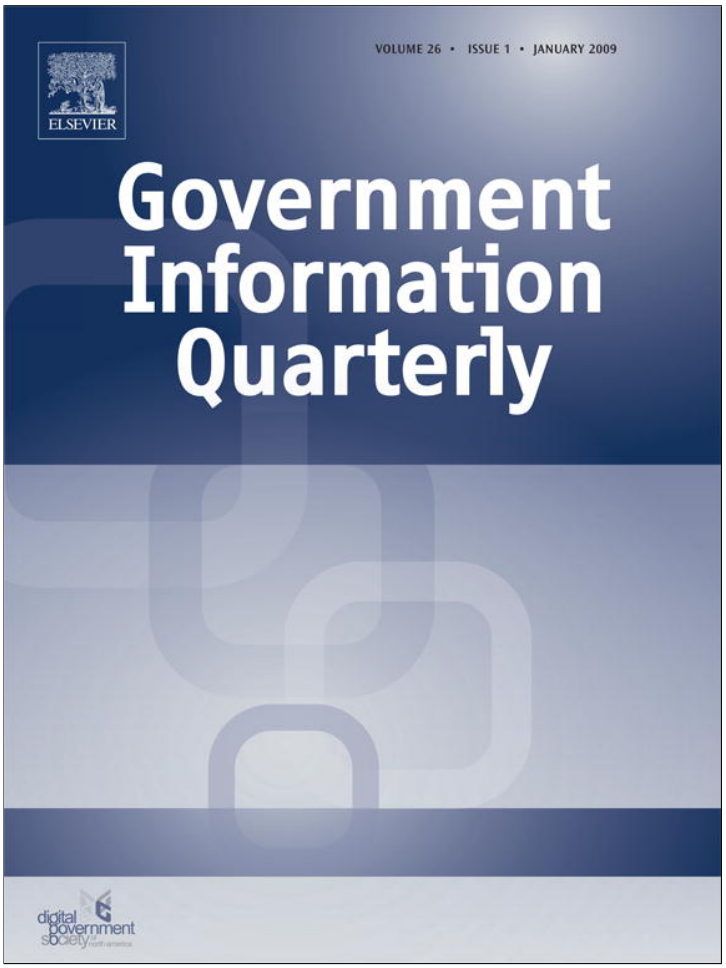

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Maturity levels for interoperability in digital government

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ABSTRACT

Interoperability refers to a property of diverse systems and organizations enabling them to work together. The current exchanges are, however, often inefficient and error-prone. Improved interoperability between public organizations as well as between public and private organizations is of critical importance to make digital government more successful. In this paper, a model of maturity levels for interoperability in digital government is presented. The five-level model might be applied by public organizations to identify current maturity and future direction for improved interoperability.

1. Introduction

Improved interoperability among public organizations and between public and private organizations is of critical importance to make electronic government more successful (Pardo and Tayi, 2007; Wang et al., 2007). The mobilization of electronic information across organizations has the potential to modernize and enhance information exchanges. The current information exchange is, however, often inefficient and error-prone (Eckman et al., 2007). Exchanges of information and services are fragmented and complex, plagued by technical and organizational problems (Gouscos et al., 2007).

For e-Government to be successful it must develop agile, citizen-centric, accountable, transparent, effective, and efficient government operations and services (Scholl and Klischewski, 2007). The integration of government information resources and processes, and thus the interoperation of independent information systems, are essential to achieve these goals. Yet, most integration and interoperation efforts face serious challenges and limitations.

The purpose of this paper is to define maturity levels for interoperability in digital government. 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. Specifically, the objective of this conceptual and exploratory paper is to identify issues and develop a model for interoperability based on these maturity levels. The question from which we proceeded was: *How can improvements in interoperability in digital government be conceptualized in terms of levels of maturity?*

2. Interoperability

Interoperability refers to a property of diverse systems and organizations which enables them to work together (Cabinet Office, 2005; Government CIO, 2007). Interoperability is the ability of government organizations to share information and integrate information and business processes by use of common standards and work practices (State Services Commission, 2007). When information and services are provided to and accepted between systems and organizations, they are said to inter-operate. In a narrow sense, the term *interoperability* is often used to describe technical systems. In a broader sense, social, political, and organizational factors influencing systems and systems performance must also be 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 health-care information exchange is inefficient and error-prone. In most countries it is largely paper-based and fragmented (therefore overly complex), and often relies on antiquated information technology.

At the same time, health care costs are rising dramatically. Errors in medical delivery are associated with an alarming number of preventable, sometimes fatal adverse events. A promising strategy for reversing this trend is to modernize the health-care information exchange, that is, the mobilization of health-care information electronically across organizations within a region or community (Eckman et al., 2007).

However, in the case of hospitals, there are limitations to the free flow of information. Systems often handle sensitive data about individuals, relationships, groups, and organizations. Collection and sharing of this 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 organizations. The interaction between citizens and civil servants occurs in the front office, while

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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 standardization in information systems. It is necessary to define the compatibility standards to be adopted among systems (Santos and Reinhard, 2007). Some organizations will have to change their technical and organizational processes and make accommodations in response to standardization initiatives (Gogan et al., 2007).

Interoperability of systems enables interoperability of organizations. 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. Organizational 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).

Semantic interoperability is part of the interoperability challenge for networked organizations. Inter-organizational information systems only work when they communicate with other systems and interact with people. This facet of interoperability 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 common information systems platform, then, is a set of standards that allows network participants to communicate and conduct business processes electronically (Papazoglou and Ribbers, 2006).

A distinction should be made between *interoperability* and *integration*. Integration is the forming of a larger unit of government entities, temporary or permanent, for the purpose of merging processes and/or sharing information. Interoperation in e-Government occurs whenever independent or heterogeneous information systems or their components controlled by different jurisdictions, administrations, or external partners work together (efficiently and effectively) in a predefined and agreed-upon fashion. E-Government interoperability is the technical capability for e-Government interoperation (Scholl and Klischewski, 2007).

According to Papazoglou and Ribbers (2006), interoperability requires standardization in four dimensions: technology, syntax, semantics, and pragmatics. *Technology standards* concern middleware, network protocols, security protocols, and the like. *Syntax standardization* means that the network organization 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. invoice descriptions). *Semantic standards* constitute agreements in extension to syntactic agreements on the meanings of the terms used for an enterprise's information systems. *Pragmatic standards*, finally, are agreements on practices and protocols triggered by specific messages, such as orders and delivery notifications.

3. Digital government

Governments worldwide recognize e-Government as a strategic option to enhance their (internal and external) operations. In order to foster citizen-centric services, they need to integrate themselves and stakeholders both vertically and horizontally. This can be achieved by bringing the efficiencies and experiences of e-business to e-Government. That requires new e-business models to reduce costs and improve services in government (Papazoglou and Ribbers, 2006).

Digital government, *e-Government*, and *e-governance* are terms that have become synonymous with the use of information and communication technologies in government agencies. Inter-organizational information integration has become a key enabler for e-Government. Integrating and sharing information across traditional government boundaries involves complex interactions between a variety of participants all using complicated technical and organizational processes. From a technical perspective, systems designers and developers must regularly overcome problems related to the existence of multiple platforms, diverse database designs and data structures, highly variable data quality, and incompatible network infrastructure. From an organizational perspective, these technical processes often involve new work processes, mobilization of limited resources, and evolving inter-organizational relationships. These necessary changes are influenced by specific types of social interaction, which take the form of group decision-making, learning, understanding, trust building, and conflict resolution (Pardo and Tayi, 2007).

A recent line of e-Government research has emphasized the importance of inter-organizational information sharing in the public domain. For example, Schooley and Horan (2007) explored information sharing relative to service performance. They utilized a time-critical information services conceptual framework as analytical lens.

Inter-organizational systems concepts provide a targeted means to look at the cross-organizational features of a socio-technical system. Examples include criminal justice and services to citizens. These examples demonstrate a need to improve capabilities to share data, information, and experiences across departmental, organizational, geographic, and institutional boundaries. Such inter-organizational improvements in information sharing will improve the performance of public sector services (Schooley and Horan, 2007).

It is increasingly important for government agencies to collaborate across jurisdictional and functional boundaries. Inter-organizational systems supporting interagency collaboration must accommodate a wide range of factors from the external environment and participating organizations as part of their design and operation (Fedorowicz et al., 2007).

In order to enjoy some of the greatest benefits of digital government, the integration of information across organizational boundaries is necessary. However, these digital government initiatives face serious challenges, since the required level of inter-organizational collaboration and trust is often not supported by existing institutional arrangements, organizational structures, and management processes (Luna-Reyes et al., 2007).

Although much digital divide research focuses on access to technology, another cause of the divide is the lack of information awareness that we call *information asymmetry*. Information asymmetry often stems from inadequate information sharing and can result in negative consequences for both the information poor and the information rich (Clarkson et al., 2007).

Scholl and Klischewski (2007) list nine constraints that influence government integration and interoperability. These constraints have to be considered at different stages in our model. These are: (1) constitutional and/or legal constraints, (2) jurisdictional, (3) collaborative, (4) organizational, (5) informational, (6) managerial, (7) cost, (8) technological, and (9) performance. While several of these constraints can be easily solved, others should be considered in their full complexity when identifying the optimal stage of interoperability.

Each of the nine constraining influences on electronic government integration and interoperability are described by Scholl and Klischewski (2007) as follows:

1. Constitutional/legal constraints: 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 integration and interoperability between and among branches and levels might upset constitutional checks and balances. On the other hand, the constitution also affords and sanctions integration and interoperation within certain boundaries.

2. Jurisdictional constraints: Since under the constitution, governmental and non-governmental constituencies operate independently from each other and own their information and business processes, integration, interoperation, and information sharing cannot be imposed on them. Rather, as an independent entity, each constituency's participation in any interaction is voluntary. However, by means of jurisdictional authority, the government entity can engage in integration and interoperation with other entities.
3. Collaborative constraints: Organizations are distinct in terms of their disposition and readiness for collaboration and interoperation with others. Past experience, socio-political organization, and leadership style influence the degree of willingness and adeptness of potential interoperation. However, in cases of compatible leadership styles, adequate socio-political organization, and positive past experiences, integration and interoperation might flourish.
4. Organizational constraints: Organizational processes and resources may differ between organizations to such an extent that integration and interoperation might prove exceedingly difficult to achieve without standardizing of processes, systems, and policies. Yet, when organizations align their organizational context they enable increased degrees of integration and interoperation.
5. Informational constraints: While transactional information might be more readily shared, strategic and organizational information might be not; also, information quality issues arise when integrating information sources across various domains of control and quality standards. Still, information stewardship fosters the use of shared information, which in turn fosters stewardship for sharing information.
6. Managerial constraints: Interoperation becomes inherently more complex the more parties with incongruent interests and needs become involved. As a result, the demands of the respective management task might exceed the management capacity of interoperating partners. However, along the lines of shared interests, interoperation and integration can materialize.
7. Cost constraints: Integration and interoperation between diverse constituencies might be limited to the lowest common denominator in terms of availability of funds: also, unexpected budget constraints might pose serious challenges to long-term interoperation projects over time. On the other hand, information-sharing initiatives have reportedly helped contain costs. Within the cost boundaries of the respective partners, certain projects appear to be sustainable.
8. Technological constraints: The heterogeneity of e-Government platform and network capabilities might limit the interoperation of systems to relatively low standards. On the other hand, an increasing number of e-Government information systems might adhere to higher standards over time, such that increased interoperation becomes possible.
9. Performance constraints: As performance tests suggest, the higher the number of interoperating partners, the lower is the overall system performance in terms of response time. Yet, the focus on prioritized needs might enable fewer but more effective interoperations.

These nine constraints describe a complex environment for electronic government interoperation. The elimination or accommodation of these constraints will help achieve e-Government operations and services that are efficient, agile, citizen-centric, accountable, transparent, and effective (Scholl and Klischewski, 2007). The integration of government information resources and processes, and thus the interoperation of independent information systems, is essential to achieve these goals. Yet, most integration and interoperation efforts face serious challenges and limitations.

4. Maturity levels

Stages-of-growth models have been used widely in both organizational research and management research. According to King and Teo (1997), these models describe a wide variety of phenomena — the organizational life cycle, product life cycle, biological growth, etc. These models assume that predictable patterns (conceptualized in terms of stages) exist in the growth of organizations, 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, and (3) evolve a broad range of organizational 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 organizational evolution over time. For example, Nolan (1979) introduced a model with six levels for information technology maturity in organizations, which later was expanded to nine levels. Earl (2000) suggested a stages-of-growth model for evolving e-business which included: (1) external communication, (2) internal communication, (3) e-commerce, (4) e-business, (5) e-enterprise, and (6) transformation. Rao and Metts (2003) described a maturity 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 identified certain characteristics that typified 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 and maturity levels has been widely employed for many years. Two decades ago, Kazanjian and Drazin (1989) found that a number of multistage models had been proposed which assumed that predictable patterns existed in the growth of organizations and that these patterns unfolded 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 organizations progress through stages while others argue that there may be multiple paths through the stages.

Kazanjian (1988) applied the concept of dominant problems to the stages of growth. Dominant problems imply that there is a pattern of primary concerns which firms face for each theorized maturity level. In criminal organizations, 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) argued that either implicitly or explicitly, stages-of-growth models share a common underlying logic. Organizations undergo transformations in their design characteristics which enable them to face the new tasks or problems elicited by growth. 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 organization must address.

Stage of maturity models of e-Government illustrate that, over time, providing users with seamless information and service delivery involves a great degree of complexity across several dimensions of e-Government. These models suggest that e-government capabilities begin modestly and initially provide static, one-way information, but grow increasingly sophisticated and add interactive and transactional capabilities. These models predict an ultimate evolution of e-Government that includes horizontal and vertical integration and the development of true portals and seamless inter-organizational exchanges (Chen et al., 2007).

According to Chen et al. (2007), three models of e-Government maturity point this out, but in somewhat different ways. One model displays, in some detail, the policy, technology, data, and organizational issues that must be resolved for organizations to progress to higher levels of e-Government maturity with an attendant increase in benefits for both government organizations and end-users. Achieving more mature levels of e-Government requires higher levels of both technology and organizational complexity.

Another model identified the following four stages of e-Government integration: (1) catalogue with online presence, catalogue presentation, and downloadable forms, (2) transaction with services and forms online, working database, and supporting online transactions, (3) vertical integration with local systems linked to higher level systems and within similar functionalities, and (4) horizontal integration with systems integrated across different functions and real one-stop shopping for citizens (Chen et al., 2007).

The third model stresses increasing levels of data integration required for true transformational e-Government, but warns that such data integration raises significant privacy issues when the data involves personally identifiable information. Chen et al. (2007) commented that these models imply, but only sometimes make explicit, that the complexity of these various forms of integration have likely resulted in many organizations reaching the highest level of e-Government maturity.

Based on the reviewed literature on systems interoperability and stages-of-growth models, we are now ready to present a potential maturity model for e-Government interoperability, as illustrated in the Fig. 1. Semantic interoperability is defined as the extent to which information systems using different terminology are able to communicate. Organizational interoperability is defined as the extent to which organizations using different work practices are able to communicate.

4.1. Level 1. Computer interoperability

Computers require hardware and software systems in order to communicate with each other. Today there exist several products and technical solutions dealing with the challenges relating to physical connectivity and communication between systems involved in a given exchange. These solutions generally function by sharing messages or employing tightly coupled workflow designs. However, what is lacking from most available technology solutions (and would improve the odds for integration success) is the ability to *directly* exchange messages and meaningful, context-driven data between autonomous systems. The challenges of enabling each system to appropriately understand the shared information relates to the logical aspects of using and sharing data and business processes based on their intended meaning. This is part of a broader problem known as the semantic interoperability problem. Semantic interoperability needs to be examined and resolved at both the computer and process levels (Papazoglou and Ribbers, 2006).

To clearly delineate the separation between stages in our model, we studied interoperability between police and customs in Norway as a running example. According to the UN e-Government Survey for 2008, Norway is ranked third on the e-Government readiness index (following Sweden and Denmark, ahead of the United States and the Netherlands). Computer interoperability between police and customs implies that information exchanged on criminal activity in terms of trafficking and smuggling is technically feasible.

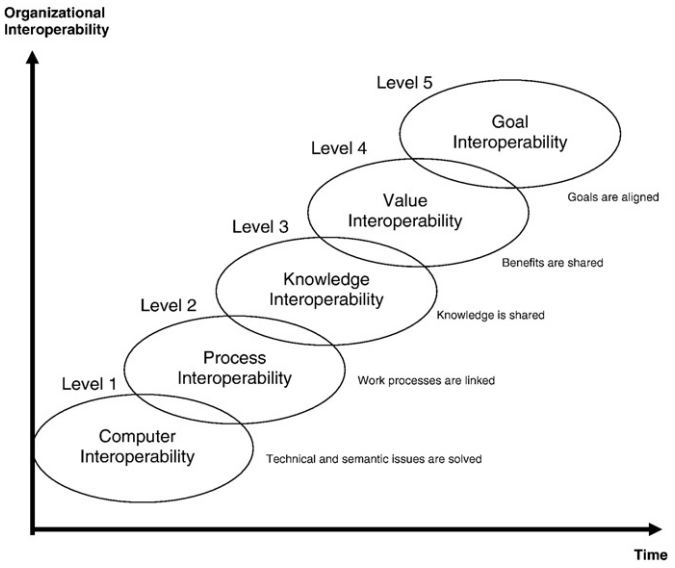

Fig. 1. Maturity levels for interoperability in digital government.

4.2. Level 2. Process interoperability

In a given work process, each employee does his or her tasks in a way that is adopted to both the organization and the person. Aligning work processes in inter-operating organizations enhances e-Government interoperability. 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, analyze, and project the transformational impact of electronic government on organizational work processes in intra-as well as inter-organizational relationships. At this level, integration and efficiency in work processes from interoperability is important.

Process interoperability between police and customs is achieved when police investigations are supported by border-control information, and border-control is supported by information from police investigations. For example, information about vehicles crossing the border including their registration number and time of entry is useful to police investigations, while information on suspects from law enforcement is useful to border control.

4.3. Level 3. Knowledge interoperability

In knowledge sharing, a flow strategy is focused on collecting and storing knowledge in interoperating organizations (Hansen et al., 1999). While electronic work processes handle information, knowledge work is handled by employees in collaborating organizations (Bock et al., 2005; Wickramasinghe, 2006). At this level, effectiveness and learning in inter-organizational relationships from interoperability is important. Organizations must establish and maintain collaborative relationships in which knowledge sharing is critical to resolving numerous issues related to data definitions and structures, diverse database designs, highly variable data quality, and incompatible network infrastructure (Pardo and Tayi, 2007).

Knowledge interoperability occurs when police and customs share knowledge about organized crime and criminal organizations. For example, trafficking in women to Norway from Nigeria occurs mostly through the Oslo airport, while women from the Ukraine are primarily

transported by car via Sweden. Heroin from Afghanistan is carried through Kurdistan and Denmark to Norway by Albanian crime groups, while cocaine from Colombia travels via the Netherlands to Norway. Sharing knowledge on organized crime will improve knowledge development and knowledge management in both law enforcement and customs service.

4.4. Level 4. Value interoperability

In value creation, inter-operating organizations 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 level 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 organization for patients, having *value shop* as the dominant value configuration, a public transportation authority is a production organization, having *value chain* as the dominant value configuration. At this level, added value from interoperability is important.

In our example of police and customs in Norway, both organizations have several value configurations depending on public service functions. In the case of police investigations, *value shop* is the appropriate value configuration. Similarly, in the case of customs control at airports, harbors, and land borders, customs personnel represent a *value shop* configuration. Hence, value interoperability is possible and feasible by combining primary activities from the two agencies.

4.5. Level 5. Goal interoperability

In strategic alignment, interoperating organizations apply two-way linked planning with reciprocal integration in strategy work. The purpose of integration is to support and influence organizational strategy (King and Teo, 1997). The role of information technology functions is to be a resource supporting and influencing organizational strategy. At this level, synergy among interoperating organizations is important, and there are no conflicting goals (as is often the case at lower stages).

For example, when a lorry loaded with family boats from Latvia passed the border of Norway from Sweden in December 2007, Norwegian police had instructed customs to let the lorry pass. The reason was that Norwegian police knew there were narcotics hidden in one of the boats. Since the lorry was part of an organized crime syndicate, the police wanted to follow the vehicle to its destination. Customs, however, was desperately in need of success and stopped the lorry, invited the press, and showed how much narcotics they had captured. The police were upset. From our perspective, this situation occurred because the two federal organizations had conflicting goals. While customs authority was concerned with confiscating smuggling goods, police authority was concerned with fighting organized crime (Dean et al., 2006). At this final stage 5, there should be no conflicting goals among interoperating organizations.

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 challenges are the result of the division of work between individuals, departments, and organizations, and occur in the context of exchanges between organizations. Transaction cost theory suggests that the transaction between interoperating organizations is the basic unit of analysis and regards governance as the means by which order is accomplished in a relationship in which potential conflict threatens opportunities to realize mutual gains.

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

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 the impacts these attributes have on transaction costs. First, investments in hardware and software have to be carried out at Stage 1 to facilitate inter-organizational 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 standardization. According to Papazoglou and Ribbers (2006), interoperability requires standardization in four dimensions: (1) technology, (2) syntax, (3) semantics, and (4) pragmatics. Technology standards concern middleware, network protocols, and security protocols. Syntax standardization means that the network e-Government organization 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 organization's information systems. Pragmatic standards are agreements on practices and protocols triggered by specific messages, such as orders and delivery notifications.

5. Discussion

The integration of back offices 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, Bekkers (2007) notes a number of interoperability problems evoked by domain integration. These include:

1. Conflicting, exclusive, or overlapping jurisdictions and accountability.
2. Different legal regimes with conflicting rights and obligations (e.g. in relation to privacy and safety regulations).
3. Different working process and information processing process, routines, and procedures.
4. Incompatibility of specific 'legacy' information and communication technology infrastructure.
5. Conflicting information specifications and lack of common data definitions.
6. Conflicting organizational norms and values, communication patterns, and growth practices.

Integration models are 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[1] by means of state-of-the-art integration technologies as well as organizational 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 create 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 focuses, purposes, limitations, and constraints, as well as the 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 organizing findings.

The optimal level of interoperability is not necessarily the highest at Stage 5. 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 organizations. Stating that organizations suffer under lack of interoperability in electronic government means that interoperability research efforts should be spent in finding out which level of interoperability best suits a particular organization (Legner and Lebreton, 2007).

Scholl and Klischewski (2007) list a number of constraints influencing government integration and interoperability. While several of these constraints can be resolved, others should be considered in more detail 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 organizations. Inter-organizational 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).

Depending on process types to be supported in inter-organizational relationships, various types of transactional characteristics of processes have to be specified at the conceptual level: autonomous requirements of parts of a process, isolation requirements of parts of a process, and integrity constraints with respect to a process. Autonomous requirements can be of two kinds: strict autonomy and loose autonomous requirements (Grefen et al., 2003).

To specify strict atomicity, parts of a process are indicated that are to be executed in an atomic (all-or-nothing) fashion. A first approach is to strictly partition a business process into atomic sub-processes, which may be referred to as business transactions. This means that every process step is part of a business transaction. A second approach is to annotate arbitrary (non-overlapping) sub-processes as atomic, which may be called atomicity spheres. This means that not all process steps are part of atomic sub-processes (Grefen et al., 2003).

Many countries have developed interoperability frameworks. For example, New Zealand e-Government interoperability framework (NZ e-GIF) is a set of policies, technical standards, and guidelines. It covers ways to achieve interoperability of public sector data and information resources, information and communications technology (ICT), and electronic business processes. It enables any agency to join its information, ICT or processes with those of any other agency using a predetermined framework based on "open" (i.e. non-proprietary) international standards (State Services Commission, 2007).

Hong Kong's special administrative region's interoperability framework supports the government's strategy of providing client-centric joint services by facilitating the interoperability of technical systems between government departments, as well as between government systems and systems used by the public. The interoperability framework defines a collection of specifications aimed at facilitating the interoperability of government systems and services. By bringing together the relevant specifications under an overall framework, IT management and developers can have a single point of reference when there is a need to identify the required interoperability specifications that should be followed for a specific project (Government CIO, 2007).

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 guidance. 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 awaited benefits from e-Government might be expected.

There is a need for measures which can be used by an organization to assess its current stage of interoperability. This is important for future empirical research in evaluating the proposed framework. Also, it could serve as a precursor to research in general on e-Government measurement and metrics. While this is an interesting topic for future research, we would like to suggest some measures.

Measures should be related to benchmark variables that have different values at different stages. The role of management seems to be an obvious benchmark variable, where the management role might be labeled resource developer, entrepreneur, personnel leader, liaison, and strategist (respectively for the five stages). Other benchmark variables might be benefits, legal issues, and organizational culture.

6. Conclusion

A conceptual model of maturity levels for interoperability in digital government has emerged out of this exploratory research. Five levels were identified: (1) computer interoperability, (2) process interoperability, (3) knowledge interoperability, (4) value interoperability, and (5) goal interoperability respectively. Content and focus are very different at each of these levels, a point which satisfies significantly different requirements (including minimal overlap) while achieving complete coverage of relevant issues.

However, only empirical research can establish the extent to which this theoretical model exists in governments around the world. Therefore, future research should study cross-sectional data from many agencies within a nation as well as cross-sectional data from different nations. For empirical research there will be a need to identify characteristics and their values at each stage. For example, the role of technology and the role of management will change from one level to another.

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[1] Internal Entrepreneurship = Intrapreneurship.

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