

A Method for eGovernment concepts Interoperability Assessment

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Abstract — Since the late 1990s, with the raising of eGovernment concepts and the increase use of ICT by public administration entities, the need for collaboration among these organizations is a reality with which systems, managers and other stakeholders must deal. In order to increase performance, to supply the online services, and the search for cost reductions the governments paradigms focus, now more than ever, on how to better manage information. As the need of these ‘inter operations’ is real, interoperability is a key factor for organizations facing with collaborative-cooperative environments. The modern architecture of information systems (ISs) is based on distributed networks with a grand challenge of representing and sharing knowledge managed by ISs and consequently, to remove semantics interoperability barriers. This paper presents a literature review and a research method that defines the mechanisms for the creation of guidelines, attributes and an assessment methodology in public administration domain. The presented research strategy identifies the basic phases and activities, purposing a structure of how to collect and compose the guidelines, and how to define an assessment method through the help of semantic technologies.

I. INTRODUCTION

At least in the last twenty years, organizations are facing a competitive marketplace and they must, among other things, develop partnerships and work in an integrated way with others competitors and stakeholders. Interoperability takes into account dimensions such as concerns, barriers, degrees of maturity and types of assessment. Interoperability can be defined as the ability of two or more systems to share, to understand and to consume information [1]. When put together and analyzed, this set of views and perspectives can help to increase the level and quality of collaboration, interaction and transactions between organizations (public or private) and between areas (agencies) inside the same organization. This is not an exclusive concern of private administrations, once the increasing need for information exchange among government agencies, the supply of online services to citizens, and the cost reduction of public operations and transactions demand that the government organizations must be ready to provide an adequate interface to their users.

With the increasing use and importance of ICT in government institutions, a concept, known as

eGovernment, rose in the late 1990s [2]. The term eGovernment, e-gov, eGov and similar are an abbreviation of “electronic government” and refers to the use of information and communication technologies to support the government business, providing or enhancing public services or managing internal government operations [3]. Considering the concepts in an integrated way, the eGovernment interoperability domain arises as the ability of constituencies or public agencies to work together attempting to meet interoperability requirements, which will be the focus area of this research.

An important aspect of interoperability is the assessment of the adherence regarding some specific model or maturity degree. That is, the evaluation of how adherent (or how mature) is an organization in comparison with a baseline model and/or in comparison with other organizations. Enterprise Interoperability Assessment (EIA) provides an organization the opportunity to know their strengths, weaknesses and prioritize actions to improve its performance and maturity. Characterization and measurement of different degrees of interoperability allows an organization to know its “as is” stage and plan the ways to achieve higher degrees (“to be”). The complexity presented in the eGovernment context requires additional effort regarding influence factors as legal, political and policy, and sociocultural issues. This scenario is particularly prominent in some emergent countries, providing a broad field for research in the eGovernment interoperability domain, once eGovernment interoperability frameworks focus almost entirely (90%) in technical domain [4]. Bring all of these concepts to a public administration domain is not an easy task, once the complexity, barriers and variables of a government organization are different from those found in the private companies.

This paper has two main goals: (i) present a literature review and analysis positioning the theme and exposing information regarding the countries engaged, authors, evolution through the years and others aspects and (ii) present a research strategy in order to identify attributes and guidelines to assess interoperability in public administration entities.

II. BACKGROUND

A. Interoperability, interoperability assessment and interoperability models

Terms such as integration, collaboration, cooperation and compatibility are frequently used to compose or explain

some aspects of interoperability, although they are not the same thing. Integration, for example, has a strong link with concepts of coordination and consistence in which the parts are tightly coupled, whereas interoperability has the meaning of coexistence and environment, characterizing two loosely coupled parts. Collaboration concerns sharing the work or the engagement of participants in a coordinated effort, whereas cooperation concerns the division of labor among participants, where each person is responsible for a portion of the solution. Compatibility is also related to interoperability, once that in order to interoperate, systems must be compatible, i.e. capable of existing together and/or possible to work with another part. Finally, according to [5], interoperability is “the ability of two or more systems or components to exchange information and to use the information that has been exchanged”. In terms of a typology, interoperability has four major categories: semantic, organizational, technical [1] and governance elements [6].

- Technical interoperability: concerned with technical issues regarding computer systems, definition of interfaces, data formats and protocols.
- Semantic interoperability: related to ensure that the precise meaning of exchanged information is understandable by any other application not initially developed for this purpose [1, 7].
- Organizational interoperability: concerned with modelling business processes, aligning information architectures with organizational goals and helping business processes to cooperate [1, 7].
- Governance interoperability: refers to agreements between governments and others stakeholders involved in the interoperability issues, including the ways of achieving and creating those agreements.

Interoperability has three main dimensions: barriers, concerns and approaches (adopted to solve the barriers and attack the concerns) [8, 9]. Table I shows more detail of these aspects:

TABLE I. INTEROPERABILITY ASPECTS AND DIMENSIONS

Barriers	
Conceptual	Related to the syntactic and semantic differences of information to be exchanged.
Technological	Relates to the possible incompatibility of ICT and the use of software systems.
Organizational	Definition of responsibility, authority and others factors associated with human and organizational behaviors that can be obstacles to interoperability.
Concerns	
Data	Put together different data models, different languages and heterogeneous bases.
Services	Put together multiples services/applications by solving possible syntactic and semantic differences as well as finding the connections to the various heterogeneous databases.
Process	Put together multiples processes, connecting internal with external processes and creating

common processes.	
Business	Related to the creation of harmonized way of working at the levels of an organization in despite of different modes, methods, legislations and culture.
Approaches	
Integrated	Exists a common format. It is not necessarily a standard, but must be agreed by all parties.
Unified	Exists a common format but only at a meta-level. The related metamodel provides a mean for semantic equivalence in order to allow mapping between models and systems.
Federated	No common format. In order to interoperate parties must accommodate ‘on the fly’. There is no imposition of models, languages and methods of work by one of the parties.

Interoperability involves two (or more) organizations (or units) and, usually, these organizations have different systems, models or structure. Enterprise Interoperability Assessment (EIA) provides to an organization the opportunity to know its strengths, weaknesses and prioritize actions to improve its performance and maturity level assessment. Assessing interoperability implies the establishment of measures to evaluate the degree of interoperability between organizations and one of the measures that can be used and defined is the maturity level that is (intend to be) achieved. Table II exemplifies three interoperability maturity models (IMMs) presented in the literature.

TABLE II. EXAMPLES OF IMMS AND ITS LEVELS

Model	Level 1	Level 2	Level 3
LISI	Isolated. Manual gateway (CD, DVDs).	Connected. Homogeneous product exchange.	Functional. Heterogeneous product exchange.
OIMM	Independent. Personal communication.	Ad hoc. General guidelines. Share basic data.	Collaborative. General frameworks and some sharing.
MMEI	Unprepared. No capability for interoperation.	Defined. Limited. Simple data exchange.	Aligned. Able to adopt common formats.

Model	Level 4	Level 5
LISI	Domain. Shared databases. Collaboration.	Enterprise. Distributed information.
OIMM	Combined. Some shared culture oriented by headquarter.	Unified. Interoperating on a daily basis.
MMEI	Organized. Heterogeneous partners.	Adapted. Shared domain ontologies.

B. eGovernment, eGovernment interoperability models and frameworks

According to [2], eGovernment is relatively a recent concept, formalized in 1999, when Al Gore, then Vice President of U.S. opened the 1st Global Forum on

Reinventing Government, in Washington, attended by representatives of 43 countries. eGovernment works with models considering interactions such as government to citizens (G2C), government to business (G2B), government to employees (G2E), government-to-government (G2G), government-to-organizations (G2Org) and government-to-other-governments (G2OG) [10]. eGovernment is defined in [3] as the use of information and communication technologies to support the government business, such as providing or enhancing public services or managing internal government operations. Integrating the concepts of eGovernment and interoperability helps the “creation of systems that facilitate better decision making, better coordination of government agency programs and services in order to provide enhanced services to citizens and businesses, the foundation of a citizen centric society, and the one-stop delivery of services through a variety of channels” [10].

Although the models already presented in section 2.1 can be used (abstractly) in various types of organizations, there are few models regarding specifically government issues. According to [11], a Government Interoperability Framework (GIF) is a set of standards and guidelines that a government uses to specify the preferred way that its agencies, citizens and partners interact with each other, being one way to achieve eGovernment interoperability. A GIF includes, context, technical content, process documentation and, among other things, the basic technical specifications that all agencies relevant to the eGovernment strategy implementation should adopt. In order to illustrate, three examples of government interoperability models and/or frameworks are exposed in Table III.

TABLE III. EXAMPLES OF GOVERNMENT INTEROPERABILITY MODELS/Framework

Source	Brief description
[12]	Government Interoperability Maturity Matrix (GIMM). Provides a way for administrations to evaluate their status on eGovernment issues. There are maturity levels defining the characteristics of the formalism degree and the way of exchanging data and information.
[13]	The e-PING is a Brazilian Government framework effort that defines a minimum set of premises, policies and technical specifications to regulate the use of ICT in the interoperability of services regarding the eGovernment. Establishes conditions and interactions with other government agencies and the society, covering aspects such as interconnection, security, access and data interchange.
[14]	Federal Enterprise Architecture Framework consists of a set of interrelated “reference models” that describe six sub-architecture domains in the framework: strategy, business, data, applications, infrastructure and security.

The implementation of interoperability issues in the eGovernment domain allows data compiled by different agencies to be used together to make better decisions and increases transparency and accountability, enabling one-stop, comprehensive online services for citizens and businesses by linking the diverse services that are offered by different agencies [10]. Among the difficulties, it is important to mention items such as variety of legacy systems, difference of standards, cultural differences between departments, legal and political issues, managerial and jurisdictional [15].

III. LITERATURE REVIEW

A. Systematic review

In order to define the goals, concepts and help to identify and map the actual context, a literature review and content analysis was made. Table IV shows the attributes created to run the search, with the definitions of strings, databases and filters. The results are exposed in Figure 1.

TABLE IV. ATTRIBUTES USED IN THE SEARCH FOR FILES WITHIN THE GOOGLE SCHOLARS DATABASE

Attribute	Description
Database	Google Scholars, SciELO [16], Capes Database [17], Google, Bing and other search engines.
Goal	Verify the publications regarding eGovernment in the context of interoperability (and vice versa). That is, researches considering the interoperability aspects within government organizations. Provide this overview across the years. Create a research repository.
Start/Finish dates	Considered since 1986 until may/2013.
Criteria	Criterion 1: string “interoperability” and (“government” or “public administration”) in the title and abstract of the publication. Criterion 2: string “interoperabilidade” and (“governo” or “administração pública” or “egov” or “e-gov”) in the title of the publication. The words “governo”, “administração pública” e “interoperabilidade” are portuguese and stands for “govern”, “public administration” and “interoperability”.
Filters	Filter 1: documents before 2000 were removed. Filter 2: duplicated documents were removed.

The preliminary results identifies some main sources of the publications and a vision of the distribution across the years. The sum of all publications found is 432, without specific filters except those listed in Table IV. It is possible to notice that the period with more publications is around 2009 and 2010, followed by a decrease of publications found in all databases.

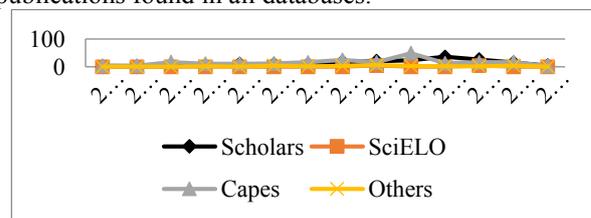


Figure 1: Results from all database (without specific filters)

As a next step, a content analysis of the documents was performed. The objective was to review all the 432 publications found and apply filters in order to select only those with connection to the research field and remove those not related to the theme but whose may use some of the same strings adopted (e.g. warfare papers also uses government and interoperability words, as radio transmission themes and others). The method adopted to perform this task was the reading of the title and abstract (and when necessary the introduction) of all documents and apply a relevance and pertinence analysis. After this step, an amount of 150 documents left, as shown in Figure 2. The 150 publications remained are distributed according to Table V, considering the types of documents.

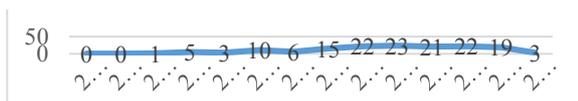


Figure 2: Distribution of publications considering all documents found in all search mechanisms

TABLE V. DISTRIBUTION PER TYPE OF PUBLICATION

Type of publication	Quantity	Type of publication	Quantity
Papers in conference	47	Book chapters	5
Papers in journals	60	Dissertation (masters and doctors)	6
White papers	11	Others (presentations, docs)	2
Technical reports	19		

A brief author analysis was also made. The objectives were (i) verify the dissemination regarding the number of authors related to the documents; (ii) verify the production of these authors (# of published documents) and (iii) try to detect if there is a main group of authors that is responsible for the major number of publishing. The author’s analysis identified 240 different authors associated to the 150 documents. Most of the authors contributed with one document and there is two authors with the maximum number of contributions detected (six). For those documents generated by a committee and/or government agency, it is considered that the author is the “committee”. Therefore, from the 240 authors identified, there is one (the committee) that is responsible for 19 documents. Table VI does not consider the “committee” for its distribution.

TABLE VI. PERCENTAGE OF AUTHORS ACCORDING TO THE NUMBER OF CONTRIBUTIONS

# Contributions	1	2	3
# -- % Authors	195 -- 81.59%	27 -- 11.3%	5 -- 2.09%
# Contributions	4	5	6
# -- % Authors	6 -- 2.51%	4 -- 1.67%	2 -- 0.84%

As Table VI shows, more than 81% of the detected authors contributed with only one document, followed by approximately 11% who have two contributions. At least two things come to attention: (i) the “small” number of the maximum contribution and (ii) the significant number of researchers involved: 239 (plus the “committee”).

A United Nations survey [18] presents eGovernment development rankings for 2012, analyzing how governments of the world are employing eGovernment policies and programs to support efficiency, effectiveness, and inclusiveness as the parameters of sustainable development efforts worldwide. The index can go from zero (no eGovernment) to one (high degree of e-government). According to the survey, the Republic of Korea is the world leader (0.9283) followed by the

Netherlands (0.9125), the United Kingdom (0.8960) and Denmark (0.8889), with the United States, Canada, France, Norway, Singapore and Sweden close behind. Europe has the highest eGovernment development ranking, followed by the Americas (0.5403). Within America, United States is in the first position, followed by Canada and, considering South America. Although the United Nations survey deals with general eGovernment maturity around the world, not focusing on specific themes such as interoperability, frameworks, and models; it gives a good idea of the world adoption regarding the theme. In order to evaluate the country (and region) distribution of the researches regarding eGovernment interoperability, an analysis was made considering the 150 documents retrieved from the literature review. The distribution considers where the authors are working (which university, laboratory, country), even though the research may be related to other country or organization (the author’s birthplace are not considered). The information was collect in each of the 150 documents, considering that each country are considered only once (per document) and they were grouped in regions (e.g. Asia, Europe, North America). The review detected 62 different countries in the 150 documents analyzed. Each of the 62 countries are associated at least once to a researcher but some of them are cited more times (considering the different documents) and, because of this, there are 192 references of countries within the 150 documents (e.g. Greece appears 12 times considering only one appearance per document).

IV. RELATED WORKS

From the literature review important issues emerged, such as the related works, the approach those works give to the subject and the specific concerns and difficulties of eGovernment interoperability. Among the detected difficulties it is possible to mention the great variety of legacy systems, collaboration between agencies, difference of data standards, cultural differences, issues of trust, timing, legal and political issues. It is important to remember that, usually, private sector suffers only a little of politicization while eGovernment (for its nature) is more government centric. At the end of the literature review process it was possible to identify at least seven major points: (i) distribution of the research domain across the years; (ii) existent models, frameworks, concepts, barriers and concerns; (iii) engaged countries in the research area; (iv) authors and their publications; (v) the majority of approaches are related to technical aspects; (vi) there is a gap regarding influence factors such as behavior, human aspects and political issues and (vii) there is a gap regarding the research methodology adopted to identify guidelines, attributes and perform assessments. As it is not a good idea to transfer concepts (without the proper adaptations) from private sector into the public one, the following section exposes a specific research strategy for public administration.

V. PROPOSED METHODOLOGY

Derived from the literature analysis, related works and existent gaps detected, this section presents a research strategy (Figure 3) to define the mechanisms for the identification of guidelines, attributes and an assessment methodology in public administration domain.

The presented method identifies the basic phases and activities, purposing a structure of how to collect and compose the guidelines, and how to define an assessment method in order to fulfill the requirements and goals s stated in Table VII.

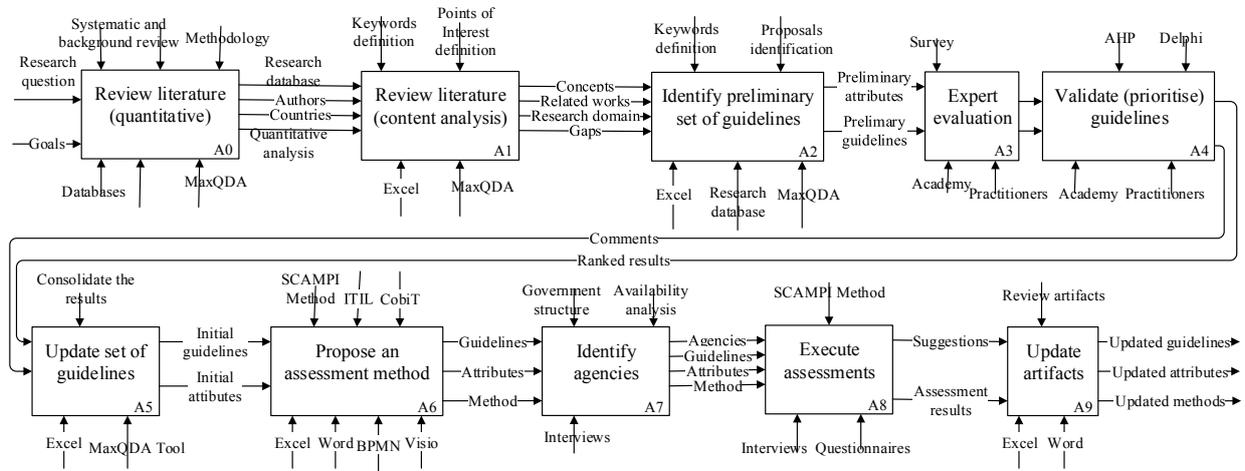


Figure 3: Illustration of the methodological activities

TABLE VII. NEEDS AND GOALS

Research question	
How to know the interoperability degree (or adherence) of a public administration entity regarding its business and organizational aspects?	
Main goal (MG)	
Propose a model to assess the interoperability between public administration entities regarding its business and process x conceptual and organizational aspects.	
Specific goals (SGs)	
SG1: gather main concepts and position the domain.	SG5: propose an assessment method.
SG2: formalize the research domain.	SG6: execute an assessment.
SG3: propose a preliminary set of guidelines.	SG7: update the guidelines according to the results.
SG4: validate the guidelines with specialists.	
Brief description	
SG1: Provide a background, literature and theoretical review.	
SG2: Define the research domain using concept mapping.	
SG3: This preliminary guidelines is generated after (and based in) the theoretical review.	
SG4: Execute a survey in order to review the preliminary set of guidelines. Update the guidelines according to the information gathered from the survey.	
SG5: Definition of a set of rules and procedures to assess the government interoperability entity, proposing methods for assess, rank and evaluate the adherence to the guidelines.	
SG6: Assess a government entity, collecting information about the adherence and suggestions for update the model (guidelines and assessment method) according to the specific needs.	
SG7: Update the model (guidelines and assessment method), generating a final version.	

After the definition of the guidelines and attributes, it is necessary to define a process to letting us to fragment activities knowledge through the transformation of attributes into entities and relationships, and thus to emphasize some fine-grained knowledge atoms. In the proposed knowledge working process (Figure 4) of our general methodology, the starting point can be various: an application, a data model, a logical view, a model, etc. There are several reverse engineering methods through which a model from can be derived. Then, the resulted initial model is enriched and corrected through the combined action of the domain expert and knowledge extraction and matching application. Finally the model is examined with the help of a domain expert or an end-user, who are the most qualified persons to describe the context of the peculiar domain and to put in evidence the contextual knowledge. According to the administration best practices and its data, they would clean and better organize the knowledge represented in the derived model. However, the obtained initial conceptual model, in the form of a UML class diagram, has yet a major limit. In fact, its semantics is in a tacit form because all the attributes are buried inside single classes and it is then difficult to make their semantics explicit.

Thus, the next step of our approach is a Fact-Oriented Transformation [19] through the application of a set of patterns rules for transforming the enriched conceptual model to a fact-oriented model (FOM) with its semantics completely displayed. The resulting fact-oriented model, displaying the finest-grained semantic atoms, is then used as an input for the last step of the process, a number of structural optimization through formal concept analysis methods [20] (not presented in this paper).

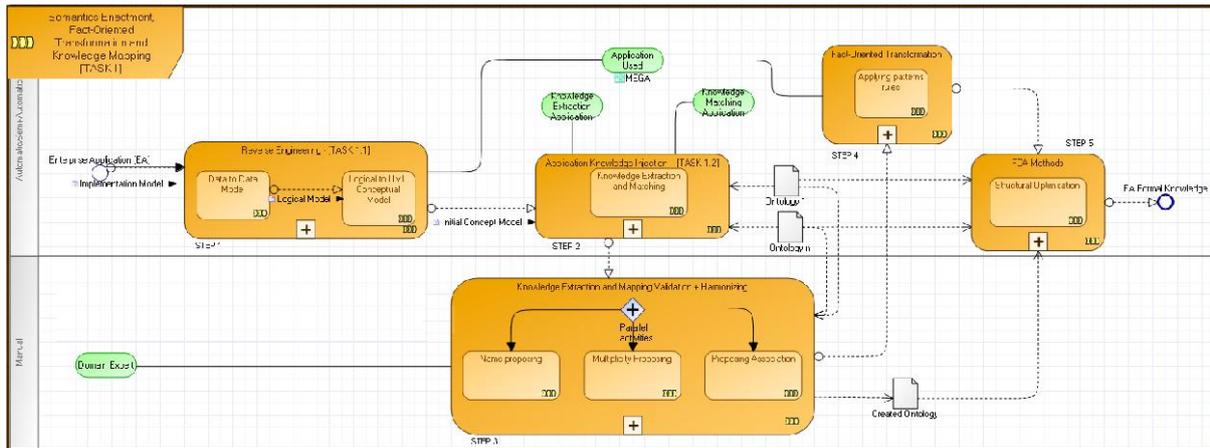


Figure 4: Knowledge extraction process

After the definition of the explicit knowledge process, it is necessary to define the assessment method, which will describe how the assessment will occur, how to rank the items evaluated, what are the steps and other issues. The evaluation method will be based in the Standard CMMI Appraisal Method for Process Improvement [21], which is designed to provide benchmark-quality ratings relative

to the model. The method relies on an aggregation of information collected via defined types (interviews, questionnaires) and worked through the knowledge extraction activities process. The method is based on three stages (plan and prepare for assessment, conduct assessment and report results) as illustrate in Figure 5.

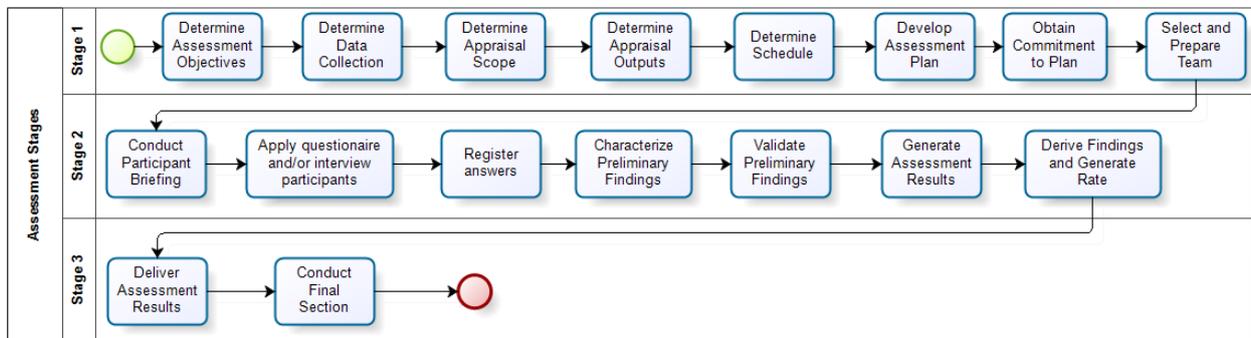


Figure 5: Detailed activities of the assessment

In summary, the purpose is to define measurement attributes (guidelines and/or models) linked to domains not related entirely to technical aspects. Considering a scenario proposed in Figure 6, the idea is to apply the research guidelines (assessment and other results achieved) in one (or more) aspects of the relationship involved in the eGovernment (e.g. G2G, G2B), depending on the needs.

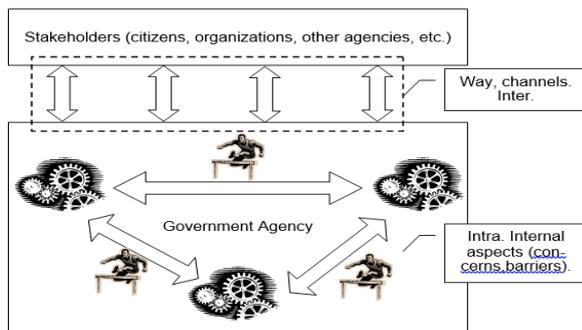


Figure 6: Scenario regarding the involvement of organizations

VI. CONCLUSIONS

Although there are basically three primary goals associated with achieving interoperability in any system (data exchange, meaning exchange and process and business agreement), when it comes to government, the context can be even more complex because of the necessity of dealing with some influencing factors such as legal, political and sociocultural issues. In government related interoperability, the context is very important, once some major differences must also be addressed (e.g. poor infrastructures, dictatorial countries). In spite of that, the majority of government related models deals with issues concerning eGovernment, whose objectives are generally to improve efficiency and effectiveness, offering (if pertinent) online services and information that can increase democratic participation, accountability, transparency, and the quality and speed of services areas [3]. The approach of such eGovernment models is similar to that of the “non eGovernment” models, that is, the focus is basically the exchange of information, considering the availability of public services, integration of agencies and others.

This paper presents results regarding the execution of a literature review based on the eGovernment interoperability topic. The results show some distribution of the research around the world, characterizing the evolution of some countries in comparison to others. Besides that, it was possible to identify 150 documents from an initial database universe, with the identification of the authors, quantity (and type) of publications. A series of important definitions were gathered from the database (including the confirmation that the growth of the subject began in 2000), helping to establish the problem and create a theoretical reference, exposing methodologies, frameworks and models. This paper also presented a methodology to structure a research for assesses public administration interoperability, considering since the initial activities until the assessment itself. It was detected gaps regarding the research field in some aspects of eGovernment interoperability, especially when dealing with non-technical aspects. This paper considers that the development of models (guidelines or frameworks) that contribute to the processes of assessing semantic interoperability levels in the government (or eGovernment) context is relevant, both for the development of the research field and also for the government organizations and public administration managers.

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