Chapter IV
Interoperability in E-Government: Stages of Growth

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ABSTRACT

Improved interoperability between public organizations as well as between public and private organizations is of critical importance to make electronic government more successful. In this chapter, stages of e-government interoperability are identified and discussed. Four stages are presented: work process stage, knowledge sharing stage, value creation stage, and strategy alignment stage.

INTRODUCTION

The mobilization of electronic information across organizations has the potential of modernizing 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 organizational 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 chapter 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.

INTEROPERABILITY

Interoperability is referring to a property of diverse systems and organizations enabling them to work together. When systems and organizations 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 organizational 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 health-care 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, health care 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 modernize and transform 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 free flow of information. Information systems often handle sensitive information about individuals and other organizations. 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 organizations. 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 co-operation 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).

STAGE MODELS

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 (i) 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 stages for information technology maturity in organizations, which later was expanded to nine stages. Earl (2000) suggested a 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 organizations, 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 organizations 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 theorized stage. 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) argue 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 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 organization must address.

SEMANTIC INTEROPERABILITY

Semantic interoperability is defined as the extent to which information systems using different terminology are able to communicate. Semantic interoperability is part of the interoperability challenge for networked 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 is called interoperability, and it 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, basically is a set of standards that allows network participants to communicate and conduct business processes electronically (Papazoglou and Ribbers, 2006).

As semantic interoperability is broader than the technology, syntax and practice levels, and encompasses elements of them, it deserves to be discussed further (Papazoglou and Ribbers, 2006).

Semantic issues at the data level is concerned with the actual meaning of data found in one system, and how it relates to data found in each and every one of the other partners' systems. Addressing these semantic concerns involves discovering how information is used differently by each the cooperating organizations, and how that information maps to the normative alliance view (Papazoglou and Ribbers, 2006).

Semantic issues at the business process level is concerned with mutual agreement about how business processes are defined and managed. A need for process re-engineering, corresponding implementation efforts and organizational changes are often needed. These efforts are often more about redesigning business processes than about making them easy to change and combine with those of cooperating organizations (Papazoglou and Ribbers, 2006).

A semantic network is a directed graph in which concepts are represented as nodes, and relations between concepts are represented as links. It is a map of the cognitive terrain that surrounds and gives meaning to a concept and through which each concept is ultimately understood. A concept is a unit of information that can be represented by a word or phrase, and the meaning of which is embodied in its relations to other concepts. On the other hand, relations are a special category of concepts that depict the linkages between and among concepts. An instance, or sometimes termed a proposition, is a unit composed of two concepts and their relationship. As each concept can be linked to many other concepts, semantic networks can be complex and multidimensional (Khalifa and Liu, 2008).

Khalifa and Liu (2008) studied a semantic network applied in computer-mediated discussions. The semantic network was the discussion representation for computer-mediated discussions. Computer-mediated discussions have become an integral component of many knowledge management systems used to support knowledge management activities. In communities of practice, for example, computer-mediated discussions support the externalization, communication and internalization processes of knowledge sharing among members.

ORGANIZATIONAL INTEROPERABILITY

Organizational interoperability is defined as the extent to which organizations using different work practices are able to communicate. Interoperability represents a dynamic capability for transacting organizations. Teece et al. (1997) define dynamic capabilities as the organization's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments. Dynamic capabilities thus reflect an organization's ability to achieve new and innovative forms of competitive advantage given path dependencies and market positions.

Dynamic capabilities are identifiable, specific processes. Some dynamic capabilities integrate resources. For example, product development routines by which managers combine their varied skills and functional backgrounds to create revenue-producing products and services are such dynamic capability (Eisenhardt and Martin, 2000).

Inter-organizational business processes are dependent on knowledge sharing and knowledge creation. There is a need for know-what, know-how, as well as know-why in cooperating organizations to be able to explore and exploit information exchanges.

According to Kutvonen (2007), the main challenge for the interoperability knowledge management is to provide an extensible discipline to capture detailed enough ontology of business network models, service types, and service offers for automated use in the interoperability checking both at establishment and operational time. This discipline provides the inter-enterprise collaborations a kind of interoperability safety.

By ontology is meant a conception of reality. It seeks to describe or posit the basic categories and relationships of being or existence to define entities and types of intetities within its framework. In an interoperability context, ontology is concerned with knowledge creation and sharing to the extent that it can make information exchanges safe, correct and efficient.

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 Figure 1.

Stage 1. In *work process*, each employee does his or her tasks in a way that is adopted to both organization and person. By aligning work processes in inter-operating organizations, 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, analyze, and project the transformational impact of electronic government on organizational work processes in intra- as well as inter-organizational relationships. At this stage, integration and efficiency in work processes from interoperability is important.

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 are 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 organizations participated in data sharing projects for GIS, indicating that half of the organizations 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.

Stage 2. 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 stage, effectiveness and learning in inter-organizational relationships from interoperability is important.

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.

Stage 3. In *value creation*, inter-operating organization 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 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 stage, added value from interoperability is important.

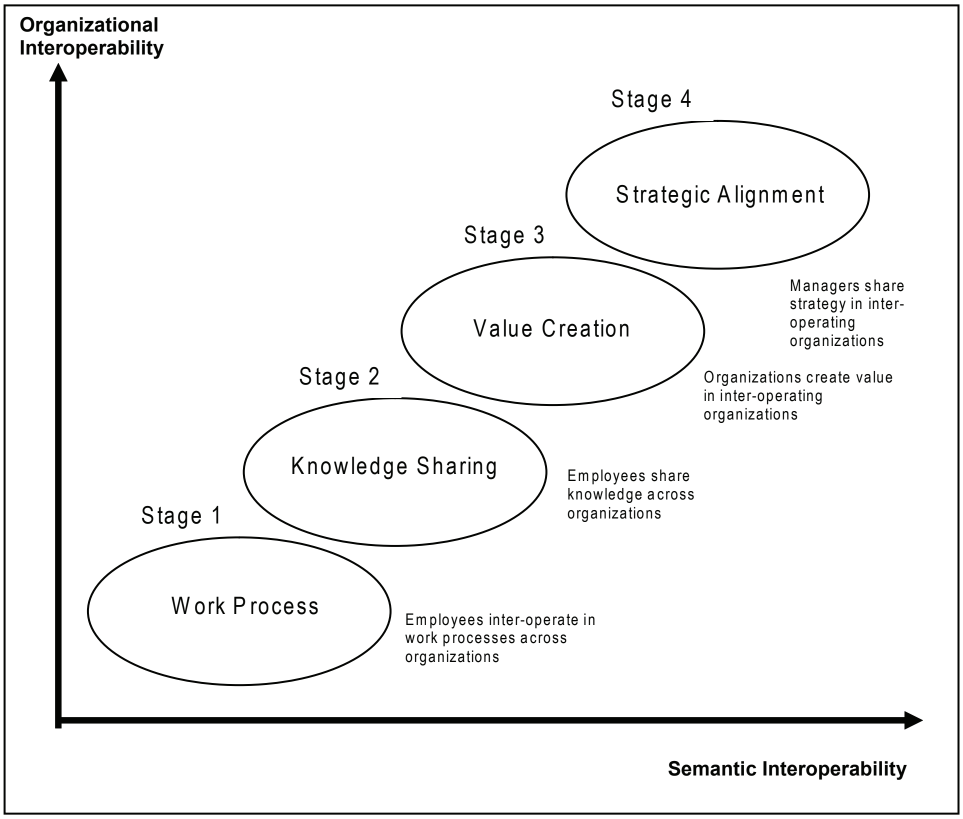
Stage 4. In *strategic alignment*, interoperating organizations apply two-way linked planning with reciprocal integration in strategy work. The purpose of integration is to support and influence organizational strategy (King and Teo, 1997). The role of information technology functions is to be a resource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

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 amphetamin hidden in one of the boats. Since the lorry was part of organized 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 organizations have conflicting goals. While customs authority is concerned with confiscating smuggled goods, police authority is concerned with fighting organized crime (Dean et al., 2006). At this final stage 4, there should be no such conflicting goals among interoperating organizations 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 organizational actors. Transaction cost theory concurs 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 relation in which potential conflict threatens to undo or upset opportunities to realize 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; and (5) interdependencies with other transactions. Overall, higher stages of interoperability will reduce impacts of these attributes on transaction costs. First, investments

Figure 1. Stage model for e-government interoperability



in hardware and software have to be carried out at Stage 1 to allow 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: technology, syntax, semantics, and 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, finally, are agreements on practices and protocols triggered by specific messages, such as orders and delivery notifications.

MEASURING TRANSACTION COSTS

The extent of interoperability can be measured in terms of transaction costs. Higher levels of interoperability are assumed to be associated with lower levels of transaction costs. This assumption is based on the argument that transactions between collaborating agencies are performed more cost-effective when work processes are aligned, knowledge is shared, value creation is joined, and strategies are aligned.

This assumption is valid given the same characteristics of transaction volume and form. Typically, however, higher levels of interoperability will be associated with higher transaction intensity, as transactions have become easier to carry out between cooperating agencies.

Five attributes are associated with transaction costs:

1. The necessity of investment in durable, specific assets: If transacting organizations need investments in assets to carry out their inter-organizational transactions, then investment costs are part of transaction costs.
2. Infrequency of transaction: Cost estimate for each transaction has to be higher and included as part of transaction costs.
3. Task complexity and uncertainty: Cost estimate is dependent on complexity judgment and risk assessment.
4. Difficulty in measuring task performance: Transaction cost has to take into account the hidden costs associated with invisible inefficiency in task performance.
5. Interdependencies with other transactions: Transaction cost has to include changes in other transactions as a consequence of inter-organizational transactions.

These five attributes determine transaction costs for all participating agencies (Williamson, 2000). In addition some agencies may suffer from additional transaction costs because of opportunistic behavior by other agencies. Opportunism is self-interest seeking with guile and includes overt behaviors such as lying, cheating and stealing, as well as subtle behaviors such as dishonoring an implicit contract, shirking, failing to fulfill promises, and obligations.

To measure transaction costs, then, is a matter of estimating certain cost elements and changing the size of these elements according to certain factors.

According to Anderson et al. (2000), empirical research indirectly tests transaction cost theory by relating observed information sourcing decisions to transaction attributes that proxy for transaction costs. Evidence on the relation between transaction-specific investments, contract duration, and technological uncertainty generally supports the theory. The consistency of the empirical results seems startling in light of two problems with the hypothesis that organizations take sourcing decisions to minimize the sum of production and transaction costs. First, production and transaction costs are rarely neatly separable. For example, the choice of production technology (and subsequent production costs) is often inextricably linked with production volume, which in turn depends on whether the organization produces some or all products internally. Second, decision-makers are likely to be affected by wealth effects associated with sourcing, and thus are unlikely to take decisions that strictly maximize organization profit.

Anderson et al. (2000) argue that because production costs are objectively calculated by the accounting system, while transaction costs are assessed subjectively through indirect indicators, functional managers are likely to differ in the importance that they assign to reducing transaction costs. Consequently, the effect transaction costs have on a make-or-buy choice can partly reflect the influence exerted by the purchasing manager. Production cost differences seems more influential in sourcing decisions than transaction cost differences, and experience of the decision-maker is related to assessments of technological uncertainty. Profit center managers engage in influence activities that increase the costs of price renegotiations above the level that is observed in comparable external market transactions. Managers sometimes seem more reluctant to outsource when investments in specific assets are necessary; and contrary to theory, managers sometimes consider previous internal investments in specific assets a reason to insource. In certain circumstances decision-makers systematically misestimate (or fail to consider) transaction costs.

SERVICE-ORIENTED ARCHITECTURE

An approach to support interoperability is service-oriented architecture (SOA). SOA is an architectural style that attempts to guide all aspects of creating and using business processes, packaged as services, throughout their lifecycle. It is a style defining and provisioning the IT infrastructure that allows different applications to exchange data and participate in business processes loosely coupled from the operating systems and programming languages underlying those applications (www.wikipedia.org).

SOA is an architectural style whose goal is to achieve loose coupling among interacting software agents. A service is a unit of work done by a service provider to achieve desired end results for a service consumer. Both provider and consumer are roles played by software agents on behalf of their owners (webservices.xml.com).

Implementing a service-oriented architecture means to deal with heterogeneity and interoperability concerns. A flexible, standardized architecture is required to better support the connection of various applications and the inter-organizational sharing of information. SOA is one such architecture. It unifies business processes by structuring large applications as an ad-hoc collection of smaller modules called services. These applications can be used by different groups of people both inside and outside the company, and new applications built from a mix of services from the global pool exhibit greater flexibility and uniformity. Building all applications from the same pool of services makes achieving interoperability much easier and more deployable to affiliate organizations (www.wikipedia.org).

SOAs build applications out of software services. Services are intrinsically unassociated units of functionality, which have no calls to each other embedded in them. They typically implement functionalities most humans would recognize as a service, such as filling out an online application for a building permit, viewing tax statements, or submitting a school priority request. Instead of services embedding calls to each other in their source code, protocols are defined which describe how one or more services can talk to each other. The architecture then relies on a business process expert link and sequence services, in a process known as orchestration, to meet a new or existing business system requirement (www.wikipedia.org).

Interoperability is an important guiding principle for service-oriented architectures. SOAs are commonly built using web services standards that have gained broad industry acceptance. These standards (also referred to as web service specifications) are expected to provide greater interoperability and some protection from lock-in to proprietary vendor software. Furthermore, basic profiles and basic security profiles are developed to enforce compatibility (www.wikipedia.org).

With the increasing use of software applications for the conduct of business, the need to link software applications of co-operating organizations with minimal effort and in short timeframes is becoming ever more evident. This need for interoperability has stimulated not only SOA but also a similar approach labeled service-oriented computing (SOC). SOC is emerging as a promising paradigm for enabling the flexible interconnection of autonomously developed and operated applications within and across organizational boundaries (Dijkman & Dumas, 2004).

SOC is a distributed application integration paradigm in which the functionality of existing applications (the services that they provide) is described in a way that facilitates its use in the development of applications, which integrate this functionality. The resulting integrated applications can themselves be exposes as services, leading to networks of interacting services known as service compositions or composite services (Dijkman & Dumas, 2004).

SOC brings along a number of specific requirements over previous paradigms (such as object-oriented or component-oriented) that should be taken into account by service-oriented design (Dijkman & Dumas, 2004, p. 338):

- Autonomy: As services are expected to be developed by autonomous teams, service-oriented design is an inherently collaborative process involving multiple stakeholders from different organizational units. This raises the issue that certain organizational units may opt not to reveal the internal business logic of their services to others, making it difficult (yet indispensable) to ensure global consistency.
- Coarse granularity: Services are highly coarse-grained, at least more so than objects and components. Often, a service maps directly to a business object or activity (e.g. a purchase order or a flight booking service). It follows that the design of services (and in particular composite ones) is a complex activity. It involves reconciling disparate aspects such as the involved providers and consumers, their interfaces, interactions, and collaboration agreements, their internal business processes, data, and legacy applications.
- Process awareness: As services often correspond to business functionality exported by an organizational unit, they are likely to be part of long-running interactions driven by explicit process models. Hence, service-oriented design should take into account the business processes as part of which services operate and interact, and in particular, the integration (or retrofitting) of services into business processes. This effectively places service-oriented design at the crossroads between software and enterprise design.

At IBM, a top-down approach to service-oriented architecture was implemented. The IBM enterprise architecture is designed to ensure effective linkages between enterprise business and IT deliverables. It is a means to integrate business strategy, process, data, applications, and infrastructure. Enterprise architecture governance attempts to unify design approaches with a set of published principles, architecture criteria, standards, and guidelines (Walker, 2007).

INTEROPERABILITY BENCHMARK VARIABLES

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 & 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.

In the table, some potential benchmark variables for the interoperability levels are suggested. This table might be applied in several ways. First, for one specific government agency, the level for each benchmark variable can be determined. While the result will not be consistent for one level, the average level might nevertheless be

Exhibit A. Benchmark variables at levels of interoperability in digital government

BENCHMARK VARIABLES	Level 1 Business Process Interoperability	Level 2 Knowledge Management Interoperability	Level 3 Value Configuration Interoperability	Level 4 Strategy Position Interoperability
Purpose of integration	Administrative efficiency when doing the things rights	Administrative effectiveness when doing the right things	Functional effectiveness when adding value to the work	Organizational effectiveness when adding business value
Role of information systems	Support for inter-organizational workflow	Mobilization of information resources	Integrating primary and secondary activities	Enabling mutual organizational benefits
Primary task for the CIO	Transformation of business process design into IT solutions	Establishing electronic knowledge exchanges	Transformation of value logic into IT solutions	Translation of strategic vision into implications for information systems
Primary role of the CIO	Monitor learning from the environment	Resource allocator prioritizing initiatives	Entrepreneur understanding inter-organizational business needs	Architect linking IT to business value of cooperating organizations
Main governance challenge	Standardization of work processes	Standardization of information systems	Integration of value creation activities	Common architecture and infrastructure
Design focus	Information exchange	Knowledge exchange	Service exchange	Benefits exchange
Top management role	Decisions on solutions	Stimulation of knowledge exchange	Communicating business value	Clear strategic direction

computed, thereby identifying the average level at which the organization is currently.

Second, when two cooperating agencies do this exercise for themselves, results might be compared. Typically, one agency will be at a higher level than the other. This insight is useful, as cooperation might be easier when becoming aware of differences.

Finally, a wide distribution of answers (some at level 1, others at level 4) might indicate that the organization has a very unclear understanding of what and why in terms of integration efforts currently underway.

This way of measuring organizational interoperability by applying benchmark variables to levels represent a new approach in need of more research. Future research might look at conceptualization of benchmark variables as well as empirical testing. See Exhibit A.

Each of the eight benchmark variables can be explained more in detail as follows:

- ***Purpose of integration***. At Level 1, integration focuses primarily on solving administrative problems and irritation related to re-entering of data and misunderstandings of information content. Avoiding mistakes and doing things right the first time is important at this stage. This gradually changes as information systems begin to support new ways of doing the work based on knowledge and learning (Level 2) or influence value creation (Level 3). At Level 4, there is joint strategy development for collaborating organizations – at which business and IS truly acting as one with strategic influences going both directions.

- ***Role of information systems***. While each system will only do what it is supposed to do, it will nevertheless change its role in an inter-organizational setting. At Level 2 for example, an environment of knowledge sharing is created around the information system, enabling knowledge workers in different organizations to learn from each other.
- *Primary task for the CIO*. This is the most critical success factor for the IT manager. At Level 1, the most critical success factor is to establish inter-organizational workflow in an efficient and secure way. At Level 4, a very different success factor can be found. It is concerned with the CIO's ability to translate strategy into action. While a mutual strategy might be concerned with overall goals, the strategy does not always tell how those goals might be reached and how information systems might support the effort. Therefore, the CIO must be capable of translating general statements into detailed specifications of future systems.
- *Primary role of the CIO*. The CIO must initially get used to the idea of not having his or her 'kingdom' of systems anymore. Now systems become part of relationships with other 'kingdoms'. Thus, the CIO need to develop relationships and cooperative arrangements with collaborating organizations to work for interoperability. At Level 4, all CIOs involved become members of a group of architecture, who work together to create the joint architecture.
- *Main governance challenge*. IT governance is concerned with decision rights related to key IT management areas. Initially, decisions should be made concerning standardization. At higher levels, architectural decisions are more important.
- *Design focus*. When information systems are designed, focus will change from standardization at lower levels to exchanges at higher levels.
- *Top management role*. The chief executive might find it difficult to 'let others into' his or her organization, as strengths and weaknesses become visible to outsiders. Especially at Level 2, where openness concerning operations and problems is a prerequisite for inter-organizational knowledge management.

THEORY-BASED BENCHMARK VARIABLES

One of the theories introduced in this book is *transaction cost theory*. When applying this theory to levels of organizational interoperability, we find different costs at different levels, as described in the table.

Another theory is *agency theory*, where the agency problem occurs when cooperating parties have different goals and division of labor. The cooperating parties are engaged in an agency relationship defined as a contract under which one or more organizations (the principal(s)) engage another organization (agent) to perform some electronic information service on their behalf, which involves delegating some decision making authority to the agent (Jensen & Meckling, 1976). According to Eisenhardt (1985), agency theory is concerned with resolving two problems that can occur in agency relationships. The first is the agency problem that arises when the desires or goals of the principal and agent conflict and it is difficult or expensive for the principal to verify what the agent is actually doing. The second is the problem of risk sharing that arises when the principal and agent have different risk preferences. The first agency problem arises when the two parties do not share productivity gains. The risk-sharing problem might be the result of different attitudes towards the use of new technologies. As illustrated in the table, agency problems can be defined as conflicts in the interoperability stage model.

Alliance theory is concerned with partnership, often referred to as alliance. Das and Teng (2002) discussed partner analysis and alliance performance. An important stream of research in the alliance literature is about partner selection. It emphasizes the desirability of a match between the partners, mainly in terms of their resource profiles. The approach is consistent with the resource-based theory of the firm, which suggests that organizations are defined by their resources profiles. See Exhibit B.

Relational exchange theory is based on relational norms. Norms of importance to interoperability include:

- Flexibility, which defines a bilateral expectation of the willingness to make adaptations as circumstances change
- Solidarity, which defines a bilateral expectation of a high value placed on the relationship.
- Trust, which defines an expectation of a predictable and desirable behavior in the future.

More theories could be added to this table, such as network theory, contractual theory, theory of

Exhibit B. Theory-based variables at levels of interoperability in digital government

BENCHMARK VARIABLES	Level 1 Business Process Interoperability	Level 2 Knowledge Management Interoperability	Level 3 Value Configuration Interoperability	Level 4 Strategy Position Interoperability
Transaction cost theory	Information interpretation costs as well as business process understanding costs	Communication costs as well as disagreement costs	Management costs associated different and conflicting value creation logic	Executive costs associated with conflicting ambitions, visions and goals
Agency theory	Conflict between risk-seeking and risk-aversive government organizations when applying new technologies	Conflict between open and closed government organizations when sharing knowledge	Conflict between efficiency oriented value chains and problem solution oriented value shops	Conflict between collaborating government organizations about sharing productivity gains and results
Alliance theory	Partner organizations approach each other to establish information exchanges	Partner organizations implement all agreements of the alliance and the alliance grows rapidly	Alliance performance produces benefits for partner organizations	Partner organizations join forces by establishing joint goals for mutual benefits
Relational exchange theory	Flexibility by adapting to collaborating organizations' work processes	Solidarity by helping collaborating organizations	Profitability by aligning value creation to collaborating organizations	Positioning by joining forces with collaborating organizations

core competencies, stakeholder theory, theory of organizational boundaries, production cost theory, and social exchange theory.

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, domain integration evokes interoperability problems, such as (Bekkers, 2007, p. 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 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 chapter. Understanding intrapreneurship 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 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 chapter might prove helpful in organizing 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 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 an organization 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.

FUTURE TRENDS

However, the idea of total interoperability might be explored in future research, since it is not at all sure that it is possible when including issues such as parameter checking and authorization. Furthermore, the term 'total interoperability' might imply that transaction costs are zero, which is a hypothesis with no empirical evidence so far.

Scholl and Klischewski (2007) list eight more constraints: jurisdictional constraints, collaborative constraints, organizational 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 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).

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 chapter 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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REFERENCES

Anderson, S. W., Glenn, D., & Sedatole, K. L. (2000). Sourcing parts of complex products: evidence on transactions costs, high-powered incentives and ex-post opportunism. *Accounting, Organizations and Society, 25*(5), 723-749.

Bekkers, V. (2007). The governance of back-office integration, *Public Management Review*, *9*(3), 377-400.

Bock, G. W., Zmud, R. W., Kim, Y. G., & Lee, J. N. (2005). Behavioral intention formation in knowledge sharing: Examining the roles of extrinsic motivators, social-psychological forces, and organizational climate. *MIS Quarterly*, *29*(1), 87-111.

Cabinet Office (2005). *Geographic Information: An Analysis of Interoperability and Information Sharing in the United Kingdom*. E-Government Unit, Cabinet Office, London, UK.

Das, T. K., & Teng, B. S. (2002). Alliance Constellations: A Social Exchange Perspective. *Academy of Management Review, 27*(3), 445-456.

Dean, G., Fahsing, I. A., & Gottschalk, P. (2006). Profiling police investigative thinking: A study of police officers in Norway. *International Journal of the Sociology of Law*, *34*(4), 221-228.

Dijkman, R., & Dumas, M. (2007). Service-oriented design: A multi-viewpoint approach, *International Journal of Cooperative Information Systems*, *13*(4), 337-368.

Drejer, A., Christensen, K. S., & Ulhoi, J. P. (2004). Understanding intrapreneurship by means of state-of-the-art knowledge management and organizational learning theory. *International Journal of Management and Enterprise Development*, 1(2), 102-119.

Earl, M. J. (2000). Evolving the E-business. *Business Strategy Review*, *11*(2), 33-38.

Eckman, B. A., Bennett, C. A., Kaufman, J. H. & Tenner, J. W. (2007). Varieties of interoperability in the transformation of the health-care information infrastructure. *IBM Systems Journal*, *46*(1), 19-41.

Eisenhardt, K. M. (1985). Control: Organizational and economic approaches. *Management Science, 31*(2), 134-149.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, *21*, 1105-1121.

Fahey, L., Srivastava, R., Sharon, J. S., & Smith, D. E. (2001). Linking E-Business and operating processes: The role of knowledge management. *IBM Systems Journal*, 40(4), 889-907.

Frankfort-Nachmias, C., & Nachmias, D. (2002). *Research Methods in the Social Sciences*, Fifth Edition, UK: Arnold.

Gogan, J. L., Williams, C. B., & Fedorowicz, J. (2007). RFID and interorganisational collaboration: Political and administrative challenges. *Electronic government, An International Journal*, *4*(4), 423-435.

Gottschalk, P. (2007). Information systems in police knowledge management. *Electronic Government, An International Journal*, *4*(2), 191-203.

Gottschalk, P., & Solli-Sæther, H. (2006). Maturity model for IT outsourcing relationships. *Industrial Management & Data Systems*, *106*(2), 200-212.

Gottschalk, P., & Tolloczko, P. C. (2007). Maturity model for mapping crime in law enforcement. *Electronic Government, An International Journal*, *4*(1), 59-67.

Hansen, M. T., Nohria, N., & Tierny, T. (1999). What's your strategy for managing knowledge? *Harvard Business Review*, March-April, 106-116.

Housel, T., & Bell, A. H. (2001). *Measuring and Managing Knowledge*. New York: McGraw-Hill Irwin.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structures. *Journal of Financial Economics, 3*(4), 305-360.

Kazanjian, R.K. (1988). Relation of dominant problems to stages of growth in technology-based new ventures. *Academy of Management Journal*, *31*(2), 257-279.

Kazanjian, R. K., & Drazin, R. (1989). An empirical test of a stage of growth progression model. *Management Science*, *35*(12), 1489-1503.

Khalifa, M., & Liu, V. (2008). Semantic network representation of computer-mediated discussions: Conceptual facilitation form and knowledge acquisition. *Omega*, *36*, 252-266.

King, W. R., & Teo, T. S. H. (1997). Integration Between Business Planning and Information Systems Planning: Validating a Stage Hypothesis. *Decision Sciences*, *28* (2), 279-307.

Kutvonen, L. (2007). Interoperability knowledge management issues, In: Goncales, R.; Müller, J.P., Mertins, K., Martin Zelm (editors), *Enterprise Interoperability II*, Springer Verlag, London, pp. 629-632.

Legner, C., & Lebreton, B. (2007). Business Interoperability Research: Present Achievements and Upcoming Challenges. *Electronic Markets*, *17*(3), 176-186.

Nolan, R. L. (1979). Managing the crises in data processing. *Harvard Business Review*, March-April, 115-126.

Otjacques, B., Hitzelberger, P., & Feltz, F. (2007). Interoperability of E-Government Information Systems: Issues of Identification and Data Sharing. *Journal of Management Information Systems*, *23*(4), 29-51.

Papazoglou, M. P., & Ribbers, P. M. A. (2006). *E-Business: Organizational and Technical Foundations*. UK, West Sussex: John Wiley & Sons.

Rao, S. S., & Metts, G. (2003). Electronic commerce development in small and medium sized enterprises: A stage model and its implications, *Business Process Management*, *9*(1), 11-32.

Santos, E. M. D., & Reinhard, N. (2007). Setting interoperability standards for E-Government: An exploratory case study. *Electronic government, An International Journal*, *4*(4), 379-394.

Scholl, H. J., & Klischewski, R. (2007). E-Government Integration and Interoperability: Framing the Research Agenda. *International Journal of Public Administration*, *30*(8), 889-920.

Sheehan, N. T. (2005). Why old tools won't work in the "new" knowledge economy. *Journal of Business Strategy*, *26*, 53-60.

Stabell, C. B., & Fjeldstad, Ø. D. (1998). Configuring value for competitive advantage: on chains, shops, and networks. *Strategic Management Journal*, *19*, 413-437.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management, *Strategic Management Journal*, *18*(7), 509-533.

Walker, L. (2007). IBM business transformation enabled by service-oriented architecture, *IBM Systems Journal*, *46*(4), 651-667

Wickramasinghe, N. (2006). Expanding the explanatory power of agency theory for the knowledge economy. *International Journal of Management and Enterprise Development*, *3*(5), 510-520.

Williamson, O. E. (2000). The New Institutional Economics: Taking Stock, Looking Ahead. *Journal of Economic Literature, 38*(595-613).