Conceptualising Citizen’s Trust in e-Government:
Application of Q Methodology

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Abstract: In e-government context, trust plays a vital role in helping citizens overcome perceived risks. Trust makes citizens comfortable sharing personal information, make online government transaction, and acting on e-Government advices. Thus, trust is a significant notion that should be critically investigated to help both researchers and practitioners to understand citizens’ acceptance to e-Government. Prior research in trust has focused mainly on consumer’s trust in e-Commerce. Most of existing literatures on trust in e-government focus on technical perspective such as PKI. This paper contributes by proposing a conceptual model of citizens’ trust in e-Government. The proposed conceptual model of citizens’ trust in e-government is integrated constructs from multiple disciplines: psychology, sociology, e-commerce, and HCI. The research is aimed also to develop items in order to measure the theoretical constructs in the proposed model. The pool of items is generated based on literature review. Q-Methodology has been utilised to validate the generated measurement items. The outcome of two Q-sorting rounds resulted in developing a survey instrument for proposed model with an excellent validity and reliability statistical results.

Keywords: e-government, trust, perceived risk, citizens’ participation, technology acceptance model

1. Introduction

Electronic commerce, or in short, e-commerce and its sophisticated technologies have enabled governments and companies to provide their products and services for their citizens and customers through web sites. Online services are cheaper, more convenient, and easy to provide. Electronic Government or e-government has been classified as one instance of e-commerce (Schneider, 2003). Many governments around the world have launched their e-government initiatives to provide citizens and organisations with more convenient ways to access government information and services (Turban, King, Lee, Warkentin, & Chung, 2002). Previous research has been carried out to evaluate the quality and quantity of the provided e-government services and the overall adoption of e-government. One factor that plays a vital role in e-commerce adoption, especially e-government, is a mature trust between citizen and the government. Although trust has been recently studied in e-commerce, there is still yet a lack of sufficient research that investigates the trust phenomenon in e-government. Most of the existing online trust literatures focus on e-commerce in particular B2C e-commerce.

The purpose of this paper is twofold. The first purpose is to identify the factors that most likely affect citizens’ trust in e-government. This is contextualised by investigation of the elements and components that transact the trust beliefs in electronic services, whether these elements and components are related to technical aspects such as Human Computer Interaction (HCI), or related to business, psychological, sociological, or cultural perspectives. The second purpose is to develop an instrument to measure the theoretical constructs in the proposed model.

2. Literature review and theoretical background

2.1 Overview of e-government

There are a number of e-government definitions in the existing literature. Most definitions of e-government revolve around the concepts of government’s employment of technology, in particular web-based application to improve the access and delivery of government services to citizens, business partners, and other government agencies. World Bank defines trust as “the use by government agencies of information technologies (such as Wide Area Networks the Internet, and mobile computing) that have ability to transform relations with citizens, businesses, and other arms of government.” (World Bank Group, 2007)
2.1.1 Stages of e-government development

There are various stages of e-government development. According to (Howard, 2001; Lau, 2001), there are four major stages of e-government development:

- **Information Publishing**: this is a basic form of e-government where government posts information on the official government websites. The presented information may include information about available public services, government contract, and government events.
- **Two-way Communication**: in this stage citizens communicate with the government through the Internet and make simple requests. Usually, the information requested in not processed immediately online but sent to the requestor by mail or email.
- **Transaction**: this stage is more sophisticated than previous stages where citizens can conduct all transactions online. Driving licence renewing is one example of these transactions.
- **Integration**: this is the most sophisticated stage of e-government development. In this stage, all government services provided from different departments and agencies are integrated together and accessed through single website called e-government portal.

2.1.2 E-government sectors

The nature of e-Government adoption decision is depending on the degree of the engagement of several parties including: citizens, businesses, and other government agencies. Therefore, the applications of e-Government are categorised according to users’ needs and the capacity of ICT. The different users and beneficiaries of e-Government shape the characteristic of e-Government applications. The e-Government applications are classified according to the governmental relationships with a variety of constituents.

E-government has been divided into the following four sectors according to who participates: Government to Government (G2G) for all operations inside or between government agencies, Government to Business (G2B) for all interested participants in institutions or private companies and the government, and Government to Citizen (G2C) which refers to all dealings between citizens and the government (DeBenedictis, Howell, Figueroa, & Boggs, 2002). Some observers, such as Ndou (2004), further identify a fourth sector, Government to Employees (G2E).

**Government-to-Citizen (G2C)**

The Government to Citizen (G2C) sector refers to all dealings between citizens and the government over online medium (DeBenedictis et al., 2002). G2C e-Government is designed to facilitate citizen interaction with government and is perceived to be the primary goal of e-Government (Seifert, 2008). Using G2C e-Government, citizens transactions with government, such as license renewal, can be less time consuming and easier to carry out.

The citizen demand for G2C e-Government is expected to increase significantly over the next ten years as the youth, who are now growing up in the information age with personal computers and the Internet as routine presence in their live, becomes adults (Seifert, 2008). One example of G2C initiative is GoBenefits.gov which is an American governmental web site that provides a single point of access for citizens to locate and determine potential eligibility for government benefits and services.

**Government-to-Business (G2B)**

The G2B sector deals mainly with the sale of surplus government goods to the public and the procurement of goods and services. Recently, G2B initiatives received a significant amount of attention as a result of the high enthusiasm of the business sector and the potential for reducing costs through improved procurement practices and increased competition (Seifert & Petersen, 2002). When implemented effectively, G2B e-Government has potential to streamline and improve the consistency of personnel-intensive tasks (Seifert, 2008).

E-Procurement is the main application of G2B e-Government that allows government agencies to reap the benefits being realized in the private sector though electronic means (Fang, 2002). One example of G2B initiative is FedBizOpps.gov which is a web site that is administered by the General Services Administration (GSA), an independent agency of the Untied States government established
to manage and support basic functions of federal agencies. FedBizOpps.gov is designed to serve as a central location for agencies to post procurement notices.

**Government-to-Government (G2G)**

The G2G sector represents the backbone of e-Government in which governments (federal, state, and local) integrate their internal systems and procedures into a central system (Seifert, 2008). The main aim of G2G e-Government is to facilitate processes if inter-government organisations by streamlining collaboration and coordination.

G2G e-Government involves sharing data and conducting electronic transactions between governmental actors. The main motivating force behind the G2G sector includes the growing attention being paid to improve the efficiency by saving transactions cost, increasing the speed of transactions, reducing the number of personnel necessary to complete a task, and improving the consistency of outcomes (Seifert, 2008). Examples of G2G e-Government include E-Identity, E-Security services, Electronic Document Management, and Process Management Services.

2.2 **Research model**

In the context of Government-to-Citizen category of e-government, there are two major objectives: providing citizens with effective information access and providing citizens with access to full range of e-government services online (National Research Council, 2002). The basic idea behind e-government is to allow citizens to interact with their government through the internet; for example, they ask questions and receive answers, get updated government regulations, obtain government official documents, fill applications, pay tax and bills, receive payments, and forth. The two forms of citizens’ engagement in e-government are receiving e-government information and requesting e-government service (Warkentin, Gefen, Pavlou, & Rose, 2002). The following research model describes how citizens’ trust can affect their intention to engage in e-government.

The theoretical research model (see Figure 1) consists of nine constructs that delineate the conceptual model of citizens’ trust in e-government. The model attempts to formulate an important number of factors that have been observed to affect citizens’ trust in e-government. These factors have been integrated from different models of trust that are existed in the literature. The proposed model applies to Government-to-Citizen (G2C) situation and it delineates the roles of significant factors in the process of trust in e-government. Following is the theoretical review in which each construct is derived.

![Figure 1: Theoretical research model](image-url)
2.2.1 Trust in e-government

In this research, trust is defined as an individual's (trustor, here is citizen) belief or expectation that another party (trustee, here e-government) will perform a particular action important to trustor in the absence of trustor's control over trustee's performance (Mayer, Davis, & Schoorman, 1995). Hence, trust indicates that trustor will rely on trust behaviour (Rotter, 1971b). Trust is occurred in uncertain environment (Schlenker, Helm, & Tedeschi, 1973) where the risk is existed (Lewis & Weigert, 1985) and trustor is vulnerable for unfulfilled expectation or harmful outcomes (Zand, 1972). People use trust as mental mechanism to reduce the complexity and uncertainty of living environment (Luhmann, 1979).

Trust has been cited as important and crucial requirement for economic and social interactions (Baier, 1986; Barber, 1983; Dasgupta, 1998; Lewis & Weigert, 1985; Luhmann, 1979; Mayer et al., 1995; McAllister, 1995; Rotter, 1971a). In the context of e-commerce, trust has been also observed as a key value in e-commerce (Gefen, 2000; Gefen & Straub, 2004), and in e-government (Galindo, 2002). Furthermore, trust enables cooperative behaviour (Gambetta, 1988). Hence, Trust beliefs lead for trust behaviour; in this model trust in e-government will lead citizens to engage in e-government (Warkentin et al., 2002).

H1: citizen trust in e-government positively influences intentions to engage in e-government.

2.2.2 Disposition to trust

Individuals have differences in terms of tendency to trust other party (Rotter, 1971a) wether this party is a person, a group, an organisation, or a business. Disposition to trust “is a propensity or tendency to believe in the positive attributes of others in general” (D. H. McKnight, Kacmar, & Choudhury, 2004 p. 36). Disposition to trust has been identified as a construct for trust in many trust models (D. McKnight, Choudhury, & Kacmar, 2002; D. H. McKnight & Chervany, 2001; D. H. McKnight et al., 2004). McKnight and Chervany (2001) proposed two constructs for disposition to trust Faith in Humanity and Trusting Stance. Faith in humanity is underline assumptions that others are usually upright, well meaning, and dependable. Trusting stance means that one believes that, regardless of other people reliability, one will obtain better outcomes result from dealing with other people; i.e. trust others until they prove truster is wrong. Research has shown that disposition to trust has a significant impact on trust in online context (D. McKnight et al., 2002; D. H. McKnight et al., 2004; Pavlou & Gefen, 2004). Trust in the web institution is positively affected by disposition to trust because people who trust other generally will trust institutions involving people (McKnight et al., 2004) such as online vendors. Thus, disposition to trust is positively associated with consumer’s trust in e-commerce (Y. H. Kim & Kim, 2005). In e-government context, disposition to trust has been argued to increase trust in e-government (Warkentin et al., 2002). This leads to the following hypothesis:

H2: Citizens’ disposition to trust is positively associated with trust in e-government.

2.2.3 Familiarity

Familiarity is stage where people use their previous experience (Luhmann, 1979), interactions, and learning to understand what, where, why, and when people do what they do (Gefen, 2000). It has been argued that familiarity is precondition for trust (Luhmann, 1979) and that trust is occurred in a familiar world, and the familiar features of the world may be changed which in turn may impact the possibility of developing trust in human relations (Luhmann, 1988). The Luhmann's note about the impact of changeability of familiarity on trust is useful in understandability of e-government trust because the e-government environment of providing government services for citizens are different than tradition government environment. Therefore, most of citizens are not familiar with e-government environment especially in the early stage of e-government which will influence citizens’ trust in e-government.


2.2.4 Institution-based trust

Institution-based trust is the trustor’s confidence that the situation structures are existed to facilitate outcome success of trusting behavior (Pavlou, Tan, & Gefen, 2003) and more impotently to impose sanctions when trust is breached (Humphery & Schmitz, 1998; Lane & Bachmann, 1996). Following
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McKnight et al. (2002), institution-based trust is defined as “the belief that needed structural conditions are present (e.g., in the Internet) to enhance the probability of achieving a successful outcome in an endeavor like e-commerce” (p. 339). Institution-based trust is generated when trustor believes that safety, guarantee, insurance and other performance structures are presented to secure a situation (Pavlou et al., 2003; Shapiro, 1987). In economic context, Institution-based trust “proved to be the most resilient…, expanded and elaborated [trust creating model]” in impersonal economic environment (Zucker, 1986, p. 96 p. 96). In e-commerce context, institution-based trust has been argued to be best suited for online marketplaces because the secure online transactions (between and buyer and seller) are conducted under the aegis of third party who constitute an institutional context (Pavlou & Gefen, 2004).

McKnight et al. (2002) defined two dimensions (sub-constructs) of institution-based trust: structural assurance and situation normality. Structural assurance is related to structures that existed to promote success such as guarantees, regulation, and legal resources. Situation normality is the belief that success is expected as the environment is normal and in appropriate order. Example of situation normality in internet environment is the expectation that infrastructure of the communication is secure, i.e. security mechanisms and techniques (encryption) are employed to secure the communication channel. Accordingly, the following hypotheses are proposed:

H4a: structure assurance trust positively affects citizens’ trust in e-government.
H4b: situation normality trust positively affects citizens’ trust in e-government.

3. Perceived website quality

Several research studies have been conducted to identify the design elements that communicate trust in e-commerce web sites. Studio Archetype and Sapient study (1999) is significant research that has investigate trust in e-commerce from HCI perspective. They identified different types of forms that communicate consumers’ trust in an e-commerce website. Navigation and Presentation of the websites have been identified in Studio Archetype and Sapient study as very important design elements that facilitate the users’ trust in the websites. Based on empirical evidence (Studio Archetype/Sapient & Cheskin Research, 1999), the following hypotheses are proposed:

H5b: E-government website presentation positively affects citizens’ trust in e-government.

3.1.1 Technology Acceptance Model (TAM)

Other important components that are assumed to affect citizens’ trust in e-Government are: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU and PEOU are two main components in Technology Acceptance Model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). TAM is an adaptation of the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975). PU is the degree to which the user believes that the using of the system enhances his or her task performance. PEOU is the degree to which the user believes that using the system is easy and free of hard effort. TAM has been applied to the usability of e-commerce websites (Gefen, Karahanna, & Straub, 2003); also several researchers have hypothesised that PEOU and PU are positively affect trust in e-vendor (Chau, Hu, Lee, & Au, 2007; Koufaris, Kambil, & Labarbera, 2001; Pavlou, 2003; Tang & Chi, 2005).

In e-government context, the following hypotheses are proposed:

H6a: PEOU of e-government website positively influences citizens’ trust in e-government.
H6b: PU of e-government website positively influences citizens’ trust in e-government.

3.1.2 Perceived risk

Risk is closely connected with trust; if there is no risk, there is no need for trust (Luhmann, 1988). Therefore, trust is manifested with present of risk where the possible damage is greater than advantage that is sought (Deutsch, 1960). Trust “derives from the calculus of gains and losses, weighed by perceived risks” (Rousseau, Sitkin, Burt, & Camerer, 1998, p. p. 398). However, “placing trust means suspending, discounting, bracketing the risk, acting as if the risk were not existent” (Sztompka, 2003 p. 31). Therefore, trust effects risk which in turns affects behaviour, i.e. perceived
risk moderates the relations between trusting belief and intention to trusting behaviour (Gefen, Rao, & Tractinsky, 2003). Accordingly, the following hypotheses are proposed:

**H7a:** Citizens’ trust in e-government negatively affects perceived risk.

**H7b:** Perceived risk negatively affects intention to engage in e-government.

### 3.2 Instrument development

The constructs are theoretically based on a comprehensive review of the literature and grounded in existing theories. Multi-item scales were developed or adapted from the literature in order to measure the constructs. The application of multi-item or summated scales is useful for investigating latent constructs (Borsboom, Mellenbergh, & Heerden, 2003; Colton & Covert, 2007) and, if properly developed, multi-item scales will provide meaningful measurement and the measurements derived from them will be accurate and interpretable (Peterson, 2000). Therefore, the theoretical constructs in this research are composed of three or more items (Cronbach & Meehl, 1955). As delineated in the research model (Figure 1), there are 9 major constructs. We developed the scale to measure intention to engage in e-government construct. Items to measure the other constructs were adapted from previous empirical research. The adapted items were considerably modified. Following is the discussion of the literature that supports the items in each construct.

### 3.3 Items generation

<table>
<thead>
<tr>
<th>Construct ID</th>
<th>Construct</th>
<th>Subconstruct/ Dimension</th>
<th>Number of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Disposition to Trust</td>
<td>Benevolence</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrity</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Competence</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trusting Stance</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Familiarity</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Institution-Based Trust</td>
<td>Structure Assurance Trust</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Situation Normality</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>Website Design</td>
<td>Navigation</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presentation</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Perceived Ease of Use</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Perceived Usefulness</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Trust in e-Government</td>
<td>Competence</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrity</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Benevolence</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Perceived Risk</td>
<td>Security risk</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Performance risk</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time Risk</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Intention to engage in e-Government</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>87</td>
</tr>
</tbody>
</table>

The items for “Trust in E-Government” construct were adapted from: empirical research on consumer trust in the internet (Corbitta, Thanasankit, & Yi, 2003; Sirkka L. Jarvenpaa, Tractinsky, & Vitale, 2000), the empirical research on interdisciplinary typology of trust for e-Commerce (D. McKnight et al., 2002; D. H. McKnight & Chervany, 2001), and the literature of trust building technology in the electronic market (Ba & Pavlou, 2002). The items for “Disposition of Trust” were synthesized from an empirical study on the trust measurement in e-Commerce (D. McKnight et al., 2002), and the literature on the consumer trust relationship in e-Commerce (D. H. McKnight & Chervany, 2001). The items for “Perceived Risk” construct were drawn from empirical studies on conceptualization of trust, risk and their relationship in e-Commerce (Gefen, Rao et al., 2003; Sirkka L. Jarvenpaa et al., 2000), from an empirical work that has investigated the perceived risks as barriers to Internet and e-
commerce usage (Liebermann & Stashevsky, 2002), and from an empirical investigation on the effect of perceived risk on purchase intention in the Internet (L. H. Kim, Kim, & Leong, 2005). The items for “Familiarity” construct were primarily based on empirical study on the impact of familiarity on the consumer trust in e-Commerce (Gefen, 2000), and based on the description of the meaning of familiarity in the literature (Luhmann, 1988; Zhang, Ghorbani, & Cohen, 2007). The items for “Trust in e-Government” construct were adapted from an empirical research on the trust measurement in e-Commerce (D. McKnight et al., 2002), from an empirical study on the role of trust in e-Commerce (Gefen, 2000), and from an empirical investigation of citizens’ trust in government and its linkage with their satisfaction with e-Government (Welch, Hinnant, & Moon, 2005). The items for “Institution-Based Trust” construct (Situation Normality and Structure Assurance) were drawn from previous empirical research on the institution-based trust and its effect on the trust in the online environment (D. McKnight et al., 2002), and from a theoretical exploration of institute-based trust (Zucker, 1986). The items for “Perceived Website Quality” construct (Navigation and Presentation) were adapted from an empirical study that have identified e-Commerce virtual design elements that effect consumers’ trust (Stephens, 2004). The items for “Perceived Usefulness” and “Perceived Ease of Use” constructs were adapted from an empirical research that have investigated the relation between trust and technology acceptance model in the online environment (Gefen, Karahanna et al., 2003). Table 1 shows the number of items in each contrast and sub-construct in the theoretical research model.

3.4 Scale development: Q-Sort method

The Q-Sort method is derived from Q-Methodology, a factor analysis technique. Q-Methodology was developed by Stephenson (1953). It has been used by psychology and social sciences to investigate people’s subjectivity, i.e. their viewpoints. Unlike R-factor analysis which studies the correlation between variables, Q-methodology examines the correlation between individuals (Brown, 1997). In Q-methodology, the items are the sample in the Q-sort and the people who complete the Q-sort are the experimental condition (Cross, 2004). Therefore, Q-methodology examines the correlations between subjects across a sample of items. One of the main application of the Q-methodology is to assess reliability and construct validity of questionnaire items that are being prepared for survey research (Nahm, Solis-Galvan, Rao, & Ragu-Nathan, 2002). Nahm et al. (2002) demonstrated how the Q-sort method can be used to pre-test items after they have being developed or generated based on the literature review and before questionnaire items are the administrated as a survey. The method consists of two stages (Nahm et al., 2002). In the first stage, two independent judges are asked to sort the items of the questionnaire according to different constructs. Based on this stage, the agreement between the two judges (inter-judge agreement) is calculated. In the second stage, items that were classified incorrectly and were found ambiguous in the first stage are reworded or deleted. The two-stage process is repeated continuously until a satisfactory level of agreement is reached.

In this research, items were placed a common pool and were subjected to two sorting rounds by two independent judges in each round. The participants in the Q-sort process (judges) were chosen so they represent the target population of the research and they are experts in the field. Two participants were directors in the e-Government program in Saudi Arabia, one participant was a consultant in the e-Government program in Saudi Arabia, and one participant was a manager of IT departments in a government ministry. Participants were grouped in pairs. Each pair composed two independent judges in each round. The judge were asked to sort a list of items into groups, each group represents one of the 9 constructs. The differences and similarities among sorted items are used as an indicator for the constructs validity.

3.4.1 Q-sorting procedures

The research model and its 9 constructs with their definition were presented to the judges. Items, that were generated to measure the constructs, were printed on individual 3 by 5 inch cards. After randomly shuffling the cards (items), each judge was given these cards and asked to sort them into categories. Each category represents one of the 9 constructs. Additional to the nine constructs, a “Not Applicable” category was included to make sure the judges will not force any items into a particular category. Each round consisted of different pairs of judges. Judges were allowed to ask any question either related to the sorting procedure or related to the research model and constructs.
3.4.2 Q-sort evaluation

In order to evaluate and assess both the validity and reliability of the instrument, three evaluation criteria were used to assess the Q-sort: the inter-judge agreement level, Cohen’s Kappa Index (Cohen, 1960), and Moore and Benbasat’s “Hit Ratio” (Moore & Benbasat, 1991). The inter-judge agreement level is calculated by counting how many items that both judges agree to place into a particular category. Then, the number of agreed items is divided by the total items number to get the percentage of the inter-judge agreement. The second measure is Cohen’s Kappa index which is “the proportion of joint judgement in which there is agreement after chance is excluded” (Nahm et al., 2002, p. 115). For instance, assume that two judge independently classified a set of N components as either acceptance or rejectable. After the classification was finished, we can construct the following table (Nahm et al., 2002):

<table>
<thead>
<tr>
<th></th>
<th>Judge 1</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Acceptable</td>
<td>Rejectable</td>
<td>Totals</td>
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<tr>
<td>Judge 2</td>
<td>X_{11}</td>
<td>X_{12}</td>
<td>X_{1+}</td>
<td></td>
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<tr>
<td></td>
<td>X_{21}</td>
<td>X_{22}</td>
<td>X_{2+}</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>X_{+1}</td>
<td>X_{+2}</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

The Cohen’s Kappa index can be calculated as following:

\[ k = \frac{N_i \times X_{ii} - \sum_i (X_{ii} \times X_{ii})}{N^2 - \sum_i (X_{ii} \times X_{ii})} \]

Where:

- \( N_i \): total number of items
- \( x_{ii} \): number of items agreed on by two judges
- \( X_{i+} \): number of items in the i\(^{th}\) row
- \( X_{+i} \): number of items in the i\(^{th}\) column

Previous research has considered score of Kabb index greater than 0.65 to be acceptable (S. L. Jarvenpaa, 1989; Landis & Koch, 1977; Todd & Benbasat, 1993). The third measure is Moore and Benbasat’s “Hit Ratio” which measures how many items were correctly placed in the intended category by the judges. The “Hit Ratio” is computed by counting all items that were correctly sorted into intended theoretical construct by each judge, and then divide them by twice the total number of items.

3.4.3 First sorting round

The first round consisted of 87 items for the nine constructs. The judges in this round were a director in the e-Government program in Saudi Arabia and a manager of IT department in a government ministry. In this round, the inter-judge raw agreement scores averaged 80% (Table 2) and the initial overall placement ratio of items within the target constructs was 75% (Table 3) as 131 of 174 items were correctly classified.
Table 2: Inter-judge scores: first sorting round

<table>
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<tr>
<th>Judge 1</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
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<th>NA</th>
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<tbody>
<tr>
<td>1</td>
<td>10</td>
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<td>1</td>
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Total Items: 87  Number of Agreement: 70  Agreement Ratio: 80%

Table 3: Items placement ratios: first sorting round

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<tr>
<th>Actual Categories</th>
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<td></td>
<td>88%</td>
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Total Items Placement: 174  Number of Hits: 131  Overall Hit Ratio: 75%

The results of the first round indicate some confusion among some constructs. In order to understand this confusion, the off-diagonal items in Table 3 were examined to look for clusters. On the Institution-Based Trust construct, 11 of the 13 misclassified items are in the Trust in e-Government construct. This is expected since in both constructs there are items that are related to the trust beliefs. A similar effect appears in the Trust in e-Government construct, where 8 of the 10 misclassified items are in the Institution-Based Trust construct. This misplacement of the items confirms the confusion between Trust in e-Government construct and Institution-Based Trust construct, enforcing the need for further clarification between these two constructs in the next round. Another cluster appears in the Perceived Website Quality construct, where 6 misclassified items were placed in the Perceived Ease of Use construct. This is understandable from the fact the ease of the quality of the website promotes and enhances the ease of use. On the Perceived Risk construct, there are two clusters; one on the Familiarity (2 out of 4 misclassified items were placed in this construct) and one on the Institution-Based Trust (2 out of 4 misclassified items were placed in this construct). Similarly, two misclassified items in the Trust in e-Government construct were placed in the Perceived Risk construct. This confusion may be due to the strong link between risk perception and trust, which demands for further clarification of the items that suppose to measure these construct in the next round. On the Intention to Engage in e-Government construct, two misclassified items were placed in the Trust in e-Government construct. Another cluster found in the Institution-Based Trust, where 2 out of 13 misclassified items were placed under the Familiarity construct. On the Perceived Ease of Use construct, there are two clusters; one on the Perceived Website Quality construct (1 out of 2 misclassified items was placed in this construct) and one on the Perceived Usefulness construct (1 out of 2 misclassified items was placed in this construct). Finally, 6 items were classified as not applicable; 2 items from Disposition to Trust construct and 4 from the Perceived Usefulness construct.
Cohen’s Kappa for this round was computed as:

\[
K = \frac{87 \times 70 - 131}{87^2 - 131} = 0.80
\]

Following the guidelines (1977) for interpreting the Cohen’s Kappa, the value of 0.80 indicates an excellent level of agreement beyond chance for the judges in the first round. This value is same as the value of raw agreement (Table 2). The item placement ratios averaged 75%. The lowest item placement ratio value was 57% for the Institution-Based Trust construct, indicating a low degree of constructs validity. Also, the Perceived Website Quality, Perceived Usefulness, and the Trust in e-Government constructs had a low value of item placement ratio: 67%, 67%, and 71% respectively. On the other hand, several constructs, namely Familiarity, Disposition to Trust, Intention to Engage in e-Government, Perceived Risk, and Perceived Ease of Use obtained 100%, 92%, 88%, 82%, and 80% of item placement ratio respectively, indicating a high degree of constructs validity.

In order to identify the cause of misclassifications in round one, the individual judge classification for each item were examined. An examination of the off-diagonal entries in the placement matrix (Table 3) was conducted. The ambiguous items that had been fitted in more than one category or fitted in no category were carefully analyzed. The analysis led to the rewording of ambiguous items including 11 items belonging to Institution-Based Trust, 3 items belonging to Perceived Website Quality construct, 2 items belonging to Perceived Risk construct, one item belonging to Trust in e-Government construct, and one item belonging to Intention to Engage in e-Government construct. The analysis led also to deleting the too indeterminate items including 5 items belonging to Trust in e-Government construct, 2 items belonging to Disposition to Trust construct, 2 items belonging to Perceived Usefulness construct, and 2 items belonging to Perceived Ease of Use construct. Overall, 11 items were deleted, and 18 items were reworded. One additional item suggested by two judges was added to the Perceived Ease of Use construct.

3.4.4 Second sorting round

The second round consisted of 77 items for the nine constructs. The judges in this round were a director in the e-Government program in Saudi Arabia and a consultant in the e-Government program in Saudi Arabia. In this round, the inter-judge raw agreement scores averaged 91% (Table 4), an 11% improvement of the previous round. The overall placement ratio of items within the target constructs was 88% (Table 5), a 13% improvement from round one, as 131 of 174 items were correctly classified.

**Table 4:** Inter-judge scores: second sorting round

<table>
<thead>
<tr>
<th>Construct</th>
<th>Judge 1</th>
<th>Judge 2</th>
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**Table 5:** Items placement ratios: second sorting round

<table>
<thead>
<tr>
<th>Total Items: 77</th>
<th>Number of Agreement: 70</th>
<th>Agreement Ratio: 91%</th>
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In the second round, the changes done on items in round one had resulted in a very good improvement of the measures. However, a further examination of the off-diagonal entries in the placement matrix (Table 5) is needed in order to improve potential reliability and construct validity. The analysis of the placement matrix showed that there is a relatively small cluster around the Institution-Based Trust construct. A closer investigation of the items causing this cluster indicates that those items have words such as “confidence” and “rely” which are related to trust, causing a slight confusion between Institution-Based Trust and Trust in e-Government constructs. The analysis led to reword the items so the difference between trust in the Internet in general (Institution-Based Trust) and trust in e-Government in particular is distinguishable. Additionally, 3 misclassified items in the Perceived Website Quality construct were placed in the Perceived Ease of Use construct. A closer look to the items causing the confusion revealed that items that have words like “easier” and “easy” caused a slight confusion between Perceived Website Quality and Perceived Easy of Use constructs. The analysis led to reword two items in Perceived Ease of Use so it is clear to distinguish between ease of searching and requesting e-Government services and the features and characteristics of e-Government websites quality.

Cohen’s Kappa for this round was computed as:

\[ K = \frac{77 * 70 - 136}{77^2 - 136} = 0.91 \]

Following the guidelines of Landis and Koch (1977) for interpreting the Cohen’s Kappa, the value of 0.91, a 11% improvement from round one, indicates an excellent level of agreement beyond chance for the judges in the second round. At this point, we decided to stop the Q sorting round two, with Cohen’s Kappa of 0.91, the average placement ratio of 88%, and the inter-judge raw agreement of 91%, indicating high level of reliability and construct validity. See Appendix A for the complete items list.

4. Summary and conclusions

In this paper a conceptual model of citizens’ trust in e-Government is proposed. The model consists of nine theoretical constructs which delineate the concept of citizens’ trust in e-Government. An instrument to measure these constructs is developed also in this research. A pool of 87 items was generated. Then Q-methodology was utilized to ensure the constructs validity and reliability. Two Q-sorting rounds were conducted to validate the instrument. After the analysis of the Q-sorting, 77 items remained and are reported in Appendix A. This instrument can be used to investigate citizens’ trust in e-Government. The future direction for this research is to administer a large scale survey for user of e-Government.
5. Appendix A. measures

Disposition to Trust
1. In general, people really do care about the well-being of others.
2. The typical person is sincerely concerned about the problems of others.
3. Most of the time, people care enough to try to be helpful, rather than just looking out for themselves.
4. In general, most folks keep their promises.
5. I think people generally try to back up their words with their actions.
6. Most people are honest in their dealings with others.
7. A large majority of professional people are competent in their area of expertise.
8. I usually trust people until they give me a reason not to trust them.
9. I generally give people the benefit of the doubt when I first meet them.
10. My typical approach is to trust new acquaintances until they prove I should not trust them.

Familiarity
1. I am familiar with looking for government services on the Internet.
2. I am familiar with conducting online translation with government on the Internet.
3. I am familiar with the e-Government web sites.
4. I am familiar with communicating with government agencies and departments through their official web sites.

Institution-Based Trust
1. I feel good about how things go when I do purchasing or other activities on the Internet.
2. I am comfortable making purchases on the Internet.
3. I feel that most Internet vendors would act in a customers' best interest.
4. If a customer required help, most Internet vendors would do their best to help.
5. Most Internet vendors are interested in customer well-being, not just their own well-being.
6. I am comfortable relying on Internet vendors to meet their obligations.
7. I feel fine doing business on the Internet since Internet vendors generally fulfill their agreements.
8. I always feel confident that I can rely on Internet vendors to do their part when I interact with them.
9. In general, most Internet vendors are competent at serving their customers.
10. Most Internet vendors do a capable job at meeting customer needs.
11. I feel that most Internet vendors are good at what they do.
12. The Internet has enough safeguards to make me feel comfortable using it to transact personal business.
13. I feel assured that legal and technological structures adequately protect me from problems on the Internet.
14. I feel confident that encryption and other technological advances on the Internet make it safe for me to do business there.
15. In general, the Internet is now a robust and safe environment in which to transact business.

Website-Quality
1. Most of the e-Government web sites are easy to navigate.
2. Most of the e-Government web sites' contents are easily accessible.
3. Most of the e-Government web sites are intuitive.
4. Most of e-Government web sites provide sufficient information to search for the relevant government services.
5. Most of the e-Government web sites are easy to read.
6. Most of e-Government web sites are visually pleasing.
7. Most of e-Government web sites are consistent throughout the site.
8. Most of e-Government web sites are professionally designed.
9. Most of the e-Government web sites show how users can contact and communicate with them.

PEOU
1. Most of the e-Government web sites are easy to use.
2. It is easy to learn how to interact with e-Government web sites.
3. Most of e-Government web sites are flexible to interact with.
4. Communication with the state government is easier through its official websites.

PU
1. I perceived that using the e-Government web sites enables citizens to search for government services and conduct government transactions faster.
2. I perceived that using the e-Government web sites can enhance the effectiveness of citizens' transactions with government.
3. Most of e-Government web sites are useful for searching government services.
4. Most of e-Government web sites are useful for conducting government transactions.
Trust in e-Government

1. I believe that e-Government web sites are competent and effective in providing government services.
2. Citizens can always predict performance of most e-Government web sites from their past experience with the web sites.
3. Most e-Government web sites exhibit care, concern, honesty and goodwill to their citizens, thus providing a basis to advance the citizens relationship.
4. I believe most e-Government web sites will perform to the outmost of the citizens' benefit.
5. I believe that most e-Government web sites are truthful in their dealings with the citizens.
6. I would characterize e-Government as honest.
7. I believe that most e-Government web sites would keep their commitments.
8. I believe that e-Government web sites are sincere and genuine.
9. I believe that e-Government web sites are trustworthy.
10. I believe that most e-Government web sites would act in the citizens' best interest.
11. If the citizens required help, e-Government web sites would do their best to help them.
12. I believe that e-Government web sites are interested in the citizens well-being, not just their own.

Perceived Risk

1. Using e-Government web sites to transact with government departments and agencies I perceive that it is not secure to send sensitive information.
2. When using credit card to pay for government services though e-Government web sites I feel that credit card details are likely to be stolen.
3. I would feel insecure sending sensitive information via e-Government web sites.
4. Overall, it is not safe to transmit sensitive information over e-Government web sites.
5. As I consider transacting with government departments and agencies via e-Government web sites, I worry about whether they will perform as they are supposed to.
6. If I were to transact with government departments and agencies via e-Government web sites, I would be concerned that they would not provide the level of benefits that I would be expecting.
7. I am not confident about the ability of e-Government web sites to perform as expected.
8. Considering the possible problems associated with e-Government web sites performance, a lot of risk would be involved with searching and requesting government services via e-Government web sites.
9. It would be too risky to rely on the information provided in e-Government web sites.
10. Using e-Government web sites to search and request government services could lead to an inefficient use of my time.
11. Using e-Government web sites to search and request government services will take too much time or be a waste of time.

Intention to Engage in e-Government

1. How likely is it that you would request government services via e-Government web sites?
2. How likely is it that you would continue visiting e-Government web sites?
3. I would be willing to provide credit card information to pay for government services via e-Government web sites.
4. I can always rely on information provided in e-Government websites.
5. I would be willing to provide my government identification number to e-Government web sites.
6. I would be willing to provide information like my name, address, and phone number to e-Government websites.
7. I would be willing to pay to access information on e-Government web sites.
8. I will follow the procedures and advices provided in e-Government web sites.

References

IT Enactment of new Public Management: the Case Study of Health Information Systems in Kenya

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Abstract: In the last twenty years most African Governments have embarked on health sector reforms sponsored by international partners. Conceived under New Public Management, the majority of these reforms leverage information technology to decentralize hierarchical structures into more information efficient organizations. The paper illustrates the case study of health management information systems in Kenya in order to better understand how the enactment of information technology has influenced the organizational outcome of New Public Management reforms within the health sector in Kenya. The case study provides a longitudinal account of how the adoption and usage of information technology within two health management information systems of Kenya Ministry of Health has affected the implementation of NPM reforms. Data collection and analysis have been framed within an institutionalist perspective viewing different agents acting under the pressure of competing logics (New Public Management and Old Public Administration) at three main levels of action: the macro or policy level (e.g., formal policies), the meso or organisational level (e.g., professional norms and management), and the user or agency level (e.g., IS users’ routines). The case study has shown that NPM institutions were not supported by coherent actions unifying all actors involved in the restructuration of health information systems in Kenya so that IT enactment was not consistent across the health information system giving way to structural changes that were not aligned with what was envisaged in the reforms. Findings point to the rhetoric behind certain reform discourses by main actors involved, particularly, at the macro-policy level. The paper calls for a stronger source of political legitimacy to support discourses around public sector reforms so that through the right competences and systems of values at the meso level information technology can be used as a catalyst for a more consistent implementation of the reforms. New discourses around the potential of IT should be more aligned with certain institutions underpinning the practices of policy makers at the macro level inducing Government echelons to legitimize IT at the macro-policy level.

Keywords: information technology, health information systems, e-Government, new public management, institution theory, Africa, developing countries

1. Introduction

In the last twenty years most African Governments have embarked on health sector reforms sponsored by international partners (Lambo and Sambo 2003). Usually conceived under New Public Management, the majority of these reforms leverage information technology to decentralize and integrate health management and information systems structures to improve health care delivery (Kimaro and Nhampossa 2005).

Yet, available studies onto the restructuration of HMIS in Africa show that goals of decentralisation and integration are rarely achieved (e.g., Kimaro and Sahay 2007). On the contrary, in most cases the health sector scenario is still characterised by weak district health management systems (Odhiambo-Otieno 2005) storing information into vertical programmes’ data bases that are not accessible by district managers (Chilundo and Aanestad 2004).

Main challenges to the achievement of expected results were identified in the resistance of recipient local actors to imported New Public Management reform models. Such resistance was stemming from a tension between the managerialist principle underpinning the restructuring of HIS for more efficient evidence-based management practices and health workers’ and data managers’ routines shaped by the local bureaucratic culture (Smith et al. 2008). Similar tensions have been identified in relation to the adoption of Western information technologies as well. Usually these technologies are software solutions designed in Western countries and adapted to the local contexts by international consultants with little participation of final users (Kimaro and Nhampossa 2005).

Hence, challenges to restructure management information systems to implement new public management reforms in the health sector are mainly linked to institutional complexity of African health sector contexts characterised by the divide between imported reforms and IT designs at the macro level and expectations and actions of implementers at the micro-level (Madon et al. 2007).
Based onto the case study of two health management information systems of the Ministry of Health in Kenya, this paper aims to shed light onto such divide by focusing onto how new public management reforms are enacted in the restructuration of health management information systems in Kenya.

In order to answer this research question, the case study will be analysed under an institution theory perspective, in particular, by taking an institutional logics approach. “Institutional logics” determine the way institutions shape individual identities, organisations, organisational fields and sectors of society (Friedland and Alford 1991). In particular, the tension between opposite logics is viewed as a source of cultural resources through which actors may either reinvent or resist meanings of imported logics (Thornton and Ocasio 2008, p. 101).

Under this perspective, the context of the health sector of an African country like Kenya has been conceptualised as being influenced by two main sets of logics: managerialist logics belonging to New Public Management (NPM) reforms imported by international donor partners and bureaucratic logics belonging to the traditional Old Public Administration (OPA) model inherited from the British colonial domination. The analysis of the case study will focus onto how and why different actors such as international donor partners, national decision makers, and main health information system users enact behaviours that reproduce (or re-invent) either NPM or OPA logics and what consequences do these different enactments bring to the restructuring of health management information systems in Kenya. More specifically, the case study analysis will focus onto how the enactment of competing logics influences the design of information channels, monitoring indicators, and information technology investments.

In addition, information technology designs are also viewed as embedding “technical norms” (Czarniawska 2008), which have also been institutionally shaped during their designs and, therefore, may shape users’ practices and social structures in their context of usage. Whereas institutions or social structures influence the enactment of the material properties of IT, the design of the latter may promote new meanings and practices, thereby, reshaping the institutional order infused in public sector structures (Orlikowski 2000; Orlikowski and Barley 2001). Thus, the case study presented in this paper will also take into account how the IT-artefact influences the enactment of NPM and OPA logics across the spatial and temporal distance between its development and usage.

2. The New Public Management

New Public Management is one of the major public sector reforms adopted by African and other developing countries under the pressure of multilateral financial institutions such as the World Bank. New Public Management supports increased efficiency and accountability for public administrations through the adoption of market-oriented management mechanisms used in the private sector (e.g., result-based management, outsourcing, etc). Initiated in the 1980s in the United States as an alternative to bureaucracies, NPM acquired soon a global dimension (Hood 2000). One of the lead arguments of NPM supporters was that bureaucracies failed to be those efficient and rational forms of organization as it was postulated by Weber (1946). In particular, NPM was thought to enable the Governments of developing countries to take advantage of the growth opportunities of the market economy (Larbi 2006; World Bank 2002).

In particular, given the NPM focus onto the rationalisation and decentralisation of management structures and performance-based accountability, information technology assumes a strategic role in the implementation of the new reforms (Osborne and Gaebler 1992). However, some studies have linked the failure of IT initiatives within the Government administrations of developing countries to the use of pre-packaged NPM reforms (Ciborra and Navarra 2005). In particular, the disaggregation tendencies of the NPM (Dunleavy et al. 2006) matched with the inconsistencies of foreign development programmes (Therkildsen 2006) have contributed, in most cases, to the fragmentation of information systems (Kimaro and Nhampossa 2005) increasing, rather than reducing, complexity (Bellamy and Taylor 1992).

Such a failure has been related to the top-down approach of IT-led public sector reforms (Ciborra 2005), which do not account for the constraints posed by existing institutional settings. The main features of the local context, such as socio-economic conditions, weak organisational capacity (Marikanis 1994), informal systems of values (e.g., tribal norms) (Higgo 2003), incompatible legal frameworks, and poor political legitimacy have actually inhibited the success of New Public Management reforms. These same factors distorted the post-colonialist bureaucratic model by
supplanting transparency and inclusiveness procedures with patrimonial, clientelistic, and rent-seeking practices (Batley and Larbi 2006). Other institutional factors such as power relationships (Dada 2006), political change and budget processes, and different labour contexts and markets (Bozeman and Bretschneider 1986; Kraemer and Dedrick 1997) have influenced the impact of information technology within public organisations.

The challenges posed by institutional contexts to the effect of information technology in implementing public sector reforms support arguments onto the lack of a linear causal relationship between information technology and organisational structures (Kraemer and Dedrick 1997). On the contrary, there have been either cases where integrated information systems and network technology seems to have supplanted bureaucracies with centralised and networked structures (Dunleavy et al. 2006) or cases where IT use, information exchange in particular, has not been successful in converting traditional hierarchical structures of public administrations into networked forms of organisations (Bretschneider 2003).

Therefore, a deeper consideration of the institutional context and its influence on technology adoption and usage could represent the missing link between public sector reforms and the attainment of expected performance. Fountain (2001), for example, refers to “technology enactment” as the process by which organisational forms, both affecting and being affected by existing institutional arrangements, influences the adoption of IT. The “enacted technology” can send feedback that directly creates changes into the organization and indirectly into policy institutions. Thus, the effects of information technology in relation to public sector reforms can be better understood by situating IT-enabled organisational change in the actual institutional context of a public organisation.

This is particularly true in the case of health sector reforms in most African countries aiming to decentralise and integrate health care and health management information systems. These objectives are envisaged in a series of international and regional agreements. One of these is the Alma Ata Declaration on Primary Health Care of 1978 (WHO 1978) putting emphasis onto decentralised health management systems (Kimaro and Sahay 2007) for a more efficient and inclusive health care delivery. Another significant reform was started in 1996 by the United Nations Special Initiative on Africa which led the way to Health Sector-Wide Approaches (SWAps) to coordinate health interventions among international and national development actors (Lambo and Sambo 2003).

Yet, the implementation of such reforms through Government IT innovation involves multiple stakeholders (international organisations, foreign consultants, governments, public employees, etc.) all acting according to different sets of rules, norms, and interests. In addition, rules and norms embedded in exogenous reforms and information technology designs may enter into conflict with values and norms shaping the actions of local public sector employees.

3. Theoretical framework

The case study presented in this paper has been analysed through an institutional logics perspective. “Institutional logics” are “sets of ‘material’ practices and symbolic constructions which constitute a field’s organising principles and which are available to organisations and individuals to elaborate” (Friedland and Alford 1991). They represent the content and meaning of institutions (Thornton and Ocasio 2008) defined as socially constructed systems of rules, norms, and meanings (Berger and Luckmann 2004), which shape human action into regularities of behaviour and interaction patterns (Barley and Tolbert 1997).

Institutional logics determine the way institutions shape individual identities, organisations, organisational fields and sectors of society (Friedland & Alford 1991). Yet, actors are embedded within institutional logics (Thornton and Ocasio 2008) and social structures do not prevail over action (DiMaggio and Powell 1983). On the contrary, institutional logics can either constrain and enable individuals in advancing their interests and increase their political, social, and economic advantages by granting them partial autonomy (Thornton and Ocasio 2008, p. 104).

Following an extensive literature review of public and health sector and management information systems reforms in Africa and in other developing countries (e.g., Kimaro and Sahay 2007), the health sector of African countries can be viewed as characterised by two main logics: the managerialist logic imported through “New Public Management” reforms (Hood 2000) and the bureaucratic logic of “Old Public Administration” (Lynn 2006), namely, the traditional post-colonial bureaucracies. These two
Different logics are believed to produce variation into the main institutions (Thornton and Ocasio 2008 p. 113) characterising the different dimensions of organisational structures (e.g., Child 1972) (Table 1).

**Table 1:** Main institutions of an organization’s structural dimensions under New Public Management, Old Public Administration, and “hybrid” logics

<table>
<thead>
<tr>
<th>Structural dimensions</th>
<th>NPM Institutions</th>
<th>OPA Institutions</th>
<th>Hybrids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control systems</td>
<td>Accountability</td>
<td>Non-evidence based management</td>
<td>-</td>
</tr>
<tr>
<td>Decision making</td>
<td>Decentralisation</td>
<td>Centralisation</td>
<td>-</td>
</tr>
<tr>
<td>Integration</td>
<td>Disaggregation</td>
<td>Functional/vertical integration</td>
<td>Horizontal integration</td>
</tr>
</tbody>
</table>

These different institutions characterise the institutionalisation of information processing practices or routines of an information system users sustaining a particular type of organisational structure dimensions. Variation of content and meanings of these different institutions is shaped by the institutional logic that users enact.

Under the logic of New Public Management, the *institution of accountability* underpins management practices meant to account for results through outcome-based and performance measurement mechanisms (Osborne and Gaebler 1992). The *institution of decentralisation* stands for the deconcentration of authority to front-line managers (Olowu 2006). Deconcentration, however, has also brought to fragmentation or agencification of the public service into independent implementing units (Therkildsen 2006) such as in the case of the verticalisation of health programmes underpinned by the *institution of disaggregation*.

In opposition to these stand institutions identified under the OPA logic. Firstly, the *institution of non-evidence based management* stemming from a patronage system resisting efforts to implement result- and performance-driven systems (Kiragu and Mutahaba 2006). Secondly, the *institution of centralisation* involving the concentration of decision-making at the highest ranks of the hierarchy. The latter is strongly connected with the *institution of functional or vertical integration*, whereby actions are controlled through uniform and rigid administrative procedures (Grindle 1997).

An additional institution identified in the literature review is the *institution of horizontal integration* referred from now on simply as *institution of integration*. This institution falls neither under the NPM logic nor under the OPA logic. It represents international partners’ intention to integrate data management practices across all levels of the health system in order to reverse the trend of donor-driven fragmentation and verticalisation of HIV/AIDS programmes and their information systems. Hence, the institution of integration can be considered as being characterised by a hybrid logic between the NPM and OPA logics.

Thus, objective of the case study is to identify between those institutions that are actually enacted as taken-for-granted and institutionalised information processing practices and those that, in contrast, occur only in the form of policy accounts. The latter, therefore, are not reflected into IS users’ institutionalised behaviours.

More specifically, the acceptance of NPM reforms are expected to give way to the adoption and institutionalisation of information processing practices that encode institutions underpinned by the managerialist logic of new public management. In contrast, the resistance to NPM would maintain old institutionalised practices or institutions informed by the bureaucratic logic of Old Public Administration. A third outcome is that the NPM is only partially accepted and adapted to the local bureaucratic context, in which case the adaptation of new public management practices to the local context would give way to the creation and institutionalisation of “hybrid” information processing practices.

By analysing which institutions or taken-for-granted information processing practices are either re-invented or replicated, the analysis of the case study will take a multilevel perspective which views the context of health sector reforms and health management information systems in Kenya as characterised by three main levels of action: the macro or policy level (e.g., formal policies), the meso or organisational level (e.g., management structures) and the user or agentic level (e.g., IS users’ routines). The multilevel perspective helps identify the main motivations or factors that drove main
actors (e.g., international donor partners, national decision-makers, public employees, etc.) involved in health sector reforms and the re-structuration of health management information systems to enact specific institutions.

In addition, the enactment of institutions at different levels is associated with the technical features of technology. Depending on how institutionally-embedded actors enact institutional norms embedded in software designs, the technical properties of a technology can also influence the way actors enact institutions characterised by competing logics.

4. Methods

The paper adopts a case study methodology to analyse a multiplicity of context-embedded processes that are not linked by linear causal relationships (Yin 2003, p. 13). Thanks to its holistic focus, the case study is one of the research methods most widely used and discussed in qualitative IS research particularly in relation to the analysis of the situated interaction between organisations, information technology, and people (e.g., Dubé and Paré 2003).

The case of the Ministry of Health in Kenya was primarily selected for its typicality (Yin 2003, p. 41). Like other African countries, Kenya’s health sector reforms aim to decentralise and integrate its health management information systems (Figure 1, 2).

As the purpose of the research is mainly to explain the variation underpinning different enactments of IT-enabled New Public Management reforms, the selected case incorporates more than one unit of analysis to provide enhanced analytical insights into the processes under study (Yin 2003, p. 46).

The units of analysis were chosen based on the criteria of “theoretical replication” whereby specific differences between them were known to generate contrasting but significant results bringing an enriched theoretical understanding of the complex interrelationships the research seeks to unravel (Yin 2003, p. 47). This led to the choice of the following units of analysis: the central Division of Health Management Information Systems (HMIS), the Kenya Expanded Programme of Immunisation (KEPI), and the Division of HIV/AIDS.

Figure 1: Vertical and centralised health information systems in Kenya
This paper illustrates the case of the first two units of analysis, the central Division of Health Management Information Systems and the Kenya Expanded Programme of Immunisation. Each unit has a vertical information system in place. The two units have been chosen based on the ratio between donor and government funding, the status of their information system and their technological maturity. Thus, the first unit is the least donor funded and the one with the oldest and least efficient and technologically innovative information system in place. The second unit has seen a gradual phase out of donor funding against an increase in government funding. It also has a mature information system and is the one with the best achievements in the Ministry in terms of technological innovation and information system performance.

**Figure 2**: Planned decentralised and integrated health management information system

Given the longitudinal perspective of the case study, when possible, informants with the earliest dates of employment have been selected. They represent not only health records information officers (HRIOs), the direct users of the information system, but also medical management and technicians (Table 2). This sample allows to have a diversified and comprehensive view of the evolution of the information system, and of how institutional reforms and technological changes have affected roles, working practices, and management structures within the information system.

**Table 2**: Matrix of sample of informants grouped according to unit of analysis, profession, date, and length of deployment in the unit

<table>
<thead>
<tr>
<th>Deployment date</th>
<th>No. of years per unit</th>
<th>HMIS</th>
<th>KEPI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HRIO</td>
<td>Medical Doctor</td>
</tr>
<tr>
<td>Before 1980</td>
<td>30 to 35</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1980-1985</td>
<td>25 to 30</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1985-1990</td>
<td>20 to 25</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1990-1995</td>
<td>15 to 20</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

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Roberta Bernardi

The documents selected comprise: main donor project and policy documents, Government policies, the units’ official documents including minutes of meetings and reports of the information system. The documents cover a period from 1980s to 2008 and have been sampled randomly per time period.

Interviews and relevant documentary extracts were transcribed and coded in NVIVO 8. Starting from a pre-defined set of institutions classified under NPM and OPA logics respectively (see Table 1), new codes were created along the process of data analysis (Miles and Huberman 1984, p. 58) and organized within time-series.

5. Case study analysis

5.1 Division of Health Management Information Systems (HMIS)

5.1.1 The 80s and 90s: misalignments between policy discourses and enactments

The Division of Health Management and Information Systems (HMIS) was established in the first half of the 70s under the aegis of the World Health Organisation. Since its establishment HMIS has been the target of sporadic capacity-building interventions within the scope of donor-driven projects. In particular, the lack of a systemic and countrywide approach to the strengthening of the health information system was rooted into the World Bank-sponsored principle of Selective Primary Health Care preferred by most donor partners to the system approach to primary health care advocated by WHO in the Conference of Alma-Ata (Brown et al. 2006).

The selective principle in international aid undermined the legitimacy of policy discourses of integrated planning and management of health care in favour of ad-hoc and small scale projects. This strengthened the verticalisation of information systems, which supported evidence-based planning and management practices encoding the institution of accountability only within the limited scope of donor-funded projects instead of the whole health system. Hence, such activities contributed to reinforce the institution of disaggregation encoded into non-integrated processing of separate data sets by stand-alone systems both at national and district level.

Donor partners’ legitimacy of a “selective” approach to health care was most likely linked to the limitations of different governance and funding mechanisms across donor agencies to take long term commitments and pool financial resources into a common basket. Secondly, donor partners were not motivated to support wide-sector approaches due to the Government’s lack of engagement into the reforms. Major supporters for decentralisation were, in fact, donor partners, who, faced with the financial mismanagement of the central government, were more willing to fund local projects rather than channel their money through the central administration (Kenya 1997, p. 29).

The Government’s resistance towards the implementation of these reforms was due to the strong centralised orientation of its bureaucratic structures. In particular, decentralising more administrative autonomy to local authorities was not seen positively as it would have meant a loss of power by the national leadership in favour of local political leaders belonging to opposite ethnic factions (Ogot 1995).

Other reforms such as the pre-electoral split of districts were meant to sustain an institution of centralisation to fasten political control rather than bringing to the legitimacy of new health management practices supporting the institutionalisation of decentralisation for better public service delivery. These were in fact face-lifting reforms limited to change the administrative boundaries of districts without empowering health facilities.
Overall, the Government’s resistance to reforms was underpinned by *institutions of centralisation* and *non-evidence based management*, whereby decisions and budget allocations were still made centrally without relying onto data. The persistence of old institutions created resistance to the creation and institutionalisation of new practices of *decentralisation* and *accountability* in health management. Hence, the poor Government’s support to HMIS, which, in contrast, was at the centre of reforms of integration and decentralisation of health information and management systems.

Under these circumstances, local managers saw information as only addressing the monitoring and planning needs of donor projects, rather than those of the health system overall. This contributed to lack of local ownership of information reinforcing the *institution of non-evidence based management* encoded into mere data management practices that were not in function of either local planning or management.

5.1.2 The years 2000: a new boost to health sector reforms

The issue of the Second National Health Sector Strategic Plan in 2005 marked a shift of engagement in the strengthening of HMIS. The new strategic plan, in fact, put more emphasis onto Monitoring and Evaluation systems in order to assess progress towards the Millennium Development Goals (UN 2000). Donor partners were the major source of funding for the Division.

One donor partner in particular, the Danish International Development Agency (DANIDA), was keen on scaling up its support to HMIS across the country in compliance with the discourses of integration and improved aid coordination entailed in the Paris Declaration on Aid Effectiveness of 2005. In addition, DANIDA’s endorsement of a sector-wide approach was also due to increased trust commitment to reforms after the elections of the new President Mwai Kibaki in 2002.

Increase in aid brought about by the reforms and the new political environment constituted a source of new legitimacy of health information. As part of the reforms, the Ministry of Health also planned to integrate and decentralise its health information systems.

Yet, the Government did not show much commitment to the strengthening of the health information indicating that the central Government action was still underpinned by *institutions of centralisation* and *non-evidence based management*. This contributed to the uneven development of the health information system across districts.

In addition, support received from donor partners was not successful in instilling a culture of evidence-based culture underpinning the usage of information for decision making encoded into the *institution of accountability*. The analysis has in fact highlighted the persistence of separate sources of funding and hence accountability shaping data management practices across different information systems.

5.1.3 Poor legitimacy of health records information officers (HRIOS) and management

Lack of legitimacy of the health information system by the Government and donor partners’ incapacity of providing a sector-wide support characterised the poor institutional support to health records information officers. Their performance was thus undermined further exacerbating the negative perception of the usefulness of health information particularly at district level where it was needed for neither planning nor management. The more HMIS did not work efficiently, the more the Department and medical records officers were regarded responsible for it.

In order to elevate their status health records information officers tried to advocate for the utility of health information with the executives of the Ministry of Health: “we have worked for many years to enable the gurus... in this ministry... to understand what we are... to show them... how we can use that data we have collected and worked on to show incidences, prevalence of the diseases”.

Despite lack of support from both donor partners and the Government, health information officers and their managers engaged into discourses of decentralised and integrated computerisation of the health information system since the 90s. Hence, health records information officers’ intentions were supportive of *institutions of accountability, decentralisation, and integration* and constituted the main source of endogenous legitimacy of the health information system, on which, their survival and growth depended.
It is only after 2005 and the new health sector reforms of the Second Strategic Plan that HMIS starts receiving funds to decentralise and integrate the information system. Yet, management lacked the capacity and vision to negotiate a more integrated, rationalised and gradual approach to the process of computerisation sponsored by donor partners. In addition, the lack of a national ICT strategy at the macro level left HMIS management without any guidance onto the technical standards to implement during the process of computerisation besides posing serious threats to the harmonisation of computerised systems across the whole Ministry and other Government departments.

The result was a non-homogenous strengthening of the information system country-wide whereby some districts were still using hard copies for data reporting. The persistence of manual systems in certain districts, lack of storage capacity of Excel that other districts were using, and the usage of a strongly centralised computer system such as Clarion at the national level contributed to maintain strongly centralised patterns of information processing practices encoding the institutions of centralisation and disaggregation.

5.1.4 Computerisation

Since the late 80s computerisation has been mainly undertaken to address donor projects needs with very poor vision of the capacity and information requirements of HMIS. The result was inefficient computer systems and the lack of programmers and other IT professionals that could have advised on how to use few development resources available for the set up of a more functional computing environment.

The IT system used in the division was a Clarion data base. Clarion is a warranty-free programming tool for the development of Data Base Management Systems supplied by a donor partner project in the early 90s in order to computerise all HIS subsystems and data reports generation. Yet, the Clarion experience showed that IT potential was not fully achieved due to the co-participation of three factors: i) the technical complexity of the system; ii) human capacity; iii) and institutional dynamics.

First of all, the technical complexity of Clarion framed users’ perception of the inadequacy of the system in meeting certain information requirements. However, being Clarion a development tool, its design was more flexible rather than rigid. However, its flexibility needed enablers to emerge, such as, programming skills which were not available in the Division. Most of interviewed users referred to Clarion as an unfriendly and inefficient system: “it is very cumbersome, it is based on Dos… before you access it there is always a problem… we entered the data and we could not do anything with that, we called a programmer and he is not based here”.

Technical complexity has most likely influenced negatively the diffusion of Clarion across the health information system. In fact there was no trace of Clarion being used at the districts, whereas, until the introduction of Excel in the years 2000, Dbase III was a core part of the Ministry’s computer training. It can thus be assumed that computerised districts were mainly using Dbase. This situation encouraged the co-presence of manual and stand-alone computer systems and lack of common standards (Grafton and Permaloff 1991), which, in turn, gave way to fragmented and inconsistent information processing behaviours encoding the institution of disaggregation.

One institutional factor that by interacting with technical complexity contributed to bog down HIS computerisation was the low institutionalisation of information technology as evidenced by the language used to refer to computer-related issues both before and after the reforms in the years 2000: “The Ministry as a minimum should endeavour to make as many cadres as possible “computer literate”, a term used to express knowledge of what computers are and what they can do”. Poor institutionalisation of IT brought to poor planning and management of the IT component including lack of IT expertise within the Ministry of ealth, which, by the way, amplified users’ perception of technical complexity.

5.2 Kenya Expanded Programme of Immunisation (KEPI)

5.2.1 The 80s and 90s: the verticalisation of immunisation and disease surveillance information systems

The Kenya Expanded Programme of Immunisation (KEPI) in 1980 as part of a ten-year project funded by the Danish International Development Agency (DANIDA). The Programme’s mission constituted
the national effort towards the achievement of the global immunisation goals set by the World Health Assembly in Geneva in 1974 (WHO 1974).

Under the pressure of DANIDA, the project put emphasis onto the set up of a sound monitoring system for the planning and management of KEPI activities. Facing the inefficiency of the central Health Management Information Systems Division in feeding the Programme with data, DANIDA recommended the set up of a vertical immunisation and disease surveillance information system.

The phase out of DANIDA project in 1990 marked the end of a substantial and consistent flow of funding to the Programme. On top of this, this was the time when international donors started downsizing their support to immunisation systems all over Africa leading to a decline in immunisation coverages. One of the major causes of this reverse trend was the rise of other health priorities attracting donor interest such as HIV/AIDS (WHO 1994).

The evidence of a donor-driven pilot District Health Management Information System between 1988 and 1990 assumes a small scale and piecemeal effort towards the decentralisation and strengthening of the health information system initiated in 1985. The inadequacy of such an approach was recognised by the Ministry authority as well: “the PS is meeting with donors on September 16th [1991] to seek long term funding for HMIS activities in the Ministry including our district work”.

Therefore, In contrast with policy discourses of “integration”, donor partners preferred the creation of vertical information systems rather than integrating with HMIS. Vertical systems such as the one created for the Programme represented the enactment of the NPM institution of disaggregation which is at the core of the fragmentation of the health information systems in the country. This is because the institution of accountability was not encoded in the whole health information system, but applied only for the scope of activities of donor-funded projects, given that data management practices were meant to account for resources invested in immunisation activities and not for the whole health system.

In addition, the Government was putting very little effort to the implementation of decentralisation reforms, whereas its contribution to the Programme was very little compared to foreign aid. As reported by official records of the Programme, in 1999 the Programme was in fact receiving only 15% of its funding from the Government budget and 85% from donor partners. In one instance in particular the Government decided to delegate the procurement of stationary (e.g., data reporting tools) and office equipment to the district offices without granting the districts the necessary financial autonomy: “Medical stationary in the District is in acute shortage. This is as a result of Government’s action of decentralising printing of medical stationary”. Not only were budgets still approved centrally, funds were also allocated by the Treasury: “Government funds are controlled initially by the Division of Primary Health Care... and secondly at the district treasury [...] Availability of finances at the facility and district levels is subject to availability of cash at the district Treasury, which depends on reimbursement by the national treasury”. Thus, districts lacked the means to enact the new policy of decentralisation. This confirms the reluctance of the central government to hand over power to the local administrations, which, by resisting decentralisation, contributed to the persistence of centralised information processing practices encoding the institution of centralisation.

Thus, districts were only dependent onto the piecemeal approach of donor partners, which contributed to an uneven development of the health information system on the ground characterised by good- and bad-performing districts. This exacerbated the de-motivation of health workers and district medical officers in charge with the collection and reporting of data. Thus, data management practices on the ground were supportive of the institution of non-evidence based management given that local managers were not the direct consumers of information.

5.2.2 The Global Alliance of Vaccines and Immunisation (GAVI)

The end of the 90s saw the stepping in of a new contributor to immunisation in the country, i.e., the Global Alliance for Vaccines and Immunisation (GAVI). GAVI was meant to support the Programme not only through the introduction of new vaccines (e.g., HiB in 2001) but also by contributing to the strengthening of the monitoring and evaluation system through its “performance-based grant programme” (GAVI 2007). Funds were in fact released against periodical performance measurement through a Data Quality Audit (DQA) (GAVI 2004). GAVI’s emphasis on reliable quality data to justify
funding increased the Programme management’s support to the strengthening of the information system.

Yet, as the Global Alliance’s funding was limited to the financing of vaccines, the majority of the remaining expenses on immunisation were covered by the Government, which, increased its contributions to immunisation from 49% in 2000 to 53% in 2001 (WHO 2001). In 2001 GAVI’s share of contributions to immunisation was instead 34%, whereas other multilateral and bilateral donor partners were contributing a 13% (WHO 2001). Moreover, the trend of funding from 2003 to 2005 shows an exponential increase of Government contributions to immunisation starting from a 44% share in the financial year (FY) 2003/2004 and reaching a 91% share in FY 2004/2005 (Health 2008, p. 45).

It is therefore possible that GAVI performance-based grant was not the only reason behind the stronger legitimacy of the information system within the Programme. Increased funding from the Government may also have constituted a strong source of legitimacy of the information system, which was now important to be accountable to the Government and not only to donor partners as it used to be ten years before. Under this perspective, the management perceived longer term benefits from the enactment of the institution of accountability through the strengthening of the information system. Through a sounder base of data on its activities, the Programme aimed to gain a more advantageous position in the competition for a share of the national public health funding with other health departments.

Hence, both the start of GAVI and the increase in Government contributions increased the management’s awareness of the utility of decentralised health information systems to account for funding. As a consequence, the management started to give more credit to health records information officers’ discourses of decentralisation by mobilising donor funding for the set up of a “decentralised […] multiuser window based programme which can be used in a networking environment”. The original design of the proposed system was meant to fully delegate data processing to the lower levels, starting from the provinces all the way down to the facilities. Still, it took almost four years before the implementation of the new system started. Until then, although “the year (2002-2003) witnessed a continued improvement in data processing” at least in a few provinces, there are reports of misalignment between type of technologies and information processing practices on the ground and inconsistent data processing across the different levels of the information system causing duplications and delays.

### 5.2.3 Computerisation

Following the decision to create a stand-alone vertical information system for routine immunisation and disease surveillance, around 1990 an IBM computer equipped with a Computerised Epidemiological Information System (CEIS) was procured with donor money. CEIS was a dos-based and centralised IT system designed for the management and statistical analysis of epidemiological data. Due to its stand-alone architecture, it only provided a single-user environment and hence a centralised processing of information.

The acknowledgement of the limitations of a centralised computerised information system was one of the trigger of discourses for the installation of a decentralised computerised information system in the late 90s. Despite this, CEIS continued to be used for a long time. Data kept being entered centrally into the system reiterating the institution of centralisation which clashed with accounts of decentralisation.

Between 2003 and 2004 CEIS broke down forcing the programme to rely exclusively on Excel, which, although being an efficient data analysis tool, had low data storage capacity posing no little constraint to the maintenance of an updated immunisation and disease data base. The need for a new computerised system became thus more compelling to such an extent that in 2004 the new system EPI-Info was implemented with the support of the U.S. Centres for Disease Control (CDC) in conjunction with WHO. Epi-Info is a public domain (free-of-charge) statistical software for epidemiology developed by CDC. It has been in existence for 20 years. Its first Windows version, Epi-Info 2000, was released in 1999. Until then, it could be run as a DOS programme in a Windows environment (Harbage and Dean 1999). Its simple programming language allows non-programmers to easily build and customise data based management systems (Ma et al. 2008).
Epi-Info was rolled out to the provinces but not to the districts as originally planned. Data entry was thus decentralised only to the provinces whereas data analysis was still performed by the central data management unit. Districts would send data to the provinces, which would share data with the central data management unit either by entering them into Epi-Info or by sending data sheets by e-mail.

Therefore, the decentralisation of the information system produced the partial decentralisation of data entry practices. Hence, the new system did not have a substantial impact onto the decentralisation of planning and management structures at the lower levels, given that both districts and provinces were not empowered in decision making as data analysis was still performed at the central level reiterating the institution of non-evidence based management.

It is arguable that the slow pace through which the whole process of computerisation was carried out was due to misalignments between the legitimacy of the new IT system driving the supportive action of health records officers and management at the meso level and the legitimacy of a well functioning monitoring and evaluation system by donor partners and decision makers at the macro level. First of all, although donors recognised the importance for a more efficient information system at all levels, they might not have been ready to commit considerable funding for its automation. Secondly, the central government support to automation was still very poor due to little awareness among decision makers of IT as a powerful control and monitoring tool. In addition, the Government was still privileging a central mode of governance so that policy-makers’ actions were still encoding institutions of centralisation and non-evidence based management in contrast with new practices of decentralisation and accountability envisaged in the reforms and in the new computerised system.

6. Discussion of findings

The case study of the central Division of Health Management Information Systems and the Programme of Immunisation of the Ministry of Health shows different outcomes in the implementation of health sector reforms. This has been mainly due either to the partial enactment of NPM logics, such as in the case of sector-specific accountability underpinning donor projects or the resistance of OPA institutions such as centralisation enacted by the Government (Table 3).

Table 3: Across-unit comparison of NPM and OPA institutions per levels of action

<table>
<thead>
<tr>
<th>Levels of action</th>
<th>HMIS</th>
<th>KEPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro level: Donor partners</td>
<td><strong>Decentralisation</strong></td>
<td><strong>Higher financial support to computerisation, but not enough for large scale IT support</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Sector-specific accountability</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Disaggregation</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Poor financial support to computerisation</strong></td>
<td></td>
</tr>
<tr>
<td>Macro level: National policy-makers</td>
<td><strong>Centralisation</strong></td>
<td><strong>Higher financial support after 2000</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Non-evidence based management</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Poor legitimacy of information technology</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Poor financial support</strong></td>
<td></td>
</tr>
<tr>
<td>Meso-level: HRIOs</td>
<td><strong>Decentralisation</strong></td>
<td><strong>Sector-specific accountability</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Integration</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Sector-wide accountability</strong></td>
<td></td>
</tr>
<tr>
<td>Meso-level: management</td>
<td><strong>Decentralisation</strong></td>
<td><strong>Support decentralised IT system only after GAVI and increase of Government funding</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Sector-wide accountability</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Integration</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Poor IT vision</strong></td>
<td></td>
</tr>
</tbody>
</table>
First of all, the case study has shown how donor support to the decentralisation and integration of the health information system was not strong enough. Given the sector-specific focus of donor initiatives, the accounts of accountability underpinning donors’ call for an efficient monitoring and evaluation system on the ground applied only for the scope of activities of donor-funded projects. In other words, donors did not legitimise the decentralisation and integration of the health information system for a better performance of the whole health system, thereby the verticalisation of the health information systems reinforcing fragmented information processing practices encoding the NPM institution of disaggregation.

On the other hand, the central government was reluctant to hand over power to the local administrations so that its governance practices are strongly rooted into the OPA institution of centralisation. The gap between the institutional discourses and enactments of decentralisation by the central government has contributed to the persistence of centralised information systems structures and data management practices supporting the institution of centralisation.

Thus, health workers’ motivation to collect data was very low as they could not see the benefits of the system. Since the main consumers of data were donors and national programme managers, health workers’ information behaviour was informed by the institution of non-evidence based management underpinning the lack of local ownership of information and the poor perception of the importance of data evidence for health planning and management.

The lack of legitimacy of health information on the ground was a major concern for health information officers in both units of analysis. In fact, their power and legitimacy in the health system depended onto the strengthening of the health information system. Under these circumstances, health information officers were at the front line to increase the legitimacy of health information among its users. This is why they advocated the upgrading of centralised dos-based computer systems to networked and decentralised IT systems. Thus, in both units health records information officers played a key role to promote new information processing practices encoding the institution of decentralisation and accountability across the whole health system. In addition, the division of HMIS was also keen to integrate information processing structures and practices supporting the institution of integration to gain a leading role in maintaining the health management information system for the entire Ministry as it was envisaged in the reforms.

Yet, the management support to health information officers’s discourses of computerisation came under different circumstances. Whereas the management of HMIS showed immediate interest in supporting computerisation, the management of KEPI showed its support only when it saw the opportunity to leverage increased capacity of the information system to attract funding from GAVI and to secure increasing Government funding. This can be explained by the fact that KEPI’s mission was not completely shaped around the health information system as it was for HMIS.

Still, only the managers of KEPI have been successful in bringing technological and structural changes in their information system. This was because they could count onto higher donor support. In contrast, donor support to implement the necessary technological innovation for the restructuring of HMIS came much later, whereas its management lacked the capacity and the vision to negotiate the terms of computerisation with donor partners to better suit IS users’ requirements.

Thus, despite the fact that computerisation in both units was slacking due to the piece-meal approach of donor partners and lack of legitimacy of IT by the Government, KEPI was the only successful in implementing a new decentralised IT system.
In contrast, HMIS was still relying onto a centralised dos-based system after more than fifteen years of discourses of restructuring of their information systems. Due to its centralised architecture and technical complexity, Clarion could not be easily and cost-effectively adopted by the lower levels of the health system posing limitations to the decentralization of the division’s information processing structures. As a consequence, apart from a few districts sending their reports in Excel sheets, most data entry was still done at the central level enacting the OPA institution of centralisation.

On the contrary, a Windows and web-based IT system like Epi-Info was more friendly and easier to adopt by the lower levels. Due to institutional constraints such as inconsistent donor funding and lack of support from the central Government, Epi-Info was implemented in the provinces but not in the districts as planned leading to a partial decentralisation of the health information systems and data entry practices. Although this was not enough to instil and institutionalise accountability in the lower levels of the health information systems, the new computerised system represented the major achievement towards reducing the gap between institutional accounts of decentralisation and their enactment.

Hence, the case study has shown how processes of computerisation and technical complexity are influenced by institutional dynamics. At the same time, it can be argued that more user-friendly systems like Epi-Info can produce different outcomes from more complex systems like Clarion with the same institutional arrangements such as lack of legitimacy of IT. This means that different systems with different technical properties may require different institutional arrangements to be optimised. In addition, although professional norms and management’s engagement are essential for IT innovation in the public administration, they need institutional enablers at the macro-policy level in order to fully exploit the innovation potential of computerisation.

7. Conclusions

The case study has shown that NPM institutions were not supported by coherent actions unifying all actors involved in the restructuration of health information systems in Kenya. Its main sets of meanings were either eluded or reinterpreted so that IT enactment was not consistent across the health information system giving way to structural changes that were not aligned with what was envisaged in the reforms. In particular, the case study has highlighted three main misalignments of political discourses: the clash between NPM institutions such as decentralisation with the old public administration institution of centralisation; different interpretations and enactments of NPM institutions by different actors (e.g., sector-specific accountability in donor projects implementations vs. sector-wide accountability in health management by HRIOs and middle-management). This not only unleashed internal contradictions in NPM reforms but gave way to the abuse of the NPM institution of disaggregation by being more driven by donors’ priorities related to project implementation and monitoring rather than the reforms of the health sector. The consequence was an incomplete implementation of reforms, including partial attempts of decentralisation across the health information system leaving unheard discourses of integration.

Moreover, the case study has shown that misalignments between policy discourses and their enactments can be particularly deleterious if they occur at the macro policy level. This highlights the importance of political legitimacy of reforms in the public sector to bring more results in shaping certain behaviours that are meant to be changed at the micro level. This was evidenced, for example, by the partial decentralisation of the immunisation information system brought about by piecemeal donor support and lack of IT legitimacy by the government. As a result, management was not successful to achieve most substantive change into health management and planning practices and structures.

Thus, the findings of the case study do not put under question the efficacy of NPM reforms. Rather, they point to the rhetoric behind certain reform discourses by the main actors involved, particularly, at the macro-policy level. A stronger source of political legitimacy need to support these discourses so that through the right competences and systems of values at the meso level IT can be used as a catalyst for a more consistent implementation of the reforms. This new source of legitimacy could stem from the codification of new sets of meanings constituting a valid intermediary between NPM and African OPA models. For example, the institutional discourse of “controlled decentralisation” or “decentralised bureaucracies” could replace more dissonant discourses of “decentralization” or “managerialism”. Such new discourses could induce Government echelons to legitimize IT at the macro-policy level. Under this perspective IT could be seen as keeping the operational freedom given
to peripheral units under control. In the health sector, this would facilitate integration rather than disaggregation of health management practices.

Localised policy discourses could also help determine the role of IT in building an interface between informal and formal governance systems characterising most African Governments. Under this perspective, more research of the main value systems characterising these two different levels of governance in relation to IT usage is recommended.

References


Practical Aspects of DynaVote e-Voting Protocol

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Abstract: Voting is regarded as one of the most effective methods for individuals to express their opinions on a given topic. Electronic voting (e-Voting) refers to the use of computers or computerised voting equipments to cast ballots in an election. e-Voting performed over Internet can be universally accepted in the upcoming years due to the fact that Internet plays a key role in people's lives. The DynaVote e-Voting protocol claims that it is practical over a network since it does not use complex algorithms and has no physical assumptions such as untappable channels, whereas fulfilling core voting requirements such as privacy, accuracy, uncoercibility and individual verifiability. Software development requires a considerable amount of time and money. Therefore, in order to utilise all resources, the prototype implementation gains more importance as it gives quick feedback about the practicality of the system. This paper presents a prototype implementation of DynaVote e-Voting protocol over the Internet. Since DynaVote relies on Pseudo-Voter Identity (PVID) scheme, which is an unlinkable pseudo identity mechanism, the prototype includes implementation of a PVID scheme component as well. The main outcome of this study is to prove that DynaVote protocol over Internet is practical and applicable in real life and to illustrate that PVID scheme provides unlinkability. This study also contributes some improvements in DynaVote e-voting protocol. Furthermore, this paper analyses how the prototype fulfils some electronic voting system requirements such as efficiency, transparency and mobility.

Keywords: DynaVote, e-Voting, electronic voting, implementation, practically, e-Voting requirements

1. Introduction

Electronic democracy is a necessity in this era of computers and information technology. Electronic voting (e-Voting) is one of the pillars of the e-democracy, which refers to the use of computers or computerised voting equipment to cast and to tabulate ballots in an election in a trustable manner. Due to the nature of electronic systems the security and reliability of the system should be handled properly in order to make the e-Voting system an applicable alternative to the paper based voting system for the governmental elections.

The DynaVote voting protocol claims that it is secure and practical over a network whereas fulfilling core voting requirements (privacy, eligibility, accuracy etc.) (Cetinkaya 2007-2). DynaVote does not use complex algorithms such as homomorphic encryption and does not require anonymous communication channels such as mix-nets. Besides it has no physical assumption such as untappable channels. It only needs an unlinkable pseudo identity mechanism, so it employs Pseudo-Voter Identity (PVID) scheme (Cetinkaya 2007-1) which relies on blind signature. PVID scheme provides PVIDs that are unlinkable to the voter's real identity.

It is widely known that the development of whole protocol as a software implementation is not an easy task. Developing software requires considerable time and cost. Therefore, in order to utilise all resources, implementation of prototypes gains more importance. This paper presents a prototype implementation of DynaVote voting protocol over Internet. The prototype includes implementation of a PVID scheme component as well. In its current state, the prototype mainly serves experimental purposes to test the DynaVote protocol and PVID scheme. During the development some implementation issues have arisen. Therefore, we have made three improvements in the DynaVote protocol; these are described in Section 3. This study shows that the implementation issues are resolvable and DynaVote protocol over Internet is practical and applicable for large scale elections, as well as illustrating that PVID scheme provides unlinkability.

The remainder of the paper is organized as follows. In the next section, related work is stated. Section 3 illustrates the improved DynaVote protocol. Section 4 explains the details of the DynaVote prototype implementation, analyses how the prototype fulfils some electronic voting system requirements such as efficiency, transparency and mobility and contains the experimental results of the prototype as well. Finally, conclusions are drawn and future work is suggested.
2. Related work

There are numerous cryptographic voting protocols in the literature. The protocols proposed so far could be classified into three categories by their privacy preserving approaches as: protocols using mix-nets, protocols using homomorphic encryption and protocols using blind signature (Forsythe 2005). However, most of them are not practical and not applicable over the Internet (Sampigethaya 2006).

In homomorphic encryption based voting protocols, the voting result is obtained from the accumulation of encrypted votes whereas no individual ballot is opened and the corresponding individual vote remains secret. Correctness of the tallying cannot be guaranteed without validation, so each vote must be verified to be valid in homomorphic voting. One of the implementation studies has been done by Forsythe (Forsythe 2005) and Weber (Weber 2006), where they implemented prototypes for their academic studies.

Ballot tabulations are efficient when the number of candidates is small in homomorphic encryption based voting protocols, however, communication complexity of these protocols is quite high if the number of candidates is large. Computational and communicational cost for the proof and verification of vote validity is relatively high so that homomorphic voting actually becomes inefficient for large scale elections. Thus, voting protocols based on homomorphic encryption are far from being both secure and practical in real-life.

In general, the voting protocols, stating that they satisfy practicality and privacy, have a strong assumption of anonymous communication channels which are provided by verifiable mix-nets. There are several approaches to achieve mix-nets; the main idea is to permute and shuffle the messages in order to hide the relation between the message and its sender. In verifiable mix-nets, a mix server additionally has to prove in zero knowledge that it decrypts/re-encrypts and shuffles the inputs correctly. However, mix servers suffer from computational cost for proving that their mixing is correct, so the main difficulty is efficiency of proof techniques.

Blind signature based voting protocols employ blind signatures in different stages of the voting process in order to assure voter privacy. The idea behind these protocols is that the voter prepares a ballot stating for whom he wishes to vote. He either obtains an authorized ballot or interacts with an authentication authority to make his vote authorized. Finally, he sends his cast ballot to another authority that is responsible for counting votes. Blind signature based voting protocols generally assume the existence of an anonymous channel.

There are several implementations that have been piloted in small scale elections. The SENSUS system (Cranor 1997) was the first to be implemented. The EVOX system (Herschberg 1997) was used at MIT for undergraduate association elections. DuRette (DuRette 1999) improved the EVOX system in order to eliminate single entities capable of corrupting the election. Both DuRette’s system and EVOX are very sensitive to failures in communication or servers, these problems were solved by REVS which is proposed by Joaquim et al. (Joaquim 2003) as another implementation based on DuRette’s work. Later, some improvements were done on REVS to make it more robust (Lebre 2004). Votopia project (Kim 2002) which is created jointly by Korean and Japanese was tested in the election of the MVP (Most Valuable Player) in the Soccer World Cup of 2002. Votopia is not publicly available and does not provide anonymity. All aforementioned protocols use mix-nets or assume the existence of anonymous channels.

3. DynaVote implementation issues and improvements

During the implementation studies, a detailed analysis of DynaVote protocol revealed a privacy issue. In the original protocol, there is a possibility that corrupted Counter authority may trace the voter’s IP over Internet. Thus an improvement is made in the protocol by introducing the Collector authority to distribute the power of Counter. In the improved version of DynaVote, Counter authority has no direct relation with other authorities and the voter.

Another improvement is introducing a sequence number which shows the number of dynamic ballot requests for a particular voter. Each dynamic ballot is associated with a sequence number. This improvement is done to handle the recasts in the counting stage more easily and efficiently whereas the original protocol uses DateTime information to order the recast votes.
Furthermore, a customization is made in order to increase client-server communication speed. While communicating the servers, DES symmetric key algorithm is used to encrypt the network messages instead of RSA without sacrificing the security of the original protocol.

3.1 Improved DynaVote overview

In this section we will give a brief overview of improved DynaVote voting protocol. A detailed explanation can be found in the original work (Cetinkaya 2007-2). DynaVote protocol consists of three distinct stages: Authentication & Authorisation (performed at the beginning of the election), Voting (carried out during the election period) and Counting (performed at the end of the election). There are five authorities in the protocol:

- **PVID Authority** provides PVID-list which consists of pseudo voter identities which are unlinkable to voter’s real identity.
- **Ballot Generator** is an authority which provides dynamic ballot to the voter for each voting operation.
- **Key Generator** provides vote encryption key to the voter via Ballot Generator.
- **Collector** is an authority which collects cast dynamic votes.
- **Counter** reveals and counts the actual votes at the end of the election and then announces the election results.

Interaction between authorities is shown in Figure 1. Counter authority has no direct relation with other authorities and the voter; therefore it is not shown in the figure.

![Figure 1: DynaVote overview](image)

3.1.1 Authentication and authorisation stage

In this stage, PVID scheme (Cetinkaya 2007-1) is employed. The voter applies PVID authority to obtain a PVID-list by using his real registration identity (RegID). PVID Authority checks voter eligibility and issues the voter’s PVID-list. A PVID-list is nothing but a list of approved anonymous pseudo identities which are unlinkable to the voter’s registration identity. In PVID scheme, the voter performs RSA blind signature with PVID Authority in order to obtain PVID-list.
A PVID-list can be used at any time and place during the election period. DynaVote employs PVID scheme for two identities. The voter’s real registration identity is hidden to the voting authorities. Authorities can easily check the validity of any PVID by employing PVID Authority’s public key on it.

3.1.2 Voting stage

In voting stage the voter obtains a dynamic ballot and casts his dynamic vote. In dynamic ballots, the ordering of candidates in the ballot is dynamically created and changes randomly for each voter. A dynamic vote is defined as the voter’s candidate selection in the dynamic ballot. So, dynamic vote has a contextual meaning depending on the ordering of candidates in the dynamic ballot.

The voting stage consists of two phases. In the ballot obtaining phase Ballot Generator provides dynamic ballot to the voter. Key Generator provides vote encryption key to the voter over Ballot Generator. In the vote casting phase, the voter selects his vote from the dynamic ballot and then encrypts his dynamic vote by using vote encryption key. Lastly, the voter casts his encrypted dynamic vote by using his PVID. During the voting stage, Ballot Generator, Key Generator and Collector publish hash of subsets of relevant information on the bulletin boards. Figure 2 represents the overview of the voting stage.

![Figure 2: Overview of the voting stage](image)

3.1.3 Counting stage

Counting stage is performed after the election period has been completed. Before proceeding with the counting of votes, Ballot Generator announces the generated ballot list; Key Generator announces the generated vote encryption key list and Collector announces the encrypted dynamic votes which include partial election information. They then send the complete lists to the Counter. Counter compares the complete lists and announced lists for consistency and checks against the hash values in the bulletin boards. Any passive observer or organization can also check the consistency of the election by using the announced lists and bulletin boards.

Counter processes the lists by decrypting the encrypted dynamic votes with the corresponding private keys and produces the dynamic vote list. Later, Counter matches the dynamic votes with corresponding dynamic ballots and obtains the actual votes. Now votes are easily tallied and the election result is announced. Lastly, the election result is verified by Key Generator.

In all stages bulletin boards are employed in order to increase security and trust in the protocol. Authorities append information to their local bulletin boards in different steps of the protocol. Thus, in each stage the voter can check and individually verify intermediate outcomes against bulletin boards. In case of any corruption he can make an objection. All communications with the bulletin board are
public and therefore can be monitored. Data already written to a bulletin board cannot be altered or erased.

4. **DynaVote implementation**

In the previous section, we briefly described the overview of DynaVote. In this section, we will introduce the prototype of the protocol. The prototype simulates the typical voting process. The basic scenario of the protocol over Internet is as follows: (1) Voter obtains two PVIDs by using **PVID application web page** on the Election web site. (2) He accesses to the **Voting web page** on the Election web site by using PVID₁. He selects his candidate from the ballot list provided by Ballot Generator and casts his vote by using PVID₂. (3) When the election times out, **Counter application** is used to count the votes and to announce the election result.

In order to implement this scenario we have developed a client/server web application with Java. Voters represent the client side and authorities represent the server side. Servers are designed as Java applications and clients are designed as Java applets embedded in HTML files. Java applets are executed in a sandbox by web browsers, preventing them from accessing to local file system.

The voter should provide his private key while establishing a connection with PVID Authority server. Furthermore, on the voting stage he provides his PVIDs. For keeping the implementation user friendly we should not force the voter to memorize his public-private key pair and the PVIDs. Thus, prototype allows voters to save and load those data into files located in flash disk. Due to the fact that a Java applet is executed in a sandbox, we used signed applet to be able to access a local file system. This is a facility that current web browsers allow for an extension of an applet’s execution space beyond the sandbox. When a signed applet arrives on the user’s system, the user is notified of the identity of the applet’s signer and of the capabilities that applet requests. Then the user can give permission for only required capabilities.

We have used JDK 1.6 (Java 2009) for software development. Therefore, the system can be installed and executed on any computational platform with Java Virtual Machine (JVM). For the cryptographic functions, Java Cryptography Architecture (JCA) and Java Cryptography Extension (JCE) frameworks are used. In our implementation Sun JCA which includes JCE are used since it’s available with JDK 1.6. JCA consists of a set of packages and provides several cryptographic services. In this architecture, a variety of cryptographic algorithms are supported. We have used RSA public key algorithm, DES symmetric key algorithm, SHA1 PRNG (Pseudo-Random Number Generator), and SHA-256 cryptographic hash function. For database operations we have utilised the sql package of Sun. In addition to those packages, we have also used java.math.BigInteger and java.math.SecureRandom classes.

A voter connects to the servers on a TCP (Transmission Control Protocol) socket. We have used Sockets, ServerSockets, InputStream and OutputStream classes for communication between client and servers. We utilised the multi-thread support of Java in order to allow voters to connect simultaneously. For each request servers create a thread and different voters may concurrently access the server.

We have used MySQL 5.0 database (MySQL 2009) to store election data. MySQL provides an opportunity to export and import data. This opportunity is so essential to transfer data between authorities since online data transfer between authorities is not preferable. There are five databases in DynaVote prototype. BallotGenerator, KeyGenerator, Collector and Counter databases are used to store server data. BulletinBoards database is used to implement bulletin boards and it is read only accessible by all authorities and voters. As well as, each authority can write only its own bulletin board table in BulletinBoards database. The writing operation is disabled for unauthorised users.

In order to configure databases, there is an initialisation file. This file drops the existing databases and then creates all election databases with their tables required for the authorities. It initialises databases and tables.

4.1 **Software packages**

The software packages are explained in this section and the interaction between the packages is depicted in Figure 3.
4.1.1 e-Voting.authorities.Ballot_Generator

This package contains BallotServerProtocol, BallotServer, BallotServerThread and classes. BallotServer is the main class for Ballot Generator. The application listens on a dedicated port for voter connections and runs until the end of the election. BallotServer class uses multi threading. If a voter connects to the server, then an instance of BallotServerThread class is created.

Initially, the server backs up old election data, and then truncates the database for a new election. At the end of the election it exports data on its own database and data in BGGB (Ballot Generator Bulletin Board) table of BulletinBoards database. Hence, it creates a <BallotGenerator.sql> data file in order to send Counter authority and it announces dynamic ballots in <BallotGenerator_Result.html>.

BallotServerThread is a class where messages are received from the voter, checked and processed by calling BallotServerProtocol’s method and sent back to the voter. The thread runs until the processed messages are not equal to terminating messages. BallotServerProtocol class defines the communication protocol between the voter and Ballot Generator during ballot obtaining phase. Dynamic ballot is prepared in this class with SHA1 PRNG algorithm. All the transactions are written to databases.

4.1.2 e-Voting.authorities.Collector

CollectorServerThread, CollectorServer and CollectorServerProtocol are contained in this package. The relations between classes and general working scheme of this package are similar to e-Voting.authorities.Ballot_Generator package. CollectorServer is the main class for Collector. The application listens on a dedicated port for voter connections and runs until the end of the election. Dynamic votes are collected with associated PVIDs in CollectorServerProtocol class.

4.1.3 e-Voting.authorities.Counter

This package contains Counter, CounterGUI and Information classes. Counter is the main class for counting and tallying operations. The application provides a user interface to process all data sent by BallotGenerator, KeyGenerator and Collector and to check consistency of internal lists, published lists and bulletin boards. Counter class includes some methods to check whether a vote will be counted in the final tally or it will be discarded as well. CounterGUI class is used to provide the application user interface. Information class is a small class which prints the election result and gives information about the winning candidate.

4.1.4 e-Voting.authorities.Key_Generator

This package contains KGServer, KGServerThread and KGServerProtocol classes. In terms of the relation between classes and general working scheme, this package is very similar to the package e-Voting.authorities.Ballot_Generator. The application listens on a dedicated port for Ballot Generator connections and runs until the end of the election. It does not communicate with voter. Voter’s public-private voting key pair for casting his dynamic vote is generated in KGServerProtocol class. At the end of the election, this class produces one sql and one html file which are <KeyGenerator.sql> and <KeyGenerator_Result.html>, respectively.

4.1.5 e-Voting.database

This package contains four classes: VoterDatabase, BGDatabase, KGDatabase and CollectorDatabase. VoterDatabase class is implemented for voter to check consistency of data came from servers with data in BulletinBoards. Others are used for servers and they include internal lists of authorities. The classes are used to perform database operations for both authorities and voter.

4.1.6 e-Voting.PVID_Authority

This package contains PVIDServer, PVIDServerThread and PVIDServerProtocol classes. The relations between classes and general working scheme of this package are very similar to the
package e-Voting.authorities.Ballot_Generator. PVIDServer is the main class for PVID Authority. The application listens on a dedicated port for voter connections and runs until the end of the election. PVIDServerProtocol class generates signed PVIDs.

![Diagram of package interaction and hierarchy]

**Figure 3:** Package interaction and hierarchy

### 4.1.7 e-Voting.utils

This package contains Constants, CryptoUtil, FileUtil, GUIUtil and Keys_Construction classes. The methods, variables and constants in these classes are static and they are used by almost all packages.

*Constants* class includes configuration data. *FileUtil* class performs file I/O operations. *Keys_Construction* class includes methods to generate RSA public-private key pairs and to reconstruct RSA keys. *GUIUtil* class helps to produce user friendly results. It provides some conversion methods between different types and some concatenation and split operations for byte arrays. *CryptoUtil* is one of the most significant classes in the prototype, since all cryptographic functions are implemented in this class.

### 4.1.8 e-Voting.voter

This package contains *Voter* and *VoterGUI* classes. *Voter* is the main class for the election web application. The web page provides voters to cast their votes. Communication between voter and authorities is carried out by this class. Voter requests dynamic ballot from Ballot Generator and casts his dynamic vote to Collector. Besides, voter verifies hashed values related to his vote against KGBB
(Key Generator Bulletin Board) and BGBB databases. VoterGUI class is used to provide web user interface.

4.2 Prototype usage

In this section, the software usage of the prototype is described. In order to perform an election, firstly PVID Authority, Ballot Generator, Key Generator and Collector servers should be started with the same election termination time parameter on command prompt as Java applications. Afterwards any voter can access to PVID application web page on the Election web site over Internet to obtain signed PVIDs. PVID application web page has a simple user interface, which asks the voter for his registration ID and his private key. The private key is only used in client-side to encrypt voter messages.

Then any voter can access to the Voting web page on the Election web site and he can perform voting process if he has valid PVIDs. The Election web site uses signed applets embedded in HTML files so while using the system, voters are notified about it and the system requests permission to read the files in flash memory to be able to reach voter’s private key and his PVIDs. Figure 4 shows a screen shot of the Voting web page which has printed after the voting process.

After election time-out, all election data in server databases are exported by authorities. These exported data are sent to Counter server in an offline way. Counter server application can be run after this point. Counter application imports all election data and then starts the counting process. During counting, it announces dynamic votes; and after tabulation, it opens a popup window that shows the winner. The number of cast votes for each candidate and their percentage are also published. Figure 5 shows a screen shot of Counter application.

![Voting web page](image)

Figure 4: Voting web page

4.3 E-Voting system requirements analysis

It is explained how DynaVote protocol fulfils core voting requirements (privacy, eligibility, uniqueness, uncoercibility, fairness, accuracy, robustness, individual verifiability) in (Cetinkaya 2007-2). This
Orhan Cetinkaya and Mehmet Levent Koc

section analyses some e-voting system requirements and highlights how DynaVote prototype implementation satisfies them.

**Efficiency** (In all phases, the processes should be done efficiently): Complexity of the counting process is $O(n)$ which is considerably efficient. We run some performance tests for both voting and counting processes. The detailed and comprehensive benchmark tests are described in Section 4.4.

**Convenience** (A convenient system allows voters to cast their votes quickly, in one session, without any extra equipment or special skills): Anyone who is familiar to use Internet can easily vote via DynaVote prototype by using its clear and easy-to-use graphical user interface. So the prototype is convenient.

**Transparency** (The whole voting process must be transparent): The whole voting process is transparent and bulletin boards are used to publicise the election process. The security and reliability of the system does not rely on the secrecy of the network or any other physical assumptions.

**Mobility** (An e-Voting system is mobile if there is no restriction on the location from which a voter can cast a vote): The prototype is mobile since the voting is performed over Internet. There is no restriction on the location from which a voter can cast his vote.

**Figure 5:** Counter application

*Empty Ballot* (An e-Voting system should allow the voter to cast a blank vote): The prototype supports the empty ballot requirements. Those blank votes are also counted as empty ballots and cannot be invalidated, altered, deleted or copied.

**Cheap Elections** (The cost of the e-Voting should be less than the cost of the paper-based voting): The cost of voting by using DynaVote prototype is reasonably less than the cost of other e-Voting systems which require special hardware equipment such as DRE machines, special printers, etc.

### 4.4 Experimental results

In this section, we have provided performance results from our prototype for both voting and counting processes. We evaluated this performance test on Intel Pentium M processor 1.60 GHz with 752 MB RAM. For voting tests, we have simulated $n$ number of voters by first creating their pseudo voter
identity files. Then, for each voter, a random number $r$ is created with PRNG and the party which is $r^{th}$ among all parties is cast. After the voting process is completed, votes are counted by Counter class. The performance results for voting and counting processes are shown in Table 1. For a sample simulation which contains 1000 voters and 1000 different votes, a result of the simulation is given in Table 2.

Table 1: Performance results for the prototype

<table>
<thead>
<tr>
<th>Number of voters</th>
<th>Runtime (in seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Voting</td>
</tr>
<tr>
<td>1</td>
<td>3.805</td>
</tr>
<tr>
<td>5</td>
<td>17.325</td>
</tr>
<tr>
<td>10</td>
<td>23.464</td>
</tr>
<tr>
<td>100</td>
<td>238.573</td>
</tr>
<tr>
<td>1000</td>
<td>2470.042</td>
</tr>
</tbody>
</table>

Performance of voting part may seem impractical at first. For testing voting, we did not use the multi-threading feature of the prototype in order to see the worst results. In other words, each vote process is performed after the previous one is completed. Since each voter has his own connection, multi-threading feature will be benefited, so practicability will be preserved.

Table 2: Election result simulation for 1000 votes

<table>
<thead>
<tr>
<th>Party Name</th>
<th>Number of votes</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Party1</td>
<td>141</td>
<td>14.099</td>
</tr>
<tr>
<td>Party2</td>
<td>155</td>
<td>15.500</td>
</tr>
<tr>
<td>Party3</td>
<td>132</td>
<td>13.201</td>
</tr>
<tr>
<td>Party4</td>
<td>135</td>
<td>13.500</td>
</tr>
<tr>
<td>Party5</td>
<td>160</td>
<td>16.000</td>
</tr>
<tr>
<td>Party6</td>
<td>134</td>
<td>13.400</td>
</tr>
<tr>
<td>Party7</td>
<td>153</td>
<td>15.299</td>
</tr>
</tbody>
</table>

In the efficiency part of Section 4.3, we mentioned that complexity of counting process is $O(n)$ which can also be deduced from Table 1. Considering this, it is obvious that the counting process will become less practical when the number of voters increase. However, note that simulations are performed with only one computer. Splitting the data in Counter’s database into more than one part, the counting process will become easier and more practical, but while splitting, there is a very significant and delicate point. In DynaVote, a voter may cast more than one vote and the last one is counted. However, if Counter’s data are split into different computers and if a voter’s different casts are also divided into different computers in this splitting process, votes of same voters are counted separately. In other words, more than one vote is counted for same voters. To prevent that inconsistency, first the table has to be ordered by Pseudo-Voter Identity, and then splitting should be performed by paying attention that the same Pseudo-Voter Identities are in the same division. Otherwise, votes of the same voters are counted more than once which causes incorrect election results.

5. Conclusion

As a proof of concept, the prototype has been developed that implements the entire DynaVote protocol over Internet. The prototype includes implementation of PVID scheme component as well. This paper discusses implementation issues and improves the protocol. It presents the prototype implementation details by explaining the core design specifications and technologies used in the development; describing the packages in the prototype and providing some information about prototype usage.

This implementation study shows that improved DynaVote protocol is scalable and it is applicable to large scale elections. Since it has no physical assumption such as untappable channels, voting booths, special hardware, etc., and it has no computational complexity in all stages of the protocol. Furthermore, this prototype proves that DynaVote protocol is practical since it employs a PVID scheme which is based on blind signature. It can be performed over an uncontrolled network, such as
the Internet. DynaVote has one reasonable condition, which is a recasting feature. Due to the fact that this is an acceptable high level condition related to election policy and is not a mathematical assumption; recasting can be allowed by election authorities. Thus we can conclude that DynaVote is practical in real-life.

As a future work, we will put this system into a web site in order to measure its efficiency, effectiveness and other features with real users instead of simulations. We will get feedback from users in order to improve DynaVote. The main aim is to make DynaVote as an applicable alternative for paper based voting systems by initiating and carrying out a comprehensive project which covers every aspect of an election process. Actors other than cryptographers should participate and contribute to the project.

References

The use of ICT in Brazilian Courts

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Abstract: Transparency and effectiveness are emphasized as two positive consequences of the use of information and communication technologies (ICT) in the Courts. Indeed, ICT expanded the possibilities of access to information and judicial decisions, as well as its use especially in acts of distrainment, have given greater transparency and effectiveness to the judicial acts. In Brazil, federal, state and labor courts have web sites where judicial information is disclosed and their decisions are published. Moreover, they have agreements with the Federal Revenue Secretariat, the Central Bank and the National Register of Automobiles that allow them to implement all acts of distrainment. However, not all Courts are at the same stage as to the use of ICT because, on one hand, their web pages do not have all the features available and, on the other hand, their users are unable to explore the full potential offered by the new technologies. Delivering a diagnosis of the existing offer in the Courts’ web sites and of the use of their agreements with other public services is the first task that is being proposed here. This paper intends to examine how such things are changing the judicial function and, in particular, the figure of the judge, in addition to contributing to a new insertion of the Judiciary in the society.

Keywords: e-justice. Brazil. web services. access

1. Introduction

Judicial work isn’t what it used to be. In fact, in a time not so long ago, decisions used to be written as if they were one of a kind even for cases related to mass litigation. In order to get to know its contents, even if one could anticipate them, one would have to physically go to Court. A daily follow-up of every case was required in order to avoid surprises such as the missing of a deadline. Briefly, the everyday judicial work was then a very time consuming task. But, one must recognize, the widespread use of ICT in the Courts has completely reshaped judicial work (Fabri & Contini, 2001; Oskamp, Lodder & Apistola, 2004; Santos, 2005). It is definitely no longer what it used be. Computers have redefined the access to information and redesigned the decision-making process. Judicial information can now be gathered on a worldwide basis as much as computers have shortened the judicial procedures required to bring effectiveness to its decisions. Acts of distrainment, for instance, are no longer done by an Officer of the Court, but are executed through a single keyboard touch. Paperwork seems condemned to disappear as cases are filed and decisions are rendered online. In brief, nothing is as it used to be.

Brazilian Courts are not unaccustomed to such a scenario. As a matter of fact, the widespread use of ICT has provoked a whole set of questions that vary from the originality of a judicial decision to the parties’ protection of privacy. Furthermore, it has redefined the boundaries of lawyers and judges’ works as it enables just about anyone to track the law in the making and most of all to question the professional decisions they make. On the other hand, this direct contact has a significant impact on the courts’ effectiveness as it reduces time and increases participation. As a consequence, what used to be a ciphered knowledge becomes then available to the parties who no longer feel the necessity to go through a professional’s mediation in order to know what is happening and anticipate what may happen.

In this paper, it will be discussed how the suppression through ICT of such an intermediation is bringing transparency and effectiveness to the Brazilian judicial system and additionally changing judicial function. Delivering a diagnosis of the existing offer in the courts’ web sites and of the use of their agreements with other public services is the first task that will be examined. Federal, state and labor courts web sites will be explored as to verify how judicial information is disclosed and decisions are published. Secondly, the availability of agreements with the Federal Revenue Secretariat, the Central Bank and the National Register of Automobiles that allow them to implement all acts of distrainment will be verified. Finally, in a third and final part, speculation as to how these things are changing the functioning of the judicial system will be forwarded.
2. The general public knows what is going on: ICT and web services in the Brazilian courts

There are at least two different ways to present the Brazilian judicial system: from a political approach, it is split between a federal branch and a dispersed state system as well as from a jurisdictional perspective it is mostly divided into three separate branches: federal, labor and state courts. The first two structures are responsible for matters related to federal institutions and labor conflicts respectively. All other matters are usually processed by the states’ jurisdictions, which are autonomous and regionally organized by every State. There is a national appellate court for labor subjects, the Tribunal Superior do Trabalho (Superior Labor Tribunal). Both the general federal system and the states’ courts systems are submitted to the federal law empire granted by a possible review of the decisions by a federal established high court, named Superior Tribunal de Justiça (Superior Justice Tribunal). The constitutional judicial review is made in a tribunal that operates partly in the way of a constitutional court, named Supremo Tribunal Federal (Federal Supreme Tribunal). In its agenda, it operates also as the last review court, when any suit has a constitutional consequence.

While this brief presentation of the Brazilian judicial system may not translate the complexity found in its everyday work, it suffices for a general grasp of its functioning and to set the basis for the data that will be dealt in this paper. As a matter of fact, the Brazilian judicial data is actually separately gathered by the three branches, which allows different analysis for each one of them. As table I indicates, 72.07% of the Brazilian judges are attached to the states' system. But their distribution is very unequal as the State of São Paulo by itself is responsible for 2,154 judges, i.e., 19.69% of the total number. On the other hand, the federal and labor systems are responsible for 8.87% and 19.06% of the Brazilian judges respectively.

Table 1: Brazilian judicial system

<table>
<thead>
<tr>
<th>System</th>
<th>Courts</th>
<th>Judges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>05</td>
<td>1,346</td>
</tr>
<tr>
<td>Labor</td>
<td>24</td>
<td>2,892</td>
</tr>
<tr>
<td>States</td>
<td>27</td>
<td>10,936</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>15,174</td>
</tr>
</tbody>
</table>

Source: Justiça em números, edição 2006. retrieved 18 January 2009

Every court has its web page which provides different services to the general public (Veronese, Fontainha & Fragale Filho, 2006). Moreover, their autonomy allows every web page to have a design of its own. For this paper, every court web site has been visited to track a predetermined set of web services:

- **Acompanhamento processual** corresponds to an online lawsuit follow-up that allows any user to obtain the latest information on any judicial case, requiring the use of any one of three different data: the bar registration number from the lawyers involved, the name of either one of the litigants or the number of the law suit itself;
- “Push system” relates to the e-mail sending of information relating to a single and specific law suit upon request by the user;
- “Jurisprudential database” corresponds to a solved cases database, which is indexed from a thesaurus and access from simple to more refined queries;
- “Jurisprudential newsletters” corresponds to the periodical release of the courts various opinions on different legal matters; and
- “Electronic petition” which is the basis for a paper free law suit where petitions are sent to the Court in a PDF format.

The data gathered from the web pages is presented in figure I. As one can see, the basic web service provided by all courts is *accompanhamento processual*. Such an offer means that just about anyone can gather information on any lawsuit at anytime. It is though a service that requires a reiterative action from the user, i.e., every time one wants any information on a lawsuit, one has to go back to the court web page and repeat the procedure. This can be avoided by the so-called “push system”, which sends, upon request by the user, any news on a given lawsuit. Such a service is nonetheless not available in every court. As a matter of fact, although offered by all federal courts, the “push system” doesn’t exist in three labor courts and in seven state courts.
The existence of a jurisprudential database is a reality in almost every court, as there is only one state court that does not offer such a service. Actually, the federal databases have been unified by the Conselho de Justiça Federal (Federal Justice Council); the labor databases have been integrated in the same manner by the Tribunal Superior do Trabalho. Thus, one does not have to visit every court web page in order to gather information, but can easily do it through the high courts. Such an integrated system does not exist for the states’ courts, although links to their jurisprudential database are available at the Conselho Nacional de Justiça (National Council of Justice) web page. On jurisprudential matters, it is also necessary to refer to the “jurisprudential newsletter”. Although present at every federal court, at a little bit more than three fourths of the labor courts and at almost one third of the state courts, it is rare to find courts that offer such a service in the same way as the “push system”. “Jurisprudential newsletters” are therefore available to every user who is willing to visit the court web page.

Finally, there is the electronic petition system. Although figure I can give the impression that such a system is generalized in almost every court, such data must be examined very carefully. As a matter of fact, e-petition is not present in the federal courts as a whole, but is specifically used for the Juizados Federais Especiais (Special Federal Jurisdictions), which have a very specific jurisdictional competence. On the other hand, it is present in almost every labor and state court mostly because both the Tribunal Superior do Trabalho and the Conselho Nacional de Justiça respectively have made available all the necessary technology in order to make it possible. The former has then integrated all 24 labor courts in an e-doc basis as well as the latter has incorporated all state courts into the PROJUDI system, which stands for Processo Judicial Digital (Digital Judicial Procedure).

While they are not accounted for in figure I, there are other services provided by the Brazilian courts (Silva and Borges, 2003) that are worth a mention. For instance, some courts offer a “push system” through cell phones. One of the federal courts allows the making of “oral arguments by video conference” which is a web service that allows lawyers to take part in the judicial hearings and deliberations although they are not physically present at the court. Many other courts allow an online service through which one demands to physically take part in the oral arguments. Some courts offer a communication service through podcasts in which they talk about and inform the general public of the courts’ jurisprudential tendencies and the legislative innovations. One labor court broadcasts its hearings on the web. Briefly, there are no limits to creativity!
3. The public service comes together: ICT and judicial agreements with other services

One of the major difficulties for the public service has been the building up of a common database which would allow cross-referencing of the general public data. For instance, a judicial order asking for information on a litigant’s tax revenue would take months, or even years to be answered. The scenario would not be different in the case of a seizure of a car, as it would take several months for the order to be correctly registered on the National Register of Automobiles. The disclosure of a bank account could undergo several months, even years. These situations would not be the result of a surprising incapacity to provide an answer but it would mostly be related to the difficulty in gathering the requested information, putting it all together and forwarding to the judicial system. This happened mostly because the different databases would not communicate among themselves. ICT has nonetheless made possible such communications and for now, courts have agreements with the Central Bank of Brazil, the National Department of Transit and the Federal Revenue Secretariat that allow them to implement online all acts of distraint (Ponciano, Barbosa and Freitas, 2006; Ponciano, 2008). In the following sections, each agreement will be very briefly examined.

3.1 The Central Bank of Brazil and the Bacenjud system

Over the years, the Central Bank of Brazil (BCB) had become overloaded by judicial requests of banking information and money seizures. Thus, a partnership was established in 2002 among the BCB, the Brazilian Superior Courts and the different entities of the national financial system in order to establish a computerized system to respond to the judicial orders of distraint in the bank accounts and financial applications, to provide financial information and to register bankruptcy episodes. As a consequence, the software “Bacenjud 1.0” was created and, in less than a year, as it can be seen in table II, the computerized orders corresponded to more than the double than those on paper.

Table 2: Seizure orders 1998-2008

<table>
<thead>
<tr>
<th>Year</th>
<th>Paper orders</th>
<th>Bacenjud 1.0</th>
<th>Bacenjud 2.0</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>6,384</td>
<td>0</td>
<td>0</td>
<td>6,384</td>
</tr>
<tr>
<td>1999</td>
<td>54,515</td>
<td>0</td>
<td>0</td>
<td>54,515</td>
</tr>
<tr>
<td>2000</td>
<td>71,461</td>
<td>0</td>
<td>0</td>
<td>71,461</td>
</tr>
<tr>
<td>2001</td>
<td>80,586</td>
<td>524</td>
<td>0</td>
<td>81,110</td>
</tr>
<tr>
<td>2002</td>
<td>99,697</td>
<td>44,756</td>
<td>0</td>
<td>144,453</td>
</tr>
<tr>
<td>2003</td>
<td>118,505</td>
<td>262,892</td>
<td>0</td>
<td>381,397</td>
</tr>
<tr>
<td>2004</td>
<td>116,350</td>
<td>473,198</td>
<td>0</td>
<td>589,548</td>
</tr>
<tr>
<td>2005</td>
<td>128,856</td>
<td>615,870</td>
<td>61,946</td>
<td>806,672</td>
</tr>
<tr>
<td>2006</td>
<td>134,114</td>
<td>62,149</td>
<td>1,320,289</td>
<td>1,516,552</td>
</tr>
<tr>
<td>2007</td>
<td>75,838</td>
<td>79,908</td>
<td>2,693,576</td>
<td>2,849,322</td>
</tr>
<tr>
<td>2008 (until Nov.)</td>
<td>57,037</td>
<td>20,123</td>
<td>3,328,899</td>
<td>3,406,059</td>
</tr>
<tr>
<td>Total</td>
<td>943,343</td>
<td>1,559,420</td>
<td>7,404,710</td>
<td>9,907,473</td>
</tr>
</tbody>
</table>

Source: Banco Central do Brasil, retrieved 19 January 2009

After the release of “Bacenjud 1.0”, things would no longer be the same. As a matter of fact, acts of distraint became so easily done that some questions around its legality were brought forward, mostly based on an alleged breach of financial records’ confidentiality and on a violation of privacy (Marinoni, 2008). Nonetheless, as the Bacenjud system progressed, such a debate was settled by a Bill introducing a disposition on the Civil Procedure Code establishing the legality of the online seizure. By that time, the BCB released a new version of the system, i.e., the software “Bacenjud 2.0”, which very shortly replaced the old version in all courts. As it is shown in figure II, three years after its release, seizure orders in paper and in the old software version are extremely residual and represent only 2.2% of all orders.

Thus the system became very popular in the courts and its use, which was originally made mostly by labor judges, progressed to include both the federal and states systems. But the curves’ tendencies shown in figure III should not be misinterpreted. Bacenjud is still mostly used by labor judges as they average 536.3 annual orders while state judges issue only 145.8 orders on average. Actually, federal judges who average 136.3 annual orders are almost at the same level as the state judges.
As electronic seizure orders become a usual task and an important tool for the judicial celerity and effectiveness, the Conselho Nacional de Justiça decided in October 2008 that the use of “Bacenjud 2.0” was mandatory for every judge in the country.

### 3.2 The National Department of Transit and the Renajud system

Similarly to the BCB, the National Department of Transit (DENATRAN) was overloaded by judicial requests of information and seizure orders for automobiles registered in the National Register of
Automobiles (RENAVAM). By November 2006, the example offered by the Bacenjud system was followed and the Renajud system was put in place. As it is shown in figure IV, it is a web electronic tool that connects the Judiciary and the DENATRAN and allows judges to place online seizure orders in the RENAVAM database. Such orders are then transferred to the States’ Departments of Transit (DETRANs) database with the specified restrictions imposed on the vehicle, which can forbid either its transfer, the annual renewal of its matriculation, or its circulation (what imposes its conveyance to a public deposit).

![Renajud system](source)

Although there are still no available statistics on its use, it is obvious that its adoption will provide a very much welcomed procedural standardization and it will shorten the delay between the judicial order and its execution.

3.3 The tax revenue services and the Infojud system

The Informações ao Poder Judiciário (Infojud) system was implemented by the Secretaria da Receita Federal (Federal Revenue Secretariat) in June 2006, shortly before the Renajud system. It eliminates all paper work and allows judges to formulate online requests for fiscal information on any Brazilian taxpayer. In other words, it does not grant direct access to the Federal Revenue Secretariat database. The request requires a digital signature which identifies the judge at its origin and also provides for latter traceability. The requested information is processed and forwarded to the judge’s mail box. Among the data that can be solicited, one finds the declarations of income tax, rural land tax, and real estate transactions. Even though it seems quite evident that such a system may improve the quality of the judicial work, similarly to the Renajud system, there are still no available statistics on the extent of its use.

As it is shown in figure 5 Infojud is in fact a service integrated in the Centro de Atendimento Virtual (e-CAC), which is a web service center for taxpayers provided by the Federal Revenue Secretariat. At e-CAC, services are grouped accordingly to the nature and the kind of taxpayer (individual or corporate) and they all require a digital signature. It facilitates taxpayers’ life as it exempts one from the necessity to physical attend to a governmental agency to ask for a specific service. Therefore, it is rather symbolic that judicial orders are processed and answered through the same web space made available to each and every Brazilian citizen. What a change!
4. Transforming the profession: ICT and the judges’ new practices

ICT is definitely changing the practice of law. As a matter of fact, judicial professions are on the verge of a radical change as we move from a print-based industrial society to an IT-based information society. The intermediation provided by a judge’s work is thus no longer limited to the building of an accepted decision by the parties, but it has become a very complex task where other functions have been integrated. ICT provides new input to its actions as well as enhancing its accessibility and transparency. But as it also reshapes the role of lawyers (Susskind, 2008), it exposes the existence of a professional digital divide between lawyers and among different Brazilian courts and regions. Actually, even within the courts its use varies accordingly to a judges’ ability to cope with the technological innovations. Of course, there are the resistant ones who refuse to go along with it. They insist on old professional habits that do not fit into the new space-time judicial paradigm (Faria, 2004) which asks for almost instantaneous replies to recurring problems and a more participative posture from judges. Mostly they are still attached to a social division of judicial work in which their sole obligation consists in delivering a decision. From their point of view, everything else should then be completed by other public employees.

But the social division of judicial work is no longer like this. ICT has provided for judges to carry out the execution of their own decisions. They are asked to implement the technical operations that give effectiveness to their rulings. Such an improvement is followed by another major change which is transparency. As judges are encouraged to work differently, to change their posture as to the rapport they entertain with the parties and the people overall, their work becomes available to public scrutiny. As transparency grows to be a general trend of the judicial system, different and new services are offered through the web: e-petition, online court broadcasting, podcasting. Even administrative information such as the public employees’ wages is now available and subject to public criticism. As a consequence of all these changes, a new kind of accountability emerges and a judge’s legitimacy is no longer accounted for only at the public examinations one has to go through in order to join the public service. Actually, it is reiterated on an everyday basis accordingly to every judge’s assimilation of the new possibilities offered by the integration of ICT in the courts. Isn’t it a new world?

References


Case Study: e-Youth City Council Project an Alternative e-Government for Young People

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Abstract: This article presents an explanatory analysis of an e-Youth City Council project held in the town of Sant Andreu de Llavaneres, Catalonia, during the year 2008. The main objectives of this programme were to increase citizen participation, improve good governance and through it, the possibility of consolidating and strengthening democracy by ICT use. This case study was based on a survey of 628 young people aged between 14 and 18. The aim was to motivate and enable them to play an active role in politics and to take up positions of genuine authority and responsibility, within local decision making, as pre-voting citizens. In this way, the young people engaged to develop all stages of the electoral process, participated in an e-voting system and were empowered in local government for 15 days. In this case policy was translated into practice and created a successful partnership between young citizens and the local political parties. The focus of this ICT research was, basically, which tools the youngsters used and the influence it had on electorate participation In this way, the ICT acquired a new perspective relating to this study group who are considered a generation raised in a computerised era and who are leaders in the fields of innovation and communication, used as a common tool in their social life and work. The analysis is described and evaluated by explanatory variables such as; population, age, ICT use and access, number of voters and abstentions, the ajuntamentjove.cat website, political party blogs, electoral campaign spots and meetings, the electronic voting system and finally the video “Youth Government Constitution” broadcast by internet into the school classroom. Electronic voting has been incorporated as a pilot test, consisting of a voting system of closed lists with a choice of up to two preferential candidates.

Keywords: e-government, young citizens, participation, ICT, democracy and policy, e-voting

1. Introduction

1.1 Background

Sant Andreu de Llavaneres is a small town located 40km from Barcelona, Catalonia. It has a population of about 10,120 residents. The study group was made up of teenagers ranging from 14 to 18 years, representing an electoral roll of 628 people (value of 6.28% of the population). The study group can be divided into two groups with different characteristics; 14 to 16 year olds in compulsory secondary education and the 16 to 18 year olds, sub-divided into those who continued in higher education and those who went into the working world. The school group was made up of 57% (358 pupils), personal data and information about this group was taken from the school and teachers while personal information pertaining to the working group came from the council register.

1.2 Objectives and goals

The young were given a voice to make decisions on the city council.

The main objective of the project “e-Youth City Council” was focused on developing a mechanism by which the youngsters could learn about the electoral process, public administration, local government and the responsibility of being a citizen. Through this work, the youngsters were provided with the tools and resources to design their own policies and demands and also to empower the governing body to carry them out.

Creation of a Youth Commission

To create the Council of Youth as a new body:

- To inform, consult and make proposals to design a policy on youth.
- To plan activities which encourage young people to participate in community life.
- To be the interlocutor between the young and the city councillors.
- To cohere the young collective of the town.
To carry out the negotiations and management of the Llavaneres Youth township.

Educational Framework

Educational law has currently introduced two subjects into secondary schools for the academic year 2008/9, *Citizenship* and *philosophy and Education for personal development and citizenship*. The content of these subjects treats themes on concepts of the democratic system, cultural participation, interaction and relations between citizens and the government, its operation and governance. While studying these subjects the students are viewed as real citizens.

Our aim has been to give an opportunity to administration, pupils, teachers and schools, to put what they have learnt into practice and evaluate this experience of local democracy. This programme was planned with the collaboration of the school director, pedagogic coordinator and teachers who believe that the project created activities to give young people a learning experience in democracy.

Direct Political youth participation.

“Our political system is based on a representative concept of democracy ... we should not forget that the representative system is also exposed to a series of dangers...an excessive prominence on behalf of political representatives can easily undermine the central role that citizens should play in all good democratic systems.... it is thought more convenient to encourage mechanisms for participative democracy, that is, an instrument by which citizens can express their opinions and become involved in the complex world of political decisions. In effect, its objective is that citizens not only express themselves in very distant periods of time but rather that they play a leading role in the daily adoption of decisions on behalf of the corresponding administration.”

In the last decades, some of the main roles and institutions of representative democracy have suffered a constant loss of confidence from their citizens. It is known as disaffection and some studies say that the indicators of this situation are “loss of interest in policy, fall of electoral participation from the eighties (OECD countries, distrust towards institutions, authorities and representatives and the decrease of partisan and union affiliation. (Dalton and Walberg, 2000; Putnam 2003; Huse, 2003)"

Studies on disaffection, propose various measures to try to change these attitudes through explicitness, transparency and support, participation, responsibility and accountability.

For these reasons the project was an attempt to build up a culture of participation. This line of participation is based on direct involvement by the citizen which, from our point of view, means that they can identify with policy when taking part in decision making. However, the mechanism that enables citizens to participate politically requires a culture of political commitment that those implicated can only obtain when participation is put into practice. From our perspective, participation is best taught by active involvement and being given the channels and resources to apply it.

Finally, the small population of the town of Llavaneres permits a comfortable relationship between the governing body and its citizens and it is best if we refer to the study group. It should be remembered that small towns have administrations that are close to their citizens.

Promoting ICT among Llavaneres youth.

The eruption of the use of ICT is influenced, as some studies report, by the rapport between the citizens and their representatives, promoting civil participation and making changes in public administration. It is necessary to be aware that the local area favours participation due to the proximity of the local government which promotes dialogue with those involved. (Schneider). In this manner, the participants and the citizens are integrated into the processes of decision making and

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2 www.uoc.edu/idp/6/d/esp/borge_colombo_welp.pdf

public management; a mechanism to increase efficiency and to favour the implementation of policies. (Riley, 2003; Goss, 2001; Kooiman, 2005; Brugué y Gomà 1998)

Moreover, the youth collective is considered to be a group with more access to and awareness of these new forms of communication because they were born into the IT generation.

The project used ICT in:
- Electronic voting.
- Official Youth Website; www.ajuntamentjove.cat
- Entry to the political Blog.

We consider these tools are not purely political participation channels but also media facilitators as an alternative mechanism to participate.

1.3 Planning the project

This plan was divided into several parts:

First part “Acquiring basic democratic concepts”

Activities and workshops.

The purpose of this section was to provide enough knowledge for policy and the system to be understood, thereby bringing the voice of the younger generation to the government.

These activities were:
- Video Youth Council. (http://es.youtube.com/watch?v=9NJjP7Uzoqc)
  The video e-youth city council was made by the group of members of the 1st edition of the project. These members explained the steps of the electoral procedure and invited young people into the experience.
- Two conferences were given by the present councillors and the youngest councillors (aged up to 30 years)
- Informative sessions. An informative session was planned with twelve classrooms where technicians from the city council (about 20 people) explained what their work consisted of and how they developed their policies. The second session was given by municipal technicians and described the function of the Youth Council, their services and the project.
- City Council workshops. The specialists prepared five workshops on culture, the environment, urbanism, psychology and education, where pupils could participate and put into practice the concepts acquired during the informative sessions. The workshops were not compulsory and the overall attendance was 60 youngsters.

Second Part “Focusing the Knowledge

Making proposals.

Pupils from the twelve classrooms made their claims and demands to improve activities and issues in the municipal government. They made 97 proposals of which 21 were approved by the municipal plenary and were included in the current budget. Most of these proposals were listed on the electoral program. The Youth department would work, together with members from the list of candidates, in a committee to develop these policies.

Third Part. “Electoral Process”

Electoral Campaign

The period of the electoral campaign was seven days from the 3rd to the 10th November ’08. There were five lists of candidates: one list composed of people of 14 years old, another mixed list of young people between 14 and 15 years old, a list of 16 year olds and two others of 17 to 18 year olds. Each

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list was composed of a minimum of seven members and the rest were substitutes. The political parties held meetings during school breaks, in the town, in the Town hall and through the media of local and county digital television. They also published leaflets and programs to try to convince voters. They created specific blogs with:

- Statements and achievements.
- Electoral programme
- Publicity spots (www.youtube.com/watch?v=3FX3i5EZPu8)
- Surveys of their electoral programme proposals.

There were 5 lists of candidate and the blog site was housed on the official website linked by frame: http://ajuntamentjove2008e.blogspot.com/

The address of the parties blog sites are:

- http://jovesambidees.blogspot.com/ (Youth with Ideas)
- http://futures-promeses.blogspot.com/ (Futures promises)
- http://3viles.blogspot.com/ (3 Viles Group)
- http://alternativaperllavaneres.blogspot.com/ (Llavaneres Group)
- http://podemmillorarlavaneres.blogspot.com/ (We can Improve Llavaneres)

The Content of the Youth website (www.ajuntamentjove.cat) consists of:

- e-youth City Council News: Containing news, event calendar, activities they can do and summaries of their achievements with photos.
- e-youth City Council blog site with the candidates blogs.
- e-youth City Council elections. This site contains a guide to the e-voting process pilot test with demonstrations, the results and news of the electoral process.

The official website has had 7,225 visitors.

2. Electronic voting

2.1 Why electronic voting?

During the last elections held by the Youth City Council, the number of voters was about 62% we showed that this percentage of voters was similar to that of the local municipal elections.

This new addition put to the test whether technology provided a useful mechanism to engage young people democratically and increase the electorate and therefore the number of voters.

The e-youth city Council is the first pioneering project in electronic voting in the whole of Catalonia and includes a pilot test designed by the political commission of the Public Administration Department of Catalonia. The project was financed by the Catalan government, La Generalitat de Catalunya.

Therefore, the overall objectives of electronic voting are:

- To increase the number of voters in the Youth City Council elections.
- To evaluate the impact of the ICT on this group.
- To evaluate the disaffection of the pre-voters.
- To guarantee the rights of voters; secrecy and a transparent process of voting.

2.2 Requirements and features to make use of electronic voting

- The Youth electoral role was about 628.
- Election of a list of candidates among several. Closed lists.
- The election supports both types of election (ballot and remote)
Pilot test: closed lists with preferential voting system with a choice of 2 candidates. If there were 5% of voters who voted for the same preference of candidate, that candidate took up the first position on the list.

The requirements for voter identification were an authorization and a National Identification Card. The authorization was a code of 16 alpha-numeric characters which the voters received by post or from school.

The voting application was housed on the youth official website.

Remote voting allowed numerous votes, the final vote being valid.

The ballot was allowed once and automatically invalidated the electronic vote.

The voting application introduced the concept of the invalid vote. It was designed on small windows on the screen above the candidates’ names. When the voters wrote something in the space, it invalidated the previous vote.

The electronic voting election period ran from 5.00pm on Wednesday 12th November to 1.00pm on Saturday 15th November 2008 and the traditional voting from the 14th to the 15th November until 1.00 pm.

There were two electoral stations, one in the school and the other in the Town Hall which remained open from 9.00pm on Friday the 14th to the 15th November 2008.

The results of the online vote and paper ballots were posted, the day after voting ended, on the website.

After using the e-vote, the voter was asked to fill in a questionnaire on their preferences pertaining to the type and security of the voting system.

After making an e-vote, the application allowed a print out of a coded voting receipt as confirmation of the vote. The code did not include any personal data about the voter nor their electoral option but was a key that enabled the voter to verify the list of voters published by the website.

Three bodies were created by the elections: The administrative electoral body who controlled the electoral process, The electoral ballot board and the electoral electronic board which were composed of well-known people such as politicians and artists.

The software applications were developed by Scytl which is a company that specialises in the development of secure electronic voting solutions. The internet voting platform provided for this election is known as Pnyx government.

2.3 Electoral outcome

As the results show the level of participation in this election declined if compared with the 58% of the first edition project held in 2002. There were 112 valid votes, 36 of which were on line, the remaining 76 votes were by ballot which means that 67.8% preferred this option.

The successful candidates were “Youth with Ideas” which had 51.78% followed by “3 Viles Group”, Future Promises, We can Improve and lastly “Llavaneres Group”. The Hond’t Law was applied to calculate the score. As a result 5 points went to “Youth Ideas” 1 point to “3 Viles Group” and 1 point to Future Promises. This political system gives advantages to the majority parties above the minority ones.

<table>
<thead>
<tr>
<th>Candidature</th>
<th>Votes</th>
<th>Remote</th>
<th>Ballot</th>
<th>5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youth with Ideas</td>
<td>58</td>
<td>17</td>
<td>41</td>
<td>2.9</td>
</tr>
<tr>
<td>Future Promises</td>
<td>14</td>
<td>6</td>
<td>8</td>
<td>0.7</td>
</tr>
<tr>
<td>3 Viles Group</td>
<td>20</td>
<td>9</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Llavaneres Group</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>0.3</td>
</tr>
<tr>
<td>We Can Improve</td>
<td>11</td>
<td>3</td>
<td>8</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Table 1: Votes and the pilot test: preferential e-vote system. Source: Gibert Gemma
The changes to the candidate order produced by the preferential system indicates that all of the candidates, with a number of votes up to 5% of the total, will move up the list.

The three most voted lists and those that had been assigned scores, were modified by the preferential voting system. It ensured that the candidates situated in the first position changed. The second and third list saw a change in candidate. While the first list maintained its candidate, the second chair sought a new candidate.

Youth Ideas

The candidate on this list continued to be in the lead, nevertheless the candidates in the 3rd place through to 5th moved up in position to become councillors on the young government. This group received 5 seats.

Table 2: The impact of the preferential voting system

<table>
<thead>
<tr>
<th>YOUTH WITH IDEAS</th>
<th>PREF. VOTES</th>
<th>YOUTH WITH IDEAS</th>
<th>PREF. Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEANDRO DÍAZ</td>
<td>27</td>
<td>LEANDRO DÍAZ</td>
<td>27</td>
</tr>
<tr>
<td>ADRIÀ RINCÓN</td>
<td>10</td>
<td>MARÍA RUBAL</td>
<td>14</td>
</tr>
<tr>
<td>MARÍA RUBAL</td>
<td>14</td>
<td>ADRIÀ RINCÓN</td>
<td>10</td>
</tr>
<tr>
<td>DIDAC CABELO</td>
<td>2</td>
<td>POL RIVERA</td>
<td>6</td>
</tr>
<tr>
<td>POL RIVERA</td>
<td>6</td>
<td>GORKA ARANGUREN</td>
<td>3</td>
</tr>
<tr>
<td>GORKA ARANGUREN</td>
<td>3</td>
<td>JOAN MARC BARULLS</td>
<td>3</td>
</tr>
<tr>
<td>JOAN MARC BARULLS</td>
<td>3</td>
<td>DIDAC CABELO</td>
<td>2</td>
</tr>
<tr>
<td>RAQUEL RODRÍGUEZ (SUPLENT)</td>
<td>1</td>
<td>RAQUEL RODRÍGUEZ (SUPLENT)</td>
<td>1</td>
</tr>
<tr>
<td>XAVI LEONARD (SUPLENT)</td>
<td>0</td>
<td>XAVI LEONARD (SUPLENT)</td>
<td>0</td>
</tr>
<tr>
<td>JOAN MORA (SUPLENT)</td>
<td>0</td>
<td>JOAN MORA (SUPLENT)</td>
<td>0</td>
</tr>
<tr>
<td>REAL VOTES</td>
<td>58</td>
<td>5% OF VOTS</td>
<td>2.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FUTURE PROMISES</th>
<th>PREF. VOTES</th>
<th>FUTURS PROMISES</th>
<th>PREF. Votes</th>
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</thead>
<tbody>
<tr>
<td>ANDREA CASTILLA</td>
<td>0</td>
<td>MIQUEL BERROCAL</td>
<td>3</td>
</tr>
<tr>
<td>CLARA SÁNCHEZ</td>
<td>1</td>
<td>ELOI CASAS</td>
<td>2</td>
</tr>
<tr>
<td>CLAUDIA BARREIRO</td>
<td>0</td>
<td>CLARA SÁNCHEZ</td>
<td>1</td>
</tr>
<tr>
<td>BEATRIZ DOBÓN</td>
<td>0</td>
<td>ANDREA CASTILLA</td>
<td>0</td>
</tr>
<tr>
<td>ARIADNA SUBIRATS</td>
<td>0</td>
<td>CLAUDIA BARREIRO</td>
<td>0</td>
</tr>
<tr>
<td>MIQUEL BERROCAL</td>
<td>3</td>
<td>BEATRIZ DOBÓN</td>
<td>0</td>
</tr>
<tr>
<td>ELOI CASAS</td>
<td>2</td>
<td>ARIADNA SUBIRATS</td>
<td>0</td>
</tr>
<tr>
<td>REAL VOTES</td>
<td>14</td>
<td>5% OF VOTS</td>
<td>0.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3 VILES GROUP</th>
<th>PREF. VOTES</th>
<th>AGRUPATION 3 VILES</th>
<th>Pref. Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALEXANDER CLASEN</td>
<td>3</td>
<td>SERGI ARANYÓ</td>
<td>10</td>
</tr>
<tr>
<td>SERGI ARANYO</td>
<td>10</td>
<td>CARLES CARMONA</td>
<td>7</td>
</tr>
<tr>
<td>ANDREA NOGUÉS</td>
<td>1</td>
<td>MARIONA BERROCAL</td>
<td>4</td>
</tr>
<tr>
<td>ALBA SOLER</td>
<td>0</td>
<td>ALEXANDER CLASEN</td>
<td>3</td>
</tr>
<tr>
<td>ANNA RODRIGUEZ</td>
<td>0</td>
<td>ANDREA NOGUÉS</td>
<td>1</td>
</tr>
<tr>
<td>MARIONA BERROCAL</td>
<td>4</td>
<td>ALBA SOLER</td>
<td>0</td>
</tr>
<tr>
<td>CARLES CARMONA</td>
<td>7</td>
<td>ANNA RODRIGUEZ</td>
<td>0</td>
</tr>
<tr>
<td>REAL VOTES</td>
<td>20</td>
<td>5% OF VOTS</td>
<td>1</td>
</tr>
</tbody>
</table>
With reference to the candidate, Maria Rubal, who arrived to 3rd place and with preferential votes, went up to 2nd position, we found that the majority of her supporters (80%) only marked this preference, therefore the preference for this candidate was very apparent.

Future promises and 3 Viles group

These two nominations saw a variation in the order of the lists. The preferential vote moved candidates in the sixth and seventh position to the top places. We consider that having a very low number of votes gives the preferential vote a very strong influence.

3. Empower the government

Those elected were given power within the Youth government from the 21st November to the 19th December. In the beginning they had to establish the government following the articles of electoral law, they had to vote to elect the Mayor and the councillors. There were seven councillors on the government and one of them had to be elected Mayor. By consensus the Mayor was the first candidate on the list “Youth and Ideas” They assigned the departments and they started to work together with the real politicians on a daily basis. Firstly they had to get to know the specialists working in each department and the issues they were working on. One of the most important things to understand was the structure of the public budget in order to include Youth issues. Of the 91 proposals 21 were submitted, prioritised by economy and necessity. As a result these proposals were approved at a plenary meeting and the young politicians were invited to the Catalan Parliament.

4. Results and conclusion

4.1 Methodology

The methodology used to elaborate this report on electronic voting was based on a two channelled survey. On one hand, the citizens who participated in voting through the internet could choose the option to answer a questionnaire that automatically appeared on the computer once they had voted. The questions they were asked to answer were based on the type of voting they had chosen and the electronic voting system. On the other hand another questionnaire was formulated on the development of the project, the reasons to decide to vote or not, the ICT and electronic voting. This questionnaire was completed by 199 school pupils that made up 31.2% of the participants in the electoral census, an important number, when considering the tendencies reflected were representative of the collective of young people.

What happened in the first part “The acquisition of basic democratic concepts” and in the second part “Focusing the Knowledge: making proposals”.

In this first part the participants in the learning process were teachers, civil servants and the students. They all evaluated the perceptions and the benefits that they believed the project had contributed. In conclusion the teachers rated the experience as positive, in as much as the students had become involved in the project and had taken responsibility for decisions taken on behalf of the young collective that they represented. The aim of this first part was to ensure that the youngsters established which civic problems were particular to the young and tried to solve them through the use of the legal democratic mechanisms that they had learnt.

From the results taken from the student’s evaluation it stands out that their initial knowledge of government, municipal politics, and the structure and workings of the administration was flimsy. However contact with the civil servants changed their vision of politics. They had previously seen politics only as a way of making money with a certain level of corruption. This attitude could be influenced by the widespread idea that politics has become discredited. Nevertheless the second evaluation marked a new tendency as the youngsters were surprised at their lack of knowledge of the services provided for the citizens by the local government and the little perception they had of the difficulties the civil servants had implementing municipal politics.

In designing this learning programme the same standard was used for all the groups and perhaps, it would be better to revise and adapt it, according to school year and age.

In the second part the pupils learnt to make municipal proposals. A total of 91 proposals were made and those that stood out were those relating to sport, mobilization, city planning and culture. Once
again it is proved that these demands have age related motives that form a part of their own reality, such as a Youth centre, more transport, different types of sport. They made no reference to the housing situation or to employment as they considered these questions to be far from their present reality.

Finally the civil servants emphasised that their impression of the students was that there existed a general lack of knowledge of the municipal reality and that it was necessary to inform citizens of the functions of administration and to establish ways to communicate with them, so as to give a better understanding of how politicians make choices and what it means to develop those choices.

4.2 ICTs and the internet

As was indicated by the data that was taken from the study group, 94.74% of this cross section had access to a computer; ownership by 1/3 of this sample with the rest sharing one with other members of their household. Internet connection was good and fast and they had ADSL (71.60%) with access available at any time of the day (78.40%). It could be considered that this study group indicated that ICT access and availability was excellent.

4.3 Blogs

The blogs were designed by the applicants and the candidates. They included information on the electoral programme, different election events and the candidates; they also inserted publicity spots for the young voters. The object was to establish a link between the young citizens and the young, future politicians. Even though the intention was to create this interaction, the length of the electoral campaign was quite short, only 7 days. They used all the traditional ways such as school meetings where they interacted directly with the students from the whole secondary school, explaining their proposals and debating them, they also used the television and through the town hall, the candidates tried to activate all the possible means of communication to convince the voting citizens.

4.4 Electronic vote

According to data, motivation to vote a concrete listing is based, mainly, on the proposals made manifest in the electoral programme and the possibility that their chosen candidates would be able to carry out the said proposals during their mandate (27.79%). This election was also influenced by the appeal of the main candidates (13.20%). These criteria of selection, apparent in the young voters, are also prevalent in the municipal election voters.

4.5 Identification needed in order to apply as an elector

The elector was identified by a National Identity Card or NIE (if a foreigner) and with a password (PIN) that in this case was a code of 16 characters. Thus the elector had to introduce these two forms of identification into the programme and once authorised, the programme allowed them access into the voting system. This was the solution the company gave to ensure secure voting.

With reference to these two forms of identification we should point out different aspects that should be taken into account.

- The municipal registers where the voters DNI or NIE were obtained, should have been checked more frequently and the way the personal data was introduced into the programme should be standardized. Some of the youngsters DNI and NIE were taken from both the electoral roll and the school. These details were coded in different ways when entered and this caused the NIE (Foreign identity number) to be missing zeros or the letter. Human error was also found in the details entered.

- According to municipal law a resident is one that has registered in the community where they have spent the majority of time over the span of a year. The electoral rolls have not been revised since 1996 and when a citizen moves it only comes to light when a notification is received from the new community, if the citizen has registered in the new area. This makes it difficult to comprehend the exact population movement. Because of this more than 80 authorizations were returned with a notification that the citizen no longer lived at the shown address (12.78% of the population did not receive their authorization) However authorizations could be obtained from the city council.
Continuing with these classifications it is important to establish the format of entering the electorate identification into the programme (e.g. Capital or small letters, the whole number with or without spaces, etc.) and indicate the aforementioned format on the programme window or in the instructions. In these instances the system indicated 13 errors and did not permit the elector to enter into the programme.

This pilot test incorporated the null and void vote. Its introduction opened a new window on the computer screen under that of the electoral roll. A vote became null and void if the electorate introduced a note or an express comment. The real concept of the null and void vote in normal elections, comes about when various ballot papers are introduced in the same envelope, the ballot paper is marked or crossed out or when it is torn. In an attempt to introduce this new form of voting it was deemed appropriate to introduce the check box in the same window as each candidate, as it could become null and void if introduced on the candidate ballot paper.

4.6 What happened to the system established by the pilot test: closed lists and the preferential voting system

In our opinion this combination of a closed list and the preferential vote has raised some confusion. The pilot test established two voting options; voting for a list without making any preference, which meant that there was agreement with the order of the candidates, or to mark a preference, in this case it was possible to vary the order of the list by a maximum of two candidates. The modification of the candidate order became effective when 5% of the electorate manifested the same preference.

It was made obvious by the results, that the electorate who decided to mark a preference, established the 5% necessary to create the minimum parameter to vary the order of the candidates and to determine the number of seats necessary to govern. The non-preferential votes had no effect on the first two candidates on the list but they were indirectly weakened because the votes were added to the general list.

The preferential voting system did not include the order of preference of the chosen candidates (option, 1st candidate or 2nd candidate) however this order was established following the true order of the candidates on the list. This did not allow all the candidates to have the same opportunity to be favoured.

4.7 What was the participation

As was mentioned before, participation was very low and as the survey showed, the pupils commented that it was difficult to enter into the programme and that it was very slow (about 32% out of 197 students questioned). This information was compared with the company responsible for the electronic vote who, finding no technical error, argued that during voting, internet connection collapsed on various occasions.

The main reasons that the young people did not take part in the electronic vote were the following:
- Decided not to vote (33.70%)
- Lost their authorization (13.04%)
- System did not work (14.13%)
- Form of identification not accepted. (2.17%)
- Not having Java programme. (4.35%)
- The system was very slow. (1.09%)
- Considered the request exploitation. (3.26%)
- Were unable to pass from the first page of the system (6.52%)
- Lack of time (21.74%)

4.8 According to the youngsters, what advantages did the electronic vote have?

The advantages, according to the study, of the e-vote, is that the system is fast and easy (44.58%), it can be accessed from anywhere (16.27%) it is possible to increase participation. The young people assert that, why improve e-voting when there is already a good e-voting
programme (38.42%), that there should be more public computers available (31.64%) and that access to the internet should be more efficient.

4.9 Mandate

The mandate started on the 21st November with the Youth government constitution, that by consensus, voted that the head of the most voted list “Youngsters with Ideas” would be the mayor. The remaining six members became youth councillors and the municipal council briefs were handed out. Each of the young members elected, worked together with the town councillors and they saw exactly how municipal decisions were made and how different projects, underway at that moment, were developed.

The youth proposals were treated taking into account:
- The viability and technical possibilities of each proposal.
- The economic cost of every proposal
- The immediate, real necessity of the proposals
- The departments that would have to participate to develop the proposal.
- A criteria of priority relating to the cost and the need.

Of the 91 proposals collected from the young population 21 were approved in the Youth plenary session where the town councillors agreed to follow the proposals through and gave them an estimated budget. These 21 proposals were selected by the Youth government as the most important and necessary for the young population.

Another task that the young councillors worked on was a general town budget, which, at the time they entered into the government, had been finalised. The young members of the council were also present and involved, together with the town council, in the Sant Andreu de Llavaneres “Major” festival activities.

This co-operative governing has created a new link between the youth of Llavaneres and local government, in fact, the youngsters have taken the initiative to create a youth council with the aim to follow through the rest of the municipal proposals during the year 2009. Furthermore, the presence of the youngsters in the town council has modified the local politicians view in that the young people have made real and valid proposals and that now they have a more concise idea of their demands. As was commented, being young politicians has enabled them to comprehend that politics is a difficult job and to decide what is best for the town and its population is, at times, very complex, as there are many factors to take into account.

5. Final considerations

Although the present government is making a great effort to adapt to an innovative and technological society there is still a long way to go to arrive to an era of technological communications. For that reason it should be noted that the electronic vote, according to results, ought to be accompanied by the traditional voting system. The majority of the candidates on the lists, manifested that they would have liked to be physically present to vote, as they believe that the electorate have a right to see the evidence of their candidates’ vote.

Nevertheless, this pilot test might be more suitable for primary elections where the candidate to head the party is chosen. The test has shown that the preferential system had a strong influence and that the two primary candidates were easily toppled. On the other hand, not giving priority to the candidates, did not determine the real preference of the electorate.

With reference to electorate identification we consider that it is necessary to establish more valid methods of authenticity to avoid human error and maybe, in the long term the electronic identification document could correct this. It should also be noted that to implement a good technological system, such as e-voting, it is necessary for the programme to adapt to the technological resources available and also that it is simple to use.

At the same time, we should take into account that the youngsters should previously be involved in an indispensable process of participation and education so that the groups of youngsters can learn how
democracy works and become involved in municipal responsibilities and arrangements. The participation process has helped the young people to decide for themselves if they wanted to be a part of this project and have, therefore, been material in the creation of the five candidates, in their electoral programmes and in the belief that they can improve their town.

Finally, in conclusion, to involve and awaken youngsters’ interest in politics, electronic tools are not enough. However channels of communication need to be established or a new figure which we have called “Participation and Mediation Agent”, to ensure that coming generations approach public institutions.

Acknowledgements

The author would like to express their gratitude for the support provided by Joan Mora i Buch, Citizen Participation Councillor, the technicians and the Town Hall of Sant Andreu de Llavaneres.

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http://www.uoc.edu/idp/6/dt/esp/borge_colombo_welp.pdf


Fez e-Government Project: An Initiative Transforming Scientific Research to Value in Morocco

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Abstract: Information and Communication Technologies (ICT) are growing worldwide and changing many facets of modern life. Yet the digital divide persists with developing countries far behind. The low integration of ICT in emerging economies restricts opportunities in many fields of development. This paper presents a case study of ICT development in North Africa. It shows how the Fez e-Government Project (eFez), through government and academic collaboration, has assisted and transformed many of Morocco’s development challenges such as organizational misbehaviours and ills of bad governance in local government offices.

Keywords: e-government; Fez e-government; back-office automation; records computerization; records management; public value; intellectual capital

1. Introduction

In Morocco, local government offices known as Bureau d'Etat Civil (BEC), keeping records of citizens lives’ events, are the only institutions legally authorized to provide citizens with certificates authenticating their respective life events required for a variety of personal, formal and administrative procedures e.g. enrolling children in school, job seeking, applying for social services, requesting passports and other formal activities. As with other public administration activities in Morocco and on a greater scale other developing countries, the BEC operates in an archaic mode that was inherited from colonial authorities and completely predates the availability of digital techniques for information processing and management as evidenced by the complete absence of ICT use at any stage in its operational life cycle. The BEC offices in Morocco (estimated to be 2400 in total) provide their service (i.e. certificate issuance) both at the front office (i.e. the space that citizens experience and view) and back office (i.e. internal data processing and management closed to the general public). It remains completely manual and paper-based.

The archaic functioning of these community oriented government offices has led to a citizen-unfriendly service delivery characterized with numerous organizational misbehaviours such as the expectation to pass monetary tips in order to be served or to speed up service delivery (i.e. certificate issuance).

In response, the municipality of Fez collaborated with a research team of the ICT4D lab at Al Akhawayn University (Ifrane, Morocco) to address BEC related organizational misbehaviours. Accordingly, the project team launched Fez e-Government Project: eFez project in 2004 and successfully completed by November 2005 a pilot e-Government system/platform: electronic Fundamental Etat-civil System (eFES) funded by the International Development Research Centre (IDRC) through its Acacia Initiative and deployed in the local administration of the city of Fez. Project evaluation has revealed eFES transformative capabilities and influence on BEC organizational misconduct and local good governance conditions in general.

2. Background

Regardless of ICT worldwide increasing diffusion, regional disparities in e-Government implementations persist. For instance, Europe is one leading region in e-Government. The European Commission (EC) has been steering and promoting e-Government in Europe; even though it is a supranational entity not legally entitled to exercise direct authority on public administrations of Europe member states. Traunmüller and Leitner outline some of EC’s contributions to e-Government (2008). For instance, EC has been funding many of Europe e-Government projects under the umbrella of Research Framework Program. It has been organizing ministerial conferences to bring about Europe influential actors to make decisions and take actions in favour of e-Government implementation. EC has also organized three e-Government awards competitions in 2003, 2005, and 2007. Such an environment promoting e-Government implementation and pursuing innovative practices associated...
with it contributed to the mushrooming of public sector applications, particularly the public sectors as employment, social service, taxation, transportation, public protection, and public procurement.

Despite Europe ICT-based public sector deployments, most believe the transformation faces challenges (Ibid, 2008). These are mainly associated with issues such as interoperability and identity management, enabling administrations to pursue vertical and horizontal integration, service design improvements fostering e-Government service take up, and e-Participation implementations to improve public governance (Ibid, 2008). Not only does EC promote e-Government but also measures and assesses “the short and long-term results of IST-related RTD and deployment action performed at EU and national/regional level (Vontas, et al, 2008).” The rational behind e-Government assessment is measuring the value generation in the context of European e-Government implementations.

North Africa experiences difficulty in implementing e-Government though in close geographical proximity to Europe. Both share the same goal in integrating their respective regions yet, unlike Europe’s achievements within the European Community, the North African regional organisation, known as Arab Maghreb Union, has had little success. Because of deep disagreements between top North African officials, the union remains promissory and only on paper (Mortimer, 1999). As expected, there has been no supranational entity directing and supporting e-Government deployments in the region. Thus, individual states in North Africa separately launched their respective e-Government projects.

3. Fez e-government project (e-Fez)

Morocco is a rapidly developing country. By late 1990s the nation started recognising how ICTs are changing the world and thereby expressed the need to use ICT in response to two major challenges: the need to make a shift towards Information society and its underpinning ICT-mediated information intensive economy, and the need to improve governance quality towards fostering human development (Morocco, 2006). Using ICT as a development tool to Morocco’s sustainable socio-economic development became increasingly expressed as a ‘national aspiration.’ This was first officially and publicly articulated in the speech of His Majesty, King Mohamed VI, delivered during the symposium on Morocco at the Global Society of Information and Knowledge (‘Le Maroc dans la société globale de l’information et du savoir’ in French) held in 2001(Morocco, 2007).

Respectively, Morocco set up public sector modernization agenda, which rests on two major components: 1) the liberalization of the telecommunications sector; and 2) the development of eGovernment services. The telecommunications liberalisation has been successful; for instance, the penetration rate of telephony services improved from merely 5% in 1998 to 64.18% in June 2007 (ANRT, 2009). eGovernment, however, remained arguable; discussions on the elaboration of Morocco’s national cyber strategy started as early as 1993 and did not produce the needed ICT national framework until 2005 (Morocco, 2007); in addition to the delay in adopting the needed national cyber strategy, many ICT application initiatives were either abandoned or not fully implemented. Morocco’s unsatisfactory eGovernment actions is reflected in ICT low penetration, diffusion and use in areas, such as education (schools, universities, and libraries), commerce (companies and enterprises), and public administration (Mousbit, 2007).

In response to this slow implementation status, the city of Fez collaborated with a research team at Al Akhawayn University in Ifrane (AUI) known as Information and Communication Technologies for Development (ICT4D) to contribute to Morocco’s ICT integration and concerns. The project team (i.e. Fez municipality and ICT4D lab) opted for building a pilot e-government project in real-life settings (i.e. Fez) so that to investigate ICT implementation issues, specifically those related to using ICT to transform municipal service delivery. Accordingly the project team launched eFez project in 2004 and successfully completed a pilot e-government system/platform: electronic Fundamental Etat-civil System (eFES) in November 2005, funded by the International Development Research Centre (IDRC) of Canada through its Acacia Initiative and deployed in the local administration of Fez.

Lucratively, eFez introduced and initiated the use of ICT within Morocco’s pilot local government in Fez. Building an e-Government system intended to use electronic means to automate the service delivery of one of the mostly used citizen-centric services: Etat-civil certificates, issued at the local government office known as Bureau d’Etat Civil (BEC) entrusted with filing official records of citizens’ declared life events such as birth, changes in one’s name, marriage, divorce, and death. Specifically,
the project automated the BEC back office and electronically enabled the front office via a web portal and a related touch screen kiosk, available for public use and adapted for the illiterate. The ICT4D research team, within a PPP (Public-Private-Partnership) environment, built eFES platform with two complimentary building blocks:

- BEC back-end component, which retools BEC office via the automation of internal operations and processes to streamline employees’ work
- BEC front-end component, which provides front-line database technologies accessible via staff networked desktops and (self-service) touch screen kiosks to allow citizens to have convenient, speedy, transparent, and easy access (i.e. request/receipt) to necessary documents (Kettani et al, 2009)

The collaboration between Fez and ICT4D team at Al Akhawayn University was further motivated with the recognition of the e-Government worldwide track record. Sharon Dawes during the 2007 ICEGOV conference talked about the significance of e-Government in the last 10 years, with urgency in reinforcing collaboration between research and practice. Underdevelopment between the two has restricted the potential of e-Government transformative properties. In fact, “Even when actual research results are implemented, there are delays in the implementations.” (Makolm et al, 2008: 428). Furthermore, there has been technology-centred approach with respect to e-Government; issues such as interoperability, identity management, security, and users take-up have been addressed in technical ways by focusing on the technical implementations; non-technical issues called also ‘people’ related issues (e.g. organizational, political and social obstacles) have been overlooked which has led to shortcomings in ideal e-Government transformations (Heeks, 2001). Therefore, there is increasing awareness that the “transformation potential is mainly in the cooperation of the triad of research, industry, and administration. Promising is the contemporary transformation of research results into user-friendly applications (Makolm et al, 2008: 429).”

In light of these circumstances, the collaboration between Fez and ICT4D team at Al Akhawayn University conducted research in Fez’s real life settings to facilitate converting research results into practice in a productive way. This was done by implementing a real-life e-Government system for the city of Fez in an action research mode. Fez was used as a real-life laboratory or test-bed environment to conduct a tactic of e-Government called ‘concept-of-proof.’ Accordingly, the PPP between Fez and ICT4D team at Al Akhawayn University transformed scientific research into value via developing and implementing what is known as ‘back-office to front-office’ integration (United Nations, 2008). Such integration modernized and retooled the BEC office, enabling an automated service delivery. Respectively, eFez is a case where technological innovation (i.e. back-office to front-office integration) became a practice in Morocco thanks to the joint venture of academia, public administration, and private sector. This is a rare administrative arrangement of research projects in Morocco and to a larger extent, developing countries.

4. e-Fez results

4.1 Methods overview

Greater than the research actions focused on building an ICT based system responsive to the needs of stakeholders, the eFez team (including members at the municipality level and university level) pursued learning about e-Government possible outcomes and changes possibly triggered in a public administration still loyal to a bureaucracy model, operating in a developing country context such as Morocco. Accordingly, the research team not only built the system according to the stakeholders’ perceived requirements but it also assessed the influence of this e-Government output on the public administration and the people running and operating it.

To conduct needed assessments, it was important to delimit and define the scope of eFez intervention with respect to the public administration. The work of Shahin and Finger (2008, 25-27) differentiates between two interlinked elements in public sector: democratic governance and institutional governance. Democratic governance is ‘more about the perceptions of the institutions from the outside.’ At the politics level, governance refers to the interactions of state and non-state actors to influence and set the agenda; and at the policy level, governance refers to dynamics to collectively issue legislation or ‘co-legislation.’ Institutional governance ‘looks from the inside at an institution’s ability to govern.’ The work of BEC offices (consisting of keeping citizen’s life-event records and issuing certificates upon citizens’ request) is institutional governance, which is the focus
Correspondingly, the research team observed and studied BEC institutional governance before eFez implementation and after the deployments of the eFez platform and its operation within Fez pilot BEC offices. The two-temporal studies enabled comparing the institutional governance (service delivery) to identify and map changes produced by ICT intervention. The studies used intensive fieldwork to observe and conduct interviews. The studies were also supplemented with use of survey tools.

As an example, one of the most recent surveys was conducted in early January 2009. The survey rational was the recognition that two years have passed since the eFez scaling up/rolling out phase (eFez-2) started. Accordingly there has been a growing need to learn about the achievements during the two year period.

The survey focused on the following matters:
- Changes that have passed at the BEC offices involved with eFez-2 automation
- Categorizing the perceived changes
- Organizational value of the BEC changes observed in eFez-2
- Behavioural changes developing through the city-wide implementation of eFES platform
- Other issues/concerns emerging from Fez city-wide scaling up of automation
- Feedback actors have on improving eFES platform performance

To fulfill the above survey objectives, the Survey Target Population was defined. First, the survey captured perspectives of one key player in eFES automation; those operating eFES technology as the intermediary/facilitating agents: the BEC officers. The rolling out phase has included 12 BEC offices in Fez. The survey elaborated and used questionnaires combining open and closed-ended questions in an effort to capture quantitative and qualitative data. To minimize bias and maximize the response accuracy, the questionnaire was administered by field reporters unknown among the target respondents. They visited targeted BEC offices for two days [12-13 January 2009], spending an average of thirty minutes per office. During his visits, they requested each officer to complete their questionnaire (elaborated in the Arabic language). The reason behind this was to give participants confidentiality and a secure climate to speak their minds freely and aid in accurate data collection.

4.2 eFES findings

4.2.1 Efficiency gains

The survey generated several findings. There was 100% response rate; the twelve target BEC offices participated in the survey by completing the questionnaire. The survey revealed a consensus on recognizing changes taking effect the way BEC functions and delivers services. The most noticeable change [75%] was delivery high speed & quality. The survey revealed positive changes with respect to the following organizational elements:

- **Delivery elapsed time:** dropped from an average of 48 hours to 6 hours waiting time
- **Certificate delivery:** improved from ‘poor’ [58%] to ‘excellent’ [83%]
- **Error rate:** dropped from ‘many errors’ [58%] to ‘few errors’ [83%]
- **Employees effort input:** reduced from ‘too much effort’ [91.7%] to ‘less effort’ [66.7%]; to ‘no effort’ [25%]
- **Productivity:** improved from an average of 689.09 daily certificate delivery [minimum 80 – maximum 1500 per day] to 828.18 daily [minimum 100 – maximum 2000 per day]
- **Labour:** dropped from an average of 10.09 employees per BEC [minimum 2 – maximum 20] to an average of 2.27 employees per BEC [minimum 1 – maximum 8]
- **Citizen relations:** tense/conflict relations dropped [58.3% to only 8%]
- **Work conditions’ problems:** ‘too much stress’ [25%] and ‘unqualified employees’ [16%] were previously the main problems. In the survey, the main problem was ‘need for IT equipment, IT training, and labour for records’ digitization’ [24%]
Perceived organizational value of BEC changes attributed to eFES: 91.7% recognize/admit eFES saved him/her time and effort in delivering BEC certificate. The quantification of time and effort saved is as follows: 33% indicated eFES saved them 80%; 25% indicated a 90% savings and 33% indicated a 100% savings.

These survey findings show clearly that eFes intervention generated efficiency gains in BEC institutional governance. In this sense, eFes contribution was bringing about unprecedented efficient institutional governance in Morocco, a developing country context.

4.2.2 Public value

Further fieldwork and investigative studies have revealed that eFes not only facilitated BEC efficient institutional governance but also facilitated ethical efficient institutional governance. This is shown in the table below where eFes results are categorized according to the UN list of Good Governance attributes:

Table 1: e-Fez ethical aspects (source: Kettani et al, 2008)

<table>
<thead>
<tr>
<th>GOVERNANCE ATTRIBUTES</th>
<th>MEASURED INDICATOR</th>
<th>VALUE BEFORE AUTOMATED SYSTEM DEPLOYMENT</th>
<th>VALUE AFTER AUTOMATED SYSTEM DEPLOYMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transparency</td>
<td>Visibility of workflows for citizens via automated service delivery</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- No: Since the BEC back-office is completely manual, sub processes of making BC request, processing the request, and filling out the needed copies of BC are carried out in separated way (and sometimes with different employees). The citizen cannot monitor/ see the processing progress of his BC (e.g. the possibility of length/possible reasons for a delay in a processing are neither accessible nor visible).
- Yes: Since the BEC back-office is electronically enabled, sub processes of making BC request, processing the request, and printing the processed BC are merged in one process carried out on a real time basis. This secures the principle of: first-come-first-served.

| Effectiveness and efficiency (as a citizen user) | Efficiency: optimal use of resources for citizens to request & obtain BC | No | Yes |

- No: requesting and obtaining BC is costly for citizens: extended waiting time several trips to BEC need to tip (or use social connections).
- Yes: Citizens making time/money/effort savings in requesting and obtaining BC: no waiting time one trip to BEC no tip.

| Effectiveness and efficiency (as tax payer) | Efficiency and effectiveness of using scarce public resources | No | None |

- No: To deliver BC, BEC needed 3 full time employees (when demand on BC is low and moderate ) When demand on BC is high (during summer and early Fall period: from June to Sept.): All BEC employees (10) stop processing their respective tasks in order to process BC requests. Furthermore, they take BC requests home to be processed (which is illegal ).
- None (i.e. casual calls on employee time with the elimination of 3 full time dedicated employees) No BC full time employee: (any of the employee can instantly process BC requests while doing her other BEC related manual tasks) With the kiosk: no employee is needed to process the requests.

| Equity | Citizens served in equitable manner | No | Yes |

- No: Usually queuing/waiting creates motives and conditions for bribery.
- Yes: ICT eliminated the need for citizen to tip in order to be served.
Regarding the above ethical aspects, eFez stimulated what is increasingly known as ‘Public Value Management.’ This is another view advanced by Stocker in e-government thinking (Shahin and Finger, 2008: 26). The beginning of e-government debate in the 1970s and 1980s was solely driven by “New Public Management” principles where e-government was promoted to improve the efficiency of public service delivery. Yet Public Value Management emerged as alternative perspective where, “… the public sector is not driven solely towards a goal of greater efficiency, but towards the aim of delivering more public value. One of the means towards achieving this goal can indeed be the increased efficiency and effectiveness of government services, but this remains one of a plethora of
aims: others include the need to ensure transparency, accountability, legitimacy, representation, and empowerment (Ibid, 27).”

4.2.3 Intellectual capital

A closer look at the eFez research practice experience shows that eFez not only stimulated an increase in public value, but also brought about e-Government as a lever of change in Morocco. E-Government is frequently viewed as a tool “to improve effectiveness, efficiency, and friendliness in the public sector and as a consequence to improve peoples’ quality of life and to facilitate economic growth (Cellary, 2008: 150).” Nevertheless, one alternative approach views e-Government as “a direct lever to speed up positive transformations aiming at electronic knowledge-based economy and information society. This strategy is valid for all the countries, independent of how rich or poor they are (Ibid, 2008).” In this respect, one way to address e-Government is to “consciously create an internal market of digital products and services by transforming the whole society - all generations - to the information society. In other words, it is necessary to massively educate people how to use internet and to provide them with internet access, including PIAPs (Public Internet Access Points), in order to stimulate demand for digital products and services (Ibid, 2008).” Here digital products and services do not mean e-Government ‘hard’ component, software development; rather, they refer to e-Government ‘soft’ element, meaning content creation. The success of eFez research practice experience fuelled a growing recognition to roll out the eFez system to cover all of Fez’s thirty-three local government offices. This included working on the back-end of these offices to convert the paper based records to digital records. As the conversion operation is legally demanding and requires full-time labour, the municipality contracted out a company, which employed fifty-seven public university graduates to perform the job. The conversion of citizens’ lives events records is conducted on city-scale level (serving a population of one million). This is Morocco’s first large scale records’ digitization experience conducted in a metropolitan area. In addition, all employees of the twelve automated offices already abandoned delivering handwritten certificates and adopted the platform to generate and print requested certificates.

In fact when platforms need trouble-shooting the employees refuse to handwrite certificates, rather, they call the IT department for technical intervention. Last summer, one BEC office, called Atlas, ran out of printing ink. The employees phoned the county seat responsible for supplies and discovered the delivery of office supplies had been delayed. The county Secretary General was surprised when he found out that employees gathered together their pocket money and collectively purchased printing ink for immediate use. He was surprised because purchasing something for the public administration is unexpected of low ranking civil servants with modest salaries. They justified the purchase with their unwillingness to go back to the old practice of handwriting certificates and the reluctance of citizens to accept handwritten certificates.

At present, citizens (BEC certificates recipients) not only expect receiving printed certificates but also have greater expectations in regards to the protocol at BEC offices. An increasing number of citizens abandoned the conventional way of requesting certificates: approaching the employee in charge. Instead they have grown accustom to using eFez self service technology: a touch screen kiosk deployed at the BEC office, available to the public, free of charge, and more importantly adapted to the illiterate user profile. At least five of the twelve offices with automated service delivery, more than 95% of citizens request and print their certificates themselves and have them signed by BEC officer (free of shuffling through different chains of the administration). Touch screen kiosks have been used by banks for the last ten years but their use in public administration is only a few years-old. In addition, with the rolling out phase of the eFez project still in progress, the research-practice team initiated the concept of building a data centre to facilitate the interconnection and joining up of automated offices. Morocco’s first data centre in public administration is commencing in Fez. The eFez rolling out demonstrated its multidimensional effects and inspired the central government to allocate sixty million Euros to launch a project, digitizing citizens records in all of Morocco’s 2400 BEC offices (Rmiche, 2008). Now, BEC records digitization has become a priority for local and central governments in Morocco.

Furthermore, the eFez research-practice experience generated value with respect to intellectual capital. One long-term debate among economists discusses how organizations succeed and maintain a good track record. In the 1990s intellectual capital, as ‘intangible assets’ or enablers facilitating organizations’ success, became popular with the Swedish insurance company Skandia (Vontas et al., 2008: 424). Skandia developed a model known as ‘Skandia navigator’ on what determines the market
value of an organization. The model indicates that the market value rests on organizations’ financial capital and intellectual capital. This includes the following asset areas:

- **Human capital**: Includes employee brainpower, competence, skills, experience and knowledge
- **Customer capital**: Includes relations and networks with partners, suppliers, distributors, and customers. It also includes the image of the organization in the market, its social identity, and brand equity
- **Structural capital**: Covers every intellectual capital that can be owned by the organization including business processes, practices, databases, systems and intellectual property (Vontas et al., 2008: 424)

Based on this model, we tried to compile and categorize intellectual assets produced with eFez research and practice experience:

**Table 2: e-Fez intellectual capital**

<table>
<thead>
<tr>
<th>Asset Areas</th>
<th>eFez Contributions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Capital</strong></td>
<td>eFez enabled the Creation in 2005 of a spinoff service provider entity, Enhanced Technologies, specialized in developing and integrating free and open software to serve Morocco’s public administrations via: automating back office, electronically enabling the front office, creating and diversifying electronic delivery channels</td>
</tr>
<tr>
<td></td>
<td><strong>Market Capital</strong></td>
</tr>
<tr>
<td></td>
<td>eFez enabled creating and maintaining collaboration network with: Suppliers: via maintaining business relations with network cabling providers, WiMax - WiFI and infrastructure installation providers, touch screen kiosk hardware re/sellers Research effective/potential users (i.e. public administrations): eFez started with collaborating with Fez-Agdal county; with eFez pilot success, collaboration expanded in 2006 to include Fez five remaining counties; and with eFez successful rolling out in Fez, collaboration expanded to include ten additional Morocco’s cities (i.e. local decision makers) and Ministry of Interior (i.e. central decision makers) Researchers: via joining and actively participating in two pan-African research networks: LOG IN Africa network (since 2005) and Wireless-Africa initiative (since 2008).</td>
</tr>
<tr>
<td></td>
<td><strong>Process Capital</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Renewal/Development Capital</strong></td>
</tr>
<tr>
<td></td>
<td>eFez has been conducted and led within an ecology integrating research with practice by facilitating a constant transfer of research results to be converted into practice fully materialized. Within this research-practice collaboration environment, research team investigates and defines users’ perceived needs; then, proceeds to building appropriate solutions in a participatory and iterative manners following gradual approach consisting of these steps: finalizing Proof-of-concept, integrating the systems’ different modules, developing and implementing the Prototype in a real-life setting, conducting real life deployment; and then, proceeding to scaling up/rolling out phase (in order to contribute to accelerating ICT diffusion in Morocco). eFez Research team grew from five members to thirty members</td>
</tr>
<tr>
<td></td>
<td><strong>With eFez ongoing rolling-out, the research team explores:</strong> New ideas: building Morocco’s 1st Data Centres to accelerate automation and enable the joining up of local government offices New technologies: installing WiMax metropolitan area network in Fez to enable the interconnection between and among Fez local government offices</td>
</tr>
</tbody>
</table>
Clearly, pursuing innovation in a research-practice environment has made eFez generating and producing assets and resources feeding intellectual capital.

5. Conclusion

It is clear, Fez e-Government project has generated multidimensional value: (1) enabling efficiency gains for BEC administration, (2) infusing public value in BEC institutional governance, and (3) facilitating the generation of intellectual capital. This shows the transformative capabilities of pursuing innovation within triad collaboration: academia, public administration, and private sector. Such transformative capabilities have great potential in scope, influence and performance if such a triad collaboration is promoted within Morocco and among other North African countries via the Maghreb Arab Union.

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References


XML Schema Design and Management for e-Government Data Interoperability

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Abstract: One-stop public services and single window systems are primary goals of many e-government initiatives. How to facilitate the technical and data interoperability among the systems in different government agencies is a key of meeting these goals. While many software standards, such as Web Services and ebXML, have been formulated to address the interoperability between different technical platforms, the data interoperability problem remains to be a big challenge. The data interoperability concerns how different parties agree on what information to exchange, and the definition and representation of such information. To address this problem, the Hong Kong government has released the XML Schema Design and Management Guide as well as the Registry of Data Standards under its e-Government Interoperability Framework initiative. This paper introduces how the data modelling methodology provided by the Guide can be used to develop data interfaces and standards for e-government systems. We also discuss how the Macao government has formulated their data interoperability policy and has applied the Guide in their situation.

Keywords: e-government data interoperability, XML schema

1. Introduction

Hong Kong and Macao are two special administrative regions (SARs) of China. Under China's one-country-two-systems framework, the two cities are administered by their own governments. The two SAR governments are actively implementing one-stop electronic services for citizens. This way, citizens can find and access public services in a single government portal through the Internet without knowing which government departments offer what services. However, the information systems of different government departments are generally independent and heterogeneous, and one single information system for all departments is unlikely to take place for various reasons. This leads to the requirement to establish an interoperability framework for system integration among different departments. This paper discusses how Hong Kong and Macao SAR governments formulate their interoperability frameworks, particularly in enabling data interoperability among different governments using the Extensible Markup Language (XML) (W3C 2004).

1.1 Hong Kong digital 21 strategy

First launched by the Hong Kong Special Administrative Region Government (HKSARG) in 1998, the Digital 21 Strategy (HKSARG 2008) is a strategy paper setting out the blueprint for development of information and communications technology (ICT) in Hong Kong. The paper is maintained by the Digital 21 Strategy Advisory Committee, represented by ICT experts from the government, the industry and the academia in Hong Kong. It is updated regularly to reflect the current technological advancements and changing society needs. The current issue is 2008 Digital 21 published in December 2007; one of its action items is:

“Based on the experience gained through the development of the Interoperability Framework for e-government systems, the Government will collaborate with different sectors to develop industry-specific data standards taking into account international standards and best practices. In the process, we will also attempt to enhance interoperability between the data standards of different sectors to facilitate the provision of joined-up, value-added services.”

1.2 HKSARG Interoperability framework for e-government

A key business objective of e-government initiatives is to provide client-centric joined-up government services to the public. In HKSARG, public services are offered by different HKSARG Bureaux and Departments (B/Ds) in a distributed fashion. To provide one-stop comprehensive services, seamless

Reference this paper as:
flow of information across individual B/Ds is a prerequisite. In 2003, the HKSARG Information Technology Services Department, now known as Office of Government Chief Information Officer (OGCIO), established the Interoperability Framework (IF) for E-Government (OGCIO 2008) to meet this objective. IF maintains a collection of technical and data specifications to support different B/Ds to exchange data between their systems in order for implementation joined-up public services. Adopting XML as a key technology to define data exchange interface, IF enables computer systems developed on heterogeneous hardware and software platforms by different B/Ds to interoperate with each other.

A special organization structure called Interoperability Framework Co-ordination Group (IFCG) is formed, with experts from the government and industry, to oversee the IF development. IFCG coordinates with the specialist groups across B/Ds who develop specific interoperability standards for their respective business areas. Being a long-term and on-going strategic effort, IFCG regularly reviews IF every 6-12 months in order to accommodate new business requirements and current technology developments. There is a compliance policy which requires all B/Ds to adopt the IF when implementing new systems that need to exchange data with systems of other B/Ds and external parties. Moreover, IT suppliers and system integrators are also obliged to ensure their solutions provided to the government comply with the IF requirements.

1.3 Three dimensions of interoperability

IF addresses three dimensions of interoperability, namely technical interoperability, data interoperability, and process interoperability. The XML Schema Design and Management Guide (OGCIO 2006) describes these terms as follows:

- **Technical interoperability**: agreement on what communication protocol and message format to be used when one party sends information to another; e.g. the purchase order shall be encoded in XML, as defined by a specific XML schema, and XML Encryption and XML Signature shall be applied on certain content components, and the XML message shall be sent via HTTP.

- **Data interoperability**: agreement on what information has to be transmitted from one party to another, and the definition and representation of such information; e.g., the “delivery date” has to be specified on a purchase order, and the definition of “delivery date” is the date on which goods shall be received by the buyer, and the representation of “delivery date” adopts the ISO 8601 standard.

- **Process interoperability**: agreement on how the business activities of the concerned parties affect each other, i.e., the business rules; e.g., when the seller receives a purchase order from the buyer, the seller should accept or reject this order within a specified time period.

To address these dimensions of interoperability, IF maintains two sets of documents. The first set of documents, which include the **HKSARG Interoperability Framework and Analysis Underpinning the HKSARG IF Recommendations**, recommend a collection of technical specifications for implementation for application in different interoperability areas. For example, in the Application Integration Domain, Web Services standards SOAP v1.1, WSDL v1.1, and UDDI v2 are recommended for simple functional integration in an open environment while ebXML Message Service (ebMS) v2 is recommended for reliable message exchange between application systems in an open environment for business document oriented collaboration. This means when a new e-government project is recognized to fit a particular interoperability area, the B/D responsible for the project and their IT contractors are required to adopt the recommended technical standards in system implementation.

The other set of documents are collectively called **XML Schema Design and Management Guide (OGCIO 2006)** (Schema Guide). They are developed to address data and process interoperability. In this paper we focus to discuss about the contents of this Guide, which is covered in Sections 2. HKSARG has also created an online portal called the **Registry of Data Standards** to manage the e-government data standards called **Common Schemas**, which is discussed in Section 3. Section 4 lists some e-government projects that have adopted this framework. Finally, Section 6 concludes this paper.

2. **XML schema design and management guide**

The Center for E-Commerce Infrastructure Development (CECID) of The University of Hong Kong was commissioned to develop the XML Schema Design and Management Guide to help B/Ds and IT
Thomas Lee et al.

contractors define and adopt e-government data standards. This Guide provides the following to address the data and business interoperability of government-to-government (G2G) and government-to-business (G2B) joined-up services:

- a methodology for business analysts to specify the definitions and representations of information in a consistent and structured way as reusable information models,
- an approach for programmers to convert the information models of the data elements into W3C XML Schema Definition (XSD) (W3C 2004) code,
- the guidelines for the concerted alignment of the definitions and representations of data elements that have potential for reuse in joined-up services, thereby standardizing the XML schema code for these data elements, and
- the guidelines for project teams to adopt suitable concertedly aligned data elements and their standardized XSD code and also to contribute reusable data elements for concerted alignment.

The Guide consists for four parts:

- **Part I: Overview** states the objectives of the Guide and outlines its contents, and describes the data interoperability problems and strategy in e-government development. This part also covers the data interoperability measures and the guiding principles.
- **Part II: XML Schema Design Guide** provides a systematic design methodology for business analysts to model the business process and information requirements in a joined-up project. It also provides the rules for programmers to convert the information models into XSD code.
- **Part III: XML Schema Management Guide** serves as a handbook for various parties to align data elements from different projects to create data standards among B/Ds. It facilitates the development and management of reusable XML Schemas. It also helps project teams understand the process of data alignment, and their role in contributing reusable data elements for concerted alignment.
- **Part IV: Appendices** provide supplementary information to help the readers understand this Guide. Most importantly, there is a case study on using the Guide to define data standards for application for import and export licences for pharmaceutical products and medicines. This part also provides a collection of worksheets for specification of process and information models.

### 2.1 XML schema design guide

The XML Schema Design Guide (Design Guide) documents a comprehensive XML schema design methodology. There are five core sections: (1) Schema Design Process, (2) Business Process Modelling Methodology, (3) Business Information Modelling Methodology, and (4) XML Schema Definition Development. Unlike other methodologies, such as UN/CEFACT Modelling Methodology (UMM) (UN/CEFACT 2001), the Design Guide provides analysts and developers with an end-to-end and seamlessly integrated schema design methodology. It covers modelling techniques from business process modelling, data modelling to XSD coding.

#### 2.1.1 XML schema design process

The schema design process of the Design Guide is shown in Figure 1. It guides a project team to develop the XML data interface, i.e., XSD, for a government system to exchange data with other government or business systems. The process involves two types of schemas: **Project Schemas** and **Common Schemas**. A Project Schemas only needs to satisfy the specific requirements of a particular project while Common Schemas are reusable across projects and among different B/Ds. Common Schemas are centrally standardized in the government and are shared publicly in the Central Registry. Another difference between Project Schemas and Common Schemas is as follows. A Project Schema is usually document-oriented, like purchase order, because it is ready for use for data exchange. A Common Schema is data-element-oriented, such as address, person name, while it is used as a building block to construct Project Schemas.

The design process can be summarized as follows. First of all, the project team collect and analyze the user requirements to see if there is a suitable industry standard, e.g., Universal Business Language (OASIS 2003). The team start to design a custom schema only when no industry standard is suitable. Then, the business analyst models the business process in which the system exchanges data with other systems, and identifies the business documents involved in the exchange. For each
identified document, the business analyst builds its information model, i.e., the document structure as well as data constraints. The data models are converted into XSD code of the Project Schema by software tools. If the project team anticipate some data elements in the Project Schema are generic enough for reuse by other projects in future, they can propose these data elements for central standardization as Common Schemas.

Figure 1: XML schema design process

2.1.2 Business process modelling

The business process modelling (BPM) methodology is derived from the ebXML Business Process modelling approach (OASIS 2001). A business process is modelled as a collection of business collaborations. A business collaboration is a choreography of business transactions. A business transaction is an abstraction of a single document exchange, which can be a one-way or two-way document flow between two parties involved in the collaboration. When the flows of documents between different parties are identified, these documents will be modelled in the next stage.

The Design Guide provides a set of modelling worksheets for business analysts to fill in the requirements of business collaborations and business transactions. For example, the worksheet in Figure 2 documents an order entry business collaboration, which involves a buyer as the requesting role and a seller as the responding role. Two business transactions, namely Request Quote and Create Order, are identified in the collaboration. The Request Quote transaction involves an exchange of two documents Quote Request and Price Quote while the Create Order transaction is an exchange of Purchase Order and Order Confirmation documents. These documents will be used for business information modelling. The process model can be specified as a UML activity diagram.
2.1.3 Business information modelling

The business information modelling (BIM) process gathers the requirements for the business documents identified in the business process modelling. These requirements are usually in form of paper and electronic copies of those documents that are currently exchanged manually or in old electronic fashion. The modelling methodology simplifies and extends the ebXML Core Components Technical Specification (CCTS) (UN/CEFACT 2003) and allows business analysts to specify documents and data elements as the following information models:

- **Business Document**, modelling an electronic document as a unit for business information exchange; a root Aggregate Business Information Entity is used to provide the representation of the document,
- **Aggregate Business Information Entity (ABIE)**, modelling an object class and aggregates Basic and Association Business Information Entities as the properties.
- **Association Business Information Entity (ASBIE)**, modelling a complex property in an object class.
- **Basic Business Information Entity (BBIE)**, modelling a singular property in an object class.
- **Core Component Type (CCT)**, modelling a basic business data type as a building block for the above models.

BIM provides a set of Core Component Types (CCTs) as the basic business data types for building other the information models. In addition to the CCTs proposed in CCTS, e.g., *Amount, Date Time, Code, Quantity, Measure*, etc., BIM provides new data types, e.g., *Count (integer Quality), Boolean (true or false), and External*. The *External* type allows the data structure to be defined outside the pre-defined set of CCTs by an external XSD complex type. The relationships of these information models can be represented by a UML class diagram like Figure 3.

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**Figure 2**: Sample modelling worksheet for a business collaboration.
BIM provides a modelling spreadsheet as shown in Figure 4 for business analysts to enter the specifications of information models. The spreadsheet contains user-friendly macros that guide users to enter various attributes required by different models on specific dialog boxes. It also allows users to import and select existing models for reuse in defining new models. Moreover, the models specified in the spreadsheet can be converted into XSD code through an XML Stylesheet Language Transformation (XSLT) script without programmers’ involvement.
2.1.4 XML schema definition development

The Design Guide provides a comprehensive specification to standardize the conversion each information model into XSD code. For example, each BBIE or ABIE is converted into an XSD complex type. The specification has adopted the Venetian Blind XSD coding convention. A standard library (i.e., XSD file) for the set of CCTs is provided for inclusion in the XSDs developed from the information models. Since the conversion mechanisms, including XSD representations of models as well as the naming convention of types and elements, have been standardized, the conversion from information models to XSD code can be automated. The BIM spreadsheet has provided an XSLT script for this purpose.

2.2 XML schema management guide

The XML Schema Management Guide (Management Guide) defines the framework (e.g., policy, organization structure, etc.) to manage the Project Schemas and Common Schemas defined using the Design Guide.

The Management Guide describes:

- the considerations for the managing Project Schemas as well as their controlled vocabularies, e.g., code lists, namespace, etc.,
- the management process and organization structure for concerted alignment of reusable data elements proposed by B/Ds for standardization of Common Schemas, and
- the guidelines for building a Project Registry and the Central Registry for sharing Project Schemas and Common Schemas respectively.

Each Common Schema is associated with one of the following three maturity levels and the criteria to promote a Common Schema to a higher level are described in Figure 5.

- **Level 0 – Agreed in principle.** B/Ds have generally agreed on the definition, representation, and usage context of the concerned data element, but among those B/Ds that believe the data element might be applicable to their business, the majority anticipate that they require further investigation and analysis before adopting the Common Schema.
- **Level 1 – Recommended for reuse.** B/Ds have generally agreed on the definition, representation, and usage context of the concerned data element, and among those B/Ds that believe the data element might be applicable to their business, the majority anticipate that they are ready to adopt the concerned data element in most of their future projects
- **Level 2 – Matured for reuse.** B/Ds have generally agreed on the definition, representation, and usage context of the concerned data element, and among those B/Ds that believe the data element might be applicable to their business, the majority anticipate that they are ready to adopt the concerned data element in most of their future projects. In addition, the concerned data element has already been used in some projects and the information model of this data element has remained stable for a certain period.

![Figure 5](www.ejeg.com) Promotion of the maturity level of a common schema
3. Central registry of data standards
HKSARG has established the Registry of Data Standards (Registry) at http://www.xml.gov.hk as the central repository to share the following resources:

- **Common Schemas**, i.e., standardized Common Schemas reusable across B/Ds. Examples of currently available Common Schemas are different address formats, and English and Chinese names of Hong Kong citizens.
- **Project Schemas**, i.e., data models and XML schemas specific to different e-government projects.
- **Code lists and XML namespaces of Common and Project Schemas**.
- **References**, i.e., soft copy of the Guide and all papers discussing the design principles and considerations in aligning data elements.
- **Software tools**, such as modelling spreadsheets (Excel and Open Office), programs to generate XSD code from spreadsheet models, and schema documentation tools.

4. Application in e-government projects
Many e-government projects have applied the Guide to create their Project Schemas. The following are some examples:

- **Automation of dangerous goods manifests submission** (Marine Department 2003). The project facilitates shipping companies to automate submission of dangerous goods (DG) manifests to the HKSARG Marine Department in the form of XML messages through the Internet. The DG messages are transferred using the ebXML Message Service protocol.
- **Weather information in XML** (Hong Kong Observatory 2007). The Hong Kong Observatory publishes weather information in XML for businesses, such as media and transport companies, and government departments to automate processing of weather information.
- **Works Project Information Standard** (Development Bureau 2009). The HKSARG Development Bureau defines a large-scale XML data standard for various building and construction domains to realize electronic data exchange among various stakeholders in construction projects.

5. Clustering service scenario in Macao SAR government
Macao SAR government is pursuing e-government implementation for many years. They have established many e-government facilities, for instance, the Government Portal, public key infrastructure (PKI), Common Payment Gateway, geographic information system (GIS), eForms and many government websites. The current data interoperability standard for Macao SAR government is yet becoming explicitly comprehensive and completed. One important obstacle for such situation is because of the lack of joined-up services among departments, which is the main driving force for reaching data agreements and data alignment standards. Yet, this obstacle does not preclude the establishment of a unified XML schema design and management framework for new e-government scenarios. One important scenario is about how to develop and manage XML schemas for clustering services or shared services. The concept of clustering services was suggested in the six stage e-government transformation model (Turban 2006), which was proposed by Deloitte Research in 2000 and has been widely cited by academic research papers. The Deloitte Six Stage Model provides a comprehensive development path of e-government. This model provides the insight of developing data standards for e-government clustering services. A common service is to bring up and cluster the shared services into a common platform for citizens. Shared services are usually separated from service requesters through the application of information and communication technology. A shared service is a generic service that is jointly developed by government departments and can be used many times in different business processes of various government agencies. Janssen and Wagenaar (2004) suggested that shared services can be developed by unbundling and centralizing activities. Shared services can be developed using Web Services technology. Their architecture should provide the flexibility to include common services and functionality provided by legacy systems, which cannot be replaced easily and would otherwise restrict further development.

In the Deloitte Six Stage Model, the six stages are:

- **Stage One**: information publishing / dissemination.
- **Stage Two**: “official” two-way transactions.
5.1 Adopting HKSARG XML schema design and management in Macao

In view of adopting the HKSARG XML Schema Design and Management in Macao, a unified framework to design standardized Common Schemas for e-government clustering services or shared services receives high attention due to its practicability. In the adopted method for Common Schema development, a clustering service will be nominated and selected by an e-government task force. The nomination of the shared service is based on the consideration of its commonness and separability from the services being delivered. For instance, the address change service is a typical shared service among different government departments. The address data is common in most government services and its administrative functions could be reorganized as a shared service, e.g., for creation, update, deletion and authorization of address data. To turn the address change service (ACS) into a shared service, the main considerations heavily rely on the data interoperability on the address data exchanged among government departments. This requires an address data standard for ACS. During the system design of the nominated clustering service, business process and information modelling will be done. In the ACS case, the workflows and the computerized forms for address creation and modification will be captured, analyzed, and modelled using BPM and BIM spreadsheets. Then, the macro program in BIM spreadsheet is run to generate the required XSD code from the data model. For the XML schema management framework, since clustering services are the common among the majority of the government departments, the developed Common Schema would enter directly into maturity level 1 and become the recommended reusable data schema for future projects.

6. Conclusions

The XML Schema Design and Management Guide provides a comprehensive XML schema design methodology and the necessary schema management infrastructure to facilitate e-government data standardization. A library of reusable Common Schemas has been developed, and shared in a data standards registry for developing Project Schemas for new government services. While these schemas are designed for government projects, they are also published publicly to facilitate adoption by different business sectors for development industry-specific data standards. Moreover, the XML Schema Design Guide is a generic integrated methodology, which covers all necessary steps in e-business modelling, from requirement analysis, to business process and information modelling, to XSD coding. Therefore, business enterprises and other governments can easily adapt it to establish their own data interoperability infrastructures.

References


Towards an Understanding of the Factors Influencing the Acceptance and Diffusion of e-Government Services

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Abstract: Governments in emerging nations are relying on information technology as an important tool for their sustained development. Hence, it is an imperative to understand and influence user's acceptance and diffusion of e-Government services among citizens. This study makes use of the electronic tax filing and payment system in Mauritius, as an example of an e-Government service, to integrate two leading models (TAM and DOI) in order to explain user's intention to adopt and continue to make use of the electronic tax system. The main survey instrument, a structured questionnaire was used to capture the perceptions and intentions of users of the system. Moreover, locally this area is a fairly un-researched one and will be explored in light of the context and culture of Mauritius. This paper is expected to 1) contribute to the literature by explaining the factors which affect e-government acceptance and diffusion in the perspective of an emerging economy; and 2) identify those factors which practitioners (and the Government) could consider in their endeavour to promote the acceptance and diffusion of e-Government services.

Keywords: e-government, TAM, DOI and emerging economy

1. Introduction

The e-government paradigm is aimed to sustain internal networking and assist external partnership. It is fundamental for e-Government policy makers to appraise the demand of citizens for e-Government services, because this will serve as an indicator which can direct deployment and implementation of electronic services. Reddick (2005) insisted that Governments may be investing in the provision of online information and services, while the demand might not be real and present. As a result this situation is expected to have an indirect effect on the acceptance and diffusion of those information systems. On the other hand, researchers (Carter and Belanger, 2005) have found that the acceptance of e-government systems is not simply a technological concern. Adoption of e-government by users is largely affected by social, human, organisational and cultural factors (Carter and Belanger, 2005).

Many have set ambitious goals for making the internet the one-stop “back-bone” of service delivery (Chen and al., 2009). The objective of this study is to 'identify the factors leading to the acceptance and diffusion of e-Government systems in a developing country context’. A conceptual framework was developed based on existing literature and was tested using a questionnaire as survey instrument. The e-Tax filing system of the Mauritius Revenue Authority was used as an illustration of an e-Government service.

2. Literature review

The ‘e-government’ concept entails making use of IT by governmental institutions to enhance their operational efficiency and effectiveness in meeting citizens’ needs and service delivery (Chen et al., 2009). The scope of e-government services extend from posting generally requested information on a website to providing and processing online requests such as electronic payment of taxes or other fees.

The main rationale of e-government initiatives is to put together services focused on citizens needs (Moon, 2002). E-government involves novel forms of delivering and tailoring information and services, connecting communities and businesses locally and globally and reforming us towards digital democracy. E-government offers flexible and convenient access to public information and services with the view of providing citizens an improved service (Moon, 2002). For example, Governmental web pages offer citizens a single channel to interact with their government (Thomas and Streib, 2003). As a result, communication is improved and citizens do not have to visit numerous government offices to obtain the service they require.

The idea of e-Government is tagged along private-sector adoption of so called e-business and e-commerce (Moon, 2002). Since more than four decades, e-commerce, which is the use of
technologies as tools to transact in the business/private sector, have been in operation. The public sector is now pursuing a similar route. Moreover, globalisation and advancements in technology have fundamentally changed and influenced the way businesses operate and how people go about their daily lives. In a similar fashion, governments have seized opportunities to reshape traditional public service structures to improve cost-effectiveness and service delivery standards. However, it is important to acknowledge that the e-commerce context cannot be replicated in the governmental settings without accounting for the specificities of the latter’s environment (Hung et al., 2006). Several authors (Hung et al., 2006; Ha and Stoel, 2009) have associated the emergence of e-government to a fundamental redesign of government including changes in work processes, culture and behaviours of citizens and other stakeholders.

As mentioned earlier, the model of e-government involves major change in the work processes of public sector entities which will make them run more efficiently and effectively. Inherently, E-government projects are high risk and high budget projects which require the attention of policymakers and implementers. Current research in the field of Information Systems advocates that human and organisational issues are critical to the successful implementation of an information system and increased interest must be given to these issues during and after systems development (Ven der Heijden, 2004). Studies on e-commerce adoption have shown that ‘perceived risk’ of shopping online has been shown to influence attitude towards online purchasing (Ven der Heijden, 2004). Contrary to their hypothesis, ‘perceived risk’ (PR) was not found to be an important factor that directly influences taxpayer’s choice of tax-filing method (Fu et al., 2006).

In spite of the world wide diffusion of e-Government initiatives, a proper transition to an electronic form of government will take time. To acquire the alleged benefits of e-Government has not been easy for various technological as well as organisational reasons. This holds true for both industrialised as well as developing countries (Strejeek and Theil, 2002). E-Government initiatives involve complex changes with the use of new and emerging technologies to support a transformation in the operation and effectiveness of government. A pragmatic approach that involves addressing the major hurdles of implementation as well as creating a process that would improve the performance of government and create a collaborative environment that fosters ongoing improvements is required to realise the successful implementation of e-Government.

More recent studies are undoubtedly focusing on the rising fashion of e-government development (Moon, 2002). Only few have explored the organisational and environmental factors which influence the adoption decision of e-government and online services. Further empirical studies on user acceptance of e-Government services have to be undertaken to assist governments in their endeavour to enhance the effectiveness and quality of e-Government services.

Studies performed on e-government have focused on ‘performance’ by appraising the services available to citizens on government web portals (Moon, 2002). In comparison, the emphasis on online services (transactional e-citizens) is less researched; few studies have made a preliminary examination of the characteristics of citizens who tend to interact with government (Thomas and Streib, 2003). Previous studies on the consequence of new technology adoption on organisational change in government have shown that computing technologies do not always come with a change in the existing process and structure of the organisation. In her study, Fountain (2001) claims that the acceptance of a new technology is not dependent on the objective technology designed by technical people. However, he argues that the technology is built to be in line with the environment of the institution.

Several authors (Moon and Kim, 2001; Gefen and Straub, 1997) have acknowledged that factors of the TAM and DOI models influence users’ acceptance of e-commerce. Consequently, it is foreseen that they will also affect user adoption of e-government (Warkentin et al., 2002; Carter and Bélanger, 2005). The construct ‘trustworthiness’ has been found to be particularly important as it is expected to impact on citizen’s intention to use state e-government services. Bélanger et al (2002) define trustworthiness as ‘the perception of confidence in the electronic marketer’s reliability and integrity’. Privacy and security are issues which keep coming up in e-commerce and e-government research (Miyazaki and Fernandez, 2001; Bélanger et al., 2002).

Rogers (1995) stated that the nature of managerial job provides managers with the opportunity to exercise pressure on employees to acknowledge the benefits of an innovation and accept the need
for change and recognise the latter as being the “right thing to do”. According to the definition of Rogers (1983) the use of e-government services can be considered a novel approach since they are to be perceived as innovations by users (internet/citizen users). As was seen previously in the literature review, the DOI (Rogers, 1983) proposes a generic adoption model which consists of five distinct categories of adopters: innovators, early adopters, early majority, and laggards. E-government services are still in the early stage of adoption in Mauritius. As per the diffusion of innovations classification, those citizens who have already started to use e-government services can be classified as early adopters.

The DOI theory specifies that ‘early adopters’ of an innovation have common characteristics. Early adopters are most often educated young users enjoying fairly high incomes (Rogers, 1983) and many studies have pointed to the fact that citizens who make use of online facilities correspond to this description (Thomas and Streib, 2003). Then again, the DOI suggests that early adopters, in addition, to sharing demographic characteristics also have the same personality traits and communication patterns (Rogers, 1995).

As emerged from the reviewed literature the TAM and DOI share several common features. TAM however, stresses on two key factors: psychological predispositions and social influences. The model goes beyond the demographic classification of adopters to explain two important psychological dimensions that influences the adoption process, that is, PU and EOU. The TAM model hypothesises the following: the higher the perceived usefulness of the new technology, the more likely it is to be adopted by its consumer. This proposition points to the decisions that to adopt a new technology service (e.g. electronic government) is based on a subjective perception on the part of the user. Based on the reviewed literature on diffusion and TAM the main components of the conceptual framework were derived and tested in this study.

3. Constructs of interest for this research

3.1 Perceived usefulness

Perceived Usefulness (PU) is defined as “the extent to which a person believes that the technology, under investigation, will enhance his/her productivity or job performance” (Davis et al., 1989). In the e-Government context, it is perceived as the likelihood that the technology will benefit the user in the performance of some task. It is primarily connected with perceptions of the outcome as a result of technology usage. A significant body of TAM research has provided evidence that PU is a strong determinant of user acceptance, adoption, and usage behaviour (Davis, 1989; Mathieson, 1991; Taylor and Todd, 1995a). In fact, PU has been found to be the most significant factor in acceptance technology in the workplace, even doing better than EOU (Davis, 1989; Hu et al., 1999). Based on the previous discussion, this research proposes that PU will have a positive impact on attitude towards e-Government usage.

*Hypothesis 1*: The higher the PU of the e-Government service, the more positive the attitude toward the adoption of the innovation.

3.2 Perceived Ease of Use (EOU)

EOU is defined as “the extent to which a person believes that using a technology will be simple” (Davis et al., 1989). This construct is linked to an individual’s estimation of the effort he or she will have to put in to learn and use a technology. EOU is advantageous for the early acceptance of an innovation and is necessary for adoption and subsequent diffusion of technological innovations (Davis et al., 1989). EOU has been employed widely in understanding user acceptance of technology (Venkatesh, 2000). Like PU, EOU has empirical support as a critical component of the adoption process (e.g Venkatesh, 1999). The influence which EOU has within TAM, however, is less clear. Occasionally, EOU has shown to have both a direct effect on attitude, whereas in other cases only an indirect effect (via PU) has been found (Davis et al., 1989; Venkatesh, 1999). The direct effect suggests that EOU could improve attitude toward adoption regardless of the product’s usefulness. By contrast, the indirect effect stems from the situation where, other things being equal, the easier a technology is to use, the more useful it is perceived to be, thus, the more positive one’s attitude and intention toward using the technology (Davis et al., 1989). Both direct and indirect effects have been tested and found positive and significant in the workplace context (Adams et al., 1992; Davis et al, 1989). Thus, the following hypotheses emerge:
Hypothesis 2: the higher the EOU of the e-Government service, the greater the perceived usefulness of the technological innovation.

3.3 Social influence

We define social influence as the “degree to which an individual believed that others thought they should use electronic government services”. The original TAM has been criticised by several authors for disregarding the impact of ‘social influence’ on adoption and diffusion of technological innovations (Melone, 1990; Davis et al., 1989). Malhotra and Galletta (2005) investigated the effect of social influences and found that the latter plays a vital role in determining the acceptance and usage behaviour of new adopters of technological innovations. In the UTAUT model, social influences were recognised as being one of the four determinants of BI to use. Social influence may be divided into external and interpersonal. The first includes media reports, expert opinions, and other non-personal information, while the other includes word-of-mouth from friends, colleagues, and superiors. This study makes reference to ‘social influence’ as interpersonal influence.

Social influences are related to a person’s attitude towards e-government services and are based on the concept of personal innovativeness. Personal innovativeness in using IT is a trait reflecting a willingness to try out any new technology (Agarwal and Prasad, 1998). Innovations create uncertainty about their expected consequences, and individuals who are uncomfortable with uncertainty will tend to interact with their social network before making a decision. Overall, using an innovation is seen as a form of public consumption; it can be significantly influenced by friends and colleagues (Hong and Tam, 2006). In this research we propose that socially-communicated perceptions and beliefs may influence usage behaviour of e-Government services. Based on the above the following hypothesis is proposed:

Hypothesis 3: Social Influence has a positive effect on a person’s attitude towards e-Government innovations.

Although EOU is dependent on technology and user skills, explicit opinions expressed by others will affect it. Recently, Hsu and Lu (2004) studied the impact of social norms and found that this construct explains a determining factor in user’s decision to accept a new technology. People’s attitudes, behaviour, and perceptions are affected by the information he or she receives from the social environment. Social influences may shape his or her confidence in or ability to use a technological system. Potential users of e-Government services may feel that adopting the services and technologies will not require much effort if others in their social environment say that the system is easy to use. Social influence encourages people to use a technology, though it has an indirect impact on their intention to adopt. Based on the above, this study posits that:

Hypothesis 4: Social influence has a positive effect on EOU of the e-Government service.

3.4 Voluntariness

Voluntariness is defined as “the degree to which the use of the innovation is perceived to be voluntary or of free will” (Rogers, 1983); and is an objective condition about the adoption opportunity. Voluntariness is closely related to EOU and reflects user’s perceptions of specific IT adoption settings, rather than a subjective consciousness. Many organisations have implemented non-mandatory information systems that escape the conventional logic of understanding acceptance and usage. In most organisation technologies are mandated; hence the basic relationships of conventional technology acceptance models will be different (Brown et al., 2002). Because voluntary systems require voluntary behaviour, researchers have traced recent implementation failure to lack of user commitment. Malhotra and Galetta (2005) found that user commitment plays a critical role in the volitional acceptance and usage of information systems. In the case of e-Government, most e-Services implemented will be done on a mandatory basis and hence, it is justified to study the user perceptions of voluntariness on the e-Government service implemented. Thus the following hypothesis is proposed:

Hypothesis 5: The perceptions of voluntariness of using e-Government services will have a positive effect on BI.
3.5 Compatibility

Compatibility is an ‘integration factor’ and is defined as “the degree to which an innovation is perceived as consistent with the existing values, past experience, and needs of potential adopters” (Rogers, 1983). As the user’s utilisation of the target technology deepens, the compatibility will gradually change influencing in complex interaction with both PU and EOU. Agarwal and Prasad (1998) found that the degree to which potential adopters are prepared to accept an Information Technology is affected by the way they are accustomed to work. Moreover, the compatibility construct was also found to be a significant determinant in citizen’s intention to use an e-Government service (Carter and Belanger, 2005; Hung et al., 2006). Thus for this study the following hypotheses has been formulated:

**Hypothesis 6:** The perception of compatibility of the target technology will have a positive effect on EOU

3.6 Trust

Trustworthiness has been defined as “the perception of confidence in the electronic marketer’s reliability and integrity” (Belanger et al, 2002) and the challenges presented by issues related to ‘privacy’ and ‘security’ in the e-commerce literature keeps recurring (Belanger et al., 2002). In the same way, it is expected that citizens will need to have a certain degree of confidence in the electronic services provided by the Government before they accept and use the latter. Carter and Belanger (2005) found that ‘trust’ was in fact an indicator of citizen’s acceptance of e-services. Moreover, Hung et al (2006) also confirmed ‘trust’ as an important determinant of user acceptance of electronic tax filing and payment system.

Trust has been supported as a determining factor of on-line commerce usage which is as widely accepted as the two technology acceptance model use-antecedents (Ha and Stoel, 2009). The connections between trust and the technology acceptance model have been amply discussed in literature in regard to the relationships between PU, EOU and trust (Ha and Stoel, 2009). A previous study found trust to be an antecedent of PU; and EOU as an antecedent of trust, and trust as having a direct influence on BI to use. Trust has direct and positive influence on PU; EOU has a direct and positive influence on ‘trust’ (Gefen et al., 2003). Kim and Lee (2009) also found that trust has a positive effect on PU to use mobile banking and Tung et al (2008) found that ‘trust’ have positive effect on BI and PU. Hence, for the research on hand, ‘trust’ is an important ‘research variable’, and the following is hypothesised:

**Hypothesis 7:** Trust will have a positive effect on BI to use e-Government services.

3.7 Civic mindedness

Hitherto, research on e-Government suggests that e-government services have been offering greater convenience and flexibility to those citizens who ought to use government services anyway (Thomas and Streib, 2003). As a result, we can foresee that e-government users will be similar to those who already use face to face services and are more engaged in civic affairs. Typically, those citizens are likely to have the following characteristics: socially engaged, politically active, and paying close attention to the news media. In the case of the latter category of citizens, the use of electronic means to interact with government is likely to be an extension of their civic and political involvement via traditional channels. Hence, we hypothesise that:

**Hypothesis 8:** Individuals with higher civic mindedness will have a positive effect on BI to use e-Government services.

3.8 Facilitating Conditions (FC)

Venkatesh et al (2003) defined Facilitating Conditions as “the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system”. The ‘facilitating condition’ construct was added as a direct determinant of BI and usage in the DTPB. Facilitating Conditions can be related to the ‘triability’ construct of the DOI Theory, as the availability of the technological innovation will support its usage (Taylor and Todd, 1995b). Studies have shown that Facilitating Conditions construct was not significant enough to predict intention, however, was found significant in determining usage (Venkatesh, et al., 2003). Moreover, a study of Taylor and
Todd (1995b) demonstrated that the presence of facilitating conditions do not necessarily encourage usage. It has been hinted that the absence of facilitating resources may represent an obstacle to usage and thus prevents the creation of intention to usage. Facilitating Conditions as a construct has not been widely studied. It is being predicted that its impact as a direct determinant of usage will be revealing and needs to be investigated. Preliminary interviews have shown that facilitating conditions (resource facilitating conditions and technology facilitating conditions) are motivating factors for citizens’ use of e-Government services. Thus, this research proposes the following hypothesis:

**Hypothesis 9**: Facilitating Conditions has a significant influence on usage of e-Government behaviour.

### 3.9 Culture

Individuals are shaped by their culture (Hofstede, 1997). Hofstede (1997) also asserted that culture determines the values of an individual and impacts on behaviour and varies across countries. The theories/models of technology acceptance have been applied and investigated upon in the U.S mainly and; only few studies (Gefen and Straub, 1997) have been tested in non U.S cultures. Thomas and Streib (2003) have referred to the recognition of cultural and contextual variations when nations adopt information technologies. They have also stressed that the influence of culture is even greater when the borrowed technology is being implemented in a developing country. It is therefore important that managers are conscious that factors influencing technology adoption will vary depending on the prevailing culture (Schepers and Wetzels, 2007).

Cultural factors can be categorised into national and organisational cultures. They are distinguished by their different mix of values and practices. It has been suggested that both types of cultural factors will have a significant influence on usage behaviour. To study the acceptance of e-Government services in Mauritius, an important cultural aspect (i.e language) will be examined. In Mauritius, English is the official language, however French and Creole (a French dialect) is popularly spoken. Thus, this research will look into the impact which Language will have on user’s intention to use e-Government services. Also, the e-government literature converges on the fact that high income earners are those who are more likely to access government information and services online (Shelley et al., 2004; Thomas and Streib, 2003). Hence, the influence of social class on user behaviour will also be investigated.

**Hypothesis 10**: Language has a direct and positive effect on PU of e-Government services.

### 3.10 Attitude

Attitude can be defined as “the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour” (Ajzen, 1991). Attitude is an important construct of the Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980) which theorises that ‘attitude towards a technological innovation is hypothesised to determine by the users’ perceived usefulness and perceived ease of use. Both the TRA and TAM argue that, all other conditions constant, individuals execute behaviours towards which they have a positive affect (Ajzen and Fishbein, 1980). It is also suggested that individual users who develop a positive attitude toward adopting a technology are more inclined to build up firmer intentions to do so too. However, attitude though being a necessary condition might not be sufficient for success (Jackson, et al., 1997). Therefore, for this study it has been important to establish the following hypothesis for test the influence of the construct ‘attitude’:

**Hypothesis 11**: Attitude toward adopting the technology has a direct and positive effect on BI to adopt the technology.

### 3.11 Behavioural Intention (BI) and usage behaviour

BI is defined as “the strength of the prospective user's intention to make or to support the adoption of e-Government innovation”. BI to accept a new technology is an important indicator of the ultimate adoption decision and is hypothesised to be determined by attitude towards adopting the technology. It is being predicted that behavioural intention will have a positive influence on usage behaviour. A user’s stated preference to use the e-Government service will be closely related to the fact that they actually use the system; this assumption only applies when the behaviour is under a person’s volitional control (Ajzen and Fishbein, 1980). Therefore it is claimed that user’s intention to use the
system will be closely related to their usage behaviour if the use of the technology depends on their free will. Also, much previous research (Davis, 1989; Dishaw and Strong, 1999; Szajna, 1996; Moon and Kim, 2001; Venkatesh and Davis, 2000; Venkatesh et al., 2003) found that BI and usage intention have a significant relationship (see figure 1).

**Hypothesis 12:** BI to adopt e-Government services has a direct and positive effect on subsequent usage behaviour.

![Figure 1: Usage behaviour](image)

### 4. Methodology

The Mauritius Revenue Authority (MRA) offers an interesting case to be studied since it has been offering an online tax filing and payment service to citizens for the last two financial years. To answer to the objectives of this study, the Government to Business (G2B) perspective will be investigated, that is, the electronic relationship between businesses and the MRA. Preliminary fieldwork was performed by informally interviewing the stakeholders, namely officials of the Mauritius Revenue Authority, Government Online Centre and the Ministry of Information Technology. The following represents the specific research issue identified.

‘To identify the factors that contributes to the successful acceptance and diffusion of e-Government services in Mauritius’.

### 5. Survey instrument

The survey instrument is a two-part questionnaire. The first part uses nominal scales and captures demographic data while the second part of the questionnaire contains items used to measure the independent variables. Multi-items were used to measure each. A seven-point Likert Scale from strongly disagree to strongly agree was used to measure the items.

### 6. Sample surveyed

The TOP 100 Business List and the Yellow Pages directory were used as sample frame for the study. A total of 200 companies were randomly chosen from the directory and 200 questionnaires were mailed to the Head of the Accounting department of each company. Follow-up phone calls were made to ensure that the questionnaire has been received. 115 completed questionnaires were received and 20 were returned undeliverable. Of the 115 questionnaires returned, 7 were not entirely completed by the respondents and were rejected. Hence, 108 questionnaires were considered...
usable constituting a response rate of 54%. Appendix 1 below gives the list of constructs in this study and the items used in this questionnaire to measure them.

7. Findings

The hypothesis testing performed in this chapter is based on regression analysis performed using SPSS 11.5. A series of linear regression analyses were undertaken to estimate the path coefficients (β). Table 1 provides the results of hypothesis testing with the values for Rsquare, standard coefficient, and significance.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>R Square</th>
<th>Standardised Coefficient β</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>0.102</td>
<td>0.320</td>
<td>Supported (p &lt; 0.001)</td>
</tr>
<tr>
<td>H2</td>
<td>0.490</td>
<td>0.221</td>
<td>Supported (p &lt; 0.05)</td>
</tr>
<tr>
<td>H3</td>
<td>0.188</td>
<td>0.481</td>
<td>Supported (p &lt; 0.001)</td>
</tr>
<tr>
<td>H4</td>
<td>0.062</td>
<td>0.255</td>
<td>Supported (p &lt; 0.05)</td>
</tr>
<tr>
<td>H5</td>
<td>0.081</td>
<td>0.285</td>
<td>Supported (p &lt; 0.005)</td>
</tr>
<tr>
<td>H6</td>
<td>0.146</td>
<td>0.382</td>
<td>Supported (p &lt; 0.001)</td>
</tr>
<tr>
<td>H7</td>
<td>0.153</td>
<td>0.322</td>
<td>Supported (p &lt; 0.001)</td>
</tr>
<tr>
<td>H8</td>
<td>0.024</td>
<td>-0.179</td>
<td>Not Supported</td>
</tr>
<tr>
<td>H9</td>
<td>0.009</td>
<td>0.094</td>
<td>Not Supported</td>
</tr>
<tr>
<td>H10</td>
<td>0.003</td>
<td>-0.53</td>
<td>Not Supported</td>
</tr>
<tr>
<td>H11</td>
<td>0.252</td>
<td>0.502</td>
<td>Supported (p &lt; 0.001)</td>
</tr>
<tr>
<td>H12</td>
<td>0.001</td>
<td>-0.31</td>
<td>Not Supported</td>
</tr>
</tbody>
</table>

The results indicated that intention to use the e-Tax filing systems was largely influenced by PU, EOU and positive Attitude. It was found that the impact of PU on attitude was stronger than that of EOU. This result is consistent with previous studies. PU was positively affected by PEOU which is in turn affected by Social Influence which implies that peer influence and management support influence the usage of the e-Tax filing system. The relationship between PU and EOU has been well documented and the results confirm the importance of the link between them. The findings also suggest Behavioural Intention to Use is positively affected when the user perceive that the use of the system is optional.

This study has combined the TAM, DOI and other relevant constructs from the literature to put forward a hybrid model to study business users’ acceptance of the e-Tax filing system. The questionnaire and field survey yielded several significant and interesting outcomes.

Firstly, the results showed that users’ ‘attitude’ towards the e-Tax filing and payment system has been the most powerful predictor for user intention. Attitude is an important construct of the base model, Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980) which theorises that attitude towards a technological innovation is hypothesised to be determined by the users’ perception of the usefulness and ease of use of the system. Both the TRA and TAM argue that, “all other conditions constant, individuals execute behaviours towards which they have a positive affect” (Ajzen and Fishbein, 1980).

‘Social Influence’ was found to be next most determining factor in users’ decision to accept the technology. The original TAM was criticised for ignoring ‘social influence’ in the adoption and diffusion of technological innovations (Melone, 1990; Davis et al., 1989). The construct was used in many other studies (Malhotra and Galletta, 1999; Lopez-Nicolas, 2008) (among which the UTAUT) where its influence on adoption was supported. In the present study, it can be determined that the importance of what others believe and think of this e-Government service is of special interest.

‘Compatibility’ was found to be the next most important predictor after ‘social influence’. Compatibility has been defined as “the degree to which an innovation is perceived as consistent with the existing values, past experience, and needs of potential adopters” (Rogers, 1983). Hence, the results indicate that if the technology is compatible with the user’s working and life style, it is likely that he or she will adopt the system.

It has been claimed extensively in the literature, that user’s intention to use the system will be closely related to their usage behaviour if the use of the technology depends on their free will. Also, much previous research (Davis, 1989; Szajna, 1996; Moon and Kim, 2001; Venkatesh and Davis, 2000; Venkatesh et al., 2003) found that BI and usage intention have a significant relationship. The findings
of this study, however, have not been supportive of the relationship between intention and usage behaviour. This may be attributed to the fact the sample studied did not use the system under volitional conditions.

The study of Taylor and Todd (1995b) demonstrated that the presence of 'facilitating conditions' do not necessarily encourage usage. It has been hinted that the absence of facilitating resources may represent an obstacle to usage and thus prevents the creation of intention to usage. However, our study could not find a significant positive impact of facilitating conditions on usage behaviour. This is probably due to the fact that accountants who are filing taxes online are used to similar technological applications and are not finding the presence or not of 'facilitating conditions' critical.

The findings of this study do not coincide with other research on e-Government which suggested that e-government services have been offering greater convenience and flexibility to those citizens who ought to use government services anyway (Thomas and Streib, 2003). The results of the current investigation show that the construct ‘civic mindedness’ do not influence user’s decision to accept the system. As a result, it can be foreseen that e-government users will be similar to those who already use face to face services and are more engaged in civic affairs. Also, it is important to be cautious with the interpretation of findings since only business uses have been surveyed.

8. Conclusion

The contribution of this study has been to extend the literature by 1) examining the two base models, namely the TAM and DOI and all extensions of the models; and 2) reviewing the extant literature. One model has been used to critically assess the other, an endeavour which has not been attempted in prior research. Following this critical review of both models as well as a through assessment of the relevant literature, a conceptual framework was devised to test the data collected for any relationships among the constructs. Hence, this study has presented an important theory based empirical test.

Given the importance of the successful implementation of electronic government services and from a practical perspective, the Government and other responsible bodies should take a positive position towards the factors which influence system acceptance. The instrument developed and tested as a result of this study could be utilised to determine user’s perceptions of the system and help predict with much precision the expected behaviour of users. Care could then be taken to encourage use, e.g. ‘subjective norm’ which is seen as an important determinant can be created by word of mouth (Schepers and Wetzel, 2007). Also, such an understanding requires that key factors be examined in the larger context to assess their significance (Jackson et al., 1997). All this is guided towards providing a better and more effective adoption of electronic government information systems, in light of several potentially important implications.

9. Appendix 1: list of items used in survey

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Ease of Use</td>
<td>EOU1  I find it easy to prepare income tax filing using the E-tax filing and payment system.</td>
</tr>
<tr>
<td></td>
<td>EOU2  My interaction with the E-tax filing and payment system is clear and understandable.</td>
</tr>
<tr>
<td></td>
<td>EOU3  It is easy for me to become skilful at using the E-tax filing and payment system.</td>
</tr>
<tr>
<td></td>
<td>EOU4  I find the E-tax filing and payment systems easy to use.</td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>PU1  Using the E-Tax filing and payment system improves my productivity in preparing income tax filing.</td>
</tr>
<tr>
<td></td>
<td>PU2  Using the E-Tax filing and payment system makes it easier for me to complete tax filing and payment.</td>
</tr>
<tr>
<td></td>
<td>PU3  Using the E-Tax filing and payment system enhances my effectiveness in preparing income tax filing.</td>
</tr>
<tr>
<td></td>
<td>PU4  Overall, I find E-Tax filing and payment system useful in preparing income tax filing and payment.</td>
</tr>
<tr>
<td>Compatibility</td>
<td>COM1 Using the E-Tax filing and payment system is compatible with the way I like to do things.</td>
</tr>
<tr>
<td></td>
<td>COM2 Using the E-Tax filing and payment system fits with my work style</td>
</tr>
<tr>
<td></td>
<td>COM3 The set up (and aspects) of E-Tax filing and payment system is compatible with the way I work.</td>
</tr>
<tr>
<td>Trust</td>
<td>TRS1 I trust the E-Tax filing and payment system</td>
</tr>
<tr>
<td></td>
<td>TRS2 Even if not monitored, I trust the E-Tax filing and payment system to do the processing (and calculations) right.</td>
</tr>
</tbody>
</table>
### Construct Items

#### Behavioural Intention to Use
- **BI1** It is likely that I will use the E-tax filing and payment system.
- **BI2** I expect that the E-Tax filing and payment system will make paying taxes even easier in the future.

#### Attitude
- **AT1** I like the idea of using the E-Tax filing and payment systems for tax-filing action.
- **AT2** Using the E-Tax filing and payment system is beneficial.
- **AT3** Using the E-Tax filing and payment system is a pleasant experience.

#### Social Influence
- **SOC1** The senior management of my organisation has supported and encouraged the use of E-Tax filing system.
- **SOC2** On the whole my organisation has supported the use of the E-tax filing and payment system.

#### Facilitating Conditions
- **FAC1** Resources required to use online tax filing and payment system were available to me (financial and non-financial information).
- **FAC2** I had access to hardware, software, and services needed to use E-Tax filing and payment system (eg computer facilities, good internet connection).
- **FAC3** I was constrained by the lack of resources needed to use E-Tax filing and payment system.
- **FAC4** It is easy for me to get assistance/support if I needed help using the E-Tax filing and payment system.

#### Civic Mindedness
- **CVM1** I make use of electronic government services frequently.
- **CVM2** I am interested in contacting the government electronically for other business purposes.
- **CVM3** I make use of media for public affairs (eg publishing corporate information electronically).

#### Voluntariness
- **VOL1** I believe the filing and payment of taxes electronically should be optional.
- **VOL2** I believe voluntary electronic tax filing and payment systems will enhance intention to use the system.

#### Language
- **LAN1** The French language is commonly used in Mauritian organisations; do you think a French version of the system will be helpful?
- **LAN2** A French version of the system will make it easier to use the systems.

### 10. References


A Pragmatic Approach to Interoperability Practical Implementation Support (IPIS) for e-Government Interoperability

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Abstract: In recent years, e-Government interoperability has been a fascinating research and development area in order to facilitate the seamless exchange of information across government sectors. Many researchers have focused on the designing/adopting of Government Interoperability Frameworks (GIFs) and of Enterprise Architectures (EAs) for implementing the interoperability. However, merely adopting the GIFs and EAs would be insufficient since there have been several strong obstacles and barriers on the road to its achievement in the field of e-Government, such as human, semantic and technical issues. In fact, the successful implementation in government interoperability needs more practical and implementable approach. This paper firstly describes those obstacles and barriers with the solution and guideline to overcome them. We propose towards more practical approach covering three dimensions of interoperability: Business, Semantic, and Technical. The approach, is called ‘Interoperability Practical Implementation Support (IPIS)’, considers the adoption/development of integrated three components: a set of tools, an interoperability repository, and a knowledge based system. The set of tools were designed to supporting the three interoperability perspectives; the tool for modeling/specifying business processes of an organization based on UMM, the semantic tool for standardizing/harmonizing data based on UN/CEFACT CCTS, XML Naming and Design Rules, and Recommend 34, and the technical standards usage support tool. For reusability, the IPIS was designed by considering the adaptation of five interoperability repositories: business process, data standardized set, XML Schema standard, web services and technical standards. The knowledge based system integrates the knowledge resources that consist of a collection of best practice cases, ontological concepts in semantic technologies, and the related frameworks. The paper presents the overall methodology and the architecture of IPIS with the three components. By adopting the IPIS, the design, development and implementation of interoperable systems in e-Government can be practically addressed.

Keywords: interoperability, e-government interoperability, interoperability tool, GIF, e-government

1. Introduction

During the last few years, Electronic Government Interoperability has become a vivid and fascinating research and development in order to facilitate the seamless exchange of information across governmental departments. To this direction, several approaches have been proposed through the adoption of frameworks or through architectures to each other and to the environment, and the principles guiding, its design and activity (UNDP, 2006). With regards to the frameworks, Electronic Government Interoperability Framework or e-GIF facilitates this (Archmann, 2003). The e-GIFs are defined as a set of standards and guidelines that set out a common language to ensure coherent flow of information across systems (UNDP, 2007). In many countries, governments have developed their own e-GIFs like UK e-GIF (UK e-GIF, 2005), NZ e-GIF (NZ e-GIF, 2008), European Interoperability Framework (EIF) (IDABC, 2006) and Australian Government Technical Interoperability Framework (AGTIF) (AGTIF, 2007). In addition to the achievement of interoperability of e-GIFs, the architectures have an important role in ensuring e-government interoperability successes. The relevant architecture to Electronic Government Interoperability is Enterprise Architecture (EA), specifically National Enterprise Architecture (NEA). The EA stresses the planning and management of all IS assets and their architecture together with organizational structures and processes (Zachmann, 1987).

However, implementing interoperability in government requires more than just having a common technical standard or using XML to creating technical integration between two applications (Guijarro, 2007) and merely adopting EA with the e-GIFs (Saekow, 2009). The challenges and obstacles that governments face in implementing Electronic Government Interoperability include: 1) bureaucratic challenges due to the nature of bureaucracy and the lack of accountability of different agencies; 2) ensuring compliance or enforcement of the adopted standards; 3) capacity development; and 4) using the right metrics to measure the success of the e-GIF (UNDP, 2007). In fact, the bigger and more complex the bureaucracy, the more difficult it is to be implemented. Many governmental departments have entrenched cultures which avoid openness and cooperation with others. This makes
implementation in government interoperability become more difficult. Moreover, in complying with e-GIFs, there is no guarantee that other agencies will truly follow. Therefore, merely following the suggested open standards, policies and contexts guideline as well as EA approach is inadequate. The successful implementation in Electronic Government Interoperability needs more practical approach. In this paper, we propose towards more practical approach for Electronic Government Interoperability called ‘Interoperability Practical Implementation Support or IPIS’. By adopting the IPIS, we can practically address the design, development and implementation of interoperable systems and can alleviate the problems arise from the gap between the adoption of e-GIFs and EA in e-Government Interoperability implementation. Figure 1 illustrates a basic concept of our practical approach with IPIS.

Figure 1: A basic concept of the practical approach with IPIS

The paper is organized as follows: First, relevant research reviews. Then, the basic concepts and backgrounds of IPIS, conceptual model, a methodology are presented. The evaluation and comparison results are described. Finally, the conclusions and future works are presented.

2. Relevant research reviews

2.1 Current proposed strategies for e-government interoperability

Effective e-Government has the objective of enhancing citizen services and government communication as well as reducing the amount of paperwork (Hans, 2005). In order to achieve the goal, e-Government requires interoperability mechanisms that will allow numbers of government agencies to offer online access to their services and to participate in orchestrated procedures involving services provided by multiple agencies (John, 2004). Currently, the e-Government interoperability have emphasized on the strategies covering on three dimensions of interoperability: business process, semantic and technical, by adopting the open/international standards and EA designs (Saekow, 2009). In Germany, governments developed an interoperable approach by including architecture and standards in one document called “Germany Standards and Architecture for e-Government Applications (SAGA)” (Germany, 2003). In a European Union context, they are also endeavoring to adopt e-GIF, including the standards and architectures, to develop pan-European services (IDABC, 2006). In Australia, Brazil (e-Ping, 2006), Denmark (Denmark, 2005), Malaysia (MyGIF, 2003), New Zealand and the UK, the approaches propose interoperability standards by the technical aspects such as interconnection, data integration, metadata, presentation, and security. To enhance business interoperability on a semantic level, the Greek e-GIF (Greek, 2008) and TH e-GIF (first launched in November 2006) (Thailand, 2008) apply the ISO 15005-5 Core Component Technical Specification (CCTS) (UN/CEFACT, 2003) and numerous of closely affiliated standards issued by the UN/CEFACT, as well as the Core Component Library (CCL) (UN/CEFACT, 2008), representing the repository for generic business data components, the so called Core Components for their strategies. At the implementation level, the concept of the repository and ontology is considered as reusable/semantic resources (Yannis, 2007).
2.2 Obstacles and barriers to e-government interoperability

Our literature reviews found that the main obstacles and barriers to e-Government interoperability are derived from technical, semantic and human issues. The technical one refers to the great variety of legacy systems. The systems already installed and running within involved agencies. By replacing these systems for achieving interoperability is not a possibility (Benamou, 2006). The semantic obstacle is concerned on the difference of data/information standards used within organizational services. Understanding the semantics of each service is an important issue. Another important obstacle to the spread of interoperable solutions in e-Government is that of adoption of any new systems by officers. In (Archmann, 2003), the interoperability barriers identified also included cultural differences between governmental departments, issues of trust, timing, collaboration between agencies, unsatisfactory workflows, convincing stakeholders of the importance of the system, legal issues and also the importance of political support and funding.

3. IPIS: Interoperability Practical Implementation Support

3.1 Background

In Thailand, an e-GIF initiative was announced in October 2006 called “TH e-GIF”. It sets out technical policies standards and specifications. It also provides a guideline and a procedure to build and manage XML schema standards. The TH e-GIF incorporates UN/CEFACT Recommendation 34 (UN/CEFACT, 2007), Core Component Technical Specification (CCTS) and UN/CEFACT XML Naming and Design rules (XML NDR) (UN/CEFACT, 2007). However, as an initiative in e-GIF adoption, we have been facing the obstacles and barriers regarding semantic, technical and human issues. Various kinds of officers including IT personnel, system analysts, data owners and data users need to participate in project activities following TH e-GIF guideline. Each process is time consuming. It also requires higher cost and skills as well as much experience. For an e-GIF adoption initiative like Thailand or developing countries, it is an obstacle to satisfying those required factors. Therefore, developing support systems assisted in e-GIF adoption/implementation could be another key success factor for achieving e-Government interoperability in a shorter path. In May 2008, we developed a support system to assist in modeling data, designing XML schema standards and generating web services modules (Boonmee, 2008). By using the support system, data definition, analyzing and reconciling can be performed in shorter times. The participants can introduce their ideas and discuss simultaneously. Agreement on a new data standard can be achieved faster by using the support system. The system utilization was proved by simulating the use in personnel training program. In addition to the project development, in September 2008, we first proposed a more practical approach for electronic government interoperability in (Saekow, 2009). The approach considers the addition of Interoperability Practical Implementation Support (IPIS) into the former interoperability approach under e-GIF. The approach is to fill the gap between concepts and practices. At the time, the IPIS was defined as an integration of support tools. In (Saekow, 2009), it shows significantly a comparison between approaches with and without the IPIS in a case of Thailand e-GIF pilot project building a common XML schema standard for data exchange. In this paper, the progress in IPIS development and architecture design is described.

3.2 Conceptual model

The infrastructure of IPIS is shown in figure 2. It comprises main portions: e-GIF, EA, Interoperability Prospective Governmental Departments (IPGDs), IPIS, Discovery Systems and Change Management. E-GIF is defined as a set of standards and guidelines that set out a common language to ensure coherent flow of information across systems. Enterprise architecture refers to a comprehensive description of all the key elements and relationships that make up an enterprise (Zachman, 1987). It encompasses the interconnectedness of IS applications, and the degree to which individual IS applications need to be integrated. The IPGDs are defined as government agencies preferred to interoperate among their systems. Discovery systems are used to discover the interoperability repositories for existing reusable resources. Change management working group is an organization responding in managing the change of reusable resources in the repository. The most focused portion in this section is IPIS. The IPIS has been designed and developed to support in the implementation of e-Government interoperability. It first was developed as a set or an integration of interoperable support tools based on concepts and guidelines in e-GIF. In order to facilitate the approach, the IPIS has been currently designed with two additional parts: Interoperability Repositories and Knowledge Based System.
A set of support tools is one of the components in IPIS. Each tool is defined as “IPIS tool”. The IPIS tool is designed and developed to assist in the implementation of interoperable e-GIF projects. The tools include a business process modeling tool, a data modeling tool, an XML designing and developing tool, a web services developing tool and a technical standards usage support tool.

- **Business process modeling tool**: a tool to support in modeling/specifying business processes of an organization based on UN/CEFACT Modeling Methodology (UMM) (UMM, 2008).
- **Data modeling tool**: a tool to support in standardizing/harmonizing data based on UN/CEFACT CCTS and Recommend 34.
- **XML designing and developing tool**: a tool to assist in designing/generating XML schema standard based on UN/CEFACT XML naming and design rule (XML NDR).
- **Web service developing tool**: a tool to develop web service implementing modules such as SOAP call and service.
- **Technical standards usage support tool**: a tool to describe/demonstrate how to implement/use technical standards in e-GIF.

**Interoperability Repositories**

The interoperability repository is a part to store and maintain data or specimens for future reuse/reusability. We designed five repositories including Business process model, Data standardized set, XML schema standards, Web services and Technical standards.

- **Business process model repository**: it contains details of business services based on UMM with UML diagrams.
- **Data standardized sets repository**: it comprises a set of data models developed by CCTS such as Core Components (CCs) and Business Information Entities (BIEs).
- **XML schema standards repository**: it contains XML schema standards based on UN/CEFACT XML Naming and Design Rules.
**Web services repository:** it incorporates a set of functionalities of a typical UDDI repository for finding the prospective services.

**Technical standards repository:** it contains technical standards guided in technical standards catalogue.

**Knowledge based system**

The Knowledge Based System (KBS) are designed as a part of IPIS in order to support officers in IPGDs for getting interoperability knowledge as well as experiences. It also contain ontology component for semantic interoperability to mapping meaning of an information items based on ontology approaches. The KBSs are architected with three main artifacts: Best practice cases, Ontologies and Frameworks/EAs.

- **Best practice cases:** it contains successful implementation cases in e-Government interoperability.
- **Ontologies:** they are to facilitate semantic heterogeneity. In a real situation, the problems of semantic heterogeneity arise due to *confounding conflicts*-occurring when information items seem to have the same meaning, but differ in reality, *scaling conflicts*-occurring when different reference systems are used to measure a value, *naming conflicts*-occurring when naming schemes of information differ significantly. In order to fill the gap of unsolvable cases in data standardizing and modeling, the use/development of ontologies has been considered in IPIS.
- **Frameworks/EAs:** it contains interoperability frameworks and enterprise architectures that can be adopted in e-Government interoperability implementation.

**3.3 Methodology**

In this section, we describe an overall methodology for IPIS approach in order to fully engage the e-Government interoperability. The methodology is designed based on the search steps in Core Components Technical Specification V2.01 (Part 8 of the ebXML Framework) (UN/CEFACT CCTS, 2003). It includes the following nine steps as depicted in Figure 3.

- **STEP 1:** Identifying the specific inputs: Business processes, Unstructured data models and Technical standards usage. The inputs might include either one or two or all depending on the requirements of interoperability projects among IPGDs.
- **STEP 2:** Discovering the repositories for existing reusable components. The reusable components refers to business process models (UMM), CCs, BIEs, XML schema standards, web services and technical standards usage. The returned reusable components are regarded to the requests in **STEP 1**.
- **STEP 3:** Registering the reusable components. When the prospective repositories are found, the components will be registered for re-use. If not found, go to **STEP 4**. The **STEP 2** will be repeated for more components.
- **STEP 4:** Applying the IPIS tools to develop new components. Based on the specific inputs, the IPIS tools automatically develop new business process models (UMM), CCs, BIEs, XML schema standards and web services modules.
- **STEP 5:** Approving the new components being registered in the repository. The Change Management Working Group will be in charge of this responsibility. If approved, go to **STEP 6**. Otherwise, go to **STEP 7**.
- **STEP 6:** Registering the new components in the repository. Go to **STEP 2**.
- **STEP 7:** Determining the use of new components without approval. If yes, go to **STEP 8**. Otherwise, finishing processes.
- **STEP 8:** Registering the unapproved components for re-use. Repeat **STEP 2** for more components.
- **STEP 9:** Applying all of the registered components for the project implementation.

The above steps of the methodology can also be used as references and concepts in other e-Government interoperability implementation.
4. Implementation

In this section, we describe the implementation of IPIS. We first implemented the IPIS tool to support e-government interoperability implementation in the project.

4.1 Theoretical tool development architecture

In order to develop the IPIS tools, we design a Model Driven Tool Development (MDTD) based on Model-Driven Architecture (MDA) (OMG, 2003) concept. In MDA, platform-independent models (PIMs) are initially expressed in a platform-independent modeling language. The platform-independent model is subsequently translated to a platform-specific model (PSM) by mapping the PIM to some implementation language or platform using formal rules (OMG, 2003). In this paper, we define the MDTD as a new architectural approach for developing interoperable software tools based on interoperability requirements. The MDTD comprises an interoperability requirement independent model (IRIM), interoperability requirement specific model (IRSM) and software modules. The IRIM is a model of a main requirement of the development tool. The IRSMs are sub-requirements derived from IRIM. The software modules will be designed based on the IRSMs. We then implement them with software technology like Java, .ASP, and .Net.
4.2 Tool development

This section illustrates how we design and develop the IPIS tool in our pilot project. We first design the tool development architecture following the MDTD. The IRIM is defined as the requirement of the project tool development. It is to develop the IPIS tool that automatically supports in modeling business processes based on UMM and developing CCs, BIEs, XML schema standards and web service components. The expected outputs of the tool include: 1) UMM document (UML): Business Domain View (BDV), Business Requirement View (BRV) and Business Transaction View (BTV), 2) Core Components (CCs), 3) Business Information Entities (BIEs), 4) XML Schema Standards: XML code list, XML ID list and XML schema (RSM), 5) Web Service Components: Web Service Java Source Program, Web Service Caller Source Program and WSDL for Web Services. To achieve the objective, we identified six possible IRSMs. They are IRSM1: UMM design, IRSM2: core components design, IRSM3: core components library, IRSM4: business information entities (BIEs) library, IRSM5: XML schema standards and IRSM6: Web Services components. Based on the IRSMs, we design 10 software modules (SMs): SM1: BRV development, SM2: BRV development, SM3: BTV development, SM4: CC designing (Thai), SM5: CC design (English), SM6: Context designing, SM7: Code list managing, SM8: BIEs designing, SM9: XML schema generator and SM10: Web services developing. Based on the SMs, we implemented them in java technology. With regards to the IPIS tool, in BDV development, a categorization of the business domain (manifested as a hierarchical structure of packages) and a set of relevant business processes (manifested as use cases) are generated. In BRV development, it automatically generates the sub-packages of BRV including Business Process View, Business Entity View, and Partnership Requirements View. Similarly, in BTV development, it automatically produces the sub-packages of BTV: Business Choreography View, Business Interaction View and Business Information View. In the CC design module, the tool allows users to propose their required data model in Thai language. In CC English module, Thai data names are translated to English. In the context design module users can add their required contexts. In the code list manage module users can add and edit code lists. In the BIE design module users can design the required data model based on selected core components and contexts. In the XML schema generation module users can get a XML schema for a given BIE. In the web services developing module users can obtain various source programs for web service components.

5. Application

In Thailand, National Research Council of Thailand (NRCT) is established by the Government in order to provide research resources in various areas for citizens. To provide an effective service, the NRCT needs to gather the resources from different research centers as currently those centers have their
own methodology and standards to store and publish their research resources. Therefore, a pilot project on exchanging the research resources across the research agencies was proposed in order to achieve the interoperability. The project aims to develop an interoperated system for exchanging and sharing research resources across twenty three organizations. The project approach is based on TH e-GIF. To achieve semantic interoperability, the process of standardizing and modeling data and XML schema standards is required. In the process, it requires many data owners, data modelers and system analysts. The data owners extensively need to participate in activities based on the four processes in recommendation 34. Several meetings are essential to share, to analyze, to discuss and to reconcile the differences of their data models. It is time-consuming to reach agreement on common standards. Also, the data modelers and system analysts who have high skills and much experience are required. Therefore, we applied the IPIS tool to automatically assist in the process and to generate the components needed in the interoperability implementation. In the project, new data sets were standardized and modeled. They include 15 core components (CCs) and 65 business information entities (BIEs) based on Core Component Technical Specification (CCTS). Based on the data sets, the tool automatically generated the related business process models based UMM, XML schema standards based on UN/CEFACT XML NDR for data exchanges, and web services components. It also automatically generates various kinds of sample programs and scripts. These sample programs and scripts can be used in the interoperability implementation process. They include an XML document manipulation java program, a web service java program, a web service client program using SOAP, an XML digital signature java program, an XML encryption/decryption java program, WSDL specification files, database generation SQL scripts for data storage, and java server page program for managing and manipulating data. Figure 5 shows a part of automatic generated BRV result. Figure 6 shows a part of automatic generated XML schema.

Figure 5: A part of automatic generated BRV result

```xml
<CollaborationRequirementView>
  name: การเปลี่ยนแปลงการเรียก
  name: ResearchInformationResourceSearch
</CollaborationRequirementView>
```
6. Evaluation methodology

This section presents an evaluation methodology of the IPIS approach. In order to evaluate the approach, we design the methodology called "IDEA process" shown in figure 7.

Figure 7: An evaluation methodology of IPIS approach

6.1 IDEA process

The IDEA process includes four main steps: Initializing Requirements, Designing Factors, Evaluating Values and Analyzing Results.

Step1: Initializing Requirements: the first step is to initialize the requirements for the evaluation. We apply the IRSMs generated in the MDTD process as the requirements. In the project case, the requirements include six IRSMs: IRSM1: UMM design, IRSM2: core components design, IRSM3: core components library, IRSM4: business information entities (BIEs) library, IRSM5: XML schema standards and IRSM6: Web Services components.

Step2: Designing Factors: the step is to design factors based on IRSMs. The factors consist of evaluation factors (EFs) and Evaluation Elements (EEs). The evaluation factors are designed based on the objectives of evaluation. In this project, the EFs include Skill needed, Experience needed, Time and Cost. The evaluation elements are a set of elements related to EFs and IRSMs. For examples, the EEs of IRSM2 and EF1 are CC designing, CC naming rule, CCTS structuring and CC dictionary entry name as shown in figure 8.
Step 3: Evaluating Values: this step is to evaluate value from one to three for all of the designed factors in Step 2. The step is performed by the assigned evaluators of the project.

Step 4: Analyzing results: the final step is to analyze all the evaluated value. The methodology of the analysis is based on the following calculation formulas:

The estimate of EV of $EF_i$ is defined as follows:

$$\overline{EV}_{EF_i} = \frac{\sum_{i=1}^{N_{EF}} EV_{EF_i}}{N_{EF}}$$

and the estimate of $\overline{EV}_{EE_{Insist_i}}$ of $EF_i$ is defined as follows:

$$\overline{EV}_{EE_{Insist_i}} = \frac{\sum_{i=1}^{N_{IRSM}} \sum_{j=1}^{N_{EF}} EC_{EE_{Insist_i}} \cdot EV_{EE_{Insist_i}}}{N_{IRSM} \cdot N_{EF}}$$

where, $N_{IRSM}$: number of IRSMs (six for this case), $N_{EF}$: number of EFs (four for this case).

6.2 Evaluation results

The first evaluation of IDEA process was performed for the TH e-GIF pilot project in September 2008 (Saekow, 2009). The evaluation compared the evaluated results between the TH e-GIF approach with and without IPIS. In (Saekow, 2009), the results show that the approach using the IPIS tool can assist the pilot interoperability project to achieve objectives more easily and economically. The time spent in the project approximately becomes shorter (65%). The cost estimate also was reduced about 53%. It also indicates that by using the support tool, the officers need less experience and skills to achieve the desired interoperability requirements. With regards to the evaluation of the NRCT project, it has been under process and the significant results will be reported in future paper.

7. Conclusions and future works

This paper presents a practical approach to implementing electronic government interoperability. The approach called “Interoperability Practical Implementation Support or IPIS” was designed and developed as an assisted mechanism for e-government interoperability implementation. The IPIS consists of three main components: support tools, interoperability repositories, and a knowledge based system. As a pilot phase, we first implemented the IPIS tool. The tool can assist in automatically modeling/specifying business processes based on UMM and standardizing and developing data sets and XML schema standards based on UN/CEFACT CCTS and XML NDR. We also proposed interoperability repositories and a knowledge based system as the additional artifacts in the IPIS at the implementation level. The repositories include: business process models, data standardized sets, XML Schema standards, web services and technical standards. With regards to the knowledge based system, it incorporates a collection of best practice cases, ontologies, and interoperability frameworks as well as enterprise architectures. For the IPIS adoption, we designed and introduced the methodology that comprises nine steps. As a result, it significantly indicates that
the IPIS can assist the e-Government interoperability project to achieve the objectives more easily and economically. The time spent in the project also becomes shorter. The result furthermore reveals that the successful project needs less experience and skills by using the IPIS tool. Future steps of our work include the implementation of the repositories with the design of discovery approach for reusing resources. The expansion of e-Government interoperability projects adopted by IPIS will be proposed for our further improvement and evaluation.

Acknowledgements

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8. References


Ontology Driven e-Government

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Abstract: This paper presents an approach to model ontologies for the e-Government domain as a basis for an integrated e-Government environment. Over the last couple of years the application of semantic methodologies and technologies in the e-Government domain has become an important field of research. A significant number of these approaches aim at automatic service discovery and service orchestration (Lu et al. 2004) (Crichton et al. 2001) approach to e-Government. That is why we call it Ontology Driven e-Government. The principle is rather straightforward. Every public service is semantically modeled and contains references to the required input semantic rules and evaluated by semantic reasoners. This allows for an automatic creation of (web) forms and elements. Any constraints on the service input element – also known as preconditions – can be expressed by semantic rules and evaluated by semantic reasoners. This allows for an automatic creation of (web) forms and interactive plausibility checks of data gathered from the user. Instead of scattering logic over numerous functions and procedures in all possible layers of an application, it is now consistently kept in the semantic model. Another key advantage of this approach is that the knowledge of public services becomes available in a machine processable form which allows for much more than just forms creation. Discovering the citizen’s actual goal is one of these use-cases and is actually a very central and important step. When developing the idea of ontology driven e-Government it was one main idea to achieve a strong decoupling between the form solution and the backend. Such a decoupling can be achieved by transforming the input data into a common data interchange standard format, which was EDIAKT II (Freitter et al. 2006) – an XML Schema definition for the exchange of electronic documents between public authorities in Austria – in our case. Following this approach the input data can be consumed by any application supporting the data interchange standard EDIAKT II like the SOA-backend also proposed in this paper.

Keywords: e-government, ontology, WSML/WSMO, goal orientation, form generation

1. WSMO-PA – an e-Government meta-model

Figure 1: GEA-PA service model (Wang 2007)
To ensure that all public services are modeled in a consistent way, a meta-model that acts as a modeling guideline is needed. Therefore we chose a model proposed in the Government Enterprise Architecture – Public Administration (GEA-PA) respectively its WSMO implementation WSMO-PA (Wang 2007) as shown in Figure 1. GEA-PA is technology neutral. Thus it does not make any assumption about the semantic framework or the nature of the actual implementations of public services, hence most often they will be implemented as web services. It also models goals and needs to link citizens (societal entities) to public administration services. This allows for goal-oriented discovery of public services that do not necessarily have to be implemented as (semantic) web services.

2. Goal-oriented e-government

One big advantage of semantic web services is their inherent goal orientation. They contain a semantic description of what they do or achieve. Before a user can make use of one (or more) of these services, the following phases have to be passed through (Leitner 2003):

- Goal discovery phase: In this phase the actual goal of the user has to be correctly formulated using semantic notations.
- Semantic web service discovery phase: A set of semantic web services that might fulfill the goal is retrieved.
- Service selection phase: The web service that will actually be executed is selected from the set of retrieved services.

Formulating the goal using any of the semantic methodologies can become relatively difficult. This is due to the fact that the problem domain itself can be relatively complex and, since this process involves user interaction, a simple and easy to use interface for expressing the goal is needed. In our prototype implementation of ontology driven e-Government we have limited the problem domain to the construction approval process. According to the construction law that has to be applied in this example there are three different categories any construction might fall into:

- Building development requiring official approval: In this case you have to apply for approval which will trigger a fairly complex process.
- Notifiable building development: In this case you have to notify the responsible public agency providing detailed information about the project. The agency can prohibit the project within six weeks. Otherwise approval is granted.
- Building development not requiring official approval: In this case you just have to inform the responsible public agency about when construction work will start and provide some basic information about the project.

Which of these services is needed for a given project depends on the type but also probably the size or extent of the structure. The correct answer to this question requires some in-depth knowledge of the construction law. To offer these services via e-Government to citizens you also have to provide some easy to use means of identifying the required service. This is done by semantic goal and service discovery.

3. Selecting the semantic modeling framework

There are currently several competing frameworks for modeling semantic web services submitted to the W3C. Among them is OWL-S (Martin et al. 2005) and WSMO (Fensel et al. 2007). We implemented evaluation prototypes based on both approaches and eventually chose WSMO which is based on WSML (Bruijn et al. 2006) over OWL-S which is layered on top of OWL (W3C 2004). While a detailed discussion of the differences between these two approaches can be found in (Bruijn et al. 2005) and (Polleres et al. 2004), here we will simply state the reasons for our decision.

One basic idea of our approach is its forward engineering nature. This means, that we want to start new e-Government projects by modeling the ontology first and then using this ontology as a domain model to form the basis of the generation of an application or service. In contrast to this, semantic technologies are usually used to add annotations to already existing services. In our context, the ontology can be compared to a platform independent model (PIM) as it is used in model driven architecture (Miller et al. 2001). Since the ontology is the key element, we had to look for a modeling approach that is simple and yet expressive and powerful enough to cover all possible aspects that might be needed for creating a runtime environment that is based on this model.
While OWL is based on XML, WSML can be seen as a domain specific language based on Meta Object Facility (MOF) (OMG 2002). As a consequence there is no XML overhead in WSML. Table 1 and Table 2 represent the same facts. Every person has a name and parents. It is obvious that the WSML version is easier to read, which is definitely an advantage in this case since models can be easily created and reviewed by authors even without the use of tools.

Besides the expressive notation of WSML there exists a language variant called WSML-Flight, which supports logic programming based on F-Logic (Kifer et al. 1995). In contrast to OWL, this approach favors the closed world assumption, which makes the formulation of logical constraints much easier. As you can see, another minor difference is the terminology. OWL uses the term class whereas WSMO uses term concept for the abstraction of a thing. Both terms can be used synonymously.

4. Modeling the ontology

As mentioned above, the first services that should be supported by this new approach are construction approval services. These services are governed by a local construction law. Thus this law is an important source for modeling the required ontology since it contains all needed concepts and the logical rules and requirements that form the basis of the public agency's actions. Even though some attempts to automatically extract semantic information from laws (Biagioli et al. 2005) (Schweighofer et al. 2001) already exist, we conducted this step manually, identifying needed concepts and their interdependencies by carefully analyzing the text.

Other important sources, especially for modeling the attributes of identified concepts, are existing (paper based) forms. Every input field on a form is considered to be a property of one of the concepts involved (e.g. “family name” is a property of the person concept acting as builder in this context).

While modeling the ontology for the construction approval domain, it became clear that it is relatively hard for non experts to even find out which one of the existing services (see Section 2) is the appropriate one or whether any service is needed at all. This is why we have introduced goals/desires to guide the user while selecting the appropriate service.
4.1 Goal templates

Goals are elements in all frameworks that are used to describe semantic web services. Since they are used to describe the capability of these services they typically exist at a relatively low and technical layer (Fensel et al. 2007). In the context of this paper we use the term goal as a synonym for the terms desire or need as they are suggested by GEA-PA (Wang et al. 2007). An abstract, yet typical goal in the given context would be:

“I want to {build|knock down|rebuild} a {structure}!”

This goal is a typical semantic triple consisting of subject (“I", the citizen), predicate (“build” or “knock down” or “rebuild”) and object (“structure”). Our top-level goals reflect what citizens might want to do or want to achieve (e.g. “to build something”). This should make it easy to identify appropriate goals that fit the needs of a particular life-situation. At this top-level, a goal typically cannot be uniquely mapped to one single service. Therefore every goal has to be refined so that it becomes a concrete one like

“I want to build a garage!”

However, this still does not unambiguously identify the required service since in this example the required type of service depends on the type and number of motor vehicles that will be parked in the garage. Thus, we would need a more specific goal like

“I want to build a garage for three cars!”

Which type of approval or service is actually needed is clearly defined in the underlying regulations. Assuming that the applicable law is consistent – which is typically the case – this approach does not lead to any goal conflicts since every possible case falls into exactly one category and is therefore assigned to one particular service.

Figure 2: Part of the concept hierarchy

After analyzing the construction law, a model containing all concepts/classes was created. Since the construction law sometimes referred to more abstract concepts (e.g. “building”) and sometimes to more specific ones (e.g. “detached family house”), the resulting concepts formed a hierarchy (see part of hierarchy in Figure 2). The top-level concept that could be used in the goal template is “construction”. All other identified concepts representing more specific types of a construction are modeled as sub-concepts resulting in a tree of concepts.

The basic idea of the goal discovery process was to start with a goal template containing the most abstract concept (e.g. “construction” or “structure”) and assist the user in refining these concepts by specialization until the administrative service that is needed to fulfill this goal can be unambiguously identified. The goal discovery algorithm is explained in Section 5.

4.2 Specialization and classification

An ontology is defined as (Ehrig et al. 2004):
A similar definition of an ontology not including datatypes can be found in (Bloehdorn et al. 2005).

The is_a relationship between two classes is defined as follows:

\[
c_1 \subseteq c_2 \mid c_1, c_2 \in C \Rightarrow c_1 \text{ is subconcept of } c_2
\]

The is_a relationship is transitive:

\[
c_1 \subseteq c_2 \land c_2 \subseteq c_3 \Rightarrow c_1 \subseteq c_3
\]

Defining a function \( attr(c) \):

\[
attr(c) : C \rightarrow A
\]

that returns the set of attributes belonging to a given concept \( c \) the following statements also hold true:

\[
c_1 \subseteq c_2 \mid c_1, c_2 \in C \Rightarrow \text{attr}(c_2) \subseteq \text{attr}(c_1)
\]

This means that all sub-concepts contain all the attributes of all their super-concepts but might also posses additional attributes. Since a concept might also have several direct super-concepts, the following statement has to be true:

\[
c_1 \subseteq c_2 \land c_1, c_2, c_3 \in C,
\]

\[
\Rightarrow \text{attr}(c_2) \cup \text{attr}(c_3) \subseteq \text{attr}(c_1)
\]

Sub-concepts are also called specializations of their super-concepts since they are more specific. In our ontology model, however, we use two different types of sub-concepts. One is classical specialization. For example garage is a sub-concept of building. The second type of a sub-concept is no real specialization but more a kind of classification. As mentioned above, which type of administrative service needs to be used when building a garage depends on the size of the garage, which in turn is defined by law referring to the type and number of vehicles that will be parked there. Therefore we have defined three sub-concepts called small-, medium- and big-garage. These sub-concepts represent different classes of garages rather than more specific types of garages. Consequently one characteristic of classification compared to specialization is that attributes of sub- and super-concepts will be identical:

\[
c_1 \subseteq c_2 \Rightarrow \text{attr}(c_2) = \text{attr}(c_1)
\]

...in the case of classification

The difference between sub- and super-concepts in the case of classification lies in the domains (i.e. values) of some of their attributes. In WSML these differences can be modeled by axioms which are used by the reasoner. Thus, having given any instance of the concept garage, the reasoner can infer the correct sub-concept it belongs to by analyzing number and type of vehicles parked there.

Table 3: Axiom defining a small garage

<table>
<thead>
<tr>
<th>Axiom SmallGarageDefinition1</th>
</tr>
</thead>
<tbody>
<tr>
<td>definedBy</td>
</tr>
<tr>
<td>?x memberOf SmallGarage</td>
</tr>
<tr>
<td>impliedBy</td>
</tr>
<tr>
<td>?x[forVehicleType hasValue ?vehicleType, vehicleCapacity hasValue ?capacity] memberOf Garage and (?vehicleType memberOf vehicle#Car and ?capacity &lt; 3) or ?vehicleType memberOf vehicle#Motorcycle and ?capacity &lt; 6).</td>
</tr>
</tbody>
</table>

The meaning of the axiom in Table 3 is almost self-explanatory. There is some \( x \) that pretends to be a Garage and therefore has to have some attributes. If the values of these attributes meet the constraints of the axiom than this \( x \) becomes a SmallGarage.

5. The goal discovery algorithm

Initially based on the GEA-PA service model, we have refined and adapted parts of this model as shown in Figure 3.
A goal might refer to one or more concepts (e.g. “I want to build a (construction)!”). Services are mapped to goals. There might be several services that fulfill a goal (e.g. in our construction approval example there are three different services), however, the combination of goal and a concrete (sub-) concept uniquely identifies the service needed. This assumption is based on the following constraints:

- Every concept that has sub-concepts is considered to be abstract.
- Every concept that has no sub-concepts (a leaf in the concept graph) is considered to be non-abstract.
- Public services only accept instances of concrete, non-abstract concepts.

This allows for a very simple algorithm:

- Start with a goal template
- For each concept the goal template refers to, go down the concept hierarchy till a leaf is reached.
- Lookup the matching service.

As shown in Figure 4, these constraints do not impose any limits on our approach. Assuming that there is a concept b, that has sub-concepts and is not abstract (i.e. instances of this type are valid input to services), the concept hierarchy can be remodeled by declaring b abstract and introducing a non abstract concept b’ with the following behavior:

\[ \text{attr}(b') = \text{attr}(b) \]

In this case an instance of the formerly non-abstract concept b is needed, an instance of concept b’ is used.

The entire algorithm represents the following function:
findService\(g, c\): G[xC]^n \rightarrow C

where \(g\) is a goal and \(c\) is a possibly empty set
of concepts;

The central part of this algorithm is traversing the tree of concepts. There are two different methods to
identify the required sub-concept. In the case of real specialization, the user has to select the
appropriate sub-concept from a list as shown in Figure 5. The question always follows the same
pattern:

“You want to [build|knock down|...] a [currentConcept]. Please further specify the type
of [currentConcept].”

Possible answers are the sub-concepts of currentConcept. In use-cases where there are many
different concepts organized in multiple hierarchies, this approach might be perceived as being a little
onerous. Therefore, we are already considering about integrating some search facility as well.

You want to erect a Building, we give you our support!

Which type of "Building" is it?*

- Adjoining building
- Electric power substation
- Garage
- Greenhouse
- House
- Place of public assembly
- Sacred building (church, chapel ...)
- Toolshed

Figure 5: Prototypic user dialog for selecting a sub-concept

In the case of classification, the prototype system analyses the axioms
and asks for the attributes that
are evaluated to infer the correct sub-concept (see Figure 6). The sub-concept is identified by the
semantic reasoner.

6. Form generation

After identifying the appropriate service for the citizens’ goal the next step that has to be taken is to
identify the relevant input for the selected service and to transform the semantic representation of the
required information into a corresponding web form. In our prototype application the java library
wsmo4j (details see http://wsmo4j.sourceforge.net) was used to access the created ontologies. We
have used Java Server Faces (JSF) as our web technology.

Table 4: Concept representing inputs to building permit service

<table>
<thead>
<tr>
<th>concept</th>
<th>BuildingPermitApplicationRequest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>nonFunctionalProperties</td>
</tr>
<tr>
<td></td>
<td>dc#description hasValue</td>
</tr>
<tr>
<td>applicant ofType</td>
<td>(1 *) personData#Person</td>
</tr>
<tr>
<td>construction ofType</td>
<td>(1 1) Construction</td>
</tr>
<tr>
<td>delegate ofType</td>
<td>(0 1) personData#PhysicalPerson</td>
</tr>
<tr>
<td>sitePlan ofType</td>
<td>(1 1) segofUtil#File</td>
</tr>
<tr>
<td>floorPlan ofType</td>
<td>(1 1) segofUtil#File</td>
</tr>
<tr>
<td>constructionViews</td>
<td>ofType (1 1) segofUtil#File</td>
</tr>
<tr>
<td>buildingSiteEligibility</td>
<td>ofType (0 1) segofUtil#File</td>
</tr>
</tbody>
</table>
In table 4 a WSML concept representing relevant input to the building permit service is shown. This concept is characterized by several properties, like applicant, construction, delegate etc, which in turn represent WSML concepts. These properties – so called object-properties since they do not hold simple data values but references to other concepts instead – have to be further explored by a citizen within the generated form (see Figure 7). For each object-property in the generated form a button is added to further specify the values of the object-property.

By clicking such a button, another form with all properties of the previously selected concept is generated. As shown in Listing 4 an “applicant” is of type “Person”. A person is characterized by personal data and address data. The form representation of the concept “personal data” is shown in Figure 8. This concept doesn’t consist of object-properties but consists of so called datatype-properties that hold simple data values like string, integer or date values.

<table>
<thead>
<tr>
<th>Building Permit Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicant:</td>
</tr>
<tr>
<td>Applicant:</td>
</tr>
<tr>
<td>Construction specification:</td>
</tr>
<tr>
<td>Delegate:</td>
</tr>
<tr>
<td>Site plan:</td>
</tr>
<tr>
<td>Floor plan:</td>
</tr>
<tr>
<td>Construction views:</td>
</tr>
<tr>
<td>Building site eligibility:</td>
</tr>
</tbody>
</table>

**Figure 7**: Form representation, object-properties

<table>
<thead>
<tr>
<th>Person data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic degree prefix:</td>
</tr>
<tr>
<td>First name:</td>
</tr>
<tr>
<td>Surname:</td>
</tr>
<tr>
<td>Academic degree suffix:</td>
</tr>
<tr>
<td>Marital status:</td>
</tr>
<tr>
<td>Sex:</td>
</tr>
<tr>
<td>Date of birth (tt.mm.jjjj):</td>
</tr>
<tr>
<td>Place of birth:</td>
</tr>
<tr>
<td>Country code:</td>
</tr>
<tr>
<td>Phone number:</td>
</tr>
<tr>
<td>E-Mail address:</td>
</tr>
</tbody>
</table>

**Figure 8**: Form representation, datatype-properties

After the user has filled in all required data an instance of the corresponding WSML concept (see Table 4) is generated within the ontology and existing axioms are used to validate its correct state.

When developing the idea of ontology driven e-Government it was one main idea to achieve a strong decoupling between the form solution and the backend. Such a decoupling can be achieved by transforming the input data into a common data interchange standard format, which was EDIAKT II (Freitter et al. 2006) – an XML Schema definition for the exchange of electronic documents between public authorities in Austria – in our case. Following this approach the input data can be consumed by
any application supporting the data interchange standard EDIAKT II like the SOA-backend described in the next section.

7. Accessing SOA backend

In this section we propose a SOA (Service Oriented Architecture) backend for ontology driven e-Government. Thereby it is our intention to implement a so-called grounding for each semantic web service to a concrete web service, which is typically represented by a WSDL file. The WSMX (Web Service Modeling eXecution environment) (Fensel et al. 2008) developed within the WSMO Project (Fensel et al. 2007) represents one promising approach to establish groundings from a semantic web service to a concrete web service. As both, WSMX as well as the semantic web services and ontologies from our prototype implementation are based on WSML (Bruijn et al. 2006), the decision to use WSMX as execution framework is obvious.

As already mentioned the concrete implementation of the web service is represented and described by a WSDL file. Behind this service description in our case is a BPEL (Business Process Execution Language) process – implemented with “openESB” (open Enterprise Service Bus). Since every concept can be automatically transformed into XML-schema and each of its instances into XML based on this schema, all data gathered from the user can be seamlessly used within BPEL processes. This allows for very easy process composition, utilizing other already existing services like a central register of residents to make plausibility checks of the citizens’ address data. Not only web services but almost every single service offered by public agencies could be involved in such a BPEL process as long as it is attached to the service bus. Thus entire – or at least major parts of – back office business processes within the public agency involved are supported electronically from the beginning – which is the request of the citizen – to the end – which typically is the success/failure notification about citizens’ applications to the citizens.

8. Conclusions

The approach to using semantic technologies in e-Government presented in this paper is a first step towards an ontology based process to implement e-Government services, where modeling the ontology should be one of the first steps. Goal and service discovery is one important part of this type of e-Government solutions. Using semantic reasoners to identify the concepts involved is very powerful and can hide much of the complexity of underlying regulations from citizens. The concept tree used in this example to guide the user in identifying the concept actually involved in her goal is a good basis to start with.

Intelligent electronic forms – as described in section 6 – that know the current context they are running in, greatly simplify interaction with public agencies and back office business processes. Orchestrating all participating back office services with a tool like “openESB” – as proposed in Section 7 – would also greatly simplify the work of the particular public agency’s staff as the transparency of the offered public service itself is tremendously increased.

One of our next goals is to further enhance the quality of the citizen’s input data to public services on the one hand and to further increase the system’s usability on the other hand. One major step thereby will be to shift services, which are currently located in the back office layer, to the application layer. Preferably, it should be possible to verify an applicant’s address and personal data during form completion, instead of in the back office. Thus, a semantic representation and integration of typical validation services like a central register of residents has to be accomplished. Besides validation services another type of services, so called data provider services (e.g. address list, list of states) will be investigated to finally achieve a citizen friendly, barrier free and easy to use user interface to our “ Ontology driven E-Government” environment.

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An e-Government Stages of Growth Model Based on Research Within the Irish Revenue Offices

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Abstract: This paper describes a stages of growth model for e-Government. The proposed model is comprised of seven stages, which are divided into three phases. The model is based on research into and analysis of Information Systems and Information Communications Technology (ICT) solutions in the Irish Revenue Offices for more than a 50-year period. It is argued that this model provides a useful template for understanding the growth of ICT in government organisations.

Keywords: stages of growth, e-government, learning organisation, ICT, IT evolutionary models, IT maturity

1. Introduction

The proposition underlying this paper is that government agencies evolve through distinct stages and that those stages may be outlined as an e-Government stages of growth model. e-Government here is defined broadly as the application of innovative forms of government and governance through the use of ICT (Castelnovo and Simonetta 2007; Nygren 2009). This paper is concerned with how information systems and ICT solutions evolve within a public sector organisation. An information system in this context is understood as a system, automated or manual, that comprises methods to organise and/or process data that represent user information.

The paper focuses on the Irish Office of the Revenue Commissioners (Revenue) outlining the stages of its e-Government initiatives. The observations are then abstracted and developed into a model which may have broad use within other public service organisations.

2. Theoretical framework

Although stages of growth modelling is not new (Anthony 1965; Churchill 1969) the approach was first popularised in the information systems field by Nolan in the 70’s and 80’s. Nolan’s model evolved in each of these papers (1973; Gibson and Nolan 1974; 1979) and was strongly criticised by King and Kraemer who found it wanting on empirical, theoretical and practical grounds (1984). King and Kraemer questioned the empirical findings of the model saying that the model’s predictions are not supported by their own research and that of others (King and Kraemer 1981; Goldstein and McCririk 1981). It is interesting to note that despite the fact that Nolan’s model was the subject of heavy criticism by some academic researchers the concept of stage models was well received by practitioners and continues to be referred to in the IS literature (Friedman 1994). It provides a conceptual language which allows the ability to assess the current position and strategise future positions (King and Kraemer 1984; Benbasat and Zmund 1999).

More recently maturity models have proliferated to the extent that Mutafelija and Stromberg (2003) claim that there are now more than 150 maturity models in existence. These models address issues such as the maturity of IT Service Capability, Strategic Alignment, Innovation Management, Programme Management, Enterprise Architecture and Knowledge Management.

Most of these models simply pre-define maturity for the chosen topic and allocate progressive steps which enable the path toward that goal. According to de Bruin and Rosemann (2005) the most popular way of evaluating maturity is with a five-point scale where ‘5’ represents the highest level of maturity. This type of model can be categorised as an evolutionist type model as opposed to an evolutionary model (van Parijs 1981; King and Kraemer 1984).

3. Evolutionist and evolutionary models

Models that describe change in terms of direction are described as “evolutionist” models and are distinct from “evolutionary” models, which describe change in terms of mechanisms (Toulmin 1972; van Parijs 1981; King and Kraemer 1984). An evolutionist model views the stages of development as stepping-stones toward a progressively more complex or perfect version of itself – whatever that
might be. This type of model defines the desired endpoint and the maturity scale and is therefore a model from design. Such theories embody a clear concept of the direction of change and the destination of change. Models such as this explain the course of change in terms of its direction toward the final end point or maturity. A significant number of maturity models as described by de Bruin and Rosemann (2005) including the Capability Maturity Model Integrated (CMMI) models can be categorized as evolutionist. However these models may have a reflexive element whereby the model and the adoption of the model is likely to have some predictive qualities in as much they influence the potential outcome of the entity being assessed or tracked.

Evolutionary models, by contrast, are agnostic about the direction of change or the final stage of development. Evolutionary models focus on the mechanisms, which drive change, and the features of the new stages of development (van Parijs 1981). According to King and Kraemer (1984) “Evolutionary mechanisms are mechanisms of local optimization in which features of an entity change and in which the new features are preferable to the old features in aiding survival of the entity or improving its chances of satisfaction.”

The model presented here is an evolutionary one.

4. Stages of growth

The development of an organisation over time is known variously as organisational learning, stages of growth or organisational maturity. Two types of growth or learning are described in the literature: vertical growth also understood as conceptual learning; and horizontal growth also referred to as operational learning (Kim 1993; Chen et al. 2003). Vertical growth or conceptual learning occurs when members of the organisation challenge the organisation’s underlying assumptions, values, and procedures, attempting to replace them with new ones. According to Chen et al (2003) vertical growth requires that the organisation change its pattern of thinking and that it question its operating principles. Horizontal growth uses existing conceptual models held within the organization to create efficiencies. This type of learning or growth is concerned with detecting performance deviations from standards and goals, and reducing the level of divergence through systematic problem solving. Organisations typically engage with both types of learning or growth. Vertical growth is mapped in this paper with distinct stages of development whereby the organisation understands its environment differently and develops an ‘intelligence’ to deal with it.

The term intelligence is used here with reference to the concept of multiple intelligences, which was first introduced by Howard Gardner (1993). Gardner asserted that humans display a wide number of aptitudes, competencies or talents, which he regards as separate intelligences. Some examples of the intelligences include: cognitive intelligence; kinesthetic intelligence; interpersonal or emotional intelligence. Humans use these intelligences as distinct tools to solve problems or avail of opportunities. This term has been applied here in this paper to the stages of growth found in Revenue. More specifically it is posited that each stage of development is likened to a distinct intelligence. As each intelligence is adopted by the organisation it may be used many times, as a solution in different contexts, even when the organisation has moved to the next stage. Just as a person develops interpersonal or emotional intelligence they do not relinquish cognitive intelligence as a method to deal with problems or opportunities.

5. Research methodology

A single case study was used in this research in which evidence was collected through 15 in-depth interviews each of which averaged approximately one and a half hours duration. Other sources of evidence include: annual reports; government reports on administrative efficiency; reports of government commissions on taxation; internal documents and other artefacts.

The research approach in this case was qualitative. The philosophy used is interpretative.

6. Background to tax administration

National tax administration is a complex affair and involves several stages some of which are: drafting clear legislation; interpreting and implementing this legislation; keeping taxpayers and administrators abreast of new legislation and interpretation; identifying taxpayers, their income and wealth and on that basis assessing their liabilities; providing machinery which allows collectors and taxpayers to agree on assessments; and operating appeal procedures.
Like taxation systems in most countries, the Irish taxation system grows in a piecemeal fashion with adjustments made with the annual budget. Tax concessions are designed to encourage particular forms of economic or social behaviour and to give special relief to particular sectors of the economy. These concessions dilute the effectiveness of each existing tax and erode its efficiency over time (Commission on Taxation 1985). Taxes have a propensity for increasing complexity, and when they reach a point where they are in danger of becoming unworkable due to administrative costs they are reviewed for efficiency. Overall reviews of a tax are infrequent occurrences, which require careful consideration planning and change management.

7. Propensity for increasing complexity and administrative costs

This propensity for taxation systems to increase in complexity over time has the effect of increasing the administrative cost of running the organisation – see figure 1. Revenue’s administrative budget, the budget allocated by national parliament each year to run the organisation, acts as a driver of efficiency. The fact that this budget is not amenable to adjustment means that there is significant pressure on the organisation to adapt to any demands with renewed efficiencies.

![Figure 1: Revenue's forces for growth mechanism](image)

This propensity for increasing complexity and the restraining force of the administrative budget has acted as a driver for change and has moved the organisation through a number of stages of growth and development.

8. General description of the stages of growth model within revenue

Stages of growth in Revenue occur in a logical sequence. This also manifests itself as an increasing repertoire of intelligences with which to deal with continuing demands for efficiency. Once a stage has been reached, or taken on, it remains as part of the organisation’s response repertoire, even when later stages are adopted.

While the following model has a focus on e-Government, the use of ICT is not introduced until stage three. To understand the evolutionary processes of the e-Government era it is necessary to introduce the structural basis on which it rests. Stages one and two are therefore prerequisites and are foundational to any electronic government initiative. These stages will heavily influence the path that
subsequent stages follow and without having adopted these stages it is likely that an organisation may not commit to ICT to such an extent.

9. Stages of growth model

10. Stage 1 – structural era: legislative foundation

The legislative function is presented as the first stage and foundation level which the organisation had to adopt, in order to solve the many socio-economic demands on the taxation system. Putting a legislative process in place within the organisation is fundamental to all the subsequent stages of development and so is categorised as the structural phase or era of the organisation.
organisation has continually relied on the ability and expertise of the legislative architects and technicians to give precise direction and advice with regard to the tax acts and the substantial case law. This legislative competency was and remains essential as a foundation and support for further stages of development. As the organisation's business processes are built on the foundations of the legislation and the tax code, it is necessary that this ability be established before the subsequent stages are approached.

This legislative foundation was categorised as a stage and not merely as a foundation as it did and continues to hold the potential for generating organisational efficiencies. Legislative policies in taxation such as ‘Self Assessment’ have created and continue to create efficiencies by outsourcing tasks to the taxpayer, thereby reducing administrative costs. The legislation function acts as a foundation and source for all business processes and has the potential to impact on efficiencies within the organisation.

11. Stage 2 – structural era: organisational structure and business process

By 1939 the organisation had emerged as a strong bureaucratic machine which was capable of manually administering the complete taxation process (including assessment and collection) for all taxpayers in the State (Réamonn 1981). It is difficult to observe when exactly this intelligence or stage was reached but from this point forward there was certainly the concept of using different organisation components for different functions. The organisation structures as described in the many artefacts available, show that the organisation had taken on the classic machine bureaucracy features as described by Mintzberg (1981). The organisation had at this point already put together many analysts to maintain and design legislative structures and to standardise complex taxation processes which were being administered by the many tax units around the country. The Secretariat as described by Réamonn (1981) is clearly in line with Mintzberg’s view of this type of organisation structure – with a large hierarchy in the middle of the organisation to oversee the specialised work being performed in the operating core. Revenue took every opportunity to stabilise its environment with these technostructures and support staff. This stage was categorised as foundational and important to an organisation which was constantly coming under pressure with demands from the socio-economic environment.

12. Stage 3 – e-government era: ICT and process engineering within silos

Procedures in the organisation had now stabilised into business processes. The organisation had developed the competency to maintain this stability over time. This setting was a foundation for the introduction of ICT. The fact that ICT was introduced at this early stage was a function of the mechanism of socio-economic pressure and the administrative budget constraints. In the economic boom of the late 50’s and early 1960’s the number of taxpayers trebled. The foundation of established, stabilised and well analysed business processes provided the necessary conditions for change.

Revenue’s first e-Government initiative commenced in 1960 with the automation of existing taxation processes, each of which operated in silos within the organisation. These silos had little if any coordination between them. Each business process was separate as regards legislation, organisational structure, staffing and business processing. When the ICT function was introduced it was used to support the existing structure and not to re-engineer the process or structures. Consequently, the ICT applications were themselves very much silo based with no connections between them and with a substantial amount of duplicated functionality and code (Bannister 2001). In keeping with a machine bureaucracy the organisation developed its own in-house technical staff to support these processes and so the ICT development function began to emerge.

13. Stage 4 – e-government era: coordination with customer view

An increasing strain on Revenue resources occurred again during the 70’s and 80’s when eight new tax types were introduced – among which were: Value Added Tax; Corporation Tax and Capital Gains Tax. The silo type tax system began to turn up with an increasing number of anomalies - some of which were introduced with new taxes and others were merely becoming more observable. For instance it was possible in this era to have a substantial liability in Income tax and to simultaneously be the subject of a refund of VAT.
From a technical perspective, as the number of tax types increased and a corresponding number of ICT systems increased, more anomalies began to emerge. Not alone did business anomalies emerge, but ICT nuances were developed with each system - development work was duplicated and where any attempt was made to make these anomalies consistent across systems a substantial cost was incurred.

In 1989 an internal study took place to observe what the organisation felt was a real lack of coordination between the various taxheads. This study was based on the simple premise that each taxpayer was likely to be registered for many taxes and that each system was likely to be duplicating development and maintenance costs not to mention the larger business costs of differing business processes within the organisation.

The study led to a major reconstruction of the Revenue’s computer systems, enabling a subsequent transformation of the Revenue business processes and organisation structure. The intention was to organise data and applications around the taxpayer rather than the tax. Revenue’s own studies and global experience in other agencies had demonstrated that this led to a more efficient collection of tax, a more effective combating of tax evasion and an improved customer service for taxpayers.

This approach to the taxpayer brought about a review of existing structures, which recommended a major restructuring of the organisation, to one which deals with taxpayers in a more holistic way.

14. Stage 5 – e-government era: tax processes exposed via the web

The introduction of a fully interactive and transactional web presence was a milestone within the organisation and was significant in terms of the efficiencies it brought. Although this type of direct contact between the customer and Revenue’s internal systems was not new, webservices provided the first opportunity where this type of direct contact could be applied to many of Revenue’s business processes. While this was certainly a significant stage in Revenue’s stage development it does not fit quite so neatly into a more general e-Government stages of growth model. This stage of Revenue’s development was contingent on the introduction of web services by the ICT industry. The use of this technology by Revenue had no other contingencies apart from the structural prerequisites held by stages one and two. Therefore while this stage remains as stage five in Revenue’s stage development, any current e-Government model should incorporate this type of processing within the early ICT stages – if not the earliest.

15. Stage 6 – e-government era: data mining and knowledge management

At this point the organisation adopted a voluntary compliance model with Self-Assessment, which meant that Revenue needed to detect where taxpayers were not compliant with the new regime. As a quality assurance measure Revenue now relied on interventions with taxpayers in the form of audits. Revenue auditors are an expensive resource to train and deploy. It is important therefore that this resource be used effectively and that auditors’ interventions with taxpayers are valuable in terms of return on investment. An audit of a taxpayer who is fully compliant is a waste of resources for Revenue and the taxpayer. The ability to assess taxpayers and to target those delinquent cases, increasingly demanded more understanding of the taxpayer’s propensities. To this end a data warehouse was created, data mining commenced and an inference engine was used to assess risks in areas such as debt collection, late payments and special investigations.

This type of analysis and data mining relies for its information on the ability to focus on the taxpayer from many different perspectives in order to get a more holistic view of their propensities.

This type of data mining and inference engine use is a distinct new stage of development, in terms of its operational approach. The data is compiled from a complete customer view of the taxpayer, which up to this point was not available. The inference rules are applied to each taxpayer and resources are allocated according to the level of risk identified by those rules. The rules are continuously challenged for validity and relevance.
16. Stage 7– e-government era: service oriented architecture and business process management

Service oriented architecture (SOA) and business process management (BPM) have been adopted as a stage of development as a result of the increasingly complex requirements of many diverse taxes being applied to the single monolithic system which is a dominant feature of ICT in the organisation. SOA is an opportunity where value can be gleaned from both technology and business in terms of flexibility and reuse (Papazoglou and Georgakopoulos 2003; Krafzig et al. 2005; Erl 2006). BPM is defined as a holistic organisational management practice (Rosemann and de Bruin 2005) with an emphasis which looks to processes and process improvement in a way that can take advantage and support the standard process improvement methodologies such as ISO 9001, Six Sigma and LEAN (Persse 2006). As the complexity level grows in any system beyond a certain point, function becomes impaired, operation becomes inefficient, and reliability declines. In software terms this means that to maintain reliability and efficiency in an increasingly complex environment more effort is required. Allen and Starr (1982) point out that as code is modified in an application or an algorithm, initially modifications are simple and the utility is clear. They describe how subsequent changes bring problems through secondary effects of the modifications and so improvement is made at a price. Over time significant effort must be applied to the algorithm to compensate for deleterious effects and so balance the benefits. Eventually a point is reached where the costs of further changes and the benefits accruing cannot be balanced. Once this point is reached only a macro level change can simplify systems so further adaptation can occur.

Revenue is increasingly coming under pressure externally from the European Union (EU) to adopt additional control and taxation measures, and internally to provide more business processes, which may be short-lived or have a flexible composition. To add this type of complexity to an already complex integrated system requires a new approach to the architecture and development of software within the organisation. To this end a long-term perspective has been taken with the adoption of SOA and BPM. This approach will allow flexible processes to be built while being able to reduce the risk of rising complexity as regards software architecture. Both these are in essence a single approach to business processes, which allow process modeling and process improvement. Enterprise architecture must allow continuous changes in order to adapt to evolving legislation and or business reorganisation. The move to SOA and BPM is a move away from the development of monolithic systems. This does not imply that monolithic systems should be completely deconstructed but rather this stage appreciates the value associated with monolithic systems, and is able to recognise when return is diminishing from the further aggregation of processes in a single system.

17. Stage 8– e-government era: systems thinking and systems dynamics

This incipient stage was identified by a small number of informants but held some significance, as the most senior of the informants outlined it. The organisation was identified as having many stages of development or independent intelligences each with separate inputs, structure, governance and dynamic. For instance, Revenue now has a complex information system surrounding the stage two, legislative stage or intelligence. An internal team manages external political demands for changes. In particular it manages proposed new legislation, operations procedure and not least the implementation of ICT solutions. Similarly the ‘Structural and Process’ stage (Stage2), which is governed by the Human Resource Division of the organisation, has its own structure, system and dynamic. Although these intelligences or stages of growth remain isolated, acting as separate rational competencies, they must also be viewed as interacting currents with structural consequences, which should be considered as a whole for their systemic or overall impact. This approach should take into account all intelligences or stages of growth with a view to aligning divergent currents associated with each of the competencies. Jackson (2003) and Senge (1990) describe this approach to the management of complex systems as the field of System Dynamics. According to Jackson (2003) the field attempts to map causal relationships between subsystems. Senge (1990) describes the field as a discipline for seeing wholes and a framework for seeing interrelationships and patterns of change rather than static instances. It became clear that this stage was being identified as one, which had the purpose of unifying the many threads in a faceted enterprise of systems.

18. e-government stages of growth model

The stages of development presented in this paper are a description of how one government agency has evolved over time. These stages are not a recommendation for how an e-Government initiative should be approached. This is a descriptive, not a normative model. Some of the stages are specific
to moments in time when the advent of new technology enabled change. For example Stage 5 describes the emergence of a web presence within an organisation and does not fit neatly into an e-Government model. For any newly emerging public sector organisation it is conceivable that a web presence (Stage 5) could be developed at any point from Stage 3.

Friedman (1994) argues that stages of growth models have a ‘shelf life’ and context within which they are considered to be valuable. In this instance the model applies to an organisation, which is growing in both size and service types. Simple organisations, which remain static, may not find a requirement or pressure to advance beyond the initial stages – but this is a feature of all evolutionary models. For this model to apply, the organisation should provide a service, which is analysable in a way that its processes have some application to ICT. For an organisation, which has only one service type and remains as such, Stage 4 (consolidated customer view) does not apply. However, that does not preclude the organisation from progressing to the next stage and using data mining and knowledge management techniques to gain efficiencies. If over time the organisation takes on an additional service, which applies, to its existing customers, Stage 4 may be revisited and progress may continue forward once more in the same direction, revisiting stages 5, 6 and 7 in order to readjust them.

Figure 3: e-government stages of growth model

Given the above caveats, the model may have broad use within other public service organisations as a guideline for e-Government initiatives. Figure 3 outlines the stages of such an e-Government model. This model outlines seven stages of development which are divided into three phases. Phase 1 is the Machine Bureaucracy Phase, which includes stages 1 and 2. This phase generally sets out the basic requirements, which need to be in place before ICT is introduced to a medium or large public service organisation. The Knowledge and Learning Bureaucracy Phase incorporates stages 3, 4 and 5 where stage 4 is optional. This phase includes the initiation and knowledge specific utilisation of ICT in the organisation. Phase 3, the process improvement phase, includes two stages: Stage 6 which focuses on process improvement and flexible business process management (BPM and SOA);
Stage 7, the Integral Systems Stage, takes an overall perspective on the alignment of all the organisation’s intelligences. Organisations that progress to Phase 3 without utilising the benefits of Phase 2’s Stage 5 will miss the benefits to be gleaned from that stage. It is assumed here that if the organisation’s services are complex enough to apply SOA and BPM then data mining and knowledge management most likely has a part to play in adding efficiency to the organisation.

19. Conclusion

The stages of growth model presented, is a descriptive one, which outlines how e-Government has evolved over the period of the organisation’s history. Eight stages of growth were identified at distinct points in time when underlying assumptions, values, and procedures within the organisation were challenged and where the organisation’s existing conceptual models were replaced with new ones.

The evolution of the organisation in question was abstracted and presented as a stages of growth model for e-Government. The model was presented with seven stages, which were divided into three phases. Some caveats to the model’s applicability were presented. Firstly the model recommends the adoption of a stage provided there is consensus within the organisation that there is value in moving forward. Some stages of development may be skipped but phases may not be skipped over.

Benefits accruing from this model may include the ability to describe and gain consensus on the organisation’s current level of maturity and sophistication as regards e-Government. The model may also assist senior management in formulating an appropriate strategy to pursue their organisation’s e-Government objectives. In addition the ability to identify a repertoire of distinct intelligences, with which to approach demands on the organisation, may offer some clarity when choosing the most suitable solution.

Evidence for this research was gleaned from one public service organisation. Further research may continue to validate this model by reference to other public service organisations or indeed large bureaucratic organisations in other sectors of the economy.

The model outlined with this paper has reduced the reality of a diverse area to a perspective. This type of model is discriminatory in the sense that it includes certain features and leaves out others. A model is not the territory and if it were identical in all respects to that which is modelled it would be useless. This model is valuable if organisations are given conceptual traction on e-Government with a roadmap that charts the stages of growth, and describes the change mechanism around stages.

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Strategies for Orchestrating and Managing Supply Chains in Public Service Networks

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Abstract: Joining-up is high on the e-government agenda as this is expected to improve service delivery to citizens and businesses. It requires public and private organizations to cooperate with each other within networks that are formed around public services that cross the boundaries of organizations. Cross-organizational processes in such a network are called supply chains, aimed at delivering integrated services. The performance of each individual organization within the network influences aspects such as lead-time and quality of services delivered. In order to effectively integrate the efforts of the various organizations involved, a strategy needs to be in place to orchestrate and manage a service delivery chain. Various types of strategies can be employed. Yet little knowledge is available about which strategies are effective under which circumstances. In this paper we identify four different strategies for managing and orchestrating cross-organizational service chains. These supply chain management (SCM) strategies are based on literature research and case study analysis. The four strategies are identified based on two dimensions: the level of control (i.e. governance structure) and the architectural approach for systems integration. These four strategies are: merger, orchestra, relay race, and broadcasting. For three of the four strategies, illustrative cases have been found. The strategy selection depends on factors such as the institutional environment, political ambitions and organizational readiness. Furthermore, each strategy has its own merits and demerits. We recommend investigating the relationship between situational characteristics and SCM strategies in further research.

Keywords: e-government, joined-up government, Supply Chain Management (SCM), inter-organizational collaboration, governance, integration strategy

1. Introduction

Public service delivery crosses organizational borders. From a citizen’s perspective, a single service involves multiple steps to be taken, and these steps are often performed by multiple organizations. Currently, many of the activities required for integrating the various steps into a service are performed by citizens themselves. Government organizations want to relieve citizens of this burden by integrating their service delivery. Integrated service delivery (ISD) is realized when multiple government organizations perform a specific service in a coherent manner and it is perceived as integrated by customers. This has the advantage for customers that they no longer have to provide the same information to several organizations, which diminishes their administrative burden. To realize ISD, government organizations increasingly join-up through the formation of portals in which several organizations offer their services in an integrated manner, or through the formation of networks and chains, in which several organizations cooperate to deliver integrated services that cross organizational boundaries. “Joined-up government refers to consistency between the organizational arrangements of programs, polices, or agencies, which may enable them to collaborate” (6 2004, p. 106).

Realizing joining-up of service delivery requires coordination to ensure the quality of services when different steps that make up services are performed by different organizations. “The coordination of the dependencies of the various organizations involved in a service delivery chain in order to perform better service delivery to customers” is called orchestration (Janssen, Gortmaker and Wagenaar 2006). Coordination of a chain can take place in a central or a decentralized manner (Hodgkinson 1996; Janssen 2004). Central control emphasizes optimization of the business process, but it also means that the autonomy of organizations is often sacrificed, whereas decentralized control fosters autonomy at the expense of efficiency. At the same time, e-government needs business processes that can be continuously optimized and expanded outside their own organization. While linking information systems to these processes requires enterprise application integration (EAI) technologies, EAI has been an expensive and often problematic solution for many organizations (Linthicum 1999). These problems are multiplied in the public sector, where inefficient and bureaucratic business processes and disparate legacy information systems need to be integrated in an e-government
Therefore, modularization of information systems is often considered to offer the necessary integration options for future expansion of business processes as well as the flexibility that is needed for maintenance (Baldwin and Clark 2000).

However, limited research is available for governments that are in search for a strategy for coordinating their service delivery chains. In this paper, we investigate strategies for managing and orchestrating cross-organizational service delivery. These strategies are categorized according to two dimensions: the level of control and the integration of information systems. First, the dimensions for categorizing the strategies are derived from literature and combined to form a framework for mapping case studies. Then, in order to understand which strategies are being explored, a number of case studies of cross-organizational chains from the Netherlands are looked at and mapped according to these dimensions. Finally, we draw conclusions and identify areas for further research.

2. Theoretical background

Joining-up of service delivery requires organizations to cooperate across organizational borders as information and systems are dispersed. The dependencies between organizations realizing ISD resemble a network structure, in which a multitude of interdependent actors exist (e.g. De Bruijn and Ten Heuvelhof 2000). Realizing ISD, therefore, presents a major challenge for government organizations. It requires that organizations adapt their business processes to the service delivery chain, but often the organizational goals of these autonomous parties are not in line with the goals of the chain as a whole. However, the performance of the chain depends on the individual organizations as their performance impacts quality and lead-time of services. The division of the business process into tasks distributed over many organizations, thus, creates a need for the coordination of these tasks and the information exchanged between the organizations involved.

Supply chain management (SCM) is a term used in business literature to refer to the control of materials, information, and finances as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer (e.g. Romme and Hoekstra 1992). The term supply chain is inspired by the product flow that should be delivered to citizens or businesses by passes through several organizations. SCM encompasses the planning and management of all activities involved the creation of supply chains. Although traditional focused on physical goods, SCM can also be applied in the field of public administration, in which the flow is mainly information-based. It is, therefore, similar to the concept of orchestration found in literature on e-government.

Orchestration realizes ISD by taking over the role from the client of having to integrate the various parts performed by different organizations into a coherent service (Janssen et al. 2006). Instead, it requires government organizations to achieve interoperability of information systems and organizational activities. Joining-up is, thus, a technological challenge as well as a managerial challenge (Klievink and Janssen 2009). On the organizational level, this requires the parties involved to cooperate, share resources, and agree on the responsibilities for the activities performed by the supply chain. On the technology level this requires that the systems of the parties involved are connected and integrated using EAI and that the exchanged information is semantically interoperable. To achieve these objectives, the orchestration and management of the supply chain is necessary.

The control of supply chains always represents a trade-off between central and decentralized control (e.g. Hodgkinson 1996; Janssen 2004). A central control focus emphasizes optimization of the service delivery process, but it requires sacrificing organizational autonomy. Furthermore, although operational costs are low, set-up and standardization costs are often high as a central coordination mechanism requires organizations to agree on and to invest in certain technologies. In a decentralized structure, organizations are more flexible with regard to necessary changes, as they have complete knowledge and control over the allocation of resources to support business priorities, and the costs are fully allocated to the local organizations (Hodgkinson 1996). The chain as a whole, however, will have higher total procurement and operations costs due to inefficiencies related to the duplication of services and of multiple independent procurement procedures and suppliers. In general, centralized coordination enhances optimization of the supply chain and decentralized coordination is more flexible (White, Daniel and Mohdzain 2005).

On the technical level, coordination requires the integration of the various activities using EAI technologies. This requires investments in information and communication technology and leads to significant changes in the mechanisms used to manage the interactions that take place within and
between organizations. Clemons and Row (1992) argue that the ability to coordinate the movement of information is of key importance to both external and internal coordination. Due to changing circumstances coordination and supporting technology can change over time. New laws and regulations might require certain parts of the supply chain to be carried out differently or the participation of new organizations in the supply chain. To ensure sustainability of the supply chain design, adaptability should be realized, e.g. by maintaining a risk profile that can be updated when regulation changes (Van Veenstra and Janssen Forthcoming).

Adaptability can be defined as the ability to deal with new environmental conditions (Gosain, Malhotra and Savy 2005). It can be improved using modularization (White et al. 2005). Modularization means that the different activities that make up a supply chain are each performed by different organizational entities, instead of forming one single integrated process. In general, modularization serves three purposes: it makes complexity manageable, it enables parallel work and improvement and it is tolerant of uncertainty (Baldwin and Clark 2000). In a situation where different organizations perform different parts of the service, SCM focuses on the integration of these modular components. The integration of these modules can take place in a loosely or tightly coupled manner (Papazoglou 2003).

Coupling refers to the degree that the modules depend and rely on each other. Loosely coupled means that the modules are independent of each other and one module presents minimal requirements to other modules. This enables easy substitution and replacement of one module for another. Furthermore, input/output relations often have no direct dependency, resulting in the possibility for asynchronous communication, which overcomes the dependency in time (the need for availability). Also, minimal requirements on the data format and the number of interactions necessary to interact with other modules are a result of loose coupling. The advantage of loose coupling is, thus, that a change in one module does not (or hardly) affect the interactions with other modules, whereas tight coupling has the possibility of real-time processing and comprehensive data exchange. Other advantages of tight coupling are that at each moment in time the status is known and interventions can be made.

3. Strategies for supply chain management

![Diagram of SCM strategies](image)

**Figure 1:** Overview of the four SCM strategies

In the previous section, two main dimensions of SCM strategies were identified from literature: the level of control of the supply chain and the architectural approach for information systems integration. The former dimension refers to a situation with either centralized governance, in which the process of the supply chain is governed hierarchically by an orchestrator, or decentralized governance, in which the supply chain is coordinated on a peer-to-peer basis. The second dimension refers to the way in which the information systems are integrated. This can take place through tight coupling, in which systems are integrated, or loose coupling, in which systems and organizations retain autonomy over the activities that are carried out. Tightly coupled systems are closely connected to each other and
tracking and tracing information is exchanged to keep track of the progress. Whereas in a loosely coupled manner of integrating systems, only primary information is exchanged and tracking and tracing requires a separate service process. Combining these two dimensions, a framework encompassing four SCM strategies can be set up (see figure 1). It should be noted that the two dimensions are not completely unrelated and that this orthogonal representation is a choice for clarity and convenience.

The first strategy is called merger. This strategy coordinates the supply chain hierarchically and the information systems are tightly coupled. This results in a supply chain supported by integrated systems that are efficient and that allow for process optimization. Every time a service step is performed and passed on to the next step, a response will be sent from the system receiving the service request to the central node, enabling close monitoring of the process. Organizations involved in the supply chain have little autonomy; hence the metaphor of a merger is used. Because of the central control focus and the highly integrated systems, it is difficult for new organizations to enter the service delivery process unless they also adopt the technology of the chain. As seamless integration takes place, operation costs of the supply chain are low.

The second strategy orchestra combines central control over the supply chain with loose coupling of the information systems. The process consists of autonomous entities that perform one step of the service delivery process, but at the same time, the supply chain is managed centrally. This is similar to the way an orchestra functions: while the conductor directs the musicians, they all play their instruments in their specialized manner. Within a supply chain this means that although organizations can perform their part of the service process in a relatively autonomous manner, at the same time information has to be exchanged in such a way to allow the process to appear integrated. Therefore, tasks performed by individual organizations have to be interpreted by the orchestrator requiring standardization of outcomes. The information that is exchanged is generally ‘thick’ allowing for process information to be exchanged alongside information about the service request.

Relay race, the third strategy, on the other hand, refers to a situation in which the process is not managed centrally by the orchestrator, but the supply chain uses information systems that are tightly coupled. This means that the information systems used by the parties involved in this chain exchange predefined messages within closely integrated systems. These messages are ‘thin’ because they have been previously standardized; the outcome of one step can be interpreted directly by the next system. Central control is thereby replaced by a situation in which the system pushes information to the next party that will then perform its own task, comparable to the exchanges taking place in a relay race. As there is no central mechanism to ensure, for instance, that lead-times do not exceed the maximum duration set by law, this requires that the parties have service level agreements in place that define the role of each of the organizations involved. Costs of setting up this strategy are high and it usually takes a long time before such a supply chain is operational.

In the fourth strategy, broadcasting, there is no central control over the supply chain and information systems are loosely coupled, ensuring a flexible process in which parties can easily be replaced by other entities. In this case, all parties within the supply chain enjoy a relatively high degree of autonomy. In order to assess the status of a service (tracking and tracing), a separate request needs to be done, to which only the organization(s) presently working on a request will give a response. In case a request is broadcasted, the supply chain is flooded with a separate notification and only the relevant parties will reply. The trade-off for allowing for a high degree of autonomy for organizations is that there is likely to be a high level of redundancy within the supply chain.

4. Case studies

In order to understand which of these strategies are present within the public domain in the Netherlands, we present three case studies. We were not able to find a case study fitting the merger strategy, as this type of central control and tight coupling is not realistic in a situation of an organizational network. In such a network organizations are (semi-)autonomous, operated independently, and there is no overarching hierarchical structure or organization that guides the network. Literature (e.g. Chisholm 1989) confirms that this type of arrangement is not feasible for public sector arrangements. It is often found in situations where private organizations merge their businesses and subsequently integrate their information systems.
4.1 Asbestos removal

The orchestra strategy was found in the case of the removal of asbestos. In this case study seven organizations that are involved in the process of asbestos removal have built a centrally positioned information system to decrease the average lead-time of the process. The process covered by this information system starts with filing an asbestos find and ends when the asbestos is removed successfully. Information about each asbestos removal permission request is stored centrally in this system, thereby ensuring that all organizations involved have the same information about a particular discovery of asbestos. At the same time, this system functions as a workflow application by indicating to the client and to all the parties involved in the service delivery chain which steps have been fulfilled and which should be carried out next. This has led to a decrease of the lead-time from six weeks to one week. Control is, thus, organized centrally by the information system.

At the same time, however, the information systems are loosely coupled. All the internal information systems can be connected to the orchestrator, but they do not affect the way in which the individual parties involved carry out their specific task. For instance, the organization that is responsible for the removal of the asbestos can use the information that is stored centrally by logging into the system. They can even reuse the information that they need to carry out their task, such as the address where the asbestos was found, but they do not need to build a new information system based on the requirements of the supply chain. This has led to a higher quality of the service performed by the whole chain. Standardization of tasks has, thus, not only led to a decrease of the administrative burden for the client by not having to provide certain information to each party separately, but it has also increased the performance of the service delivery chain.

4.2 Social security chain

The relay race strategy can be found in the case of social security (SUWI) Chain (www.bkwi.nl). This supply chain is structured based on a number of predefined agreements regarding the message structures and the technical implementation (in XML), the use of databases to avoid duplication and overlap among data registers. This supply chain is supported by a system called Suwinet that supports the necessary information exchange for achieving cross-organizational processes. This network is formed by the social security agency (UWV), employment and income office (CWI) and municipalities. Both UWV and CWI have a central office that maintains technology and takes care of policy-making. The local offices ensure close collaboration with customers. Although the autonomy of the organizations is retained, there is a central organization that facilitates and monitors the exchange of information within the supply chain. The information exchange processes have been detailed in a mandatory architecture, which has evolved over a very long time. This architecture contains business process rules that prescribe which organization should receive or send information in a particular situation. Furthermore, service levels that are applicable to these interactions have also been defined.

The standardization of processes and information exchange and data formats has resulted in limited adaptability. The presence of a central organization and the description of the current coordination processes and dependencies suggests that analysis of the impact of changes on the organizations, their business processes and applications might easily be carried out. Based on this data, a blueprint and change strategy is thought to be easily developed to optimize the overall supply chain. In reality, the situation is completely different. The creation of the current interoperable architecture took many years and a long negotiation process took place among the independent public organizations. Furthermore, any changes in the organizational network require the involvement of multiple organizations, which might resist change and the division of the costs of the changes over the organizations is a major issue. In the past, the latter has been solved by providing funding by the Ministry of Social affairs for making the necessary changes. Despite this, the large changes necessary require the re-negotiation of data formats and process interactions, which is a long-lasting and cumbersome process.

4.3 System of information exchange between vital registries

An example of the broadcasting strategy can be found in the information system supporting the vital registry for citizens in the Netherlands (GBA-V system; www.mGBA.nl). This system, which is currently being implemented, supports information requests from third parties to the vital registries at the municipalities. In the case of a change taking place in one of the vital registries, for instance, if someone moves to a different address, this change of address is passed on to all organizations that
have taken out a subscription to this registry. The municipalities will notify a data warehouse that currently stored information should be updated and third parties that have a subscription to this system, can, in turn, request the updated information.

The events are not passed on directly to all organizations having an interest in them, but instead a data warehouse has been installed. In some cases, this leads to a suboptimal situation, when this information is not passed on to the data warehouse directly, resulting in third parties requesting outdated information. This system relieves municipalities of their current task of having to inform all organizations with an interest in citizens’ information about changes that have occurred; supporting information exchange by a service bus to the data warehouse instead. Although the functionality of this system is rather simple and organizations can easily join the supply chain, it takes a long time before all organizations take part, simply because many organizations are involved. Furthermore, the establishment of a unique number for information exchange was crucial. In this case, a unique citizen’s number (BSN) was introduced, which was an important enabling factor.

5. Discussion

For three of the four strategies, cases could be found in the Netherlands. These strategies have specific merits and demerits (see table 1). Therefore, we argue that all supply chains should choose a strategy based on their specific requirements. Although we cannot yet draw any definite conclusions because of the limited number of case studies carried out, some first observations can be made regarding which chain characteristics are likely to lead to the choice for one of the strategies.

Table 1: Cross-case study comparison

<table>
<thead>
<tr>
<th>Case</th>
<th>Asbestos removal</th>
<th>Social security chain</th>
<th>Information exchange vital registries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy</td>
<td>Orchestra</td>
<td>Relay race</td>
<td>Event notification</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Orchestrator facilitates information exchange</td>
<td>Supporting organizations facilitate information exchange</td>
<td>A data warehouse duplicates all information</td>
</tr>
<tr>
<td></td>
<td>Parties involved retain their own information systems and processes</td>
<td>Evolved over a long time Negotiation of data standards</td>
<td>A service bus facilitates all information exchange between parties involved</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Implemented in several steps</td>
</tr>
<tr>
<td>Benefits</td>
<td>Parties can perform their task in an optimal way</td>
<td>Overview of end-to-end supply chain</td>
<td>Source information is being accessed and reused</td>
</tr>
<tr>
<td></td>
<td>Lead-time is diminished by higher information quality</td>
<td>Clear pre-defined processes</td>
<td>Peer-to-peer links have been replaced by information exchange through a service bus</td>
</tr>
<tr>
<td></td>
<td>Overview of the chain process</td>
<td>Service level agreements and clear performance expectations</td>
<td>Source information can be checked and updated</td>
</tr>
<tr>
<td></td>
<td>Adaptable; new organizations can join easily and changes of law are supported</td>
<td></td>
<td>Adaptable; organizations can join easily</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>No clear ownership of orchestrator</td>
<td>Chain responsibility is unclear</td>
<td>Maintaining information requires a strict protocol for updating and checking information as information can vary across organizations</td>
</tr>
<tr>
<td></td>
<td>No control over quality of the tasks of individual organizations</td>
<td>No optimization of the internal processes within organizations</td>
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<td></td>
<td>Information is duplicated in some cases by organizations to and from the orchestrator</td>
<td>Low adaptability, long-lasting change processes</td>
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<td></td>
<td></td>
<td>Changes often require change of technology</td>
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<td></td>
<td></td>
<td>Bureaucratic, low level of collaboration</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Limited/no knowledge transfer among organizations</td>
<td></td>
</tr>
</tbody>
</table>

Based on the characteristics, benefits and disadvantages summarized in table 1, some first factors can be observed to be influential in choosing a SCM strategy for joining-up. Firstly, this table shows
that the institutional context of the network of organizations involved in the chain was influential. Institutional factors such as the availability of resources heavily determine the willingness of organizations to cooperate. Furthermore, it is not surprising that no example of the merger strategy could be found as public organizations are highly autonomous within the Dutch government. When joining-up, a network of interdependent departments and organizations emerges (Chisholm 1989; Powell 1990; De Bruijn and Ten Heuvelhof, 2000). Organizations, however, are not willing to give up their autonomy often resulting in a choice for a modular information systems integration strategy with loose coupling of systems. Also the stability of the supply chain processes was observed to be influential in choosing a strategy. When a supply chain is believed to be stable, organizations may not see the need for adaptive processes and they may feel that establishing a tightly integrated information system with low operational costs is worth a long negotiation process.

Other factors that were observed to be influential are the political ambitions regarding a specific service delivery chain and organizational readiness. When a certain topic becomes important for political reasons, control was observed to be organized in a centralized manner in order to be able to track the decisions and actions performed by different organizations within a supply chain. In politically sensitive supply chains, the possibility of easily tracking and tracing individual cases and the importance of being able to appoint responsibilities is considered more important than being able to achieve adaptability or retaining autonomy for individual organizations. The organizational readiness of the parties involved in the service delivery chain is also observed to be influential, as is demonstrated in the case of the supporting system for the vital registries. In this case, many municipalities were found not to be ready for implementation of the system. Therefore, a loose coupling was foreseen that allows organizations to join a supply chain when they are ready.

First observations, thus, show that institutional context, political ambitions and organizational readiness are among the factors influential in choosing a SCM strategy for managing and orchestrating cross-organizational services. In the context of these factors, a full integration of services may not be feasible, and joining-up may need to focus more on establishing consistency and enabling collaboration (6 2004). The observations made in this paper cannot be generalized as the number of cases is limited. We believe that further research on the factors influencing the choice for a cross-organizational governance strategy would be beneficial for government organizations in search for such a strategy.

6. Conclusions

This paper has identified SCM strategies for joining-up government organizations involved in cross-organizational service delivery chains based on two dimensions: the level of control of the supply chain and the information systems integration strategy. The former dimension refers to a situation in which the supply chain is governed hierarchically by an orchestrator or to a situation in which the supply chain is coordinated on a peer-to-peer basis. The latter dimension refers to tight coupling (i.e. integration) or loose coupling, in which modules are set up independent of each other, of information systems. Based on these two dimensions, we identified four strategies: merger, orchestra, relay race, and broadcasting. Each of those strategies represents another manner of joining-up in order to integrate service delivery. In the Netherlands, we found three of these strategies to be present; the fourth strategy – merger – is, considering the autonomy of Dutch government agencies, unlikely to be found in practice. Organizations need to consider their specific situation and choose a strategy based on their needs. Based on the three cases presented in this paper, we observed that the choice for a specific strategy is made depending on factors such as the institutional context, political ambitions for the service delivery chain and organizational readiness. We recommend that further research should be done on these strategies in cross-organizational public chains in order to create better understanding for government organizations about which strategies might be effective in which circumstances.

References


