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Analytical Framework for e-Government Interoperability

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Abstract: This paper is concerned with maturity in e-government interoperability. Based on the stage hypothesis model of growth, a framework to analyze and predict e-government interoperability is presented. Lessons learned from the experience of the government sector in Norway are useful for analysing the stages of growth, dominant problems at each stage, and evolutionary path. Using the organisational, semantic and technical parameters of the framework, benchmarks applicable for each stage are applied to the case studies from the government sector in Norway. This exploratory research describes the utility of the analytical framework, as well as benefits derived from improved e-government interoperability.

1. Introduction

The term electronic government or e-government appeared about a decade ago, and there is no commonly accepted definition. In this paper e-government, digital government, and electronic government is used synonymously about the use of information and communication technology in public sector [1]. The underlying assumption is that the use of Internet technologies should improve the ways government serve its citizens and the ways in which these citizens interact with governments. Making citizen-centric efficient operations and services, governments must challenge the traditional way of cooperation, and improve technical, semantic, as well as organisational interoperability.

According to Legner and Lebreton [2], business interoperability can be defined as "the organisational and operational ability of an enterprise to cooperate with its business partners and to efficiently establish, conduct and develop IT-supported business relationships with the objective to create value." This definition may as well fit for a government agency cooperating with citizens, business enterprises, or other government agencies.

Very few publications have addressed the impact of interoperability on benefits [2], but these could be identified in terms of the defining purpose of the digital government. Important issues of e-government are usually highly agile, citizen-centric, accountable, transparent, effective, and should provide efficient government operations and services [3]. According to Wilson, van Engers and Peeters [4], national, regional and municipal government agencies struggle with interoperability, standardization, collaboration and service integration as well as with information and communication technologies (ICT).

According to Gottschalk & Solli-Sæther [5], the level of e-government interoperability has the following four stages: aligning work processes, knowledge sharing, joining value creation, and strategic alignment. Collaborating and communicating agencies are assumed to be more cost-effective when work processes are aligned, knowledge is shared, value creation is joined, and strategies are aligned.

2. Objectives

This paper focuses on how to analyse and predict interoperability and discusses the productivity gains that communicating and collaborating agencies could make in using information technology to improve productivity and user satisfaction.

3. Methodology

According to Yin [6], the case study method is preferred in examining contemporary events, especially when the focus is on a contemporary phenomenon within some real-life context. The case study's unique strength is its ability to deal with the full variety of evidence, including documents, artefacts, interviews, and observations. For case studies, five components of research design are especially important: the study's questions, its propositions (if any), its unit(s) of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings [6]. In designing the case study, all of these components have to be dealt with.

This exploratory study had the following guiding research questions: "How does e-government interoperability mature and evolve?" and "What is the potential impact of e-government interoperability?" As such, the unit of analysis was at an organisational relationship level. Since the investigator's goal was to explore organisational, semantic, and technical issues rather than analytical generalizations, no propositions were developed before the study, even though the underlying assumption is that the use of Internet technologies should improve the ways government serves its citizens and the ways in which these citizens interact with governments. This approach was selected in order to understand the inherent complexities and the underlying constructs, in addition to debating the economies of e-government interoperability.

Although the global assessment of electronic government is increasing, a United Nations (UN) survey indicates that the aims to which IT is put to use vary [7]. According to the UN survey, e-government solutions are fairly well developed in Europe, particularly in Norway which ranks 3rd. The selection of cases for the study was from cooperating government organisations in Norway. The cases are of secondary interest; they play a supportive role, facilitating our understanding of something else [8]. The choice of cases was made, however, because the cases were expected to advance our understanding of e-government interoperability. The "Birth" case was, in its initial phase, trying to establish new government e-services and the "All In" case was a mature one renewing e-services at a government information portal. The cases provide a broad base of e-government interoperability practices, suggesting that the case in each cooperating constellation would be of interest and value to this research study. Table 1 summarizes some characteristics of the cases studied.

Table 1: Two e-government research case studies

Government organization	Focus area	Services involved	Start of cooperation	Users
The Norwegian Tax Authority, Norwegian Directorate of Health, Norwegian Centre of Informatics in Health and Social Care	Notification of births from hospitals to the National Registry	Birth message, choice of name, personal number	2008	Hospitals, the National Registry, parents
The Norwegian Tax Authority, The Brønnøysund Register Centre, Statisti Norway	New information portal	Tax, VAT, salary and account, annual reports	2002	Unique citizens, companies and enterprises, public agencies

Data collection was accomplished through 12 interviews, with questions addressing government e-services, dominant problems, benchmark variables, description of the evolution, and the economies of e-governance interoperability. For each case, six interviewees were selected among the participating government organisations. Interviews consisted of personal meetings with two additional follow-up interviews by phone. The individual cases serve as the evidentiary base for the study. The purpose is not to portray any single one of the relationships, but rather to synthesize the lessons learned which were dispersed throughout the separate, cross-case issues.

4. Development of the Analytical Framework

Maturity levels in terms of stages-of-growth models have been widely used in both organisational research and information technology management research. According to King and Teo [9], these models describe a wide variety of phenomena – the organisational life cycle, product life cycle, biological growth, and so forth. These models assume that predictable patterns (conceptualised in terms of stages) exist in the growth of organisations, the sales levels of products, the diffusion of information technology, 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) involve a broad range of organisational activities and structures.

Four core challenges and topics emerge when theorizing stages of growth. The first challenge is to identify and explore the number of stages of growth. Second, a set of dominant problems with primary concerns for each stage needs to be identified. Third, is a need to develop workable benchmark variables identifying the stages, and fourth, is to find a proper description for the evolution in the model.

4.1 – Number of stages and evolutionary path

Gottschalk and Solli-Sæther [5] identify and discuss stages of e-government interoperability. The four stages presented are aligning work process, knowledge sharing, joint value creation, and strategic alignment. The stage model was experimental in nature by assigning phenomenon to four stages and by labelling each stage according to a meaningful characteristic.

- *Stage 1 – Aligning work process.* Common work processes are clearly defined among cooperating agencies. Some activities are carried out in one agency, other activities in another agency. Efficient operation requires integrated activities, schemas and (physical or electronic) data exchange among different information systems. Data definitions must be specified in detail in certain cooperating areas. Interoperability at this level is partly manual work and partly supported by IT.
- *Stage 2 – Knowledge sharing.* Agencies demonstrate their ability and determination to share knowledge. Knowledge sharing plays an important role for inter-organisational learning and innovation. Agencies put effort into defining best practices, specification of metadata, methods, and technical standards for information infrastructure, systems and data exchange. Bilateral exchange of knowledge requires places to meet and support from knowledge management systems.
- *Stage 3 – Joint value creation.* Being able to see common value configuration is fundamental in creating added value from cross-agency services. Common information models and service catalogues are necessary for joint development of services for common end-users. Agencies are ready to bare costs although benefits may be created in another agency.

- *Stage 4 – Strategic alignment.* Common strategic positioning requires (political) alignment of mission statements. Joint governmental financing of projects is necessary to achieve socio-economic benefits. Adaptation of laws and regulations is necessary to achieve strategic alignment.

As an overall impression, the interviewees found these suggested four stages relevant to their particular e-services. According to the respondents in Norwegian public sector organisations, too few stages will make the partition too large, and too many stages will make the partition too detailed. The respondents recognized conceptual planning, as an important preparation in obtaining e-government interoperability. According to the interviewees, the evolutionary path seems to be logic, although it cannot be a linear progression only

4.2 – Dominant problems and benchmark areas

Jayasuriya [10] discussed the growth of end-user computing, using a framework where structure, technology, and people, are interrelated with mutually adjusting benchmark areas. In a similar way, this research builds a composite analytical framework where each stage of e-government interoperability is described in three different but related aspects: 1) organisational interoperability, 2) semantic interoperability, and 3) technical interoperability. These are similar to the three aspects of interoperability identified by The European Interoperability Framework [11].

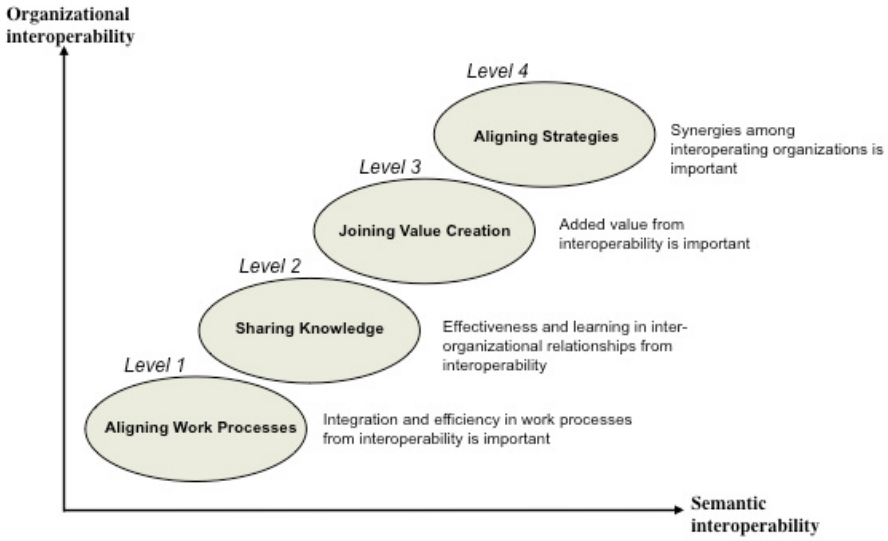
Interoperability refers to the property of diverse systems and organisations that enables them to work together. Organisational interoperability was defined as the extent to which organisations, using different work practices are able to communicate. Semantic interoperability was defined as the extent to which information systems, using different terminology, are able to communicate. Lastly, technical interoperability was defined as the extent of systems to communicate, interpret and interchange data in a meaningful way [12].

Table 2 was developed during the case studies by asking the interviewees: "What were the dominant problems at each stage?" Respondents identified one or more important characteristics for each stage, which later were grouped into the three different, but related, benchmark areas. Table 2 serves as a framework for analysing stages of growth for e-government interoperability.

Table 2: Analytical framework for e-government interoperability

Stage Benchmark area	Aligning Work Processes	Knowledge Sharing	Joining Value Creation	Aligning Strategies
Organizational Interoperability	Efficient operation requires integration of activities and schemas	Best practices Real-time knowledge transfer Change of organizational culture	Cross-agency value configuration New services based on business cases Inter-organizational control mechanisms and trust	Political decision-making Socio-economic benefits
Semantic Interoperability	High degree of specificity and common data definitions in certain areas	Meta data specification Knowledge management system	Service catalogues Information models	Adaptation of laws and regulations Business models
Technical Interoperability	Physical or electronic data exchange among separate applications Closed systems	Common architecture Technical standards	Joint application development Common databases Information security	Joint financing

Applying dominant problems to stages of growth indicates an existing pattern of primary concerns that firms face for each theorized stage [13]. Kazanjian and Drazin [14] argue that either implicitly or explicitly, all stage-of-growth models share a common underlying logic. Organisations undergo transformations in their design characteristics, which enable them to face the new tasks or problems that growth elicits. The problems, tasks or environments may differ from model to model, but almost all suggest that stages emerge in a well-defined sequence, so that the solution of one set of problems or tasks leads to the emergence of a new set of problems or tasks that the organisation must address. Benchmark variables are often used to indicate characteristics in each stage of growth and to demonstrate that transitions occur through the stages.



5. Results from Application of the Framework

To illustrate application of the framework presented in Table 2, the Birth case (B) and the All In case (A) were selected to represent different levels of e-governance interoperability. Below, they are analysed based on the relevant benchmark areas of the framework.

5.1 – The information portal "All in"

The All In case has established a common service architecture indicating level 2 of technical interoperability. Today there are common tools and guidelines for service development, but little joint application development and no common databases. To a large extent, agencies have their own professional applications made available for end-users through a common information portal. Joint application development, planned in All In II, indicating they are striving for level 3. There is a high degree of specificity and there are common data definitions in schemas used by several agencies. Metadata is specified in semantic register for electronic interoperability. This indicates level 2 of semantic interoperability. Activities and schemas are to a certain degree aligned. Although some services are agency specific, there are examples of services developed for two or more agencies. The existence of user groups and service owner groups indicates organizational interoperability at level 2. Overall, the All In case is at knowledge sharing stage trying to reach the next level of maturity by joining value creation.

5.2 – Notification of newborns

In the Birth case work process "notification of birth" is aligned with some activities carried out at hospitals and some activities carried out within the Norwegian Tax Directorate, the National Registry. Today, work process is supported by separate information systems with physical data exchange (i.e., schema is printed and sent physically by mail in batch). Although physical data exchange between hospitals and the National Registry, requirement specifications are agreed upon to be able to collect, register, store and retrieve information about newborns. Overall, the Birth case is at an early stage regarding organizational interoperability with some work processes aligned. Although the Ministry of Health and Social Care has indicated a need for clear strategic control and management of ICT in health sector (press release 14/01/2009), there is still a long way to go. Today, responsibilities are fragmented and shared among several stakeholders, e.g., regional hospitals are allowed to decide upon their own information infrastructure and systems.

5.3 – Potential benchmark variables for technical interoperability

Technical interoperability can be viewed as a starting point for achieving e-governance interoperability. Archmann and Kudlacek [12] found that key success factors for technical interoperability include the application of already existing technologies, common understanding and use of data. Data schemes, common syntax, accessibility, security, and privacy are important issues when working on technical interoperability.

In the Birth case, the work process is supported by a separate information infrastructure consisting of systems and databases with physical forms for data exchange (i.e., a form is printed and sent by mail in a batch). Although physical data is exchanged between hospitals and the National Registry, requirement specifications are agreed upon so that the institutions are able to collect, register, store and retrieve information about newborns.

The All In case has established a common infrastructure with a common application architecture, tools, and guidelines for service development, but little joint application development and no common databases. To a large extent, agencies have their own professional applications made available for end-users through a common information portal. Joint application development, is planned for in All In II. There is a high degree of specificity and there are common data definitions in forms used by several agencies. Activities are to a certain degree aligned. Although some services are agency specific, there are examples of joint services developed for two or more agencies. The differences between the Birth case and the All In case are shown in Table 3.

Table 3: Potential benchmark variables for technical interoperability

Stage / Benchmark variable	Aligning Work Processes	Knowledge Sharing	Joining Value Creation	Aligning Strategies
Role of infrastructure	Separate infrastructures (B)	Integrated architecture (A)	Joint infrastructure investments	Common infrastructure
Role of information systems	Separate applications (B)(A)	Integrated application architecture (A)	Joint application investments (A)	Common applications
Data	Separate databases (B)(A)	Protocols for sharing (A)	Common databases	Accessibility
Data exchange	Forms for physical or electronic transfer (B)	Standardized data exchange formats (A)	Data stored in common databases	Data available for other purposes
Information security	Separate security services (B)	General security services (A)	Web service security	Protection

In a similar way benchmark variables can be developed for organizational and semantic interoperabilities. Cases can be analysed based on the relevant parameters of the framework.

6. Benefits from e-Government Interoperability

We assume that interoperability cause benefits when work processes are aligned, knowledge is shared, value creation is common, and strategies are aligned. Cooperating parties should try to find at what level they are and to what level they should strive. Individuals and organizations must accumulate their experience to step from one level to another. Systematically developing interoperability in e-government may cause long-term benefits for community. The stages-of-growth model can create knowledge and insight into organization development in government. As such it serve as a tool we can use to understand development over time. The model may be used to obtain interoperability among organizations with different value configuration, give answer to the need for knowledge development and transfer, to see how value configuration fits with formal and informal organizational characteristics such as goals, strategies, culture and power. Understanding the pitfalls of interoperability governments more likely will contribute to create internal or external value.

The starting point for the stage model is standardisation. According to Papazoglou and Ribbers [15], interoperability requires standardisation in four dimensions: technology, syntax, semantics, and pragmatics. Technology standards concern middleware, network protocols, and security protocols. Syntax standardisation means that the network e-government organisation has to agree on how to integrate heterogeneous applications based on the structure or language of the messages exchanged. Normally, commonly acceptable data structures are chosen to represent well-known constructs, e.g. object descriptions. Semantic standards constitute agreements in extension to syntactic agreements on the meanings of the terms used for an organisation's information systems. Pragmatic standards, finally, are agreements on practices and protocols triggered by specific messages, such as orders and delivery notifications.

Measuring e-government is however a challenge as there is no common accepted instrument. eGEP is a framework for measuring benefits in e-government [16]. Value drivers with belonging measurement areas and indicators, indicate potential public value, defined as financial and organizational value, political value and constituency value. Level one in the maturity model has focus on integration and effectiveness, which can be measured through indicators such as financial gains and reduced administrative burden. Level two is knowledge sharing, meaning that we establish best practices across organizational boarders. This can be measure by indicators such as better empowered employees and better architecture. Third level is joint value creation. Here we can use indicators such as increased user value and customer satisfaction, and better public services. At fourth level value can be obtained through synergies among interoperating organizations, which can be measured in terms of political value. The maturity model is cumulative, as we add value when maturity is increased. Benefits obtained at level four are those specific for this level in addition to those at lower levels.

Table 4: Benefits from e-government interoperability

Maturity level	*Benefits*	*Indicators*
Aligning work processes	Integration and effectiveness in work processes	Financial gains Reduced administrative burden
Knowledge sharing	Effectiveness and learning in inter-organizational relationships	Better empowered employees Better organisational and IT architecture
Joint value creation	Added value from interoperability	Increased user value and satisfaction Better public services
Strategic alignment	Synergies among interoperating organizations	Openness Transparency Participation

7. Conclusions

In this research, the suggested stages-of-growth model for e-government interoperability suggested by Gottschalk & Solli-Sæther [5] was found relevant in two governmental e-services in Norway. The study suggests a multidimensional analytical framework incorporating organisational, semantic, and technical interoperability, investigating maturity in e-government interoperability. Application of the framework in analysing cross-agency e-services in Norway indicates:

1. Governments face different issues and challenges based on their stages of growth
2. Cooperating and communicating governments have different expectations and goals based on their stages of growth
3. Benefits from e-government interoperability vary depending on maturity level

Interoperability results in benefits when work processes are aligned, knowledge is shared, value creation is common, and strategies are aligned. Investments in e-government interoperability improve value for government agencies, businesses, and citizens, but traditional performance measures are found difficult to use in measuring the success of e-government interoperability, since stakeholders with different value dimension are involved. This has been exemplified using indicators from eGEP.

Benchmark variables should be further developed and tested through a survey, and the benefits as well as the effect model for benefits should be further developed. The study seems limited to a subset of the objectives of interoperability. In this exploratory part the study has, to a large extent, disregards potential drawbacks, risks and disadvantages. These limitations should be explored further.

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