A Business Process Analysis and Modeling Architecture for E-Government

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Abstract

National and local governments are automating bureaucratic cumbersome services by interacting fully or partially with their citizens, with the industry and commerce, and with other state offices through electronic means. Although, information and communication technologies spread at a dazzling speed bringing with them hopes of a more efficient government and more accessible information and services, the risks during the conception and implementation of e-government projects are also significant. A careful and thorough analysis of the administrative processes to be implemented must define not only the best way to do it through business process modeling and optimization, but also determine the areas of high chances of success. This paper describes a business process analysis architecture developed with the aim of delivering comprehensive analyses of e-government projects taking advantage of state-of-the-art technology, including the Semantic Web.

Introduction

Broadly defined, e-government is the use of information and communication technology (ICT) to promote more efficient and effective government, facilitate more accessible government services, allow greater public access to information, and make government more accountable to citizens. (The Working Group on E-Government in the Developing World, 2002) ICT's include the Internet, telephone, wireless devices, community centers or other communication systems.

Customers of e-government services and products are not only individuals, but also the industry and commerce, other public institutions and its own employees. In this way, we can define four user groups in e-government.

- G2C: Government-to-Citizen
- G2B: Government-to-Business
- G2G: Government-to-Government
- G2E: Government-to-Employee

Although, in e-government the specific demands of each user groups are to be satisfied by electronic means, this does not mean that e-government is only about implementing technology. Rather, it has to do more with a deep and extensive reorganization including a readjustment of the way of thinking at every organizational level (i.e. management and employees). It requires re-engineering the government's business processes, both within individual agencies and across government.

The main topic of this article is government's business process analysis. A business process analysis (BPA) will serve as the connecting layer between the strategic management policies and technological decisions. Such an analysis should deliver a comprehensive picture of the chances, the risks and the political strategic actions appertaining to an extensive re-organization in public offices. It should serve as an important driving force for further rectification of administrative processes in public institutions.

Roughly speaking, a business process analysis should embrace:

- The interests and mission of the commissioning party, which will define the goals of the analysis.
- The recognition of theoretic potentially high success areas, which will produce "winners".
- An analysis and modeling of the is-processes which will lead to the development of a model of should-be processes.
- An analysis of the technical components relevant to the processes. The analysis should include front-office systems (closest to the customer) and back-office systems (internal specific components of the administrative structure).
- The identification of the principal political, legal, organizational and technical preconditions for the realization of an e-government project.

In order to develop such an analysis, the following information is crucial for the business processes modeling:

- Process duration, process costs and process frequency.
- Interaction schemes of the participating organizational units in processes.
- Detail information about software and hardware systems with special focus on their interoperability.

- Identification of system communication disjunctions and redundant media transformations.
- Classification of products and services according to the "Information, Communication and Transaction"[1] model.
- A semantic standardization of processes and information objects (including products and services).

The overall outcome of this analysis will be an indicator of the readiness for the implementation of e-government in the target area. Here, it must be pointed out that "e-readiness" begins principally with the political will to introduce changes and take "ownership" of the project. The business process analysis will only present evidence and guidelines for its implementation.

The state-of-the-art technology in our approach borrows ideas of the "Semantic Web". We have created formal models of the organization's reality (products, processes and resources) and expressed them as ontologies[2] and process models. Reference models are developed and used in a decentralized way. The Internet or the organization's intranet will be the means of distribution for such models.

BPA in e-government projects

As we learned from the introduction, every business process analysis must beginning with clear and precise goals. Our experience has also shown us that e-government projects normally target specific products and/or services rather than an organizational unit. This is a clear result of the shift in orientation innate to most e-government projects, i.e. they aim at a customer orientated government. Such orientation will require in most cases the cooperation between different public offices, but in some cases the interaction with private services is also possible. Also, the customer must be very well identified and the point of view of process analysis will be that of the customer and not the standpoint of a specific organizational unit. Therefore, due to the magnitude of the changes in the way of thinking and linear business process in public administration, the complexity of e-government projects is enormous.

Experience has also demonstrated that every project is unique, even when the product or service is the same in two different projects. Reasons for this are different organizational structures, different technical infrastructure, continuing oral tradition, access to technology from the side of the customer, lack of expertise and information, etc.

A business process analysis methodology for e-government projects must be extremely flexible and adaptable to every situation in order to meet the requirements of every project. We have developed a modular architecture which allows the process analysis and modeling to be easily adapted to each situation. It has the requirement that every module must be fully compatible with other modules. Furthermore, to reduce costs and time of modeling, the information used and produced in each module is reusable in the same project or in other projects. In this way, we can define modularity, integration and semantic consistence as cornerstones of our methodology.

The product catalogue

The information needed for process modeling can have different sources. Basically, this information is collected during workshops, interviews and through questionnaires. The commissioning party will supply a large quantity of documentation describing procedures, products, services, technical and legal guidelines, etc.

The inputs and outputs in the public sector are classified in what is called a product catalogue. A product catalogue is a comprehensive representation of all the services provided by a specific public office. Such products and corresponding services are defined as outputs of activities in order to facilitate the management of the administrative units. Moreover, a product catalogue will contain a hierarchical structure consisting of services, products and product groups (see Figure 1).

A service is in itself the finished outcome of an administrative unit, which will be consumed by a customer outside the administrative unit. Several activities are usually needed to yield a service.
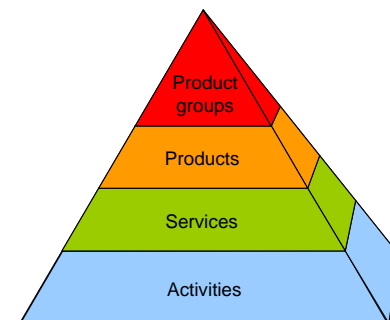

Figure 1 Product catalogue pyramid in the public sector

Services are grouped in products according to technical factors, and the task and goal orientation. Also, decisive for the aggregation of services in products are: the cost center controlling requirements, the precise identification of responsibilities and frequency. Finally, the costs of a product must to be clearly delimited, i.e. a product is always a cost unit.

Products themselves are grouped into product groups. Such classification is done for practical purposes. Some products may have characteristics that make them well suitable to be aggregated under the same factors of

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[1] Information, Communication and Transaction model (ICT model). Classification scheme for products and services within the added-value chain in public institutions. It was developed by the consulting company "Booz Allen Hamilton".

[2] Ontologies serve as metadata schemas, providing a controlled vocabulary of concepts, each with explicitly defined and machine-processable semantics. (Maedche and Staab, 2001)

services into product groups. Especially for management at superior levels the quantity of products can be too large and too detailed. A product group is more manageable at those levels.
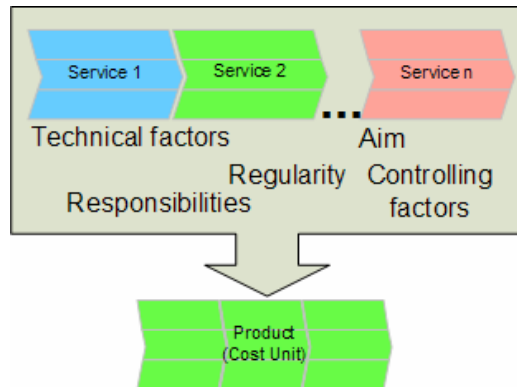
Figure 2 Product - Service aggregation

Therefore, a product catalogue will not only contain information about the products and services, but also about the organizational structure participating in the added-value chain of a specific product and/or service, product costing information and customer information. In consequence, in e-government projects product catalogues are the principal sources of information around which a business process analysis is done. Using the product catalogue external or internal experts will evaluate existing products and services and their feasibility to be implemented in e-government projects. The evaluation includes a subjective appraisal of the online potential of each top product and its services.

Methodology and architecture

Our approach transforms traditional administration models into semantic webs in order to facilitate knowledge-intensive activities within public offices. Therefore, our in-house developed methodology begins with the compilation of the product catalogue and its storage by electronic means.

E-government strategy analysis

Using the online application *eGovernment Masterplan* an officer can allocate services and products to their corresponding organizational units and classify them according to the ICT model (see Figure 3). The ICT classification is an attempt to systematize product catalogues and make them comparable for the bureaucratic system of the different German federal states and local governing bodies. This typification is as result of a federal survey commissioned by the German federal government and it has been adopted in the "Implementation plan for the E-Government Initiative 2005 (BundOnline 2005 – Umsetzungsplan für die eGovernment-Initative)".

Further information (e.g. employed software and hardware, costs, cost centre, etc.) and necessary attribute values can be collected using the user-friendly entry mask. At the same time, this platform facilitates the acquisition and analysis of management ratios of services by means of online questionnaires. A database with relevant demographic and geopolitical data "a locality[3] profile" is prepared in advance for the later evaluation and the elaboration of an optimization concept.

Additionally, a subjective evaluation of the services is done on the part of the officers according their frequency, operating expense and online feasibility. This evaluation will be the basis to obtain indicators of the readiness for the implementation of e-government in the target area.

Every product and service will go through a portfolio analysis to determine if the product is e-government suitable and to determine the product relevance as an e-government service. This analysis is done with the active participation of officers and external consultants. External consultants only play a moderation role through out this analysis. The participating officers rank the products and services using a separate module of the *eGovernment Masterplan* and select which products will continue to a more broader analysis. The active participation of officers in this phase is not only necessary because of their unmatchable experience, but also for their essential political willingness during the implementation phase.

On the other side, the IT-infrastructure will be evaluated using Gartner's[4] well-proven analysis instruments. The interoperability of the IT-components will be matched with SAGA[5] standards as well as with technical specifications of leading commercial technology suppliers.
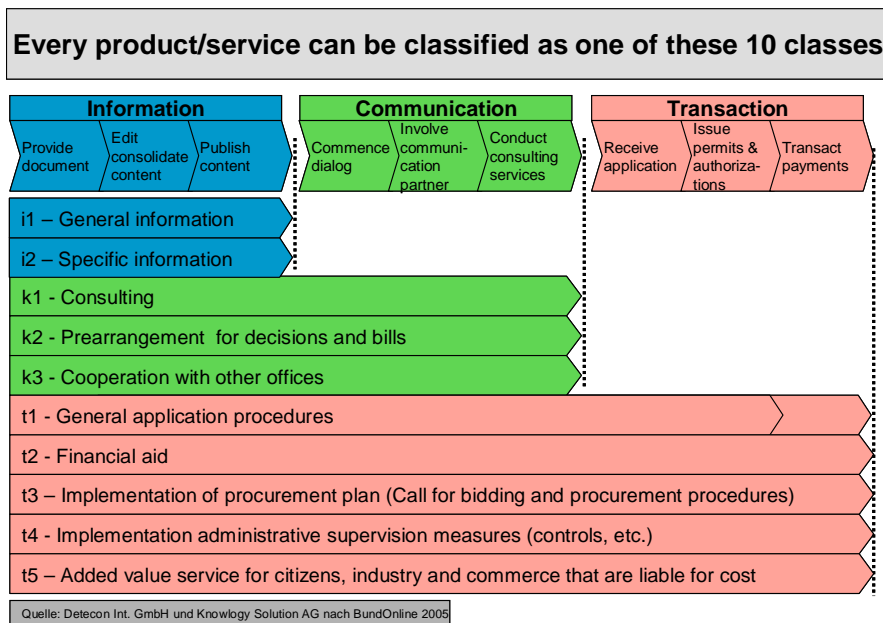
The outcome of this first stage is a representation of the starting conditions for the modernization project, which includes:

- An electronic product catalogue containing:
  - A product and service description, as well as their legal basis
  - Allocation to the organizational structure and local administration units
  - Relevant key business data
  - Mapping to the corresponding cost centers and cost units.
- Product classification according to task type (e.g. obligatory tasks, etc.)
- Classification according to services and outcome types (e.g. Application, authorization, etc.)
- Classification according user group (G2C, G2B, G2G, G2E)

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[3] Also called location profile (in German "Standortprofil")
[4] For more information please visit www.gartner.com
[5] Standards and Architectures for e-Government Applications (SAGA) http://www.kbst.bund.de/Anlage304423/SAGA_Version_2.0.pdf

Every product/service can be classified as one of these 10 classes

Information			Communication			Transaction		
Provide document	Edit consolidate content	Publish content	Commence dialog	Involve communication partner	Conduct consulting services	Receive application	Issue permits & authorizations	Transact payments

- i1 – General information
- i2 – Specific information
- k1 - Consulting
- k2 - Prearrangement for decisions and bills
- k3 - Cooperation with other offices
- t1 - General application procedures
- t2 - Financial aid
- t3 – Implementation of procurement plan (Call for bidding and procurement procedures)
- t4 - Implementation administrative supervision measures (controls, etc.)
- t5 – Added value service for citizens, industry and commerce that are liable for cost

Quelle: Detecon Int. GmbH und Knowlogy Solution AG nach BundOnline 2005

Figure 3 ICT class model in the public sector.. (Source: Project group BundOnline 2005, Booz-Allen&Hamilton-Analyse)

- Product composition and mapping of internal provider and service relationships.
- Evaluation and prioritization of every product and service with regard to their e-government suitability and e-government relevance (portfolio analysis, prioritization as a ranking, e-government potential scores).

After the first stage is completed the IT-infrastructure analysis should contain the following information:

- Individual register and evaluation of the existing e-government basic components[6] (complexity, interoperability)
- Register and evaluation of those specific systems and software applications relevant to the products (interoperability)
- Identification of essential basic components and integration requirements from the perspective of the key products for e-government.
- Determination of general requirements for basic components and process integration for each product type.
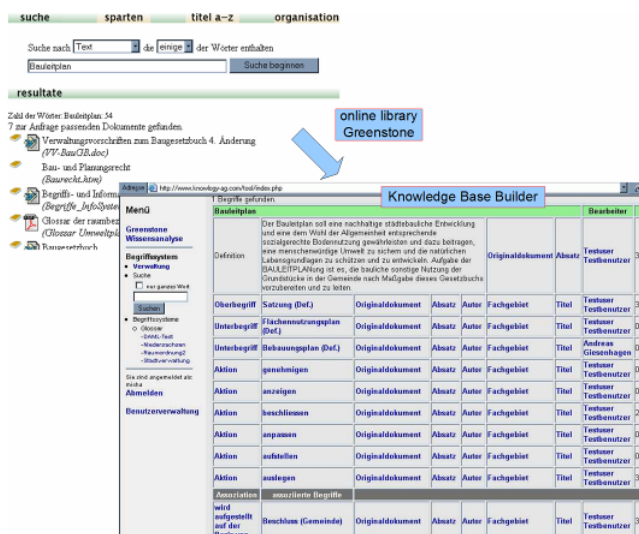
Semantic analysis

Separately, an e-government consultant analyzes the product and service documentation semantically creating a lattice of concepts and interactions representing the functional reorganization of the public office. The online application *Knowledge Base Builder* allows the semantic analysis of stored documents in the online library *Greenstone*[7] (See Figure 4). Goal of a semantic analysis is to understand the relationships between the most important concepts in the context of the document and thus model the semantic relationships between products, services, actors, technical and legal guidelines and procedures. Furthermore, the *Knowledge Base Builder* provides the user with semantic search functions for those documents in the database, as well as the possibility to visualize meta-knowledge about specific concepts

By these means, we have on the one side, the output of the *eGovernment Masterplan* as a model of the product catalogue for a specific office. On the other side, the result of the *Knowledge Base Builder* is a reference glossary. This reference glossary contains all the concepts that are important for the execution of the project. Each concept will consist of a definition, attributes, applicable actions (methods), a hierarchy of concepts and relationships to other concepts.

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[6] Basic components centrally offer certain technical functionalities which can be used by different services and public agencies. They provide functionality blocks which form part of a host of services and which are integrated, as services or modules, into e-government applications.

[7] Greenstone is a suite of software for building and distributing digital library collections. It provides a new way of organizing information and publishing it on the Internet or on CD-ROM. For more information please refer to: http://www.greenstone.org

Figure 4 *Greenstone - Knowledge Base Builder* screenshots. Semantic analysis of documents stored in an online library.

Business process analysis

The question is now, how to integrate both repositories and use in a business process analysis? This problem is solved by exporting both repositories as DAML[8] or OWL[9] files. DAML und OWL are languages for describing ontologies for the Semantic Web. Both DAML and OWL are languages expressed in XML format, with makes them compliant with modern compiler tools and techniques. XML has a limited capability to describe the relationships (schemas or ontologies) with respect to objects (XML specifies neither semantics nor a tag set), but using DAML or OWL as an extension of XML offers a very powerful way to describe objects and their relationships to other objects.

Although, the XML protocol is human-readable by definition, it seems easier for humans to discern complex models or scenarios using graphical models rather than reading a XML document. Furthermore, graphical notations have been used in business process modeling, data modeling and describing software systems (e.g. UML) for a quite long time now. (Fillies and Sure, 2002) Following this approach, *SemTalk for E-Government* was developed as the first graphical application completely based in Microsoft Visio to model public organization structures, products and processes.

The main idea behind SemTalk[10] is to empower end users to contribute to the Semantic Web by offering an MS

Office based graphical editor. Based on an easy to use Microsoft Visio-based modeling tool, RDF Schemas are created. Moreover, *SemTalk for E-Government* is anchored in the experiences of several e-government projects and it extends the communication structural analysis (CSA)[11] method developed by Prof. Krallmann for business process modeling (see Figure 5). In CSA a process consists of interfaces between activities connected by information flows made up of information and media. Class models act as building blocks for these process models. Class models help to form structured and linguistic consistent process components. This improves reuse and allows object oriented reporting. (Fillies and Sure, 2002)

SemTalk imports DAML and OWL files and uses them as reference models. Following the Internet philosophy, i.e. that objects (e.g. documents, models, etc,) are not be copied but referenced, with *SemTalk for E-Government* one can create and/or reuse the objects in reference models. In the case of public institutions, which tend to be rather large, creating one consistent reference model is almost impossible to achieve. Instead, "small" reference models, which are connected by bridges (hyperlinks), will provide the necessary consistency
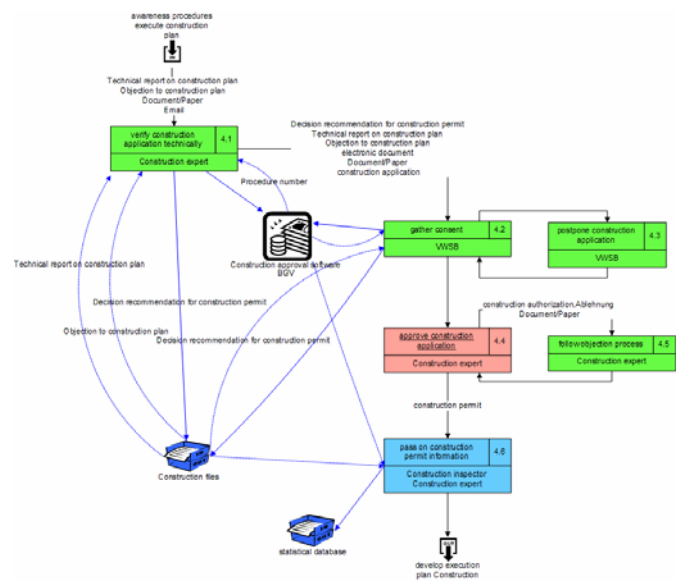
Figure 5 Example of a process model in SemTalk for E-Government (Excerpt of a process was translated from a German process model)

In *SemTalk for E-Government* an agent maintains this consistency by searching at real-time (i.e. while modeling) the object name in a reference model and offering the

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possibility to convert this object into a hyperlink to the other model. But even if modeling is supported by an agent-based infrastructure, human experts will be always needed to review models and quality control.

Object classes in references models can be used, for example, to create activities in process models. These objects are classified as information objects, products, services, roles, etc. and complemented with relevant information to the specific process. Thus, processes are modeled in a decentralized way and a certain degree of semantic consistency can be assured. Moreover, SemTalk can validate those rules locally for one model and the set of processes included in the current model. Because the models are saved in a W3C compliant format, the rules (or "axioms") can be checked for multiple models by Semantic Web inference engines such as Cerebra from Network Inference or Ontobroker from Ontoprise GmbH. This technology is used to find non trivial inconsistencies in multiple models (Fillies and Weichhardt, 2003).

In business process analysis process reports have a very important role. After simulating a process one can identify redundant activities, process bottlenecks and estimate process costs. Although, the chain of command in public institutions is always of interest, with the CSA method we focus on the flow of information instead. An analysis of the flow of information between persons and systems in a business process exposes system communication disjunctions and redundant media transformations, which a sine qua non for any attempt of reengineering organization and information systems. Such process discontinuities are displayed by *SemTalk for E-Government* as swim lane reports (see Figure 6). Besides the swim lane reports, *SemTalk for E-Government* includes a set of Microsoft Excel reports for process costs estimation, interaction tables, communication diagrams, etc. Process models can be published as HTML pages for human reference.
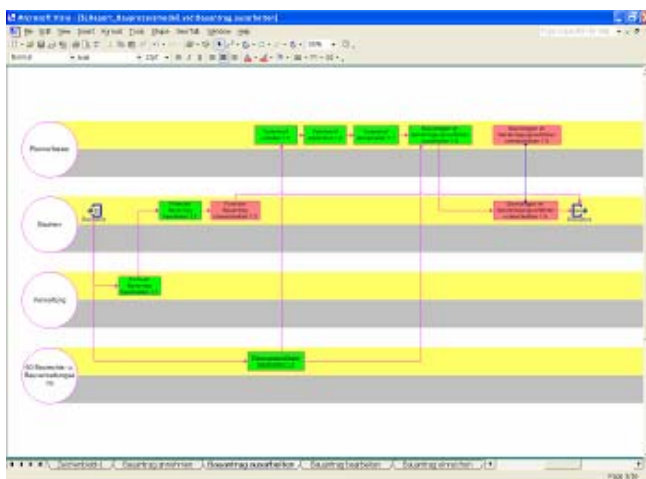
**Figure 6** Example of a swim lane report.

Together at workshops, consultants and officers analyzed the process models, swim lane reports and specific reports on human and material resources of the selected top products for an e-government implementation to develop the following measures:

- To-be (target) models for the selected top products.
  - To-be process structure
  - To-be IT-support model
  - To-be resource model
- Differentiated step-by-step concepts with alternatives for the optimization of the top products.
- Quantitative and qualitative (financial) evaluation of the beneficial effects for the different alternatives and products.
- Checklists for alternative implementations of the e-government key products including:
  - Organizational change management
  - IT-support management
  - Required technical standards and IT-standards from a process point of view

At this point the project's commissioning party should be able to use these results for the development and/or auditing of an e-government implementation master plan. Furthermore, the to-be models and documentation can be effectively used during the implementation and later phases of the project to support change management and know-how transfer activities.

Altogether, *Greenstone* libraries, *eGovernment Masterplan*, *Knowledge Base Builder* and *SemTalk for E-Government* constitute a robust architecture for business process analysis and modeling. (See Figure 7) Robust does not mean rigid in this case. *eGovernment Masterplan* is a portal, in which different consulting services can be configured according the customer's needs. *Knowledge Base Builder* can be used as a semantic search machine for documents indexed in *Greenstone* libraries. *SemTalk for E-Government* has an open meta-model that gives the modeler enough freedom to adapt the tool to each organization and functional structure of a public office.

It must be said here, that none of this tools, except for *eGovernment Masterplan*, was conceived exclusively to be used in e-government projects. In order words, the same tools and a similar approach could be used for reengineering projects in organizations of the private sector. An important factor for a successful application of this methodology and architecture is the excellent and thorough documentation available in most public offices (regulations, procedures, ordinances, etc.). Even in Germany's public sector with a federal government (16 *Länder*) products, services, its business processes and the terminology used in their documentation are fairly comparable. In the private sector, where business knowledge it mostly held by experienced employees and where business processes tend to change more frequently, a different method of capturing knowledge (so tacit
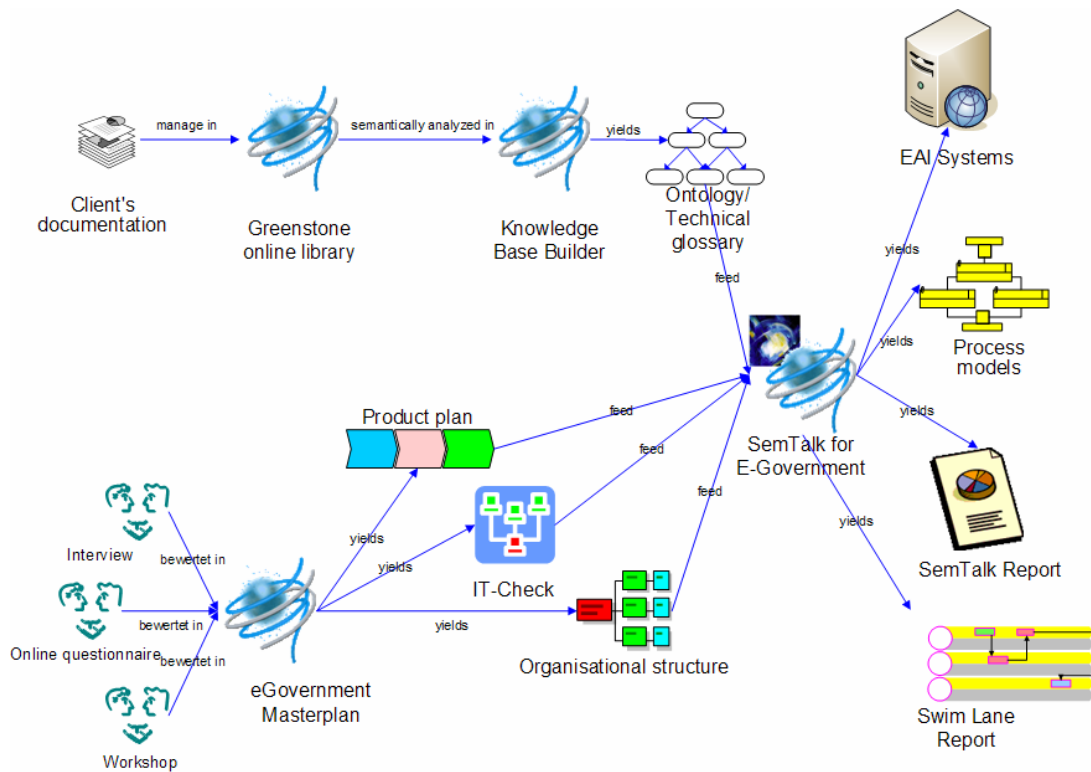
Figure 7 Modular and semantically integrated business process analysis architecture.

knowledge can be transformed into explicit knowledge on real time) should be necessary.

Our methodology and architecture describe business processes in the public sector at a semantic level and thus making some of them accessible to machine reasoning as we will see later. Our ultimate goal is to describe business processes in the public sector as modular components and make them semantically comparable so that their implementation is more agile and efficient.

Process blueprints for the public sector

Although public offices usually do not compete against each other like companies in the private sector, they must also try to minimize business process reengineering projects costs as much as possible. These costs can be represented in the following three dimensions: Cost per process execution (y-axis), cost per process setup (z-axis), and delay of process setup (x-axis) (Hepp et al. 2005). (See Figure 8)

As we saw before, the results of the business process analysis will provide recommendations on how to optimize the process execution and how to smooth the transition within the organization and IT landscape. In other words, these recommendations are meant to make the public office more efficient and more agile. But also, we described business processes and their underlying documentation at a semantic level. The latter can be used to reduce even more the costs and the delay of process setup by identifying reusable business process models, which we will call

process "blueprints", and in some cases we can generate computer code out of this models to implement these processes electronically.

After having evaluated plenty business processes in different kinds of public offices, we were able to identify similar "aggregated" business processes in public offices with similar locality profiles. For example, the business processes and their required IT infrastructure of a service like "grant of construction permit" in a big and economically dynamic city like Hamburg are comparable with those of a city like Munich, but less comparable with those of a small city like Sankt Augustin. This kind of process blueprints consist of should-be business process models and IT-requirements. Basically, they describe the arrangement and structuring of functions, i.e. a planning scheme for the applications landscape according to the needs and profile of the community. They provide enough information to tailor a future IT project without going to deep in technical details. Thereby, potentials and limits of alternative technologies of e-government market leaders as basic integration concepts are presented to support IT officers in their strategic IT planning.

A second kind of process blueprints are those "basic" business processes that repeat themselves with light variations in different services. Consider the services "grant of restaurant (pubs) license" and "notification of change of address". Although these services are performed by different public offices (the former by the consumer protection authority and the latter by the registration office) and they require different information, they have

processes in common, which can be mechanized and optimized using the same IT tools. For example, in both cases the applicant must fill an application form that will be processed by an officer. Although the application forms are different, an online version of this service could use the same form server in both cases. Furthermore, in both cases a PKI system is needed to verify the applicant's identity and to check the office jurisdiction. Such business processes and their IT integration concepts are reusable across services and localities.
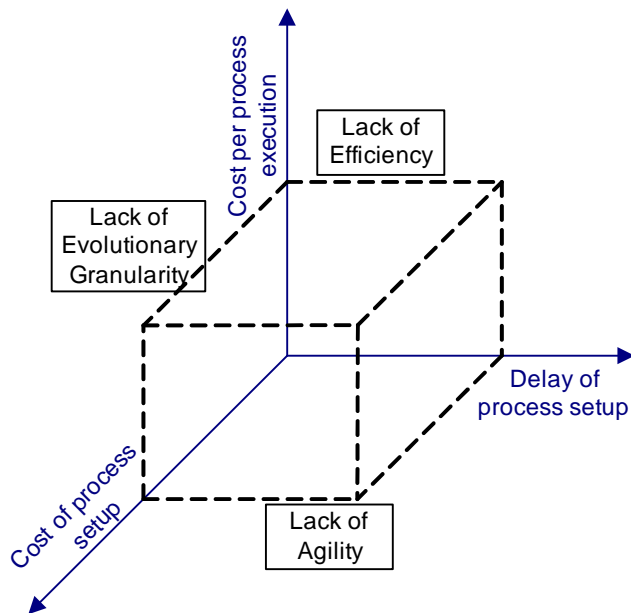
Figure 8 The three dimensions of enterprise performance from a process space view. (Source: Hepp et al. 2005)

To take full advantage of these business process models, we have added BPMN to the supported modeling methods in SemTalk. The Business Process Modeling Notation (BPMN) specification provides a graphical notation for expressing business processes. This notation has been proposed by the Business Process Management Initiative[12]. The objective of BPMN is to support business process management by both technical users and business users by providing a notation that is intuitive to business users yet able to represent complex process semantics. The main focus of BPMN is on systems that interact and interrupt one another, where there are many deeply nested independent, but coordinated, interacting threads of execution (BPMI.org. 2004).

BPMN was created with business execution languages and Web Services in mind. A BPMN model is characterized by two orthogonal flows. The sequence flow describes the progression of a business process for one of the participating partners in an orchestrated Web Services. The message flow runs perpendicularly to the sequence flow because it describes the message passing between

different partners (information systems). It contains special notations to depict message-based events and message passing between organizations. It also provides adequate notation for elements like dataflow, business rules, exceptions, transactions. BPMN and its direct mapping to computer executable languages like BPEL4WS[13] allows to model specific sections of business process that are suitable for their implementation as Web Services and, to some degree, to generate computer code automatically for enterprise application systems like Microsoft BizTalk Server, IBM WebSphere, SAP NetWeaver, or open-source projects like JBOSS.

Web Services can be orchestrated on a service-oriented architecture making business processes accessible within private and public organizations and between them. With SemTalk BPMN Edition the consultant can represent the business processes as Web Services, how Web Services are used to implement activities in a business process and which partners perform what parts of the business process. Process blueprints, like the ones we describe before, become part of reference process model library. They can be used modified and adapted to heterogeneous IT landscapes during implementation in EAI projects reducing costs and delays of process setup.

Summary

Facing the risks and high socio-economical impacts that e-government projects have, it is necessary to analyze thoroughly the existing public organization with all its attributes. Only then it is possible to identify high success chance areas and minimize the risks and efforts of re-engineering such complex organizations.

The methodology and architecture presented in this paper summarize years of research and learning by doing in e-government projects and business process modeling.

Four different applications have been integrated providing numerous consulting features to address the problem stated. The configuration of this architecture allows enough freedom to not only configure each tool and the architecture as a whole to the customer needs, but also to extend it into other areas like change management, quality management (e.g. a Balanced Score Card module), etc. This is mainly possible through the XML protocol and the development of semantic richer languages OWL. Semantic Web technology-based tools can provide an appropriate framework to make this integration easy and understandable to non-specialists in KM or in business process modeling.

Appropriate methods are also needed to assure the quality of business process models and ontologies. We believe that tools should support W3C recommendations for business process models and ontologies, and support management of distributed reference models. The use of

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[12] www.bpmi.org

[13] Business Process Execution Language For Web Services (BPEL4WS) created in a joint venture by BEA, IBM, Microsoft, and others.

common semantics will itself contribute to the consistency of models, but inference engines and simulation can be used to control statically and dynamically business process models respectively.
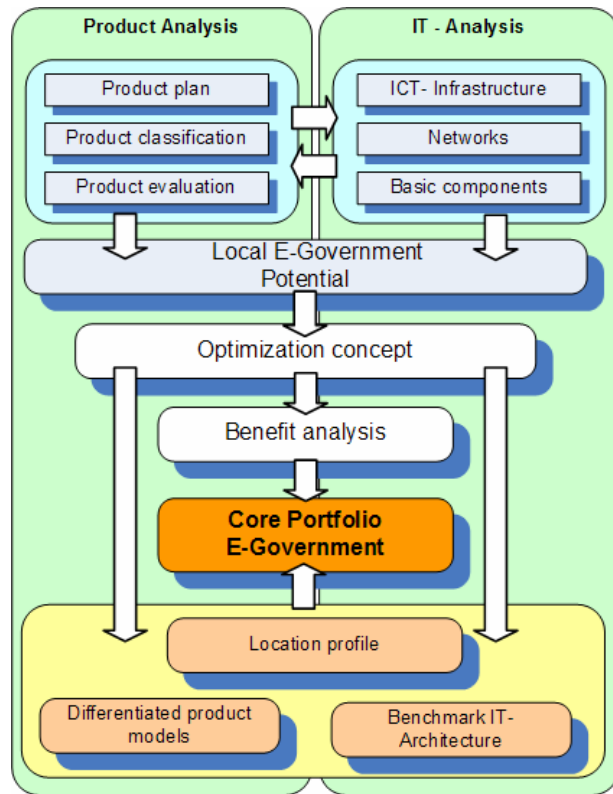
Figure 9 Summarized procedure model of the presented methodology.

Using Semantic Web technologies it is possible to add value to consulting services. By integrating ontologies and processes we have created an agreed-upon vocabulary and semantic structure for exchanging information between human beings (models) and between machines (ontologies and executable code).

Acknowledgements

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