TOWARDS A SCIENTIFIC APPROACH TO E-GOVERNMENT RESEARCH

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Abstract

E-Government has an unprecedented potential to improve the responsiveness of governments to the needs of citizens and has long been recognized as a key strategic tool to enable reforms in the public sector. However, this potential is to this day non-systematically exploited, as e-government research efforts are largely uncoordinated and there are significant barriers that hinder the effective exploration, management and distribution of the vast amounts of public sector information towards the research communities, and a lack of proper tools to allow their utilization and computation by the latter. In this context, the main goal of this paper is to review the current status of research and broader activity in the field of e-Government, identify the challenges that the e-government research and practice communities face and address the latter in terms of introducing a new scientific approach to e-government research, based on the deployment and use of a virtual research-oriented service infrastructure that will make available and enable to process large amounts of available knowledge within the public sector, internationally. For this aim, the paper presents the conceptual framework related to this approach, describes the model architecture of the envisaged infrastructure and determines a set of requirements and practical implications that need to be taken into account to ensure its success.

Keywords: e-Government, virtual research infrastructures, public sector data, data mining, simulation, visualization, multidisciplinary research.

1 INTRODUCTION

E-Government, i.e. the use of Information and Communication Technologies in Public Administration has an unprecedented potential to improve the responsiveness of governments to the needs of citizens and has thus long been recognized as a key strategic tool to enable reforms in the public sector. However, this potential is to this day non-systematically exploited, as e-government research efforts are largely uncoordinated and there are significant barriers that hinder the effective exploration, management and distribution of the massive amounts of available public sector information towards

the research communities. Furthermore, there is a shortage of experimental methods and tools that would allow effective knowledge mining, visualization or further computation, so as to underpin the work of the multidisciplinary research and practice community dealing with e-government transformation, and to consequently promote the improvement of the performance of Public Administration as well as the quality of services provided to citizens. This vast amount of public sector information ranges from socio-economical data to e-government standards and guidelines, from citizen records to geospatial databases, from municipality databases to public libraries, from operational and process-related information to indices and metrics, from financial sector databases to statistical data, from existing modelled services and procedures to document XML schemas.

Of course, data fuels the information age and databases are the binary oil fields of that age. Information is power and the ability to combine and aggregate data from a multitude of sources in order to look for patterns and to draw useful conclusions can lead to the production of new knowledge. Many e-government researchers believe that existing data and knowledge is a potential solution to the well-known challenges facing the e-Government area worldwide today. Thus, it is important that data remains available to the e-government research and practice communities.

The vision that any form of scientific content resource (e.g. statistical data, scientific reports, research articles, experimental or observational data, rich media etc.) should be easily accessible, is already clear in several scientific areas that are dealing with research challenges of global relevance and is taking shape through the establishment of user friendly e-Infrastructures (Marek, Pires & Glinos, 2009). The latter are defined as the technical and administrative framework and facilities underlying e-Science digital repositories (e-SCiDR, 2008). Although until recently the concept of e-Infrastructure has been minimally defined, to include networks, authentication and authorisation mechanisms, middleware, computational resources and grid technologies, a wider interpretation of it has been currently adopted to cover as well technologies of various kinds for creating, collecting, annotating, manipulating, storing, finding and re-using information, and services such as those to provide user support and training, and to further include information resources and associated tools such as vocabularies, ontologies, rights management and privacy protection systems, and curation. Examples of existing e-Infrastructures include the e-NMR computational infrastructure in system biology (http://www.enmr.eu/), as well as a number of cooperative grid-computing platforms in the areas of High Energy Physics, Astrophysics, Computational Chemistry, Life Sciences, Biomedics, Geophysics etc., supported by the EGEE grid computing project (http://www.eu-egee.org/).

Moving from the research area to government practice, Data.gov (http://www.data.gov/), a USA open government initiative consisting of a set of interoperable infrastructures, services and web applications, aims at increasing public access to high value, machine readable datasets generated by the Executive Branch of the Federal Government. Data.gov provides descriptions (metadata) of the Federal datasets, information about how to access them, and tools that leverage government datasets and promotes the creative use of those datasets beyond the walls of government for the purposes of building applications, conducting analyses and performing research in order to enhance the transparency, accountability and openness of the latter.

The integration of the Web 2.0 advantages into government practices, as in the former case, is also highlighted in an attempt to build an open declaration on public services 2.0 in the European Union, where it is indicated that "the needs of today's society are too complex to be solved by government alone. While traditional government policies used the web to automate public services and encourage self-service, the biggest impact of the web will be in improving services through collaboration, transparency and knowledge-sharing". On another level, the advent of research 2.0 paradigms opens new perspectives for cross-border and multi-disciplinary collaboration, leading to the emergence of global virtual research communities and proving that a cultural change is taking place in the way scientific knowledge is produced and disseminated.

Under these circumstances, achieving the full promise of e-Government requires a new systems approach that is only to be enabled by novel, interoperable IT infrastructures facilitating simpler data access, data sharing and enhanced collaboration among the research and practice communities involved. On the other hand, since the accelerated and uncontrolled proliferation of public sector data

may undermine the efficiency of the scientific discovery process as much as the unavailability of information, it is crucial to develop innovative and customized tools and methods to ensure effective utilization, preservation and further computation of the massive quantity of data.

In this context, and since e-Government research has to accompany the modernization of the public sector, this paper introduces a new scientific approach to e-government research, based on the deployment and use of a virtual research-oriented service infrastructure that will make available and enable to process large amounts of available knowledge within the public sector, internationally. The discussion in this paper proceeds as follows: Section 1 is an introduction to the issues addressed. Section 2 identifies and reviews the present status of research and broader activity in the area of e-government and defines the challenges that currently impede the work of the research and practice communities involved. Section 3 presents the conceptual framework, related to the envisaged approach to e-government research, i.e. describes the proposed virtual research-oriented service infrastructure in terms of its objectives, functionalities and model architecture. Section 4 identifies a set of requirements that imposes the deployment of the envisaged infrastructure in the context of the proposed approach. Finally, Section 5 summarizes the ideas presented and draws relevant conclusions.

2 BACKGROUND

2.1 Definition and importance of e-Government as a scientific field

Electronic Government refers to government's use of technology, particularly web-based Internet applications to enhance the access to and delivery of government information and service to citizens, business partners, employees, other agencies, and government entities (Layne & Lee, 2001). Definitions expressing the breadth and depth of the field have been formulated by various institutions, such as the European Commission ("e-Government is the use of information and communication technologies in public administrations - combined with organizational change and new skills - to improve public services and democratic processes and to strengthen support to public policies."), or the German Society for Informatics ("Electronic government refers to the implementation of processes of public participation, decision-making, and service provision in politics, government and administration with an intense usage of ICT.).

Virtually unknown a decade ago, e-Government as a term, as an identified activity, and as a topic for research has grown dramatically (Heeks & Bailura, 2007). E-Government has evolved as a field with increasing research and technology development (RTD) investments, as all countries across Europe and internationally have spent a lot of money in e-Government and the modernization of the public sector. Total (including central, regional and local layers) public administration ICT expenditure in 2004 for EU25 was estimated at about € 36.5 billion, with € 11 billion devoted in e-Government reforms (e-Government Economics Project, 2006). Since the benefits of e-Government became apparent, the number of worldwide e-Government projects also increased in the time period between 1996 and 2001 from three to more than five hundred national initiatives (Al-Kibsi, de Boer, Mourshed & Rea, 2001) and continue to expand. During the last decade, the European Commission has funded a lot of research projects in order to advance e-Government: In the 5th Framework Programme (FP5), research in the e-Government field was carried out as part of the Key Action on "Systems and services for the citizen" (European Commission, 2009a). E-Government research in the 6th Framework Programme (FP6) has focused on modernising public agencies at all levels, innovating to create new and/or improved services for citizens and businesses which can save them time and money in their dealings with government (European Commission, 2009b). In the context of the 7th Framework Programme (FP7), ICT for Governance & Policy Modelling (Objective 7.3) envisions the creation of a dynamically participative "e-Society" (European Commission, 2009c).

Throughout these years, e-Government has been placed at a crossroad between a number of other research domains, particularly computer science, information systems, public administration, and political science (Heeks & Bailura, 2007), proving also its multidisciplinary nature. E-Government research constitutes a thriving research domain from all aspects – scientific, entrepreneurial, societal

and political - that becomes more rigor (Gronlund & Andersson, 2006) and flourishes during the last years.

The use of innovative ICT in modern governments has become an increasingly important factor for improving their responsiveness to the needs of citizens and has long been recognized as a key strategic tool to enable reforms in the public sector and unlock its potential (3rd eEurope eGovernment subgroup meeting, 2004). In this direction, e-Government has been well embedded in policies and strategies across the world defining milestones and action plans at national and cross-country level. These national strategies have been streamlined to meet the objectives of the EU strategies such as the i2010 Strategic Framework (Commission of the European Communities, 2006) and the Lisbon agenda, where e-Government is recognised as a key initiative for European policy. Since the implementation of e-Government implies different objectives and levels of transformation in public services in different countries (Weerakkody, Baire & Choudrie, 2006), a future-oriented approach to e-Government research is thus just beginning to emerge leading many EU Member States to revise their existing strategies for public sector modernization and e-Government transformation (Dawes, 2008). As stated in the latest Ministerial Declaration on e-Government, e-Government has not only become mainstream in national policies but has also reached beyond national boundaries to become an important enabler to deliver European-wide policy goals across different sectors, from justice to social security, to trading business services and beyond (Swedish Presidency of the European Union, 2009). In this direction, as the EU Services Directive (2006/123/EC) (European Communities, 2007) on electronic services provision for businesses and citizens becomes effective, the need for cross-country e-Government research and solutions becomes an imperative.

Moving from theory to practice, the e-Government-led implementation of ICT in public administration during the last ten years has offered better, faster and more transparent means for citizens and businesses to interact with government (Capgemini, 2007). According to the UN Web Measure Index (UN DESA, 2008) which provides UN Member States with a comparative ranking on their ability to deliver online services to their citizens, of the 192 UN Member States, 189 were online in 2008. It further indicates that countries must continue to improve their services and infrastructures to keep up with the demands of their citizens, since even the top-9 countries in the e-Government Readiness Index have not yet achieved interoperability of their infrastructures as indicated by the gap between Stages I (Emerging) and V (Connected). Such a gap can be attributed to the fact that in most countries a wealth of independent e-Government projects has been implemented, yet they have limited coherence and remain largely uncoordinated (Janssen & Hjort-Madsen, 2007) without solving the real systems integration problem.

Furthermore, the promise of e-Government is not, as some suppose, putting existing paper-based processes of bureaucracy into digital form. Rather, the promise is really nothing less than a profound transformation of the way the government does business (Garson, 2004) and it is not an objective per se; more it has to be seen as means of organizing public governance for better serving citizens and enterprises (Traunmüller & Wimmer, 2004). In this context, Government 2.0, a term coined by William (Bill) Eggers (2005), appears as an attempt to provide more effective processes for government service delivery to individuals and businesses by applying the social networking and integration advantages of Web 2.0 (O'Reilly, 2005) to the practice of government (Osimo, 2008). Integration of tools such as wikis, development of government-specific social networking sites and the use of blogs, RSS feeds and Google Maps are all helping governments provide information to people in a manner that is more immediately useful to the people concerned.

2.2 Current challenges for e-Government research

Despite the importance of e-Government as a scientific field and considering the current status, maturity of implementation and future directions of e-Government research (Charalabidis, Lampathaki & Askounis, 2009; Dawes, 2008; EC, Information Society and Media, 2008; EC, IPTS & DG-JRC, 2006; Gartner, 2007; Osimo, Zinnbauer & Bianchi, 2007) several deficiencies and imbalances can be recognized. The research field as such is still immature and in search of defining boundaries, core focus, methods, and theories (Grönlund, 2005; Scholl, 2008). Different disciplines have a distinct understanding of research and are grounded in their single disciplinary understanding of e-

Government. Multi-disciplinary teams of research still struggle with finding common grounds of understanding, and with lack of proper awareness of the complexity of the field. A very active research community engaging researchers from organizations across the world has already been formulated, as indicated from its participation in major e-Government conferences and working groups (e.g EGOV, HICCS, and dg.o conferences, IFIP WG 8.5 on Information Systems in Public Administration, NESSI iGovernment Working Group etc.). It still suffers though from a lack of standard benchmarks and infrastructures for assessing its research outcomes.

From the practice and usage point of view, the strong interdependencies among technology, organizational, social, political, economic and legal aspects have not been efficiently explored (EC, IPTS & DG-JRC, 2006), while a proper understanding of "what the citizens really want" is missing. Even more, awareness of the existence and availability of certain solutions at the stakeholders' side (public administrations, research community), as well as proper schemes to use and exploit existing tools, and to harness the collaborative nature of the web and other advancements in e-Government, are heavily lacking.

These deficiencies indicate that there is a need for supporting the electronic government research and practice communities with advanced research-oriented methods, services and tools, that will utilize and make available large amounts of available knowledge within the public sector internationally and will make it possible to represent and support the multidisciplinary nature of the e-Government and public sector transformation activity by enabling multidisciplinary research and scientific collaboration among the multiple communities involved.

3 VIRTUAL RESEARCH INFRASTRUCTURES IN SUPPORT OF E-GOVERNMENT RESEARCH

3.1 Conceptual Framework

As already indicated, the vision of advancing the way in which e-Government research is conducted, and consequently of promoting public sector modernization requires a new systems approach. This approach is summarized into the deployment and use of a large-scale, multi-disciplinary virtual research facility that is going to incorporate distributed and diverse information resources as well as user-friendly data mining, simulation, visualization and impact assessment tools, applications and services, integrated into a unified environment.

Although, based on the former assumption, the primary concern seems to be the establishment of a technical infrastructure along with the relevant tools and services, the envisaged approach aims much deeper and intends to benefit the e-government research area in multiple levels: Addressing the challenges that the e-government research and practice communities currently face, the facility in question is intended to provide a collaborative environment and thus remove the constraints of access and usability as well as the barriers between disciplines, enabling the adoption of a truly multi-disciplinary approach to e-government research and enhancing the effectiveness of latter by allowing for the various aspects (organizational, social, economic, political, legal) involved to be addressed. More specifically, the proposed infrastructure is envisaged to promote a highly synergetic approach to e-Government research and public sector transformation by providing the ground for experimentation to actors from both ICT and non-ICT related disciplines, such as economics, law, sociology, statistics etc, as well as by ensuring that the findings and results of e-government research activities are made accessible to the latter in a structured and easy accessible way for the purposes of benchmarking, training and skills development, for avoidance of redundancies, and contribution to knowledge sharing in the field. The idea is that existing knowledge may be exploited to assist and support new scientific and research breakthroughs, while best practices may serve as potential solutions to well-known real life problems and challenges.

Moreover, the deployment and availability through the proposed infrastructure of numerous public sector digital repositories, containing operational data, financial performance information, policy and regulation frameworks, process-related information, statistics etc. will serve the objectives of

knowledge transmission, exchange and preservation and will strengthen the interaction between research, policy and practice, as it will enable the active reuse of public data and the extraction of more reliable scientific results through simulation and experimentation on large data sets. On another level, both the effective dissemination of research prototypes and the availability of public sector data will support industry suppliers, deploying systems and services for the Public Administration and will provide them with innovative models of new service paradigms.

Last but not least, the envisaged simplicity and user-friendliness of the tools and services to be provided will make possible the use of the facility by non-experts beyond the boundaries of the research and practice communities (researchers, public administrations) involved, meaning that even citizens will have access to public sector information, and empowered through user-friendly simulation and visualization tools, will be able to reach informed judgments on the cost and value of public service delivery and the process of e-government transformation in general. In fact, citizens' engagement will be bidirectional as the integration into the facility of web 2.0 mass collaboration applications (social media), will enhance citizens' participation and will provide a means of creating, sharing and tracking of knowledge about the needs, wishes and perspectives of the latter with regard to e-Government.

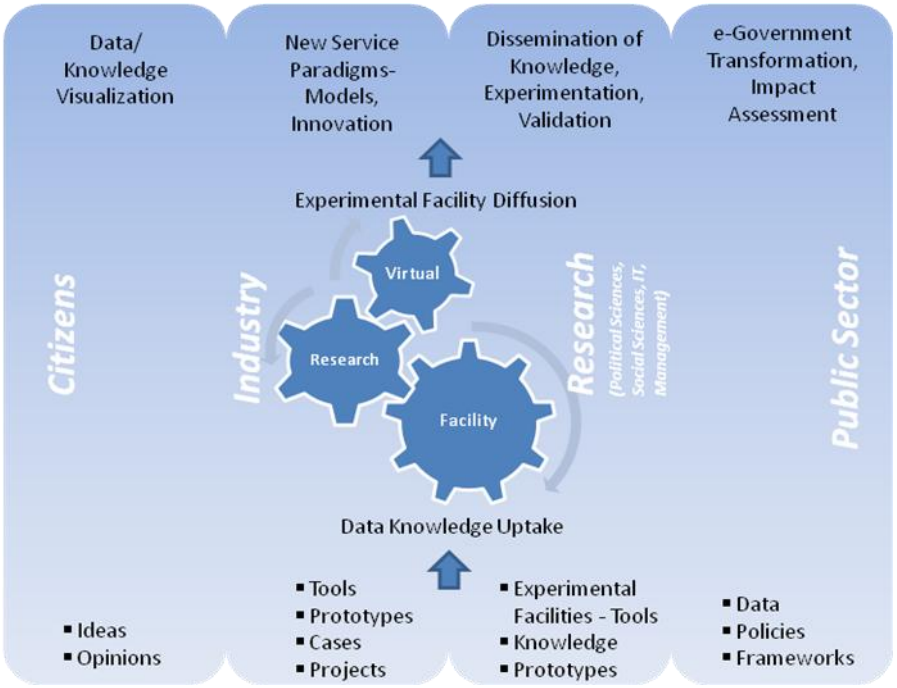

Figure 1. e-Government Virtual Research Facility

Based on the above an indicative list of the services, functionalities and key features of the proposed infrastructure will include:

- Use of the virtual facility's services and tools for effective and user-friendly data mining, simulation, visualization, impact assessment of further processing of information.
- Availability of easily deployable building blocks for the design and development of new applications and services as well as customized tools.
- Deployment and interconnection of large scale digital repositories of public sector information for knowledge transmission and preservation.
- Active reuse of public sector information and experimentation on large data sets.
- Conduction of multidisciplinary research, development and running of e-government simulation scenarios utilizing Operation Research Algorithms, Business Process Management Tools, Financial Estimation models etc.

- Showcase of research prototypes, demos and models on e-government transformation and new public service paradigms.
- Collaboration services and tools (e.g. collaboration environments, private working spaces, content management systems etc.), enabling researchers, groups and research or practice communities to share ideas and collaborate across organisational boundaries.
- Web 2.0 mass collaboration applications (e.g. social networking tools, wikis, discussion forums, chat rooms etc.) for information exchange, communication and collaboration among end users, including citizens.
- Availability of information, creating the baseline of literacy, knowledge and skills for different stakeholders to use the instruments and services provided.
- User-friendly and remote access to the facility regardless of the users' location.

3.2 Architecture and Basic Components

In order to achieve the objectives and to offer the functionalities described before the proposed facility shall have to use the principles of Service Oriented Architecture design and to be implemented as a layer of application-oriented services that will be managed by workflow tools and "science gateway" portals above a cloud computing infrastructure.

Cloud computing is an emerging internet-based service delivery model that allows more efficient computing by centralizing storage, memory, processing, bandwidth and instruments in remote servers. It is about using grid computing, which constitutes the model for managing large scale distributed resources as infrastructures for research, in conjunction with virtualization (Hoffa et al., 2008) to enable flexible, on-demand access to a shared pool of configurable computing resources and services and as such it has received a growing interest as a potential solution to the problem of forming a coherent system devoted to a "virtual organization" of users who share a common interest in solving a complex problem or building an efficient agile enterprise (Gannon et al., 2005).

On the other hand, service-oriented architecture (SOA), being a flexible set of design principles for systems development and integration, provides the foundational concepts for and has emerged as a standard way of building grids (Gannon et al., 2005), as it requires loose coupling of services with operating systems and other technologies that underlie applications and enables thus service deployment over multiple environments. Based on the above, the combination of service-oriented architecture and cloud computing is considered a beneficial approach, suitable to support a virtual research and practice community.

Therefore, adopting the typical cloud computing stack structure, which encompasses the notion of "Everything-as-a-Service (EaaS)" (Infrastructure-as-a-Service - IaaS, Platform-as-a-Service - PaaS, Software-as-a-Service - SaaS), the envisaged virtual research environment shall have to be founded on a three-layer architecture. The latter as shown in Figure 2 will involve an underlying infrastructure, composing of the hardware devices (data centres) to offer the basic computing, network and storage services, a middle layer encompassing the platform's main components and offering a series of advanced services, and an application layer, that will integrate the appropriate user interface and will serve as the entry point to the facility's features.

The basic components of the platform, described in the following paragraphs, will include:

- a Data and Knowledge Repository accompanied by a Data and Knowledge Mining Toolkit,
- a Visualization and Simulation Toolkit and
- a Multidisciplinary Research Toolkit.

All components will be interoperable with each other and seamlessly integrated into a unified virtual research facility.

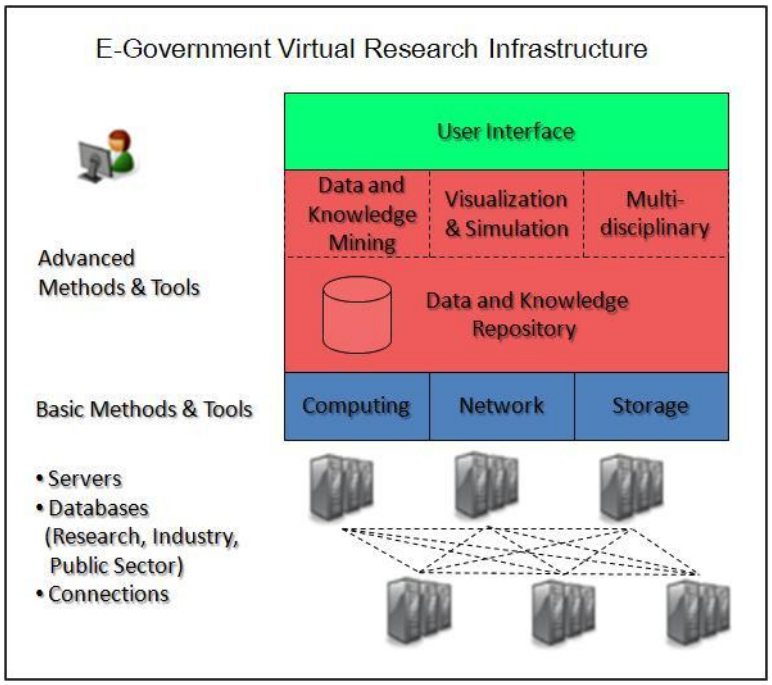

Figure 2. Virtual Research Facility Architecture

3.2.1 Data and Knowledge Repository

To serve the purposes of knowledge collection, management, aggregation and dissemination, the system's Data and Knowledge Repository will be an extended, state-of-the-art, central repository, in which the knowledge concentrated will be categorized according to a multi-criteria organization and will be easily accessed through a searchable and easy to navigate format, supported by a user-friendly interface. It will be built upon a content management system and will consolidate various types of resources, providing a central, up-to-date information point for e-government research and public sector transformation. The knowledge available through the Repository will include:

i. public sector-related knowledge (e.g. information on public sector information/processing systems and portals, ICT planning, deliberation data, organizational structures, legal and regulatory framework),

ii. research prototypes and solutions,

iii. information on other interlinked e-Government infrastructures

and will potentially be managed through the use of efficient knowledge management techniques, such as the Topic Maps (ISO/IEC 13250), an ISO standard for knowledge representation and interchange using topics (touching upon any concept), associations (representing relations between topics) and occurrences (representing information resources relevant to a particular topic). The significance of the effectiveness of the techniques to be used stems from the volume, range and complexity of the knowledge to be managed. Using such powerful tools, information from multiple resources will be combined and interrelated to provide a complete map of the e-Government landscape internationally but also specific views on this map, per country, organization, domain or system (etc.) upon will.

A consolidated version of the types of information to be provided through the envisaged facility is presented in Table 1.

Public Sector Knowledge	
Public Sector Information Systems (PS-IS)	Structure, architecture, context and operation of PS-IS
	Service Portals – Utilization - Number of registered users - Number of offered services (per level, per type) - Number of service requests (per service, service type, area, time interval) - Service completion times - Operating costs
	Information Processing Systems - Number of transactions (per service type, per org. unit) - Transaction times (per service, org. unit) - Stored data (volumes) - Operating costs - Information on investments
	Information Systems Assessment - Survey results, problems identified - Citizens' complaints (anonymised)
Public Sector ICT Planning (ICT Observatories, Policy Making Public Sector Units)	Public investments in ICT (done, planned)
	i2010, UN, other EC metrics and indicators
	National and Local ICT uptake indicators
	Forecasts on ICT uptake
Public Sector Public Deliberation Data	Descriptions of eParticipation Systems
	Number of registered users
	Number of opinions gathered, numbers of interactions
	Problems, citizens' complaints (anonymised)
Public Sector Organisational Data (Ministries, Prefectures, Municipalities, Agencies)	Number of employees per org. unit
	Employees' ICT background, skills, training, progress
	Information on public administration processes
	Information on public sector service provision
	Legal Information
Public Sector Legal and Regulatory Material and Frameworks	Legal information on services, processes, transactions
	Interoperability Frameworks and Enterprise Architectures
Research Prototypes and Solutions	
Research Methods and Frameworks	Design, modeling, development, evaluation methods and frameworks
Research Prototypes and Solutions	Models, ontologies, registries, applications and other reusable components
Training Material	Material for knowledge, skills and lessons development
e-Government Infrastructures	

Table 1. Types of knowledge to be provided by the proposed virtual research facility

3.2.2 Data and Knowledge Mining Toolkit

Due to the massive amount of information to be made available through the facility's Knowledge Repository, the use of the latter will be supported by a data and knowledge mining component. Data mining (Fayyad, Piatetsky-Shapiro & Smyth, 1996) refers to the process of extracting patterns from large amounts of data and encompasses the tasks of data classification (i.e. data arrangement into predefined groups), clustering (i.e. data assignment into non-predefined groups that include similar items), regression (data modeling attempt) and association rule learning (involving searching for correlations among items). In the sense of the proposed systems approach to e-government research, the data mining schemes to be provided shall have to involve both knowledge mining, i.e. statistical and logical analysis and information extraction from large sets of observational, experimental, operational (etc.) data as well as opinion mining, i.e. public opinion extraction from online reviews or material published in blogs, forums and social networks in general (Ku, Liang & Chen, 2006),

providing thus a means for approaching and identifying public opinion towards policies and public service delivery methods. Moreover, to support and enable automated knowledge processing, semantic technologies will have to be employed to allow (wherever possible) knowledge conceptualization and formalization (e.g. by means of ontologies).

3.2.3 Visualization and Simulation Toolkit

Data visualization is a research area that focuses on the graphical representation of data, so that the latter is made easier to read, understand or analyze (Fayyad, Grinstein & Wierse, 2002). Its main goal is to communicate information clearly and effectively by using powerful visual techniques that allow to convert massive, heterogeneous or abstract sets of data into useful information, so that the user can make the most of it in the shortest time and with the least effort, and supporting thus effective technical, business and strategic decision making. In the context of e-government research and public sector transformation, visualization of statistical data, transactions, multiple database records or geographical information as well as argument visualization are only a few of the visualization possibilities to be covered by the tools of the envisaged infrastructure.

On the side of simulation, which as a field has a scope of application in engineering, physical as well as human sciences, and refers to the process of modelling and imitating the operation of a system in order to gain an insight view of the latter and predict its behaviour, based on a set of parameters, initial conditions and scenarios, social simulation and system dynamics should be basic fields of application of the tools to be deployed through the proposed system: social simulation makes use of computational tools for research in social sciences (Garson, 2009), while system dynamics (System Dynamics Society) is a mature methodology for modelling complex issues and problems both in the private and public sector, and then through simulation estimating the evolution of critical variables, being thus an effective technique for framing and understanding difficult problems and policy options and for addressing them. Economic forecasting, process engineering simulation, strategic management and policy impact assessment should also constitute further areas of application.

Exploiting the large variety of methods and tools available, the visualization and simulation toolkit of the envisaged facility should include both generic tools facilitating simple tasks, as well as customized tools focusing on specific problems and capturing their unique characteristics, while it should also offer a set of building blocks for enabling users to develop remotely simulation models and visualization schemes easily and rapidly.

3.2.4 Multidisciplinary Research Toolkit

To address the fact that currently awareness, access and exploitation of the breath of methods and frameworks applicable to the area of electronic government and public sector transformation are limited among the various stakeholder communities, this component should offer a structured collection (toolkit) of well established methodologies, tools and frameworks, covering a variety of aspects (design, modelling, development, implementation, adoption, evaluation, benchmarking etc.), involved in the research field of interest. This collection should incorporate qualitative and quantitative methods as well as experimental techniques, and other methods such as workshops and focus groups and should be accompanied by a relevant taxonomy. Methods, frameworks and tools under this taxonomy should be mapped against multiple themes in the area of electronic governance and public sector transformation, allowing end users to use these mappings as a decision aid on the most appropriate combination of methods, tools and frameworks that need be incorporated in various research scenarios and themes.

4 RELEVANT REQUIREMENTS

In order to fulfil the objectives and functionalities outlined above, the proposed facility will be subject to a set of requirements touching upon interoperability, scalability and sustainability, services'

availability and reliability, security and authentication and data consistency concerns, and imposing the development and adoption of a comprehensive technical and administrative framework.

More specifically, since the level of complexity of such an infrastructure is expected to gradually increase due to the growing number of national resources to be involved, the number of communities to be supported and the increasing complexity of middleware to be deployed, interoperability and scalability concerns are bound to arise. Such concerns will be addressed through the joint definition and use of common standards and/or policies, practices and guidelines specifying the interoperation between the infrastructure's distributed nodes and/or the national resources.

Additionally, sustainability requirements may be accommodated by distributing the responsibility of daily operations for ensuring availability and reliability of services to the distributed data centres involved, through appropriate Operational Level Agreements, flexible enough so as to guarantee both the autonomy of the latter as well as the fact that the individual nodes of the infrastructure will fully conform with the general policies and procedures and will satisfy the specific requirements defined. The facility's operation is to be further supported by additional mechanisms, such as monitoring tools, alarm systems, ticketing systems, etc. and tools that improve automation.

On the other hand, security and authentication issues are to be managed by means of a common authentication trust domain, while concerns with regard to intellectual property rights' protection are compounding the need for a consistent IPR management framework.

Finally, aspects with regard to the usability and consistency of the vast amounts of data that will be made available through the proposed facility may be covered through the establishment of a normalization framework that will enable standardized access across organizational and international boundaries and will specify and implement validated data aggregation and curation processes and conversion schemas, with the aim of ensuring overall interoperability, availability and durability of scientific data, so that the latter can be transferred to e-government researchers and practitioners as meaningful knowledge.

5 CONCLUSIONS

Despite the fact that the fields of e-Government and public sector transformation are of strategic importance from both policy and practice perspectives, the area of e-Government research is currently facing several insufficiencies. This paper addresses these insufficiencies, by introducing a new approach to conducting e-Government research that is based on the establishment of a scientific virtual environment, through which important information and tools are to be made available. The paper analyzes the conceptual framework related to this novel approach and outlines the ways in which the latter is going to benefit the e-Government research and practice communities. The advantages and benefits of the envisaged approach, multiple and manifold, as already outlined in this paper, have also a broader perspective and a strategic dimension, which encompasses in brief the contribution to standardization processes in the field of e-Government, the promotion of interoperability and best practices, the alignment of the research orientation and scientific priorities with the corresponding strategic and political priorities and finally the acceleration of the process of e-Government transformation.

Still, the envisaged approach is limited by the set of requirements identified in section 4 of this paper, which have to be carefully addressed in order to ensure the unhindered operation of the relevant infrastructure, while its success depends also to a great extent on the eagerness of public sector organizations to make their data available, suggesting that the feasibility of the proposed approach has to be further investigated. On the other hand, although care has been taken in this paper to describe as thoroughly as possible the proposed infrastructure, it is possible that there are certain omissions with regard to the functionalities to be covered and the tools, services and research methods to be offered, suggesting that the supporting research framework might need to be further enriched and indicating that the envisaged facility is only to be seen as a powerful supporting tool for research and not as the ultimate solution to all the challenges currently appearing in the landscape of e-government research and broader activity.

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