Stages of e-government interoperability

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Abstract: Improved interoperability between public organisations as well as between public and private organisations is of critical importance to make electronic government more successful. In this paper, stages of e-government interoperability is identified and discussed. Four stages are presented:

1 work process stage
2 knowledge sharing stage
3 value creation stage
4 strategy alignment stage.

Keywords: electronic government; work process; knowledge sharing; value creation; strategy alignment; stage model.

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1 Introduction

The mobilisation of electronic information across organisations has the potential of modernising and transforming information exchanges. The current information exchange is, however, often inefficient and error-prone (Eckman et al., 2007). Exchanges of information and services are often fragmented and complex, dominated by technical as well as organisational problems.

High-ranking issues among the defining purposes of e-government are highly agile, citizen-centric, accountable, transparent, effective, and efficient government operations and services (Scholl and Klischewski, 2007). For reaching such goals, the integration of government information resources and processes, and thus the interoperation of

independent information systems are essential. Yet, most integration and interoperation efforts meet serious challenges and limitations.

The purpose of this paper is to present stages of development for e-government interoperability. By identifying development stages, scholars and practitioners have a framework within which they can diagnose the current situation and plan for future improvements in interoperability.

2 Interoperability

Interoperability is referring to a property of diverse systems and organisations enabling them to work together. When systems and organisations are able to inter-operate then information and services are provided and accepted between them. In a narrow sense, the term interoperability is often used to describe technical systems. In a broad sense, social, political, and organisational factors influencing systems and systems performance are also taken into account.

For example, new technologies are being introduced in hospitals and labs at an ever-increasing rate, and many of these innovations have the potential to interact synergistically if they can be integrated effectively. However, as pointed out by Eckman et al. (2007), the current healthcare information exchange is inefficient and error-prone; it is largely paper-based in most countries, fragmented, and therefore overly complex, often relying on antiquated information technology.

At the same time, healthcare costs are rising dramatically. Errors in medical delivery are associated with an alarming number of preventable, often fatal adverse events. A promising strategy for reversing such a trend is to modernise and transform the healthcare information exchange, that is, the mobilisation of healthcare information electronically across organisations within a region or community (Eckman et al., 2007).

However, in the case of hospitals, there are limitations to free flow of information. Information systems often handle sensitive information about individuals and other organisations. Collection and sharing of such information is affected by privacy concerns (Otjacques et al., 2007).

As electronic government refers to the delivery of government services (information, interaction and transaction) through the use of information technology, a distinction can be made between the front and back offices of public service delivery organisations. The interaction between citizens and civil servants occurs in the front office, while registration and other activities take place in the back office. Bekkers (2007) found that back-office cooperation is a serious bottleneck in e-government due to different interoperability problems.

One important action to improve information sharing is standardisation in information systems. It is necessary to define the compatibility standards to be adopted among systems (Santos and Reinhard, 2007). Some organisations will have to change their technical and organisational processes and make accommodations in response to standardisation initiatives (Gogan et al., 2007).

Interoperability of systems enables interoperability of organisations. Systems interoperability is concerned with the ability of two or more systems or components to exchange information and to use the information that has been exchanged. Organisational interoperability is concerned with the ability of two or more units to provide services to

and accept services from other units, and to use the services so exchanged to enable them to operate effectively together (Legner and Lebreton, 2007).

3 Stage models

Stages of growth models have been used widely in both organisational research and management research. According to King and Teo (1997), these models describe a wide variety of phenomena - the organisational life cycle, product life cycle, biological growth, etc. These models assume that predictable patterns (conceptualised in terms of stages) exist in the growth of organisations, the sales levels of products, and the growth of living organisms. These stages are:

1 sequential in nature

2 occur as a hierarchical progression that is not easily reversed

3 evolve a broad range of organisational activities and structures.

Benchmark variables are often used to indicate characteristics in each stage of growth. A one-dimensional continuum is established for each benchmark variable. The measurement of benchmark variables can be carried out using Guttman scales (Frankfort-Nachmias and Nachmias, 2002). Guttman scaling is a cumulative scaling technique based on ordering theory that suggests a linear relationship between the elements of a domain and the items on a test.

Various multistage models have been proposed for organisational evolution over time. For example, Nolan (1979) introduced a model with six stages for information technology maturity in organisations, which later was expanded to nine stages. Earl (2000) suggested stages of growth model for evolving the e-business, consisting of the following six stages: external communication, internal communication, e-commerce, e-business, e-enterprise, and transformation, while Rao and Metts (2003) describe a stage model for electronic commerce development in small and medium sized enterprises. In the area of knowledge management, Housel and Bell (2001) developed a five level model. In the area of knowledge management systems, Gottschalk (2007) developed a four-stage model applied to knowledge management in law enforcement. Gottschalk and Tolloczko (2007) developed a maturity model for mapping crime in law enforcement, while Gottschalk and Solli-Sæther (2006) developed a maturity model for IT outsourcing relationships. Each of these models identifies certain characteristics that typify firms in different stages of growth. Among these multistage models, models with four stages seem to have been proposed and tested most frequently (King and Teo, 1997).

The concept of stages of growth has been widely employed for many years. Already two decades ago, Kazanjian and Drazin (1989) found that a number of multistage models have been proposed, which assume that predictable patterns exist in the growth of organisations, and that these patterns unfold as discrete time periods best thought of as stages. These models have different distinguishing characteristics. Stages can be driven by the search for new growth opportunities or as a response to internal crises. Some models suggest that organisations progress through stages while others argue that there may be multiple paths through the stages.

Kazanjian (1988) applied dominant problems to stages of growth. Dominant problems imply that there is a pattern of primary concerns that firms face for each

theorised stage. In criminal organisations, for example, dominant problems can shift from lack of skills to lack of resources to lack of strategy associated with different stages of growth.

Kazanjian and Drazin (1989) argue that either implicitly or explicitly, stages of growth models share a common underlying logic. Organisations undergo transformations in their design characteristics, which enable them to face the new tasks or problems that growth elicits. The problems, tasks or environments may differ from model to model, but almost all suggest that stages emerge in a well-defined sequence, so that the solution of one set of problems or tasks leads to the emergence of a new set of problems and tasks, that the organisation must address.

4 Stages of interoperability

Based on the reviewed literature on systems interoperability and stages of growth models, we are now ready to present a potential stage model for e-government interoperability, as illustrated in the figure. Semantic interoperability is defined as the extent to which information systems using different terminology are able to communicate. Organisational interoperability is defined as the extent to which organisations using different work practices are able to communicate.

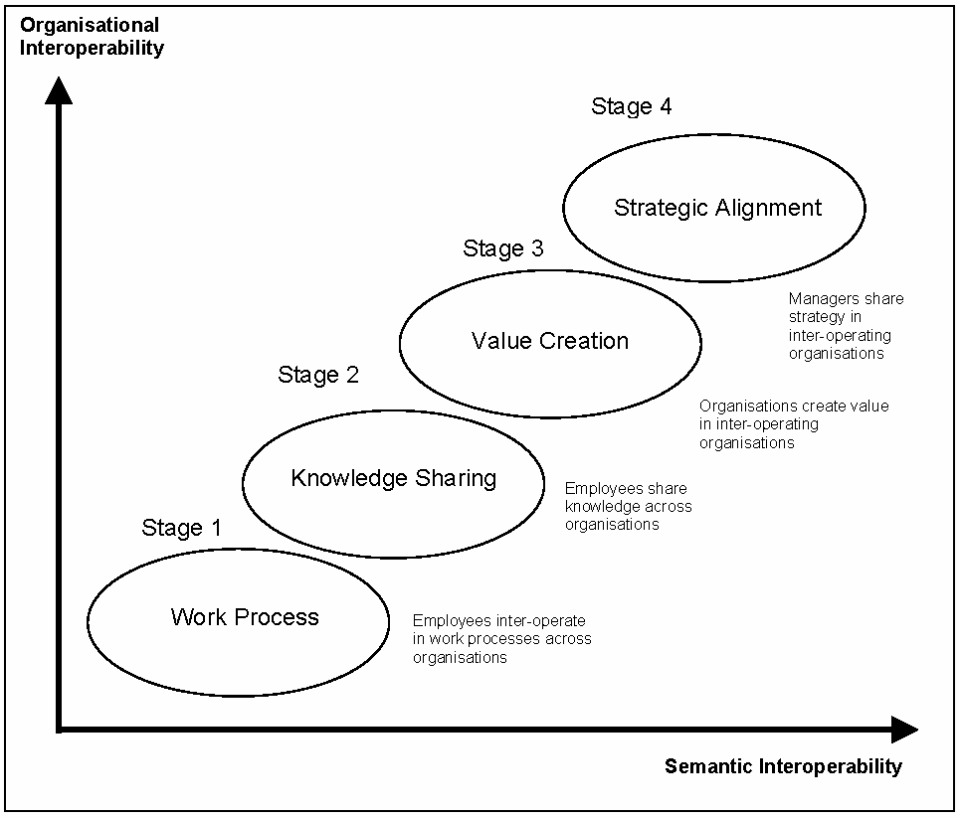
This stage model is experimental in nature by assigning phenomenon to four stages and by labelling each stage according to a meaningful characteristic.

- Stage 1. In *work process*, each employee does his or her tasks in a way that is adopted to both organisation and person. By aligning work processes in inter-operating organisations, e-government interoperability increases. Alignment is possible in sub-processes as well as complete processes and sets of processes. As argued by Fahey et al. (2001), there is a need to capture, analyse, and project the transformational impact of electronic government on organisational work processes in intra- as well as inter-organisational relationships. At this stage, integration and efficiency in work processes from interoperability is important.
- Stage 2. In *knowledge sharing*, a flow strategy is focused on collecting and storing knowledge in interoperating organisations (Hansen et al., 1999). While electronic work processes handle information, knowledge work is handled by employees in collaborating organisations
(Bock et al., 2005; Wickramasinghe, 2006). At this stage, effectiveness and learning in inter-organisational relationships from interoperability is important.
- Stage 3. In *value creation*, inter-operating organisation may have different value configurations. A distinction is often made between value chains, value shops, and value networks (Stabell and Fjeldstad, 1998). The best-known value configuration is the value chain. In the value chain, value is created through efficient production of goods and services based on a variety of resources. Primary activities in the value chain include inbound logistics, production, outbound logistics, marketing and sales, and service. In the value shop, value is created through creative problem solving for clients based on knowledge resources. Primary activities include problem identification, solutions, decisions, implementation, and evaluation (Sheehan, 2005). In the value network, value is created through efficient connections of subscribers to

the network. Primary activities include services, contacts, and infrastructure. Interoperability at this stage of value creation is concerned with interactions between primary activities in different value configurations present in electronic government. While a public hospital is a problem-solving organisation for patients, having value shop as the dominant value configuration, a public transportation authority is a production organisation, having value chain as the dominant value configuration. At this stage, added value from interoperability is important.

- Stage 4. In *strategic alignment*, interoperating organisations apply two-way linked planning with reciprocal integration in strategy work. The purpose of integration is to support and influence organisational strategy
(King and Teo, 1997). The role of information technology functions is to be a resource supporting and influencing organisational strategy. At this stage, synergies among interoperating organisations are important.

Figure 1 Stage model for e-government interoperability



At this stage, there are no conflicting goals as often found at lower stages. For example, when a lorry loaded with family boats from Latvia passed the border of Norway, police had instructed customs to let the lorry pass. The reason was that Norwegian police knew there were narcotics in terms of amphetamine hidden in one of the boats. Since the lorry was part of organised crime, the police wanted to follow it to its destination. Customs,

however, were desperately in need of success and stopped the lorry, invited the press and told how much narcotics they had been able to capture. Criminal police was upset. In our perspective, this situation occurred because the two federal organisations have conflicting goals. While customs authority is concerned with confiscating smuggled goods, police authority is concerned with fighting organised crime (Dean et al., 2006). At this final Stage 4, there should be no such conflicting goals among interoperating organisations anymore.

The cumulative effect of higher stages of interoperability might be measured in terms of transaction cost reduction. Legner and Lebreton (2007) argue that transaction cost theory seems to be an appropriate approach to quantify interoperability, as interoperability issues are the result of the division of work and occur in the context of exchanges between organisational actors. Transaction cost theory concurs that the transaction between interoperating organisations is the basic unit of analysis and regards governance as the means by which order is accomplished in a relation in which potential conflict threatens to undo or upset opportunities to realise mutual gains.

Five attributes of information exchange are positively associated with transaction costs:

1 necessity of investments in durable, specific assets

2 infrequency of transacting

3 task complexity and uncertainty

4 difficulty in measuring task performance

5 interdependencies with other transactions.

Overall, higher stages of interoperability will reduce impacts of these attributes on transaction costs. First, investments in hardware and software have to be carried out at Stage 1 to allow inter-organisational work processes. Second, task complexity and uncertainty is reduced by knowledge sharing at Stage 2. Third, measuring task performance is possible in value creation at Stage 3. Finally, interdependencies are strategically aligned at Stage 4. Only the attribute of infrequency of transaction is not necessarily impacted by higher interoperability stages.

The starting point for the stage model is standardisation. According to Papazoglou and Ribbers (2006), interoperability requires standardisation in four dimensions: technology, syntax, semantics, and pragmatics. Technology standards concern middleware, network protocols, and security protocols. Syntax standardisation means that the network e-government organisation has to agree on how to integrate heterogeneous applications based on the structure or language of the messages exchanged. Normally, commonly acceptable data structures are chosen to represent well-known constructs, e.g. object descriptions. Semantic standards constitute agreements in extension to syntactic agreements on the meanings of the terms used for an organisation's information systems. Pragmatic standards, finally, are agreements on practices and protocols triggered by specific messages, such as orders and delivery notifications.

5 The case of GIS

Geographic Information Systems (GIS) are applied in a variety of electronic government situations, from tracing the origins and spread of foot and mouth disease on farms to locating crime hot spots for law enforcement. GIS have become indispensable to effective knowledge transfer within both the public and private sector.

However, as pointed out by Gottschalk and Tolloczko (2007) the level of sophistication varies among agencies applying GIS. Furthermore, the extent to which GIS interoperate with each other is subject to substantial variation. A survey on interoperability for GIS in the UK was conducted by the e-government unit of the Cabinet Office (2005).

According to this survey, 49% of the surveyed government organisations participated in data sharing projects for GIS, indicating that half of the organisations were working on Stage 1 of the stage model for e-government interoperability. The fractions at higher levels were not identifiable from the survey.

Many different application packages were in use, such as ESRI, Mapinfo, Intergraph, GGP, CadCorp, INNOgistic and Autodesk.

To improve interoperability of such systems for GIS and other e-government systems, the UK Cabinet Office (2005) developed an e-government interoperability framework. The framework is mostly technical in nature, stressing alignment with the internet and adoption of the browser as the key interface. The framework intends to stimulate government agencies to work more easily together electronically, make systems, knowledge and experience reusable from one agency to another, and reduce the effort needed to deal with government online by encouraging consistency of approach. In terms of our suggested stage model for e-government interoperability, the framework seems only to cover Stages 1 and 2.

6 Discussion

The integration of back offices often implies the integration of information domains. An information domain is a unique sphere of influence, ownership and control over information in terms of specification, format, exploitation and interpretation. However, domain integration evokes interoperability problems, such as [Bekkers, (2007), pp.379]:

- conflicting, exclusive or overlapping jurisdictions and accountability
- different legal regimes with conflicting rights and obligations, e.g. in relation to privacy and safety regulations
- different working process and information processing process, routines and procedures
- incompatibility of specific ‘legacy’ information and communication technology infrastructure
- conflicting information specifications and lack of common data definitions
- conflicting organisational norms and values, communication patterns, and growth practices

Integration models are sometimes being introduced and applied to overcome these problems. The governance of back-office integration is critical to e-government interoperability, and its criticality rises at higher stages in the development model suggested in this paper. Understanding intrapreneurship by means of state-of-the-art integration technologies as well as organisational learning (Drejer et al., 2004) is required for success.

In an exploratory study of the European Union, Otjacques et al. (2007) found considerable cross-country differences in legal and administrative provisions and technical standards. These differences cause particular challenges for information systems in digital government, as there is a growing mobility of goods, persons, and related data within the European Union.

In a research agenda for e-government integration and interoperability, Scholl and Klischewski (2007) suggest future research projects to study the foci and purposes, limitations and constraints, as well as processes and outcomes of integration and interoperation in electronic government. In such future research projects, the stages of growth model presented in this paper might prove helpful in organising findings.

The optimal level of interoperability is not necessarily the highest Stage 4. As pointed out by transaction cost theory, infrequency of transactions might cause transaction costs to remain high, not justifying comprehensive extensive strategic alignment between interoperating organisations. Stating that organisations suffer under lack of interoperability in electronic government means that interoperability research efforts should be spent in finding out which level of interoperability an organisation should strive for (Legner and Lebreton, 2007).

Scholl and Klischewski (2007) list a number of constraints that influence government integration and interoperability. These constraints have to be considered at different stages in our model. First, Scholl and Klischewski (2007) mention constitutional and legal constraints, where integration and interoperation may be outright unconstitutional because the democratic constitution requires powers to be divided into separate levels and branches of government. The US constitution, for example, separates government into federal, state, and local government levels and into legislative, judicial, and executive branches. Total interoperability between levels and branches might offset that constitutional imperative of checks and balances.

Scholl and Klischewski (2007) list eight more constraints: jurisdictional constraints, collaborative constraints, organisational constraints, informational constraints, managerial constraints, cost constraints, technological constraints, and performance constraints. While several of these constraints can be handled and solved, others should be considered when identifying the optimal stage of interoperability.

Among the basic constraints that have to be handled early in the stage model is the challenge of semantics. Semantic interoperability is part of the interoperability challenge for networked e-government organisations. Inter-organisational information systems can only work if they are able to communicate and work with other such systems and interact with people. This requirement can only be met if communication standards are applied. A standards-based technology platform allows partners to execute a traditional business function in a digitally enhanced way. A necessary common information systems platform is a set of standards that allows network participants to communicate and conduct business processes electronically (Papazoglou and Ribbers, 2006).

7 Future research

There are several avenues for future research, as this is a conceptual research paper on which future research might be based. First, the model has to be verified by testing content validity. This might be done by an expert panel or interviews of experts. For example, interoperability is very challenging issue involving many complicated factors, such as human resistance and politics, making it interesting to collect opinions from experts on semantic interoperability versus organisational interoperability.

Next, scales applied in the stage model have to be defined. As it stands, it is simply low to high within each stage. For example, work process interoperability at Stage 1 moves from low to high, where high enables entrance into Stage 2. Also, as both semantic and organisational interoperability are part of each stage, it might be defined the scale for each of them. For example, at work process stage, semantic interoperability has to improve significantly before enabling the knowledge stage, while organisational interoperability is critical starting at Stage 2.

Finally, it should be possible to empirically test the stage model. The test procedure might either be a longitudinal study or a cross-section study. The latter kind would require questions concerning the past to respondents, which will not be easy to remember or verify.

8 Conclusion

The roles of an interoperability solution represent the stakeholders or potential users. To be successful, integration and interoperability projects have to satisfy stakeholder needs. Furthermore, such projects need to be guided by a direction. One directional approach is suggested in this paper in terms of stages of growth for e-government interoperability. By systematically developing interoperability in terms of work process, knowledge sharing, value creation, and ultimately strategy alignment, long-wanted benefits from e-government might be expected.

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