to gather service satisfaction and impact data

Multi-channel satisfaction surveys and impact indicators *webbots* have been built to periodically generate evaluation data about the inspected eGovernment online services. The data is then semantically annotated and accumulated in the database (Figure 4). In the following the two subsystems will be described.

User satisfaction analysis is a required ingredient in service quality management, where there is the need to compare internal measurements with external measurements. 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 pre-structure the data, so constraining user-input acquisition and gaining a better control on the submission channels to coherently elaborate/report the results. Semantic-web techniques were also 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.

The eGef tool fits neatly in the myPortal/myIntranet dual model (Figure 5). The eGef G2G/myIntranet interface exposes a complete *survey editor* that allows designers

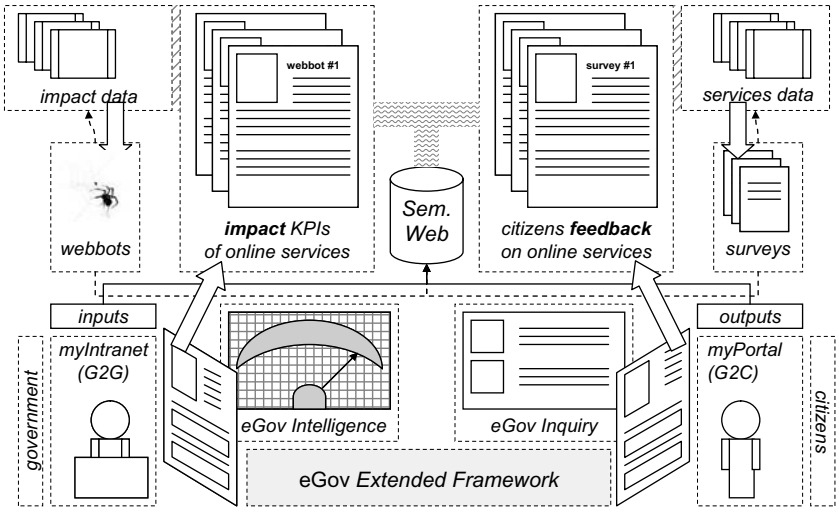

Figure 4. The eGovernment *Extended* framework (eGef) for impact and feedback about online services

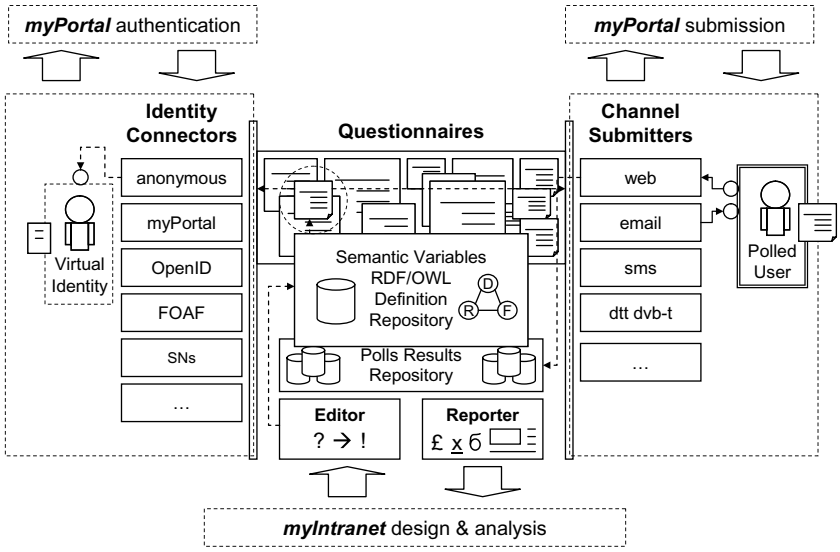

Figure 5.
The eGef inquiry tool components

to build arbitrary complex survey structures, including multiple choices, indented questions and different choices for statistical variables. The *reporter module* can then be used for the statistical analysis of the responses.

The eGef G2C/myPortal interface is used for the questionnaires submissions. Coherently with myPortal multi-channel capabilities, a plugin-based multi-channel engine makes eGef capable to deal with a wide array of different media channels. The eGef tool is a standard component of the Regione Veneto eGovernment framework.

As a correct evaluation of the impact of eGovernment investments and policies is a key concern for governments, we extended the framework in order to include also data about the measurable effects that online services have on local communities. We designed an "*eGovernment Intelligence*" application (Figure 6) around the two main sources that we identified for this scope:

(1) online data banks, exposing structured, reliable and record-organized data, commonly found for economic KPIs produced by institutions like the local Chambers of Commerce – where indicators are generally subjected to an update yearly or at most monthly; and

(2) raw web data, exposing unstructured, not so reliable data, generated freely by the local communities and found in forums, blogs or personal home pages – where it is expected a frequent rate of changes in content.

We adopted both strategies in order to combine *low-frequency*, *highly reliable*, *low-volume* data with *high-frequency, variably reliable, high-volume* data and to compose a useful picture of several local social and economical indicators and their correlations with the availability of advanced eGovernment services. The application required the realization of what is commonly referred to as a *webbot* (Schrenk, 2007), capable of extracting text data from web pages and to accumulate the data in a database.

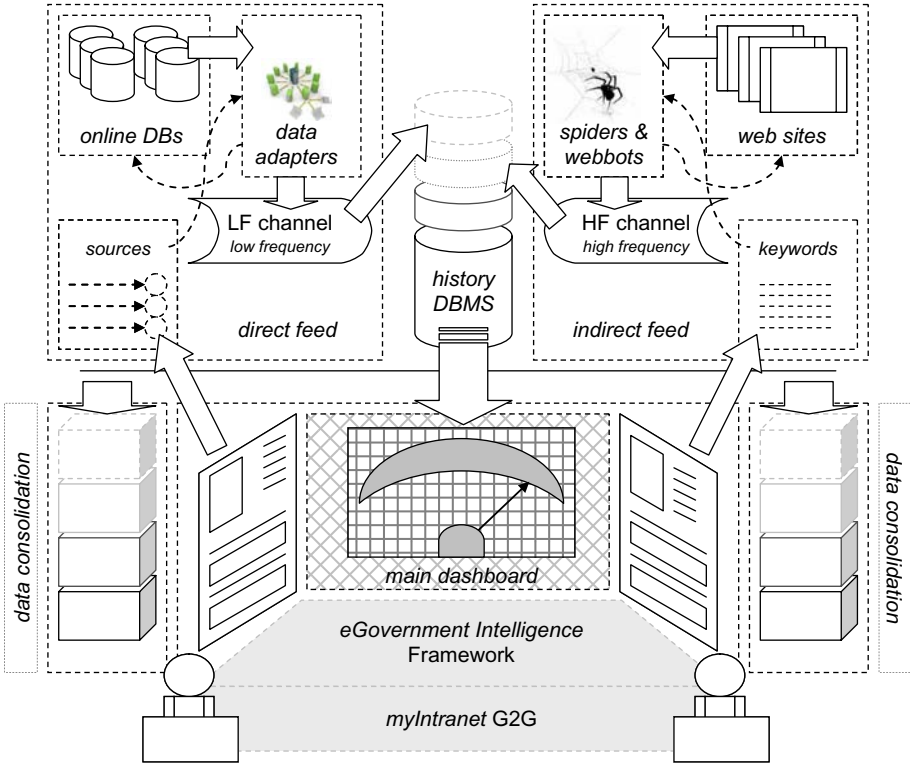

Figure 6. The *eGovernment Intelligence* architecture designed to gather online services *impact data*

3.2 A workflow-centered approach for processes QoS measurements

Quality management is increasingly applied to *immaterial* services, where QoS has to be measured and established contractually through *service level agreements* (SLAs). Such SLAs are now common in public service contracts between public organizations and citizens via *service charts*.

This kind of culture is centered on the process as the fundamental unit where quality management can be effectively grounded. The limit of conventional quality management is related to the *static model* of information management, where textual as well as graphics process representations are manually updated and then shared within the organization, with sensible resource efforts. Workflow management frameworks, able to manage dynamic processes, give indeed the opportunity to overcome this limit; the XPDL standard offers the capability to make process interoperability possible also outside the organization.

With the workflow architecture outlined in Section 2 and shown in Figure 2, both *static* process metrics and *dynamic* process indicators can be managed, satisfying the requirement to evaluate the services both intrinsically and while they are provided to the citizens. In the *eQual* QoS subsystem, the static metrics to be used in measurements of the processes are similar to the ones used in software development, like the cyclomatic metrics, and can be computed thanks to the XPDL formal definitions found in the repositories. Dynamic indicators can also be set, in the *quality management*

frame, with a strong focus to the citizens, monitoring eventual time delays between process phases and other values connected to the QoS (like the right conclusion of the processes) that has an impact on the citizens. Quantitative indicators (like the number of times a process is executed, or the number of staff members assigned to it) should also be known, in order to make a correct evaluation of the processes inspected. BPEL-XPDL interoperability, found in some workflow engines, should also ease a progressive development approach where *IT-supported*, XPDL-managed organizational processes are mixed to *IT-managed*, BPEL-orchestrated procedures.

In eQual, the process-based quality framework is interfaced directly with the citizens in order to collect the specific evaluations regarding the services used, in a higher precision complement to the standard customer satisfaction model where feedbacks are directly connected to the (*sub*-) processes involved in the services.

The eQual model is currently being experimented in specific use cases occurring in selected municipalities in Regione Veneto.

3.3 A technical-level monitor for QoS portal measurements

In order to complete our quality program to include technical-level QoS, a comprehensive architecture built around atomic "indicator units" was included. The quality tool eMon was designed (Figure 7) to give eGovernment technical staff full knowledge for operation, performance and responsiveness of portal services and applications by:

- Identifying a set of strategies to insert low-level key performance indicators in eGovernment portals and applications.
- Structuring a real-time information flux feed model of the resulting indicators for system administrators via a messaging subsystem (using e-mail, sms, IM and portlets).

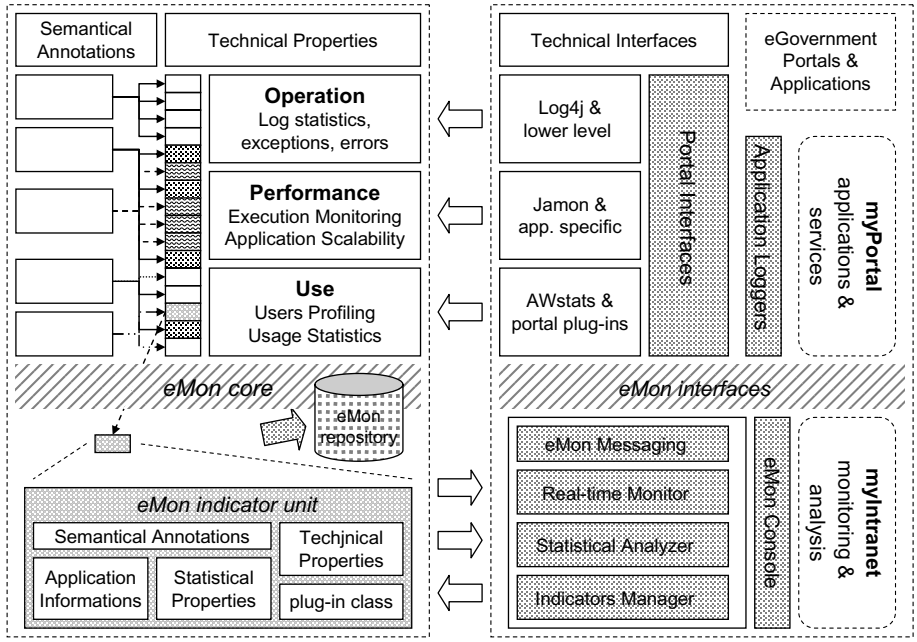

Figure 7.
The eMon tool for technical-level QoS measurements and its components

- Including a statistical analyzer to elaborate and report the evolution of the indicators and the correlation between them.
- Making indicators manageable via a dedicated user interface.

The technical-level plug-in interface model was created as an abstraction layered 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 (Figure 7):

(1) The *operation* area, to maintain information about the state of the services. In addition to other lower-level interfaces, the OS tool log4j has been identified as a useful and flexible tool to feed eMon (through *appenders*) with information at various levels of severity that the *loggers* can transmit – a form of generalization for language-specific exceptions.

(2) 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 Jamon was identified.

(3) The *user-related* area, to collect information about users accessing the portals: hits, views, robots and worm accesses, search keywords to reach the sites, through AWStats, a mature OS tool capable of interacting with the main web-, mail- and ftp-server platforms.

Like eGef, eMon exhibits a dual interface, collecting data from the G2C *myPortal* and exposing it to authorized staff with a management console via the internal G2G *myIntranet*. The eMon tool is currently under test in the Regione Veneto eGovernment framework.

4. Conclusion

In this paper, we presented the multi-layered approach adopted in our quality-oriented eGovernment research program, grounded on the open source dual G2G/G2C Regione Veneto local government reference architecture and aimed at a complete covering of the relevant inputs needed to improve online services.

Workflow management components were used in order to make reusable and measurable the key processes behind eGovernment services, offering citizens the ability to identify and to evaluate the quality of single process phases and opening to government new scenarios where services are classified and each compound process is defined, allowing a good grade of generalization between local government services.

The extension of the citizen satisfaction inquiry framework with the "eGovernment Intelligence", capable of gathering live impact data about online services, has been well received by local administrators and policy makers, as they need to continuously monitor the territory key indicators in order to validate the policies activated and to rapidly react to the expressed needs.

Thanks to its generality, we believe that the model could also be applied to other local eGovernment scenarios; its instantiation to other specific case studies is the object of our ongoing research.

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