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Development and Implementation of Interoperability Standards for Electronic Government: a Case Study of the Brazilian e-PING Framework

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Abstract

Though it may seem commonsensical that interoperability standards play an important role in systems integration and information sharing within the environment of electronic government, establishing these standards is no easy task. This process is highly complex due to the number of participating agents, the environment in which it takes place and the interrelation between the agents and the environment, not to mention the likely conflicts of interests connected with this interrelation. It is also believed that the affected agents' perception of the relevance and the legitimacy of the defined specifications may influence the latter's adoption. Based on these assumptions, this paper analyses the development and implementation processes of standards for electronic government from the standpoint of Institutional Theory. It presents the preliminary findings of an exploratory qualitative case study, based on document analysis and semi-structured interviews, of the framework interoperability specified by the Brazilian Federal Government (e-PING). The results point out some of the institutionalization processes and legitimacy mechanisms that are being used by the government in the establishment of those standards and the likely implications of those actions for full compliance with the said standards.

Keywords

Interoperability Framework, Standards for electronic government, Standardization, Electronic Government, e-PING, Brazil.

1. Introduction

Standardization can bring several benefits to public administration, such as improved data administration; it can also contribute to the information infrastructure, enhance accountability and better the coordination of programs and services, among other positive effects.

In the specific case of electronic government, the UN considers that the ideal environment for users is a single access point to all information and services (United Nations 2001). In this context, it is easy to see the importance of adopting standards, given the need for systems integration and information sharing. Several authors, such as Akbulut (2003), Dawes (1996), and Landsbergen and Wolken (2001), have already investigated these processes among government agencies and identified standardization as a conditioning factor.

Standardization is necessary to enable data exchange and its re-use over time. It also prevents getting locked into proprietary tools and formats (EPAN 2004). However, for a standard to be successful it must be accepted by all agents involved in the transactions that are affected by it. Furthermore, this adoption may depend on the perception of the standard's relevance by the agents involved. Therefore, the conduction of its development and implementation processes is very important, because of the influence that it can exercise over this perception.

The objective of this paper, based on the concepts of institutionalization, isomorphism and legitimacy proposed by institutional theory, is to analyze the development and implementation processes of an interoperability framework for electronic government and, using this analysis as a starting point, to identify the mechanisms employed for the establishment of those standards and the likely implications of their adoption. As empirical support, the article presents an exploratory case study of the e-PING framework - Interoperability Standards for Electronic Government, a set of specifications implemented by the Brazilian Federal Government (e-PING 2006)

2. Institutional Theory

The point of view of Institutional Theory, in particular of New Institutionalism (Powell & DiMaggio 1991), regarding the process of technology adoption advocates a model of rational players guided by utilitarian calculations in their decision-making. According to this approach, organizations suffer the demands and pressures of their external environment not only in relation to elements of a technical and economical nature (production and exchange of goods and services), but also of a cultural nature, which require that they play certain roles and maintain certain appearances (Scott 2001).

Thus, organizational action ceases to be the result of a choice among several possibilities delimited by internal arrangements; instead, we have a limited group of legitimated options defined by the group of players that make up the organizational field. The way in which this organizational field exercises its influence is through institutions: the set of norms, rules and values that indicate to the organization what can or cannot to be done (Hoffman 1999; Scott 2001). Thus, organizational actions can be guided by individual or social objectives, regardless of the objective, rational or efficiency criteria.

Scott (1995) defines institutions as a structure or a cognitive, normative or regulatory activity that provides stability and meaning for social behavior. Institutions rely on several types of support, such as cultures, structures and routines, in which are at play at several levels of action. According to Jepperson (1991), an institution is a process organized and established as a normative system of self-reproduced and socially constructed routines.

Another important concept established in the new institutionalism theory is institutionalization. For Zucker (1991), this refers to the process whereby individual players transmit what is socially defined about reality and, at the same time, as a variable of an action that can be considered correct within a certain social reality. This author states that this process usually happens as a by-product of the creation of other structures. According to Powell (1991), institutionalization is a compulsory process that forces units of a population to act in the same way as other units that are facing the same situations, an idea that he called isomorphism.

2.1 Isomorphism

One of the main Institutional Theory arguments is that organizations have an inclination for imitation, or isomorphism, which can be defined as the search for the homogeneity of structures, processes and actions within organizations. DiMaggio & Powell (1991) and Powell & DiMaggio (1991), point out three main mechanisms whereby organizational isomorphism occurs: coercive pressures, mimetic process, and normative influences.

Coercive isomorphism comes from formal and informal pressures on the organization (DiMaggio & Powell 1991). This pressure can be exercised by force, persuasion, or even by

order. Some organizational changes can happen due to government pressures or laws that impose procedures and operating standards upon a certain sector.

The second isomorphism mechanism is the mimetic process, justified by the fact that uncertainty encourages imitation. When organizational technologies are not understood very well, when the goals are ambiguous or when the environment creates symbolic uncertainties, organizations can model themselves on other organizations (DiMaggio & Powell 1991).

As some organizations adopt practices regarded as efficiency enablers, there are pressures from the employees, stakeholders, consumers and even from society at large for others to adopt them also. In other words, the most available solution and the one considered as more generally appropriate is the first to be adopted. There is a variety of practices that organizations need to adopt in order to be regarded as modern not only by their employees but also by their customers (or users) (DiMaggio & Powell 1991). Therefore, processes, rules, procedures and structural formats can be copied and thoroughly disseminated, although there is no concrete evidence that such models contribute to organizational effectiveness.

The third mechanism whereby isomorphism occurs is by normative pressures. Those pressures result from organizations' professionalization resulting from formal education and the legitimacy of a knowledge base produced by academic specialists. Similarly, it also comes from the professional contact networks established between organizations and professionals' groups, as well as in training institutions or commercial associations.

DiMaggio & Powell (1991) relate those normative pressures to the culture of professionalism, which aims at establishing bases of knowledge about work methods as a source of legitimacy for professionals. Like organizations, professionals also suffer coercive and mimetic pressures, not only through formal education but also from informal contact networks. Socialization is one of the forces that causes professionals to lean toward isomorphism and, consequently, to the practices that they apply to organizations.

2.2. Legitimacy

Another concept related to institutionalization is legitimacy, "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and definitions" (Suchman 1995, p. 574). For this author legitimacy can be of three types: pragmatic, moral and cognitive:

- Pragmatic - it is based on the interests of players that have a closer connection with the organization;
- Moral - it reflects a positive evaluation of the organization and its activities, based on values socially constructed;
- Cognitive - it consists of gaining the organization's acceptance due to being necessary or inevitable from the point of view of a certain cultural reference.

Those three types of legitimacy co-exist in most of the situations and they are interrelated. Due to institutional pressures, organizations adopt strategies to obtain, maintain or restore their legitimacy (Suchman 1995).

Oliver (1991) defines five types of legitimacy strategies: passive acceptance, agreement, prevention, challenge and manipulation. Those strategies help to understand how organizations, under institutional pressures, manage their legitimacy and, consequently, the acceptance of their actions by the players that interact with them.

3. Standards and Standardization

In a broader sense, a standard is defined as a group of specifications that all the product elements, processes, formats, or procedures under its jurisdiction must comply with (Tassey 2000). David & Greenstein (1990) state that a standard can be understood as a group of technical specifications that a group of suppliers complies with tacitly or as a result of a formal agreement.
David & Steinmueller (1994) classify standards into four categories: reference, minimum quality, interface and compatibility. Compatibility standards, which include interoperability, play an important role in the ITC field, because they are enablers of data exchange among components of a specific system or different inter-organizational systems.

According to Williams et al. (2004), the development and implementation of compatibility standards not only define technically an inter-operational method among the different components of a network, but are mainly a proposal for the future of the complex socio-technical systems that are the form of an inter-organizational network.

Standards can also be classified according to the processes that led to their establishment. A distinction is frequently made between formal, de facto and de jure standards. Formal standards are created through standardization entities; de facto standards are technologies unified by market mechanisms, and de jure standards are those imposed by law (Hanseth & Monteiro 1998).
According to Graham et al. (1995), the standardization process is an attempt to align the interests and business practice expectations of a group of people interested in developing and using the system that will be standardized. Therefore, standardization is not only meant to provide a usable solution but, mainly, to articulate and to align expectations and interests (Williams 1997).

David and Greenstein (1990) argue that in relation to Information Technology (IT), standardization can be defined as the process whereby two or more agents agree and comply with a group of technical specifications of a system, their parts or their functionality, tacitly or as a result of a formal agreement. Consequently, those standards both enable and constrain the several agents' future behavior (Garud, Jain & Kumaraswamy 2000). Therefore, developers of standards should take those effects over the involved agents' future actions into account, because they can influence the degree of adoption of the said standards.

4. Interoperability

Interoperability can be defined as the ability of two or more systems to interact and exchange data according to a defined method, in order to obtain the expected results. IEEE (2000) presents four definitions:

- the ability of two or more systems or elements to exchange information amongst themselves and to use the information exchanged;
- the capacity of equipment units to work together to accomplish useful functions;
- the capacity of heterogeneous equipment, usually manufactured by several suppliers, to work together in a network environment, thanks to compliance with a certain set of standards that fosters work integration, although it cannot guarantee this integration;
- the ability of two or more systems or components to exchange information in a heterogeneous network and to use this information.

Interoperability can bring several benefits, such as enhanced effectiveness (interconnection instead of isolated solutions), efficiency (reduction of the cost of transactions and enhanced participation of the involved agents) and responsiveness (better access to more information, making it possible to solve problems faster) (Landsbergen & Wolken 2001).

However, there are several barriers for organizations to achieve interoperability broadly and effectively. These barriers can be classified as being of a political, organizational, financial or technical nature (Anderseen & Dawes 1991):

- Political - definition of the guidelines for the adopted policies; conflicts in the definition of the levels of privacy regarding access to information; predominant organizational culture; ambiguity of the authority regarding collection and use of information; administrative discontinuity;
- Organizational - lack of experience and absence of a willingness to share; level of skills of the personnel involved in the processes; organizational culture;
- Financial - other agencies' lack of resources for providing information; how the resources are acquired (usually based on the criteria of lowest price rather than of best value);
- Technical - hardware and software incompatibility; property rights; insufficient awareness of data generated and stored by the systems; multiple data definitions.

Although information sharing among government agencies is a common objective, the scope of this interoperability is still limited (Dawes & Bloniarz 2001). Though recognizing the importance of sharing and the significant benefits that this offers to policy makers, government organizations and the public at large, government agencies face several technical, organizational and political barriers (Dawes 1996; Landsbergen Jr. & Wolken Jr. 2001; Rocheleau 1997). The summary of the benefits and barriers are presented in table 1.

Category	**Benefits**	**Barriers**
Technical	• Improvement of data administration • Contribution to information infrastructure	• Incompatible technologies • Inconsistent data structure
Organizational	• Better support for problem solving • Expansion of professional contacts networks	• Organizational-self interest • Dominant professional standards
Political	• Expansion of public policies' action context • Improvement of public accountability • Better program and service coordination	• External influences over decision makers • Power of agency discretion • Priority of the programs

Table 1: Benefits and barriers of information sharing for electronic government
Source: Dawes (1996); Landsbergen Jr. & Wolken Jr. (2001); Rocheleau (1997).

Because of these barriers, it is very important to have a clear perception of the legitimacy and of the relevance of the specifications of standards, to ensure that they can actually be adopted.

5. Methodology

This study consisted of an exploratory qualitative case study (Yin 2001) based on the analysis of documents and of data collected through semi-structured interviews. The research object was the e-PING framework, a set of standards specified by the Brazilian Federal Government for the use of government agencies.

An analysis was carried out of the documents that specify the guidelines of the adopted standards and the reports describing the actions the Government took to implement them. It was also analyzed the syntheses of the questions and answers from the public hearings and consultations held for evaluating the definitions of the specifications. The data collection was complemented with semi-structured interviews conducted with the project's coordinator and with one of its technical assistants, in order to clarify how the decisions regarding the specifications of standards and the strategies adopted for their implementation were taken.

6. The e-PING Framework

6.1. The conception

e-PING - the Standards for Electronic Government Interoperability - defines a minimum set of assumptions, policies and technical specifications that regulate the use of Information and Communication Technologies (ICT) in the interoperability of electronic government services, establishing the interaction conditions with other government institutions (besides states and municipal districts) and with society. Those standards include five segments: (1) interconnectivity, (2) security, (3) means of access, (4) organization and exchange of information and (5) integration areas for electronic government, as presented in table 2 (e-PING 2006).

Segments	**Covered issues**
Interconnectivity	Conditions for government agencies to connect to each other and to external institutions.
Security	Security aspects to ensure the validity and confidentiality of operations
Access means	Devices for access to the services of electronic government.
Organization and exchange of information	Issues related to the management and transfer of information.
Integration areas for electronic government.	New ways of integrating and exchanging information based on the e-PING definitions.

Table 2: Definition of e-PING segments

For each one of these segments, there is a process for analysis of the standards that will make up the architecture. That process considers that the selection, approval and classification of the specifications has five levels:

- Adopted (A) - evaluated and formally approved;
- Recommended (R) - should be used by the government agencies, but is yet to be formally approved;
- Transition (T) - not recommended due to non-compliance with a technical requirement. May be used only temporarily;

- Under evaluation (E) - still under evaluation;
- Future evaluation (F) - not yet evaluated. Left for future consideration.

In its version 3.0, as of December 2007, e-PING specified 193 standards. Table 3 presents their classifications, grouped by segments.

Segments	Total of specified standards	Classification				
		(A)	(R)	(T)	(E)	(F)
Interconnectivity	25	4	15	-	6	-
Security	33	1	23	-	7	2
Means of access	120	21	53	33	2	11
Organization and exchange of information	7	2	3	-	1	1
Areas and issues for electronic government	8	3	2	-	3	-
Total	193	31	96	33	19	14

Table 3: Classification of the e-PING standards

The e-PING framework is seen as a basic structure for the strategy of electronic government in Brazil and its development was based on the e-GIF project (Government Interoperability Framework) implemented by the British government as from 2000 and currently in its version 6.1 (e-GIF, 2004).

Initially applied to the Brazilian Federal Government's Executive Branch, the framework foresees an exchange of information between the Executive Branch and citizens, state and municipal governments, the Legislative and Judiciary Branches of the federal government, the Public Prosecution service, international organizations, other countries' governments, national and international companies and also NGOs (figure 1).

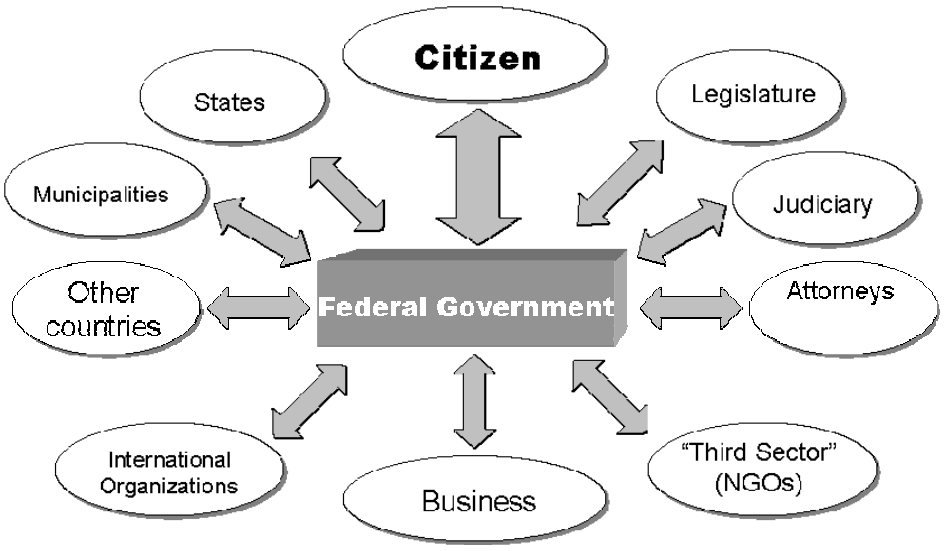

Figure 1: e-PING relationships

e-PING was devised as a compulsory tool for the use of all Executive Branch agencies (in addition to the government-owned companies and other federal entities), applicable to all the new information systems, the legacy systems that incorporate electronic government services or integration among systems, and all other systems that involve electronic services (e-PING 2006).

6.2. Development and implementation

In June of 2003, a committee of the Brazilian Government visited the United Kingdom with the purpose of becoming acquainted with the e-GIF project. After that visit, an e-PING coordination group was created in November 2003. One month later, the workgroups were formed, with IT professionals from several government agencies.

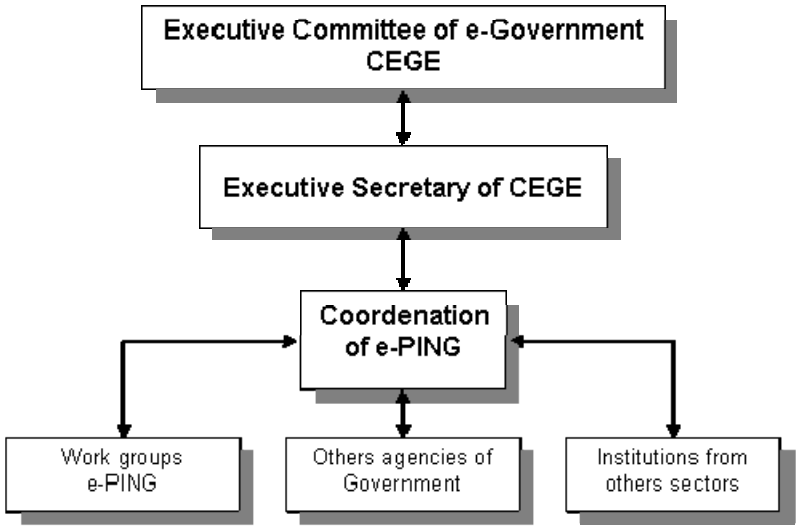

Figure 2: e-PING management model

A workgroup was created for each of the five segments covered by the architecture. Each group is responsible for holding the meetings and the discussions of its area and also for presenting the results to the other groups during the meetings with the coordination group. The coordination group is responsible for supervising the activities of the workgroups and also for presenting and discussing the project with other institutions from the public and private sectors (figure 2). This group also reports to the Electronic Government Executive Committee (CEGE) on the project's progress, through its Executive Secretary.

In January 2004, the workgroups began their discussions to specify the preliminary version of the architecture (version 0) that was released in May. From June to August this document was submitted to public scrutiny via the Internet. During the same period, six public hearings were held; they were attended by more than 600 people. The public scrutiny and hearings added the contributions of public agencies, researchers and ICT suppliers to the specification of the standards, more than 90 suggestions having been submitted. After these were analyzed, the document was updated and the version 1.0 was published in March 2005. In July, a Federal law was passed regulating the use of the architecture (BRAZIL, 2005).

The e-PING reference document established the guidelines for implementing interoperability among the several technological solutions used by the Brazilian Government. Those guidelines cover issues such as network security, computational infrastructure, technological requirements, standards for software development, and access to data and information.

As a result of the discussions driven by the workgroups, two other versions were published: the 1.5 one in December 2005 and the 1.9 one in August 2006. The latter was also submitted to public consultation and hearings. After evaluation of the suggestions received, the version 2.0 was published in November 2006. In December, Spanish and English versions (2.01) were released. The version 2.9 was published in October 2007 and was also submitted to public consultation and hearings. After an analysis of the suggestions presented the version 3.0 was released in December 2007.

7. Discussion

One of the project's strong points has been its publishing strategy and discussion. Since its inception and up to the release of the version 3.0, more than 40 national and international presentations about the project were delivered in seminars, workshops and conferences. This lent the project visibility, driving high awareness of its guidelines not only among government managers but also in society at large. The public hearings and consultations were useful to air in a public arena the expectations of all interested agents, while also providing them with the opportunity to contribute to the process, which can help to reduce the conflicts that are likely to arise as the standards are adopted. At the same time, those actions point to the advisability of using legitimacy mechanisms through a prevention strategy. By publishing the specifications of the standards and making them available for discussion through public consultations and hearings, the project's coordinators tried to eliminate further issues regarding the effectiveness of the implementation of the architecture or issues related to the prevalence of the government's interests in its definition.

The definition of the e-PING framework was originally based on the e-GIF standards established by the British government. Additionally, the technologies adopted by the Brazilian government (such as XML and web services, for instance) are regarded as *de facto* standards, which can cause the managers be more willing to adopt e-PING. Those actions can be seen as manifestations of mimetic isomorphism. Before a complex process such as the specification of standards, the adoption of already consolidated models and technologies reduces the possibility of failure and increases the involved players' level of trust in the project. Consequently, the perception of the legitimacy of the actions of the workgroups also rises.

The workgroups' member are ICT professionals from several government agencies that meet to specify the standards that will make up the architecture. Those professionals, due to their formal education and previous experiences, end up establishing a process of normative isomorphism. The current pressures regarding the level of professionalization required in their functions and the socialization of their experiences drives the isomorphism of these professionals and, consequently, of the practices adopted in their organizations. Finally, this homogenization reflects the construction of the architecture during the professionals' interaction in the workgroups.

96 of e-PING's 193 specified standards, or about 49.74% of the total, are classified as recommended (R). Only 31 (or very slightly more than 16%) are defined as adopted (A). This means that even though the project has already been under way for some four years, the level

of standards defined as adopted is relatively low. ICT managers may regard this situation as an inhibiting factor, because only a small part of the specified standards has already been formally approved. However, thanks to the Federal Government passing a law that makes adoption of the architecture by the agencies of the Executive Branch mandatory as from July 2005, they will have to adopt it regardless of that perception. This situation can be described as coercive isomorphism, though in this case the coercive pressure applies to government agencies, which will have to adopt the standards, rather than to the workgroups.

8. Conclusions

It is difficult to develop and implement standards. Some advance no further than their development phase, due to problems in the process of articulation of the discussions and definitions. Others, although specified, are not adopted as a result of construction or institutionalization processes.

The dynamics of standardization, a continuous process of evolution and adaptation, also encompass constant tension between the definition of standards and the flexibility and necessary generalization for the standards to last and be adopted. It is necessary, therefore, to achieve full institutionalization of the process and a perception among the agents affected by the standardization of the legitimacy of the actions taken during the specification of the standards.

The main results of this case study are the identification of several actions in which isomorphism is present and of several legitimacy mechanisms used by the Brazilian government to institutionalize the development and implementation processes of the e-PING framework. It was also identified certain aspects of those actions that can influence adoption of the standards and how this influence may come about.

Certain issues can be suggested for future studies, such as investigating whether the legitimacy mechanisms are really being used to improve the specifications of the architecture through the discussion and involvement of the agents affected by these standards. Another issue is whether isomorphism practices and the legitimacy strategies can effectively drive the institutionalization process of the standards or whether those actions are not sufficient to drive the establishment of these standards and their full subsequent adoption.

References

Akbulut, A., "An investigation of the factors that influence electronic information sharing between state and local agencies", Ph.D. Dissertation Thesis. Louisiana State University, 2003.

Andersen, D., and Dawes, S., "Government information management. A primer and casebook", Englewood Cliffs, NJ: Prentice Hall, 1991.

BRASIL. "Portaria normativa de 14 de julho de 2005". Institucionaliza os Padrões de Interoperabilidade de Governo Eletrônico - e-PING, no âmbito do Sistema de Administração dos Recursos de Informação e Informática – SISP, cria sua Coordenação, definindo a competência de seus integrantes e a forma de atualização das versões do Documento. Diário Oficial da União, Brasília, DF, July 15, 2005.

David, P., and Greenstein, S., "The economics of compatibility standards: an introduction to recent research", The Economics of Innovations and New Technology, 1 (1-2), pp. 3-41, 1990.

David, P., and Steinmueller, W., "Economics of compatibility standards and competition in telecommunication networks", Information Economics and Policy, 6(3-4): pp. 217-241, 1994.
Dawes, S., "Interagency information sharing: expected benefits, manageable risks", Journal of Policy Analysis and Management, Vol. 15, No. 3, pp. 377-394, 1996.
Dawes, S., and Bloniarz, P., "Knowledge networking in the public sector", New York: Center for Technology in Government, State University of New York at Albany/SUNY, 2001.
DiMaggio, P., and Powell, W., "The iron cage revisited: institutional isomorphism and collective rationality in organizational fields", In W. W. Powell & P. J. DiMaggio (Eds.). The new institutionalism in organizational analysis. Chicago: The University of Chicago Press, 1991.
e-GIF, "e-Government Interoperability Framework", Office of the e-Envoy – Cabinet Office, UK, 2004.
e-PING, "Padrões de interoperabilidade de governo eletrônico", Executive Committee for Electronic Government – Brazilian Government, 2006.
EPAN – EUROPEAN PUBLIC ADMINISTRATION NETWORK, "Key principles of interoperability architecture", Ireland, 2004.
Garud, R., Jain, S., Kumaraswamy, A., "Institutional Entrepreneurship in the Sponsoring of Common Technological Standards: The Case of Sun Microsystems and Java", Academy of Management Journal, 2000.
Graham, I., Spinardi, G., Williams, R., Webster, J., "The Dynamics of EDI Standard Development", Technology Analysis & Strategic Management, 7(1): pp. 3-20, 1995.
Hanseth, O., Monteiro, E., "Standards and standardization processes", In: Understanding information infrastructure, 1998 (manuscript).
Hoffman, A., "Institutional evolution and change: environmentalism and the U.S. chemical industry", Academy of Management Journal, Vol. 42, no. 4, pp. 351-371, 1999.
IEEE Standards Information Network, "IEEE 100: The authoritative dictionary of IEEE standards terms", 7th edition. New York, NY: IEEE, 2000.
Jepperson, R., "Institutions, Institutional Effects, and Institutionalization", In: The New Institutionalism in Organizational Analysis, W.W. Powell and P. J. DiMaggio (eds.), University of Chicago Press, Chicago, 1991, pp. 143-163.
Landsbergen Jr, D., Wolken Jr, G., "Realizing the promise: government information systems and the fourth generation of information technology", Public Administration Review. Vol. 61 (2), pp. 205-218, March/April, 2001.
Oliver, C., "Strategic Responses to Institutional Processes", Academy of Management Review, 16(1), 1991, pp. 145-180.
Powell, W., "Expanding the scope of institutional analysis", In W. W. Powell & P. J. DiMaggio (Eds.). The new institutionalism in organizational analysis. Chicago: The University of Chicago Press, 1991.
Powell, W., DiMaggio, P., "The new institutionalism in organizational analysis", Chicago: Chicago Press, 1991.
Rocheleau, B., "Governmental information systems problems and failures: a preliminary review", Public Administration and Management: An Interactive Journal, 2:3, 1997.
Scott, W., "Institutions and organizations", 2nd ed. Thousand Oaks: Sage, 2001.
Suchman, M., "Managing Legitimacy: Strategic and Institutional Approaches", Academy of Management Review, 20(3), 1995, pp. 571-611.
Tassey, G., "Standardization in technology-based markets", Research Policy, 29(4-5): pp. 587-602, 2000.

UNITED NATIONS, "Global survey of e-government", New York: United Nations – Division for Public Economics and Public Administration, American Society for Public Administration, 2001.

Williams, R., "Universal Solutions or Local Contingencies: Tensions and Contradictions in the Mutual Shaping of Technology and Work Organization", In: Innovation Organizational Change and Technology. I. McLoughlin and D. Mason. London, International Thompson Business Press: pp. 170-185, 1997.

Williams, R., Bunduchi, R., Gerst, M., Graham, I., Pollock, N., Procter, R., Voß, A., "Understanding the evolution of standards: alignment and reconfiguration in standards development and implementation arenas", Proceedings of the 4S & EASST Conference. Paris, 2004.

Yin, R., "Estudo de caso: planejamento e métodos", 2nd ed. Porto Alegre: Bookman, 2001.

Zucker, L., "The role of institutionalization in cultural persistence", In W. W. Powell & P. J. DiMaggio (Eds.). The new institutionalism in organizational analysis. Chicago: The University of Chicago Press, 1991.