E-Government Interoperability Frameworks: A Review

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Abstract—Various definitions have been defined for the word "interoperability"; in general however, "interoperability" is a property through which the systems and organizations can communicate and cooperate. In e-government domain to establish "interoperability" among the organizations, using a suitable "interoperability" framework is inevitable. Numerous frameworks have been proposed in e-government interoperability domain. Selecting a suitable interoperability framework as a reference from among the existing interoperability frameworks in e-government domain is a major challenge of great importance. This paper aims at investigating the present frameworks of interoperability in e-government domain and identifying a reference interoperability framework for this domain. The results of this study show that all the existing interoperability frameworks in the e - government domain have some drawbacks. Defining a comprehensive framework of interoperability in e-government domain is therefore inevitable.

Keywords—Interoperability, Framework, E-Government.

I. Introduction

Interoperability is a capability helping the organizations to cooperate. In an e - government domain, the governments can via identifying the standards, technologies and the current methods in the field of interoperability and adopting a comprehensive and consistent approach, achieve a considerable improvement in providing the citizens, business and governmental institutions with high efficiency and more coherent online services [1]. For attaining this goal a suitable interoperability framework must be used. An interoperability framework introduces the standards and technologies necessary for interoperability and presents a comprehensive and consistent approach for interoperability. Numerous frameworks have been proposed in e-government interoperability domain. The major challenge of selecting a suitable framework for interoperability as a reference framework from among the existing interoperability frameworks is of great importance [1]. This paper aims at investigating the present frameworks of interoperability in e-government domain and identifying a reference interoperability framework for this domain. For this purpose the successful experiences of the pioneering countries that have designed and/or implemented the e-government interoperability will also be tackled. The introduced frameworks include different dimensions such as business, information, semantic and technical, each consisting of different components. In this study, different definitions of interoperability are given first; then the reference frameworks of interoperability in e-government area are introduced and the successful experiences of the pioneering countries in the area of interoperability are considered. Thereafter the important determinants employed in any of the introduced interoperability frameworks are investigated and compared and ultimately, the important achievements of this study will be discussed in the conclusion section.

II. Interoperability Levels

According to [6], interoperability consists of four levels, namely business, information, semantic, and technical to which we will deal with in the following section.

A. Business Level of Interoperability

Business level of interoperability includes such issues as policy, legal, organization, and business. It facilitates the collaboration environment between the organizations. At the business level of interoperability, the business processes are designed by identifying common areas as well as by integrating and boosting cooperation opportunities. Business interoperability as far as organizations are concerned, means acquiring the capability of delivering services to other organizations or customers [7].

B. Information Level of Interoperability

To align with business process and contents, an organization should consider some components. In e-government area the government is supposed to increase the information level by any effective means possible [24]. At this level those components supportive of the generation and maintenance environment for governmental information are identified; such components will be valued and managed as a national asset due to their importance [8].

C. Semantic level of Interoperability

The semantic level of interoperability refers to different organizations' capability to understand data exchange on the same basis. Semantic interoperability improvement is an issue of social and training nature that should be managed at the organizational level. In the first place, it is necessary to support the experts, so that they better understand their scope

of activities for collecting structured documents of data and protocols and make them searchable. Different tools such as dictionaries, languages, complex ontologies and taxonomies are required for diffusing storage data in information systems [9].

D. *Technical level of Interoperability*

This level is comprised of the elements that are used to deliver content throughout a community having its own specific interests. Components here include messaging standards, data communication protocols, security, registry and discovery standards, syntax and grammar libraries and of course the required language that describes the processes and services [9, 10]. Governmental organizations can use the common language, conceptual model and standards that technical interoperability framework provides for them as a basis to introduce the governmental policy priorities and programs. In fact the technical interoperability aims at proposing the guidelines relating to infrastructures, technical specifications and ICT standards [10].

III. Interoperability Frameworks

Extensive researches had been done on E-Government interoperability frameworks. This section provides a review on all of the existing frameworks for E-Government interoperability produced since 1998. The frameworks were identified through a search of relevant articles published in the period from 1998 to 2012 in Web of Science database. Google Scholar was also adopted as a tool to complement the search. Keywords such as E-Government interoperability and framework were used for the search.

A. *European Interoperability Framework*

The European Interoperability Framework is defined as a set of guidelines and recommendations for E-Government services so that public administrations, citizens and enterprises could interact across borders, in a pan-European context [12]. This European Framework provides guidelines for the EU Institutions, Agencies and Member States Administrations implement a pan-European dimension in their own interoperability frameworks and administrative infrastructures, to enable interoperable pan-European E-Government services [12]. Also, the national interoperability frameworks should be adhered with the European Interoperability Framework. An overview of the main aspects of the European Interoperability Framework is shown in Figure 1. Technical interoperability, Semantic interoperability and Organizational interoperability are the three interoperability aspects that are required to be considered [12]. **Organizational interoperability:** The organizational interoperability aspect includes defining the business goals, modelling the business processes and bringing about the administrations collaborations that need information exchanges, but that might have a different internal organization and structure of their operations. In addition, organizational interoperability aims at addressing user community requirements throughout making services

available, user oriented, searchable and accessible [12]. **Semantic interoperability:** The semantic interoperability aspect includes ensuring that the precise meaning of information exchanges is understood by any other application not initially developed for this purpose. Also, this interoperability aspect enables systems to combine the received information with other resources of information and process the information in a meaningful manner [12]. **Technical interoperability:** The technical interoperability aspect contains the technical issues of linking up computer services and systems. Services security, accessibility, data exchange and presentation, middleware and data integration, interconnection services and open interfaces are included as the key aspects of technical interoperability.
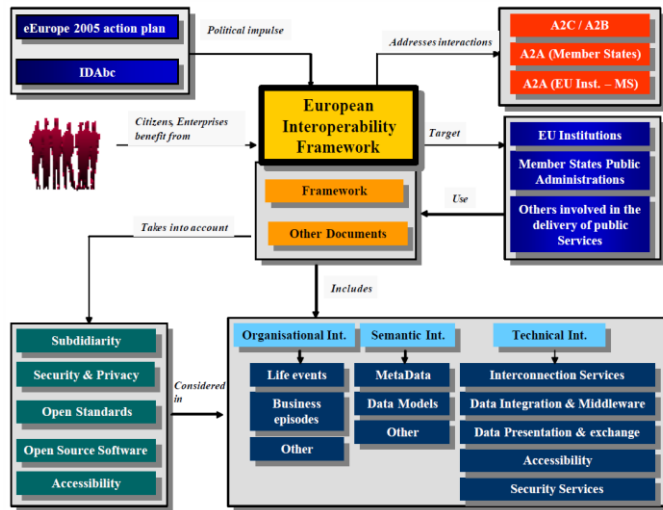

Figure 1. Overview of the European interoperability framework [12]

B. *E-Government Interoperability Framework*

The e-Government Interoperability Framework was presented by the UK's government for interoperability in the governmental organizations (see Figure 2) [13]. This framework defines the government's technical policies and specifications to achieve interoperability and Information and Communication Technology (ICT) systems coherence across the public sector. The e-Government Interoperability Framework sets the essential prerequisites for joined-up and web-enabled government. The e-Government Interoperability Framework consists of: (1) the Framework that covers high-level policy statements, management and technical policies, compliance regimes and implementation; (2) the e-Government Interoperability Framework registry that covers the e-Government Metadata Standard (e-GMS) and Government Category List (GCL), the Technical Standards Catalogue (TSC), XML schemas and the Government Data Standards Catalogue (GDSC) [13].
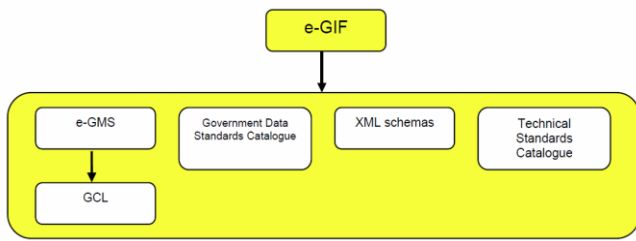
Figure 2. E-Government Interoperability Framework [13]

The minimum set of specification and technical policies governing information is defined in the E-Government Interoperability Framework in which they flow across the public sector and government [13]. In addition, they cover interconnectivity, e-services access, and content management metadata and data integration. The government is committed to ensure that these specifications and policies are kept aligned to the changing requirements of the public sector and with the technology and market evolution [13].

C. Australian Government Interoperability Framework

The interoperability framework implemented by the Australian government comprises three domains consisting of business, technical and information interoperability levels (see Figure 3) [14]. The business level of interoperability includes principles, guidelines and tools for establishing and enhancing interoperability. It assists mainly the agencies to devise strategies for executing projects with cross-agency nature. The information level of interoperability framework features those components necessary for supporting an environment in which the product information will be evaluated and controlled by the government as a national strategic asset [14]. This framework includes information management concepts, principles, tools and practices through which successful sharing of information across the governmental organizations and enterprises is confirmed [14].
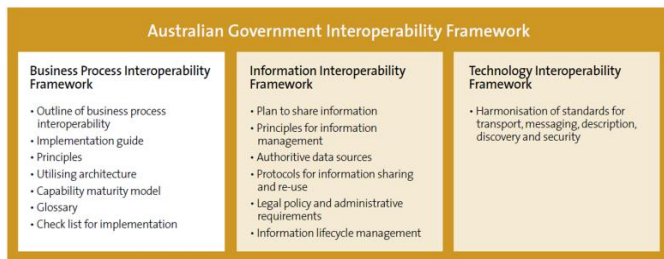

Figure 3. Interoperability Framework of Australian Government [14]

D. New Zealand E-government Interoperability Framework

The main features of this framework are policy and standards of Interoperability [16]. The standards of interoperability encompass multi-layer model components of e-government interoperability framework, determining the layers' situation, standards and standard selection procedure (see Figure 4). New Zealand's e-government policy on interoperability includes objective, project and operational management, ruling principles, extension procedures of the e-Government Interoperability Framework (e-GIF) and development of interoperability framework. The results of e-GIF are: satisfaction, convenience, integration, participation and efficiency [16].
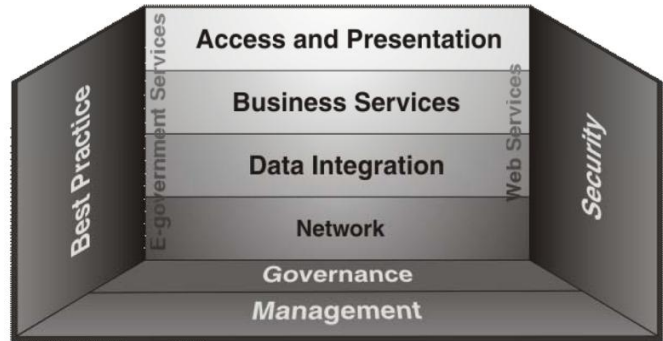

Figure 4. Interoperability Framework of New Zealand E-government [16]

E. Malaysian Government Interoperability Framework

The Malaysia has adopted technical approach to its e-government interoperability framework [17]. This framework relates to a set of technical parameters and ICT norms which control the system connections, flow of information, data exchange and business procedures. The framework consists of 5 interoperability domains including interconnection, information access, data integration, meta-data and security. Technical specifications, guidelines and ICT standards of the framework are as follows: interoperability, market support, standard life cycle, suitability with current standards and aligned with internet [18].

IV. Discussion

In this section different dimensions of the interoperability frameworks introduced in the e-government area will be considered and compared.

A. Levels of Interoperability involved in Investigated Frameworks

According to [6], there exist four levels of interoperability which include "business", "information", "semantic" and "technical" levels. Table I shows the above levels in interoperability frameworks.

TABLE I. Different levels of interoperability in frameworks

Interoperability Framework	Interoperability Levels			
	Business	*Information*	*Technical*	*Semantic*
European Interoperability Framework	√		√	√
E-Government Interoperability Framework			√	
Australian Government Interoperability Framework	√	√	√	
New Zealand E-government Interoperability Framework			√	
Malaysian Government Interoperability Framework			√	

As it can be seen from the Table I above, there is no single framework capable of supporting all the required levels of interoperability.

B. *Interoperability Domain*

Interoperability in most frameworks concentrates mainly on the interactions with and between government to government (G2G), government to business (G2B) and government to citizen (G2C). In some countries, the interaction with organizations (G2Org) and other countries' governments (G2OG) are also considered. Table II shows the interoperability scope in the studied countries.

TABLE II. Domain of interoperability

Interoperability Framework	G2G	G2B	G2C	G2OG	G2Org
European Interoperability Framework	√	√	√		
E-Government Interoperability Framework	√	√	√	√	√
Australian Government Interoperability Framework	√	√	√		
New Zealand E-government Interoperability Framework	√				
Malaysian Government Interoperability Framework	√	√	√	√	

C. *Interoperability Technical Domain*

Different domains composed of several standards and specifications have been identified in the technical level of interoperability (Table III). Interconnection domain relates to the standards and technologies necessary for connecting different systems [19]. The data exchange domain includes those standards and technologies necessary for a description of

the structure and encoding of data exchange. Discovery domain comprises the standards and technologies required for supporting the discovery and location of the resources. Security domain includes those technologies and standards which support interoperation securely [19]. Information accessibility and presentation domain covers the standards and guidelines necessary for presenting and accessing to the business systems by the users [19].

TABLE III. Technical Interoperability Domains

Interoperability Framework	Information Access	Interconnection	Metadata	Data integration	Discovery	Data exchange	Security
European Interoperability Framework	√	√	√	√		√	√
E-Government Interoperability Framework	√	√	√	√		√	√
Australian Government Interoperability Framework	√	√	√	√	√	√	√
New Zealand E-government Interoperability Framework	√	√		√	√	√	√
Malaysian Government Interoperability Framework	√	√	√	√	√	√	√

V. Conclusion

Interoperability is a tool helping the organizations to cooperate with each other. Using suitable interoperability framework causes the organizations to attain higher levels of interoperability. Numerous frameworks have been introduced in e-government interoperability domain. Selecting an appropriate interoperability framework as a reference from among the existing interoperability frameworks in e-government domain is a major challenge of high importance. In this paper in order to identifying a comprehensive interoperability framework in e-government interoperability domain, the existing frameworks were investigated. Moreover, the successful experiences of the pioneering countries in implementing e-government interoperability were also considered. The results of the study show that each one of the existing framework in e-government interoperability domain has its own drawback. Consequently, no comprehensive interoperability framework exists in the e - government domain. Defining a comprehensive interoperability framework therefore in the e - government domain is considered an important area of study. The future studies on defining a comprehensive interoperability framework therefore in the e - government domain must cover all interoperability levels including informational, semantic, and technical levels. Such comprehensive definition must be based on standard concepts and definitions of interoperability.

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References

[1] K.A. Shahkooh, M. Sadeghi, N.D. Mamaghani, Interoperability Evaluation of Iranian Organizations through Proposed National E-government Interoperability Framework (Case Study of Tehran Municipality), Journal of AISS: Advances in Information Sciences and Service Sciences, 3 (2011).

[2] K. Breitfelder, D. Messina, IEEE 100: The Authoritative Dictionary of IEEE Standards Terms, Standards Information Network IEEE Press, 879 (2000).

[3] J. Pub, Joint Publication 1-02, DoD Dictionary of Military and Associated Terms, 12 (2001).

[4] C.L. Policy, Chairman of The Joint Chiefs of Staff Instruction, (2001).

[5] U.J.F. Command, Capstone Requirements Document, in. (Washington: DoD Policy and Projects Division, 2001: 1-2, 2001).

[6] K.A. Shahkooh, M. Sadeghi, N.D. Mamaghani, Interoperability Evaluation of Iranian Organizations through Proposed National E-government Interoperability Framework (Case Study of Tehran Municipality), Journal of AISS: Advances in Information Sciences and Service Sciences, 3 (2011) 62-77.

[7] E.M. Dos Santos, N. Reinhard, Barriers to Government Interoperability Frameworks Adoption, Information Systems Journal, (2010) 1-10.

[8] L. Guijarro, Interoperability frameworks and enterprise architectures in e-government initiatives in Europe and the United States, Government Information Quarterly, 24 (2007) 89-101.

[9] D. Ray, U. Gulla, S.S. Dash, Interoperability of e-Government Information Systems: A Survey, Towards Next Generation E-government, Secunderabad: Computer Society of India, (2007) 12-25.

[10] M. Pankowska, National frameworks' survey on standardization of e-Government documents and processes for interoperability, Journal of theoretical and applied electronic commerce research, 3 (2008) 64-82.

[11] C.M.U. Software Engineering Institute, Guide to Interoperability, in., 2009).

[12] E. Commission, European interoperability framework for pan-european egovernment services, IDA working document, version, 2 (2004).

[13] E. Commission, European interoperability framework for pan-european egovernment services, (2004).

[14] J. Bartlett, D. Bartley, S. Crisp, K. Fiebig, T. Schild, C. Thorne, B. Stonebridge, Interoperability Technical Framework for the Australian Government, National Office for the Information Economy, Canberra, (2003).

[15] E.M. Dos Santos, N. Reinhard, Setting interoperability standards for e-government: an exploratory case study, Electronic Government, An International Journal, 4 (2007) 379-394.

[16] S.S. Commission, New Zealand e-government interoperability framework, in. (NZ e-GIF), version, 2007).

[17] A. Saekow, C. Boonmee, A Pragmatic Approach to Interoperability Practical Implementation Support (IPIS) for e-Government Interoperability, Electronic Journal of e-Government, 7 (2009) 403-414.

[18] A. Saekow, C. Boonmee, Towards a practical approach for electronic government interoperability framework (e-GIF), in. (IEEE, 2009), 1-9.

[19] L. Guijarro, Analysis of the interoperability frameworks in e-government initiatives, Electronic Government, (2004) 36-39.

[20] I. Estonian, Interoperability Framework, in.).

[21] J. Rothenberg, M. Botterman, C. van Oranje-Nassau, Towards a Dutch Interoperability Framework, (2008).

[22] Y. Charalabidis, F. Lampathaki, D. Sarantis, A.M. Sourouni, S. Mouzakitis, G. Gionis, S. Koussouris, C. Ntanos, C. Tsiakaliaris, V. Tountopoulos, The Greek electronic government interoperability framework: Standards and infrastructures for one-stop service provision, in. (IEEE, 2008), 66-70.

[23] P. Gottschalk, Maturity levels for interoperability in digital government, Government Information Quarterly, 26 (2009) 75-81.

[24] L. Guijarro, Semantic interoperability in eGovernment initiatives, Computer Standards & Interfaces, 31 (2009) 174-180.

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