What is the Affect of Providing E-Government Services Based on Existing Legacy Systems and Applications?

The Case of the Hellenic Ministry of Economy and Finance

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ABSTRACT

Governments take advantage of information and communication technologies (ICT) and the continuing expansion of the WWW to implement e-government strategies. The majority of Internet users in most countries are interested in using e-government for transactional services. As more complex transactional services are provided to the public, the integration between e-service provision platform and existing legacy information system becomes a one-way direction. The implications of such integration lead to the strategic decisions regarding the renovation of existing legacy systems and applications. Although current technological trends as J2EE architecture and web service platform promise the seamless integration of any type of system, this is not a trivial task. Is it possible that the legacy system itself may be an obstacle in e-service development? What is the effect of e-service support to internal public sector procedures? In such a case, one should consider the return-on-investment in providing e-services. We explored such issues in our effort to integrate recently developed transactional e-service platform with existing legacy information system of the taxation section of the Hellenic Ministry of Economy and Finance. The purpose of the paper is to present decision factors leading to legacy system renovation, discuss alternative solutions and describe benefits and drawbacks.

Keywords: e-Government, legacy system integration, case studies

1. INTRODUCTION

Over the last decade, we have witnessed the rapid evolution of the World Wide Web. This development allowed millions of people all over the world to access, share, interchange, and publish information. At the same time, public and private sector organizations are implementing highly functional and interactive web-based applications that are accessible to any user with a computer, a web browser and a connection to the Internet. These potentials impact all dimensions of our daily life. Thousands of new web sites are launched every year providing electronic services (e-services), accessible through Internet, suspending bureaucracy procedures demanding personal contact of the users and loads of paper-based forms to be filled in. This "e-" prefix has been applied to a vast number of domains and applications such as e-commerce, e-business, e-learning, e-health, e-banking, e-marketing, etc., flavoring the respective domains with e-services.

In this context, many governments worldwide have realized that their information resources are valuable economic assets, the fuel of the knowledge economy. In order to take advantage of their assets, more and more governments take advantage of information and communication technologies (ICT) and the continuing expansion of the Web and started e-government strategies to renew the public sector and eliminate existing bureaucracy and therefore reduce costs [1]). It is obvious that governments and governmental institutions are the most complicated organizations in the society providing the legal, political, and economic infrastructure to support the daily needs of citizens and businesses [2]. In their transition to the electronic operation and interoperation, the Web can be considered the key vehicle. In this framework, governments across the world are grappling today with how to use electronic technologies to improve service to citizens, increase efficiency and streamline

traditional paper processes. A survey research, supporting this effort, was recently conducted in the USA, by the Council for Excellence on Government that involved random telephone interview with users (one third from the USA and two thirds from several countries-Australia, Canada, Hong Kong, India, Singapore, and seventeen European nations). The results suggest the majority of the Internet users in each country thought that their government is doing a good or excellent job developing online resources that allow them access to information and conduct online transactions with the government [3].

Recently, attempts have been made to establish models of e-government. Riley [4] outlines a model containing three progressive stages: e-Government, e-Governance and e-Democracy. In this model, governments move from net presence (e-Government), through to service provision and representative democracy (e-Governance), to a final stage of e-Democracy. Stamoulis et al. [5] offer an alternative suggesting governments and their agencies mature in various spaces rather than in distinct stages. Building on Angehrn's [6] work they outline four spaces for a government revenue agency: Virtual Information Space, Virtual Communication Space, Virtual Transaction Space and Virtual Distribution Space.

Markellou et al. [7] proposes that for the implementation and successful operation of e-government, the proper design, which will be the basis in order to receive a series of strategic, administrative and operational benefits, is necessary. The application of e-government in the public domain can be gradually performed in fourteen levels, easing the adjustment of the traditional governmental model to the electronic one. Depending on the maturity and the resources of each governmental authority, the authority is level categorized and the bottom levels may gradually be applied. This allows the unobstructed flow of information from/to the public sector and gives the possibility not only to the citizens but also to the businesses (private sector) to acquire better access in the services that state provides.

The Hellenic Ministry of Economy and Finance and especially its General Secretariat of Information Systems (GSIS) has applied the fourteen levels approach [7] in order to provide e-services to citizens and businesses. GSIS supports a significant number of IT systems on administration of taxation and customs.

In this paper we discuss the case of reengineering the taxation information system of the Hellenic Ministry of Economy and Finance. Firstly, we present arising problems from the operation of the existing legacy and e-service platform. Subsequently, the main guidelines for the development of new e-government portal are discussed emphasizing its characteristics and provided services. Finally we discuss the requirements, decisions made, the cost of ownership and return–on–investment (ROI) for renovation of existing Legacy Information System.

2. EXISTING IT INFRASTRUCTURE

Taxation services are provided in more than 350 regional offices all over Greece. There are more than 300 different services provided to the public, while each citizen is required to register to the regional office of his/her residential area, often called "local office". Regional offices are divided into three categories according to their size and information infrastructure requirements (large, medium and small). Large size offices have than 200 employees, medium size offices more than 70 and

small size offices more than 30. More than 15.000 employees work in the organization, while more than half of them obtain positions requiring constant interaction with the public. More than 10.000 employees have on-line access to the legacy information system.

2.1   Existing legacy information system

The current version of the legacy information system is based on the client-server model and is fully functional since the early nineties. All application logic is programmed within the client platform (heavy client – light server model), while data is distributed in "local" database servers located in each regional office. A Central database is supported in GSIS for data synchronization and lookup purposes. It also facilitates computation of statistics and data maintainability and security. The information system can be characterized as the legacy system of the organization, since no services can be provided without accessing it.

Most data related to a specific citizen are maintained as local data in his/her local office. When citizen moves to a new residential area, he/she is obligated to register to the local regional office, while his/her record is transferred from the old one. Client programs access the local database to store data, while they access the central database mostly for lookup purposes. Local data are asynchronously replicated in the central database using a transaction management system (TMS). TMS clients are installed in client workstations to facilitate communication with the central database. The central database provides the overall view of each citizen's record. GSIS and all regional offices participate in a private TCP/IP network for communication purposes (Intranet), while regional offices are connected using 64Kbps to 512Kbps to facilitate efficient data replication. Oracle database and client/server programming tools and Tuxedo TMS are used for implementation purposes.

This three-layered hierarchical architecture is a typical one for client-server systems built in the nineties. Although it works efficiently, it has some drawbacks, since updating local data from another regional office or providing e-services through the Internet becomes a complicated task imposing restrictions. Client workstation support is also expensive since a large amount of software products must be installed/updated in each workstation. Thus, local support must be provided in all regional offices regardless of their size.

2.2   Existing e-services platform

Current e-services imitate existing bureaucratic taxation procedures. The basic approach of those non-electronic procedures can be described as follows: each tax payer has to visit the regional office, he/she is registered at, in person, in order to complete his/her case. Sometimes one visit is enough for the completion of a case, while sometimes the case is completed later. The electronic equivalent is that the tax payer just uses another contact media in order to carry out the same cases with similar reaction from the back office system. This means that citizens still have no feedback about the progress of a case plus the uncertainly that creates the lack of a contact in person.

The current e-services platform is based on an off-line policy. The necessity to assure maximum data privacy, security and integrity in combination with the existing technology capabilities of the time those e-services were issued, guided GSIS to implement them in an independent and different development platform and run-time environment. The process of

data exchange between the e-services platform and the internal legacy information system is carried out through manual procedures, using intermediate backup media or occasional short-time network links. The fore-described policy has a number of side effects. The most important is the frequent inconsistency between the two databases' data and the significant delays for the dispatch of certain procedures. Other side effect is the uncertainty that human interference causes.

Besides, existing e-services are implemented excursively, as most of them function independently and even in different running environment with different system software and support team. They only share the authentication data, but the replication mechanism for them, even for those data, is also manual and off-line.

3. E-GOVERNMENT PORTAL

GSIS provides a new e-services environment through an e-government portal. The main target of the portal is to minimize the need of citizens' presence in regional offices and intents to deal with all the drawbacks mentioned in the previous section. The intention for this new environment is to serve citizens so as to be able to carry out more than 90% of their common procedures, which take place at a regional office, through the Internet. The new system will be based on a uniform development and run-time environment based on the J2EE architecture. Application software is generated using open tools and solutions, like XML and Web services. The portal should facilitate on-line transactional services and ensure on-line access to the databases of the legacy information system. A number of issues are also dealt for the completeness of the new system. User certification and authorization, security, data integrity, confidentiality and other issues are under consideration and will be solved during the implementation of the system. The portal will be fully operational within the period of a year.

3.1 Target Groups of Reference

The new e-services platform refers to a significant number of target groups. Those are:

Tax Payers. This target group is composed of simple *Citizens* (mainly consisted from employees) and *Professionals* (free-lancers and traders). In general they have to carry out a number of procedures (obligations) usually in a periodic basis.

Domain Professionals. They are professional experts that assist tax payers to deal with their tax obligations (accountants, notaries). Those professionals have special requirements from the e-services platform, because of the necessity for massive use of e-services for their clients.

Businesses. Generally they act as a simple Tax Payer. They differ only to the quantity and classification of the adopted procedures. Their representatives are obliged to interact with government.

Governmental Authorities. They require G2G services, mainly consisting of data interchange for various internal tasks or for the provision of one-stop services through interoperability procedures. They are other ministries or various governmental audit authorities.

Non-Governmental Authorities. Authorities like Chambers of Commerce and Industry, the Banking System, or other institutional Independent Authorities, which require data interchange or special services for the reassurance of their actions.

3.2 Required Characteristics

The new e-services provided by GSIS will not just form a wider environment for taxation services provision. They refer to a modern, new generation governmental e-services portal. The most significant characteristics of the new e-services that affect the existing legacy information system infrastructure are:

Single, Real Time Registration and Authentication. Since all services will be hosted at the same environment (application, web and data base servers) it is easy to ensure common registration and authentication procedures. Hence, the existing problem of the synchronization of the existing authentication data for the various services will be eliminated. Since a user (tax payer) enters the e-services environment, he/she is free to use every single service he/she has the right to do, without submitting again his/her credentials. Moreover, the registration procedure will be automated and its response will be immediate. This can be achieved only through line interaction between the e-services portal and the existing legacy information system.

Implementation of the electronic Tax Office. The new e-services provision will implement the vision for the introduction of the e-Tax Office. The idea behind this vision is to offer citizens and businesses the ability to carry out their common obligations and claims for a case percentage more than 90%. That means that regional offices will receive fewer citizens in person and only for special and non-standardized cases.

Enhanced Security. A present open issue-challenge is security assurance through the Internet. For all authentication control, data integrity and confidentiality reassurance, new e-services will use the best existing techniques, adopting PKI technology and widely accepted access control and monitor schemas.

Improved Response Time. All e-services are expected to have a quick response time to the end user. That means that all back office processes and internal communication must be optimized. Exception for this demand is network transfer time because of its dependence to the user's connection type with the Internet.

Added-Value Services. The new generation of an environment, like the one we are discussing here, couldn't continue adopting the existing approach by just imitating standard bureaucratic procedures. It is time for it to offer added-value services, upgrading the relationship of citizens with government and, in our case, with the financial authorities.

Powerful User Support. The referring variety of target groups for the new e-services platform, signifies the variety of regarding user knowledge about the use of a personal computer and/or the utilization of the Internet. In order to support a significant number of users with limited IT skills, the responsible authority has to organize an efficient support mechanism for them.

Interoperability. The interoperability between governmental authorities is one big challenge for Public Administration. Interoperability means the ability of ICT systems and of the processes they support to exchange data and to enable the sharing of information and knowledge. It is crucial for the implementation of one-stop points-of-service that make it easy for citizens to access high-quality government services.

Internal Connectivity. In order to achieve the fore mentioned requirements - characteristics, the new e-services portal must communicate with the existing legacy information system in a more frequently basis supported by enhanced security mechanisms. The ultimate scope is to implement a real time communication and synchronization between the two systems, even to integrate them into one single system, addressed to both internal and external (internet) users.

3.3 Services

The new e-services that GSIS plans to provide through its e-government portal are:

Declaration Services. They cover the majority of the declarations a tax payer has to submit to a tax office in a periodic basis. The basic functionality of those services includes:

- Support of the whole life cycle of a declaration, including supplementary and overtime cases.
- Correctness and integrity checking of submitted data.
- Automated calculation of certain data.
- Declaration retrieval and display.
- Status update.
- Access to declarations of the last five years.
- Pay Notice printout.
- Relevant certificate printout.

Tax payer Profile. The e-service user will be able to retrieve relative to him/her data from the legacy database. Those data refer to:

- Tax registry
- Vehicle ownership
- Real estate
- Tax debts

Certificate Requests. The e-service user will be able to request the issue of a number of tax certificates, for example the tax clearance certificate.

Added-Value Services. These services offer citizens the ability to request and obtain personalized tax information, to track the status and the progress of their cases and finally to use various helpful tools for their future deals with financial authorities. Moreover, a number of added value services focus to the battle against fraud, providing tools for determining the validity of presented data and documents.

4. LEGACY INFORMATION SYSTEM

The current version of the legacy information system is based on a distributed client-server model, where database servers are maintained in all regional offices and a central database is supported in GSIS for data synchronization and lookup purposes. After a successful operation for ten years, GSIS obtained funding for hardware replacement of existing hardware platforms.

Taxation information system's functional requirements are constantly changing, thus there is a necessity for application maintenance. The "form-based" heavy client environment, where applications are written, is currently outdated. It was initially operating in Windows 3.11 platform. Thus, there is a difficulty in migrating it in modern operating system platforms. For application maintenance GSIS invests in maintenance contracts and training programmers in an outdated platform. Furthermore, new functional requirements regarding customer distribution may affect the performance of the distributed information system.

In the following, we discuss the requirements impose the renovation of the legacy information system, the decisions made and benefits and drawbacks of the solutions adopted.

4.1 Requirements/Constraints

The current version of the legacy information system was built having in mind the fact that most citizens expected to be serviced in their local office. Thus, all data related to a specific citizen were maintained as local data in the respective local office. Only a small percentage of transactions (less than 10%) could be performed from another office, while no services were provided through the Internet. This is no longer valid, since most transactions can now be performed using electronic services provided through the e-government portal. Furthermore, in an attempt to simplify procedures and minimize bureaucracy, it was decided to encourage citizens to ask for services in any regional office regardless of their local office. For example, when a citizen moves to a new residential area, he/she is no longer obligated to register to the local regional office, thus his/her record should be always accessible and simply updated from any regional office. Thus, database synchronization becomes far more complicated and should be performed on-line.

The central e-government portal described in section 3 facilitates e-services to citizens, allowing them to complete most common transactions (more than 90%) without visiting any office. The Web Service interface facilitates other public organizations to safely access the system. Thus, the number of citizens visiting local offices to complete their cases is decreasing and, thus, the usage of the legacy information system. It is expected that the number of citizens visiting regional offices will be decreased 30% within the first year of the portal's operation. Furthermore, in order to provide on-line transactional services, the portal should obtain secure access to the legacy system databases. This can be accomplished by interacting with Central Database, since both are hosted in the Data Center of GSIS. Thus, on-line bi-directional synchronization of local and central databases on the legacy system is a hard constraint in order to ensure consistency.

The communication infrastructure of the organization is upgraded, since the Ministry participates in the National Private Network for the Public Sector. Regional offices are connected using 4Mbps (small size offices) to 12Mbps (large size offices), while GSIS Data Center is connected using a 32Mbps line. Thus, communication bandwidth is no more a constraint, as when designing the legacy system architecture.

In order to effectively support both systems (e.g the portal and the legacy system), GSIS should be able to apply the same policies and minimize maintenance cost. Thus, the following factors should be considered:

- Unify the infrastructure supporting both systems
- Obtain a central administration policy and minimize administration cost
- Minimize training cost to support both systems

4.2 Decisions made

In order to efficiently support new requirements imposed, GSIS decided to explore redesigning the architecture of the legacy information system by adopting modern technological treads as server-based computing and light clients. It was decided to explore whether the already obtained funding for hardware replacement and application maintenance could be used for this purpose. The following conclusions were reached:

1. *Replace distributed databases of residential offices with a central one hosted in the Data Center*

This facilitates the on-line (synchronous) synchronization of the portal and the legacy system databases and simplifies citizen record management and update from any regional office. Client programs in local offices should access the central database directly, eliminating any synchronization problem.

The main drawbacks that should be addressed to support this decision are a) high availability of data and b) increased communication bandwidth demand. In a replicated distributed environment the high availability of data is ensured, since even when one replica is corrupted, the other one may be used to restore it. In the case of one central database, data availability may by ensured by clustered servers and a backup database replica. These policies increase hardware ownership and maintenance cost for the Central Database Server infrastructure. This cost is far less than the cost for local server replacement and maintenance. Since existing client applications operate as heavy clients, there is constant need for database interaction either to perform complex transactions or simple field lookups. When supporting a central database, the communication bandwidth demand between each regional office and the Data Center is increased. Since, the legacy information system is an on-line transactional system, a predefined response time must be ensured. Even though communication infrastructure is significantly upgraded, there is a need to minimize communication cost.

2. *Support server-based computing and benefit from the fact that all server equipment is consolidated in the Data Center*

This facilitates the unification of server infrastructure supporting both systems and the implementation of a central administration policy minimizing administration cost. Client application's major functionality will be executed in Application Servers within the Data Center, while light clients operating on end-user workstation in regional offices will be responsible only for user interaction.

One of the major dilemmas faced was whether applications should be rewritten to facilitate a web interface to end-users or whether a remote program execution platform (e.g. CITRIX [8]) should be used to execute existing applications.

3. *Rewrite most applications of the legacy information system to facilitate a web interface based on J2EE architecture*

Supporting a remote program execution platform facilitates the execution of most existing applications in proper Application Servers in the Data Center, while end-users initiate them through light client environments. Only screen modifications are transferred through the network, minimizing communication cost. This solution requires no modification of existing applications and in order to implement it, one should consider only the application server cost.

However, existing application development environment is obsolete. Furthermore, GSIS should maintain two different development environments (a J2EE-based one for the portal and the existing form-based one) for the same system. Both portal and legacy system support almost the same functionality, since the portal supports about 80% of the transactions supported by the legacy system. Most programmers working in GSIS are familiar with J2EE application development, which is a current technological standard. Furthermore, the cost of maintaining such applications proved to be less than the one for existing form-based environment. Although the "actual" code implementing portal e-services could not be used to replace existing legacy applications, unifying the development environment for both systems promotes code reusability and simplifies code maintenance.

4.3 Cost of ownership / return on investment

The cost of rewriting legacy application code and maintaining the system for one year proved to be the same as the cost of maintaining existing applications for three years. This cost includes basic existing application maintenance with no additional application development. GSIS decided to adopt this policy and freeze the functionality of existing legacy applications for two years. It should be noted that only the user interface part of applications is rewritten. Most application logic is embedded in existing stored procedures used in both versions of the system. The overall project duration is two years. It started almost a year ago and is currently under development. Migration issues and the parallel operation of the two versions of the system for a period of six months are also addressed.

The cost of purchasing hardware to implement a central solution proved to be 20% less than local server replacement cost. Thus, it was decided to maintain existing servers of two more years and also initiate procedures for obtaining new hardware. It is estimated that hardware maintenance cost will be decreased, although not considerably.

5. CONCLUSIONS

The provision of on-line transactional e-government services drastically affects underlying legacy information systems, since it imposes new functionally requirements to it. The purpose of this paper is to explore the necessity to renovate existing legacy systems in order the effectively support such services, having in mind the specific case study. The problems addressed, alternative scenarios explored and solution adopted were discussed.

GSIS ensured funding for hardware replacement (server infrastructure supporting databases in regional offices and the central database) and applications maintenance for the next two years. Exploiting the same funding, it was possible to redesign the system architecture and rewrite applications of the legacy information system to facilitate a web interface based on J2EE architecture.

6. REFERENCES

[1] R. Riedl, "Knowledge Management for Interstate E-Government", In Proceedings of the **Workshop on Knowledge Management in Electronic Government**

(KMGov), Siena, Italy, May 22-24, 2001, http://www.ifi.unizh.ch/egov/Sienanew.pdf.

[2] A. Bouguettaya, A. Rezgui, B. Medjahed, and M. Ouzzani, **Internet Computing Support for Digital Government. Practical Handbook of Internet Computing**, Singh, M.P. (Ed.), 2004, ISBN 1-58488-381-2, CRC Press.

[3] R. Bose, "E-government: Infrastructure and Technologies for Education and Training", **Electronic Government**, 1(4), 2004, pp 349–361.

[4] T.B. Riley, **Electronic Governance and Electronic Democracy: Living and Working in the Connected World**, presented at the Commonwealth Heads of Government Meeting, Brisbane, Australia, 2001, http://www.electronicgov.net/pubs/research_papers/index.shtml.

[5] D. Stamoulis, D. Gouscos, P. Georgiadis, and D. Martakos, "Revisiting Public Information Management for Effective E-government Services", **Information Management & Computer Security**, 9(4), 2001, pp 146-153.

[6] A. Angehrn, "Designing Mature Internet Business Strategies: The ICDT Model", **European Management Journal**, 15(4), 1997, pp 361-368.

[7] P. Markellou, A. Panayiotaki and A. Tsakalidis, "E-Government and Applications Levels: Technology at Citizen Service". In Proceedings of **IADIS International Conference on E-Society 2003**, Lisbon, Portugal, 3-6 June 2003, pp. 849-854.

[8] Citrix, Citrix Access Platform for Government, Citrix official site, 2005, http://www.citrix.com/English/ps2/segments/v/vertical.asp?contentID=1415&ntref=hp_nav_US.

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