

# Interoperability Assessment Approaches for Enterprise and Public Administration

## Short Paper

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**Abstract.** The need for collaboration among organizations is a reality with which systems, managers and other stakeholders must deal. But 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. This paper presents basic concepts of Enterprise Interoperability, some assessment models and eGovernment practices, models, definitions and concepts, providing an initial analysis of their basic properties and similarities, verifying some possible gaps that may exist.

**Keywords:** interoperability, assessment, eGovernment, maturity models.

## 1 Introduction

Nowadays, companies experience an economic and social period characterized by the need for integration and cooperation. Within this scenario, systems interoperability and networking stand for technologies that enable companies to communicate, cooperate and be aligned with their partners in an efficient and effective way. In this regard, the interoperability assessment plays an important role in diagnosing and positioning the enterprise according to its collaborative environment and goals. There are many methods related to interoperability assessment in literature [3].

A domain with current evidence is the public administration sector commonly referred to in literature as eGovernment. The term eGovernment (or its equivalents) is defined in [13] 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. The eGovernment interoperability refers to the ability of constituencies or public agencies to work together attempting to meet interoperability requirements. Such definitions infer the proximity to the Enterprise Interoperability (EI) concerns and barriers, aspects explored in [2].

In the recent scenario related to eGovernment interoperability, system designers have recognized that the entire interoperability problem consists of more than technical aspects [15]. The complexity presented in the eGovernment context requires

additional effort regarding legal, political and policy, and sociocultural issues. This scenario is particularly prominent in some emergent countries as Brazil, providing a broad field for research in the eGovernment interoperability domain.

The objective of this paper is to present, in addition to the basic concepts of Enterprise Interoperability and Enterprise Interoperability Assessment, some assessment models and an overview of the interoperability government models. Also, the paper aims to analyze their basic similarities and verify some possible gaps that may exist regarding specifically the government related models.

## 2 Enterprise Interoperability Concepts and Assessment Models

One of the most common definitions of interoperability is the ability of two or more systems or components to exchange information and to use the information that has been exchanged [11], being a mean to achieve integration [4]. Enterprise Interoperability has basically three main dimensions: barriers, concerns and approaches. There are three categories of barriers [10]: (1) conceptual, related to the syntactic and semantic differences of information to be exchanged; (2) technological, related to the possible incompatibility of information technologies; (3) organizational, related to definition of responsibility, authority and other “human factors”. Regarding the interoperability concerns, there are four areas [3]: (1) data; (2) services; (3) process and (4) business interoperability. The last interoperability dimension is related to the approach method, that is, how to put entities together in order to establish interoperations. According to [14], there are three basic ways: (1) integrated approach; (2) unified approach and (3) federated approach.

Interoperability involves two (or more) enterprises and, usually, these enterprises are different; with different systems, models or organizational structure. Enterprise Interoperability Assessment (EIA) provides a company with 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 enterprises. One of the measures that can be used and defined is the maturity level that is (intended to be) achieved. There are several interoperability maturity models (IMMs) presented in the literature which describes and graduates the degree of interoperation potentiality [14].

The Levels of Information Systems Interoperability (LISI) [7] provides a reference frame for discussing system-to-system interoperability issues, focusing mainly on technical interoperability. The Organizational Interoperability Maturity Model (OIMM) [5] does not address technical, semantic or syntactical issues, but focuses on the business and organizational areas of concern. Just like OIMM, the Levels of Conceptual Interoperability Model (LCIM), proposed in [22], explores the idea that interoperability goes beyond technical implementations. Proposed by [1], Enterprise Interoperability Maturity Model (EIMM) focuses on the enterprise. Described in [10], Maturity Model for Enterprise Interoperability (MMEI) integrates aspects (such as the four concerns and the three barriers) which are usually dealt in a fragmented way by separated maturity models. All models mentioned have basically five maturity levels, as shown in Table 1.

**Table 1.** Examples of models, maturity levels and basic comments

Model	Level 1	Level 2	Level 3	Level 4	Level 5
LISI	Isolated. Manual gateway (CD, DVD, flash drives).	Connected. Homogeneous product exchange (e-mails, files).	Functional. Minimal functions. Heterogeneous product exchange.	Domain. Shared databases. Sophisticated collaboration.	Enterprise. Distributed information. Simultaneous interactions.
OIMM	Independent. Communication via personal contacts. Limited shared purpose.	Ad hoc. General guidelines. Basic electronic shared information.	Collaborative. General frameworks. Shared some knowledge.	Combined. Shared communications. Shared culture influenced by home organization.	Unified. Organization interoperating on a daily basis.
LCIM	System Specific Data. Isolated systems. Black box.	Documented Data. Black box with a documented interface.	Aligned Static Data. Black box with a standard interface.	Aligned Dynamic Data. White box. Common Ontology.	Harmonized Data. Common conceptual model. Beyond a white box.
EIMM	Performed. Some collaboration. Ad hoc.	Modeled. Defined collaboration. Repetition occurs.	Integrated. Process is formal and frequently used.	Interoperable. Dynamic. Adaptation to changes and evolution.	Optimizing. Integrating systems, models and technologies.
MMEI	Unprepared. No capability for interoperation.	Defined. Very limited. Simple electronic data exchange.	Aligned. Able to adhere to common formats or standards.	Organized. Interoperate with multiple heterogeneous partners.	Adapted. Dynamically adjustments. Shared domain ontologies.
GIMM	Independent. Interaction between independent organizations.	Ad hoc. Limited frameworks available. Ad hoc arrangements.	Collaborative. Frameworks in place. Shared goals.	Integrated. Shared systems and goals. Preparedness to interoperate with others.	Unified. Goals, value systems, structure and bases shared among organizations.
ISIMM	Manual. Systems not connected. Shared manually.	Ad hoc. Basic data sharing. Separated applications and databases.	Collaborative. Connections facilitated. Separated applications and bases.	Integrated. Data shared. Collaboration at an advanced domain level.	Unified. Data and application fully shared and distributed.

### 3 Government Interoperability Models

Although the models already presented can be used in various types of organizations, in an abstract way, there are few models regarding specifically government issues. Such models have a strong connection to eGovernment issues, considering it as a key strategy for improving the effectiveness of public policies and programs [16]. Governments should address interoperability issues at least for four reasons [26]:

(1): leads to better decision-making, (2) allows better coordination of government agency services, (3) foundation of a citizen-centric delivery of services and (4) leads to cost savings and/or avoidance. In other words, eGovernment interoperability contributes to good governance.

Basically, eGovernment is the application of information technology to government processes in order to improve services to constituents, considering that various government organizations can share and integrate information between each other [16]. Other complementary and representative definitions for eGovernment are the use of information and communication technologies (ICTs) to: (1) improve public organizations activities [8]; (2) overcome the physical bounds of traditional paper and physically based systems for free movement of information [17] and (3) support the government business, providing or enhancing public services or managing internal government operations [13].

Proposed by [19], the Government Interoperability Maturity Matrix (GIMM) provides an easy, comprehensive and complete way for administrations to evaluate their current status on eGovernment issues. The structure is very similar to other models (presented in this paper), with maturity levels defining the characteristics of the formalism degree and the way of exchanging data and information. The GIMM works with interoperability attributes, such as connectivity with central government gateways, single sign-on facilities for user authentication, existence of web-service interfaces, interoperability with external enterprise systems, and existence of common XML-based data schemas.

In [12], the authors present important issues related to government interoperability, taking into account that eGovernment actions may, also, decrease bureaucracy. The need of a more service providing public service requires a well-defined ICT infrastructure of support. The paper has a main focus regarding technical aspects of information exchange, especially considering the necessity of a single and common language to be adopted, which, in this case, is the XML.

The model for interoperability evaluation in eGovernment services, proposed by [23], identifies some aspects in order to guarantee information and knowledge interoperability in eGovernment services. The paper proposes three basic approaches that must be taken into account: information and knowledge management (e.g. markup languages, open software and formats, and electronic document processing), metadata for knowledge representation in electronic resources, and web accessibility to improve access for all users. In [20], two government e-services in Norway are presented as a case study. The paper proposes a four-staged framework (aligning work processes, knowledge sharing, joining value creation and aligning strategies) crossing with organizational, semantic and technical interoperability issues.

In [16], the authors present a framework that structures eGovernment interoperability in terms of dynamic and interactive policy, management, and technology dimensions. The framework proposes a structure formed by basic categories and dimensions. The Interoperability Practical Implementation Support (IPIS), proposed in [18], presents a practical approach for implementing electronic government interoperability. The approach consists of three main components: support tools, interoperability repositories, and a knowledge-based system. The paper shows a methodology to

tie all three components together. The information Systems Interoperability Maturity Model (ISIMM), proposed in [21], also defines levels and degrees of interoperability evolution, focusing on technical aspects regarding data exchange and sharing. The authors present an application case of the ISIMM regarding the Government of Namibia in order to establish its interoperability level considering, mostly, technical issues. Although the ISIMM was not built to deal with government issues specifically, it is mentioned in this section, given that, in this case, it was applied for government assessment. The GIMM and ISIMM are also shown in the comparative Table 1.

The e-PING [9] framework is a Brazilian Government 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. E-PING stands, in Portuguese, for “*Padrões de Interoperabilidade de Governo Eletrônico*”, which can be freely translated into English as “eGovernment Interoperability Patterns”. This reference model establishes conditions and interactions with other government agencies and the society, covering aspects such as interconnection, security, access, and organization and data interchange. The Brazilian e-PING (and other countries Government Interoperability Frameworks) addresses technical interoperability [25], defines protocols that must be used, hypertext interchange format, databases, image extensions, BPMN notations and other issues. The idea began in 2003 with a visit to the British government to study the UK eGovernment Interoperability Framework (e-GIF). The Brazilian government organized a committee to initiate the first efforts to build the architecture and specifications. In July 2005, this initial committee was nominated as “e-PING Coordination”. The areas covered by e-PING are interconnection, security, ways of access, organization and information exchange and electronic government integration areas. The framework does not recommend tools or defines presentations patterns for information, and considers that there are technical, semantic and organizational elements that must be covered in the interoperability.

## 4 Interoperability Models Analysis and Discussion

All presented models, either related to government or not, have a strong relationship with data communication and information exchange, i.e. they strongly emphasize technical and operational issues. Such view may derive from the most adopted interoperability definition: “the ability of two or more systems or components to exchange information and to use the information that has been exchanged” [11].

The OIMM and EIMM may contain some background aspects of management and organization, whilst LISI and LCIM may refer to computer science. Another main characteristic is that all models have a strong relation with the use of standards and inter systems interoperability, whilst, on the other hand, they are not so strong when dealing with agility in reaction and adaptation. The OIMM is almost the only model that deals with issues directly related to a command style, culture and other organization values besides the technical issues. The GIMM identifies interoperability attributes that must be taken into consideration in order to evaluate the organization in the eGovernment interoperability. These attributes have a correlation with the factors

that influence (positively or negatively) the eGovernment interoperability, proposed in [2]. It is known, and for the government aspects this is not different, that interoperability is a complex problem, which deals with many conceptual definitions, multiple proposed models and domain areas [13]. Although there are basically three primary goals associated with achieving interoperability in any system (data exchange, meaning exchange and process 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. Which means, in government related interoperability, the context is very important, once some major differences must also be addressed (e.g. poor infrastructures, dictatorial or developed countries). In spite of that, the majority of government related models deal 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 [13]. The approach of such eGovernment models is similar to that of the “non eGovernment” models, that is, the main focus is still basically the exchange of information, considering the availability of public services, the integration of the agencies, and other operations involving an interface layer of information exchange.

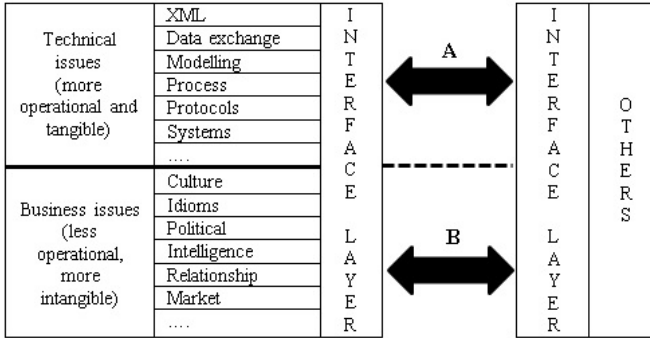
Figure 1 represents the exchange of information, considering that the dotted line represents a basic division of views related to the goals and types of information exchanged. The “A” arrow is associated to the technical aspects of interoperability, and the operational and tangible issues are well defined and treated through consolidated models. The “B” arrow represents the relationship regarding more intangible items, such as culture and market information exchange. These issues can be considered part of the influencing factors related to the interoperability government context. The “B” arrow is not so well represented in terms of models and practices such as the “A”.

As interoperability problems consist of more than technical aspects, the European Commission’s European Interoperability Framework (EIF) redefined the concept of interoperability in a more general way: “interoperability is the ability of disparate and diverse organizations to interact towards mutually beneficial and agreed common goals, involving the sharing of information and knowledge between the organizations via the business processes they support, by means of the exchange of data between their respective information and communication technology (ICT) systems” [13].

Considering this overview, and according to the models presented in this paper, there is a certain lack of definitions and models that report organizational barriers and business interoperability more fully. In addition, for the government models, specifically, there could be more issues focusing on cultural, political, intelligence and relationship aspects, i.e. the “B” arrow in Figure 1 could be reinforced.

Taking into account the characteristics of some eGovernment models presented in this paper, and also considering some Brazilian influencing factors (federal, state and municipal), such as the World Cup 2014, Olympics 2016 and the fact that the city of Curitiba was placed first in the Brazilian Index of Digital Cities, 2012 [6], there is a need of ongoing and future works that must address issues as: (1) bibliography review regarding the Brazilian context related to eGovernment aspects; (2) review the barriers, concerns and approaches related to the Brazilian characteristics for

eGovernment; (3) review the influencing factors, attributes and barriers (not only considering technical aspects) that influence the eGovernment interoperability in Brazil, such as those proposed in [2], [19] and [24]; (4) propose (and/or adapt) methods to evaluate the eGovernment interoperability in Brazil, also considering some intangible aspects.



**Fig. 1.** Data exchange according to the views

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