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The 2006 conference on Electronic Voting took place in Castle Hofen near Bregenz at the wonderful Lake Constance from 2<sup>nd</sup> to 4<sup>th</sup> of August. This volume contains the twenty papers selected for the presentation at the conference out of more than forty submissions. To assure scientific quality, the selection was based on a strict and anonymous review process. The papers cover the following subjects: e-voting experiences, social, legal, political, democratic and security issues of e-voting, as well as solutions on how to (re)design election workflows, and finally how to implement and observe electronic voting systems.



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## Lecture Notes in Informatics

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# Electronic Voting 2006

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# Proceedings



# **A generic re-engineering methodology for the organized redesign of the electoral process to an e-electoral process**

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**Abstract:** In this paper we suggest a generic re-engineering methodology for the organized redesign of the electoral process to an e-electoral process. Based on the hypothesis that the electoral process has been through a “silent” re-engineering phase, we present the process re-engineering concepts which can be used to depict the redesign of the electoral process to an e-electoral process through the use of ICTs. Following we provide a five stage outline of the suggested re-engineering methodology. Finally we discuss the benefits of its implementation and suggest areas for its prospective application.

## **1 Introduction**

The purpose of this paper is to present the process re-engineering concepts which can be used to depict the redesign of the electoral process to an e-electoral process through the use of ICTs and more importantly suggest a generic re-engineering methodology for the organized redesign of the electoral process to an e-electoral process. The paper is based on a completed doctoral research founded on evidence deriving from the case of the 2002 and 2003 UK e-voting pilot schemes. Reflecting the UK government’s intention to develop “the capacity of holding an e-enabled general election some time after 2006” [HG 02] (p.47), 16 local authority legally binding e-voting pilots took place on May 2002 followed by 20 more pilot schemes held during the local authority elections on May 2003. This research addressed the following overarching research question: “*What are the non-technical constraints in re-designing the electoral process in relation to ICTs?*”

The analysis of the e-electoral process conducted, was based on the hypothesis that the electoral process has been through a “silent” re-engineering phase. That had lead the authors to adopt a process stage approach for its analysis and suggest the use of process re-engineering methods to support its future deployment [XM 03a, 03b]. However, no evidence has been identified to suggest that any kind of organized re-engineering attempt of the traditional electoral process has been undertaken prior to the deployment of the UK e-voting pilots. According to the UK Government, future e-enabled electoral processes and services could be deployed in relation to [HG 02]:

1. Elections to the Westminster Parliament
2. Elections to the Scottish Parliament
3. Elections to the Devolved Assemblies (Wales and Northern Ireland)
4. Elections to Local Councils
5. The conduct of referendums
6. Private ballots under statutory control
7. The on-line registration of voters
8. The on-line application to be an absentee voter.

All the above electoral processes present many differences between them in terms of surrounding legislation, electoral system used, political importance, social background of the electorate and its resulting electoral behaviour.

## **2 The use of process re-engineering in government provided services**

Electronic voting is an interdisciplinary field of research based on the collaboration of a number of well established scientific fields. Computing experts need to co-operate with sociologists, political scientists, and media communication experts. Moreover, e-voting research particularly requires the contribution of legal and public administration experts. E-elections, similar to traditional elections, are government owned and initiated processes, and as such, many of the activities involved in their undertaking are closely related to public administration, in this case electoral administration in particular. In the past, process re-engineering in the public administration sector has been widely used to re-organise other administrative processes that had to be redesigned due to the introduction of ICT in some or all of their stages. Thaens [TBD 97] has discussed the use of BPR (business process re-engineering) in the case of taxation. Bellamy and Taylor [BT 97] have referred to the use of adaptive information systems in the case of the UK Criminal Justice System. Pollard [Po 97] has analysed the case of organisational transformation of the National Mapping Agency of Great Britain. Willcocks [WCJ 97] provides detailed analysis of three cases in the UK related to the healthcare sector and the postal service. Van Belle [VB 97] discusses the case of re-engineering the Flemish Department of Education with the purpose of introducing ICT. Lenk [Le 97] has explored the enabling role of ICT in relation to the risks and opportunities involved, stating the need for continuity of structures of accountability. Pratchett [Pa 97] focuses on the use of BPR at the local authority level, referring to the level of radical re-engineering, the suitability of processes to undergo re-engineering and the level of dependence on ICT. Zuurmond and Snellen [ZS 97], on the other hand, take a more managerial approach discussing organisational structures and informational architectures within the bureaucratic paradigm.

In this paper the authors suggest the development of a generic electoral re-engineering methodology. Such a methodology has the potential to support the structured re-engineering of any electoral process providing a fit for purpose approach based on the experience gained to this date.

### **3 Research methodology**

Initially, BPR concepts are used to assess the redesign of the electoral process to an e-electoral process and analyse the resulting effects on the validity of the process, the effectiveness of its administration and the social acceptance of its results. In the past, process re-engineering in the public administration sector has been widely used to re-organise other administrative processes that had to be redesigned due to the introduction of ICT in some or all of their stages. However, it was necessary to adapt the process re-engineering rational to the characteristics of the particular process analysed, which in this case is the electoral process. The challenge was to identify the different sub-processes (stages) that take place within an e-election and decide which process re-engineering concepts can be beneficially used in their analysis.

The purpose of the following section is to present the BPR concepts used to depict the redesign of the electoral process to an e-electoral process through the use of ICTs and analyse its resulting effects. To that effect a review of existing BPR methodologies was conducted in order to identify the key BPR concepts which can support the analysis of the e-electoral process. The theoretical BPR concepts presented hereafter form the basis of the process stage approach to the e-electoral process adopted in this paper. The main BPR concepts used are:

- Agent roles and their procedural responsibilities
- Agent accountability and agent obligations
- The definition of agent dependencies
- Multiple agent communication, co-ordination and control

All of the above concepts have been useful for the analysis of the three non-technical aspects of e-voting explored during this doctoral research. Defining, and re-defining agent responsibilities was used for the analysis of the trust relationships developed between agents to support the social acceptance of the e-electoral process. Defining agent accountabilities was used for the analysis of the procedural security aspect of e-voting. Finally defining dependencies and exploring how multiple agent communication, co-ordination and control mechanisms can be applied in the deployment of e-voting was useful for the analysis of the e-electoral administration.

### **4 Essential BPR concepts used for the analysis of the e-electoral process**

This section provides a reference to the essential BPR concepts which can support the analysis of the e-electoral process.

#### **- Defining agent roles and their procedural responsibilities**

Roles are related to agents who operate under an obligation to fulfil certain responsibilities. Simple actions are assigned to agents through roles. Processes are composed from the combination of these simple actions. Roles define an agent's state at any point in time. Agents rationally choose their next action according to the options associated with each specific role [Hi 85]. The description of e-voting agent roles can serve the detailed allocation of tasks attributed to each agent. This aspect mainly aims at the allocation of procedural responsibilities but also enables a better understanding of the overall process.

#### **- Defining agent accountability and agent obligations**

The notion of agent accountability is closely related to the identification of responsibilities. A person is held accountable by others in relation to the fulfilment of one's responsibilities, which will in turn create procedures even if not originally defined [Sc 93]. By identifying agent responsibilities one can also identify their procedural obligations. Obligations limit the choice of action, and therefore need to be fulfilled according to the undertaken responsibilities. Responsibility is 'for' something; obligation is 'to do' something. Obligations are concerned with keeping things the way they are or changing them in relation to the responsibility held [DM 89]. The satisfaction of obligations is achieved by the introduction of rules which constrain agents' actions. Rules are therefore constraints put on people by the organization on how they should act [Ou 92]. Constraints are thereafter inherited by processes and activities either partially or in full. In the e-voting context, business rules are substituted by the existing legal framework defining an election, as legislation varies according to different elections. We should therefore consider the relevant legal issues as a dynamic factor to which e-voting deployment should adjust accordingly.

#### **- Defining dependencies**

When agents participate in contractual relationships, they undertake a set of responsibilities that are determined by the terms of any given contract. Within an organization, contractual (responsibility) relationships determine the type of the structural relationships between pairs of co-workers whereas, a contractual relationship between an external agent and an organization exists only for the duration of a specific contract. The notion of contractual relationships is broadly used by the UK civil service where independent agencies provide the central government with their services therefore developing a contract between them [HT 88]. The analysis of contracts will in turn help identify agent responsibilities and dependencies among them, deriving from their participation in contractual relationships. Once agent responsibilities have been identified they can subsequently be allocated along the e-voting process. Defining dependency relationships between the different collaborating parties in the e-voting procedures can be achieved by clearly demonstrating each agent's role and internal responsibilities. The focus should be on the identification of dependencies that are critical for the election success.

### **- Enabling multiple agent communication, co-ordination and control**

According to Mintzberg [Mi 89] there are six types of coordination mechanisms:

1. Mutual Adjustment (informal communication)
2. Direct Supervision (common supervision of people whose work is related)
3. Standardization of the work processes (when different tasks involve different people in one process)
4. Standardization of outputs (specification of expected results)
5. Standardization of skills (based on the training of the people involved in the process)
6. Standardization of norms (describing a process so that everyone involved has the same understanding of it)

The co-ordination of the agents involved in the delivery of electronic voting is of central importance due to their multiplicity and the complex nature of the multiple channel e-voting process.

## **5 A five stage approach to electoral process re-engineering**

The following sections provide a five stage outline of the suggested generic re-engineering methodology for the organized redesign of the electoral process to an e-electoral process.

### **5.1 Understanding the context of the existing electoral arrangements and the aspirations of the main government organisations concerned**

The first stage of e-electoral redesign is a diagnostic one. The aim is to have a full understanding of the electoral process which is going to be re-designed to an e-electoral process. Initially, one has to identify the government agents involved in the voting procedures. Related government agents should be approached for data which will be later used for both modelling and analysis of the process. The primary aim is to gather internal data, in any form (previous e-voting evaluation reports, statistics, cost calculations etc.). Organizational data could also be collected from a variety of internal sources.

That should be followed by interviewing representatives of these agents. When conducting interviews with the government organisations' departmental managers, one should try to identify opportunities for improvements and understand the organisations' culture. These interviews will also identify further data collection opportunities and determine the focus issues which will constrain the re-design of the process. Interviews should however be focused on identifying:

- Each related department's tasks, responsibilities and activities in relation to the electoral process
- Expected inputs and resulting outputs related to the above activities

- Input suppliers and output customers for these activities, whether internal or external
- Formal and informal communication lines

After concluding the above practices a decision has to be taken by the main government organization concerned as to whether re-engineering will be aiming at process improvement (an e-enabled paper ballot based election) or process innovation (an e-voting process possibly including an e-enabled element as well). This would derive from the combination of the opportunities identified in the earlier steps and the aspirations of the government organisation, meaning the amount of risk they are willing to take.

In the final part of this stage, once the data has been gathered and evaluated and the decision on the aim of the re-engineering has been taken, a document should be prepared containing the specific objectives of the re-engineering effort.

## **5.2 Modelling (who, what, where and how)**

The modelling of the existing and proposed electoral process will be based on the information gathered in the previous stage. The primary concern when modelling the processes is to:

- Further analyse the agents involved into macro agents and micro agents. According to [Jo 89] micro agents are individual persons whereas macro agents are entities like organizations and companies. Macro agents have micro agents as parts.
- The identification of agent roles and resulting responsibilities
- Identification of critical contractual relationships between agents involved in technology provision contracts, authority contracts in bureaucracies (administration contracts) and long term unwritten contracts within groups based on principles of mutual latent trust.
- The identification of objectives, interactions and dependencies resulting from the above contracts
- The fragmentation of processes into stages including smaller operation and activities
- The identification of coordination and control mechanisms
- The explicit identification and statement of rules (whether legal or otherwise) limiting all the above

Three basic model constructs are suggested:

- Process stage modelling (what needs to be done and when)  
By modelling each stage of the electoral process, one can monitor the parallel activities taking place concurrently. Such models can be used to describe the activities taking place (what needs to be done) in the different stages of the e-electoral process (and when). Representing agents within the process stage models would extend their descriptive functionality.

- Contractual relationships modelling (who should deliver what and who expects what)  
The contractual relationships perspective could be modelled so as to identify the obligations of each agent towards others (who should deliver what) and accordingly the deriving dependencies of deliverables between agents (who expects what)
- Agent role modelling (how should agents act)  
The focus of these models should be on roles, activities and the agent responsibilities deriving from those activities. The question here is to define how the agents identified should respond to their responsibilities (how should agents act) within their combined activities which produce the overall electoral process.

### 5.3 Analysis (why)

The purpose of the analysis of gathered data, existing and proposed models, is to understand why process stages, contractual relationships and agent roles are executed in the way identified. Analysis tools and methods can either be developed or alternatively **adapted as appropriate from those having already been used in the re-engineering of business processes**. A set of analysis methods which have been used in BPR and could potentially prove useful for the analysis of the e-electoral process include:

- Analysis of the abstraction level of the prepared models, testing for clarity and transparency [IH 92].
- Principal-Agent analysis of the contractual relationships related to agent co-ordination, management and control [FJ 83]
- Management structure analysis to evaluate the use of management resources, by looking at issues such as span of control and layers of management [BC 91].
- Mission/non- mission analysis to assess whether an agent's obligations are critical to the achievement of the process objectives [GI 94].
- Fragmentation-concentration analysis to define the number of full time equivalent employees needed to undertake an activity, in this case related to the issue of costs and the number of staff needed for the deployment of e-voting [Ha 90], [DS 90].
- Fractionalisation analysis to establish the level of fragmentation of an employees work and consider whether the responsibilities undertaken by each agent are correctly allocated to the agent in question according to time and expertise [GI 94].

At the end of this stage one should have a full understanding of the current electoral arrangements, the proposed changes to the electoral process and the resulting effects that these changes would incur in terms of security, administration and social acceptance of the e-electoral process.

#### **5.4 Re-design**

In this stage the conclusions reached in the analysis undertaken in stage three, together with the proposed would-be models, and the models of existing electoral arrangements produced in stage two should be presented to the main government agent holding the election. A second round of interviews, this time including more junior employees could identify further opportunities for improvement and validate those already identified. Employees should be asked to contribute to the validation of the would-be models before those are applied so as to finalize them.

The internally gathered data could be supplemented by external data about known best practice on the deployment of e-voting. However this should be relevant to the specific objectives of each re-engineering exercise. If for example the aim is to introduce a certain type of e-voting technology then one should look into past experience using the same kind of technology. Nevertheless, e-voting is still at a pilot stage and accumulated best practice is hard to identify for two main reasons. Firstly there is little experience in large scale e-voting deployments. Secondly, in order to define best practice one has to set commonly accepted evaluation criteria, or at least accepted in the context of a specific re-design effort. Widely recognized best practice will take a certain amount of time and testing to develop in the e-voting environment.

The outcome of this stage should be a re-designed e-electoral process, the re-design solutions being based on the organised introduction of ICT in the traditional electoral process.

#### **5.5 Continuity of e-electoral redesign**

This last stage should be concerned with maintaining the benefits gained during the re-design effort. The necessity for adaptation to e-voting technology advances, as well as to changing voter trends, fosters the necessity for repetitive process improvement. Continuous staff training should also be undertaken, responding to the need for additional technical, procedural and managerial skills. This doctoral research produced three separate analytical methods for the evaluation of e-electoral processes which could serve the continuous assessment of e-voting schemes:

- Procedural security analysis [XM 04a], in which given security constraints are used as evaluation criteria to measure the existing or prospective security level of e-electoral procedural practices
- Trust flow analysis [XM 04b], a method which provides an abstract representation of how stakeholders interact in terms of trust within the scope of a re-designed electoral process
- Level of difficulty analysis [XM 04c], which evaluates the expected level of difficulty of a suggested e-voting scheme prior to each implementation based on specific criteria.

## **6 Conclusions**

Defining roles and responsibilities within the e-voting process could provide a better understanding of who is responsible for doing what in the different process stages so that the election result is produced. Transparency of operations could provide a better insight of agent interactivities. Thus, the comparative analysis of agent roles between the traditional and the new e-electoral process could be used to specify how agent responsibilities and obligations are altered and re-distributed due to the introduction of ICTs in the electoral process. This in turn supports trust analysis and social acceptance [XM 05].

Procedural risks such as user errors could be identified in the analysis of the e-voting process and therefore either predicted or counter-measured in a way that the outcome of the process would not be endangered. The identification of procedural security gaps which could foster fraud opportunities and their allocation to specific process stages could function as a preventive mechanism against the possibility of fraud in all its different forms. Hence this line of research would support preventive management of e-voting fraud.

Better management could be provided by identifying the opportunities for effective administration of the introduced e-voting technologies. This is in line with the requirement for customisation of e-voting technology to fit local needs and the need for common evaluation criteria on the effectiveness of e-voting technology. The stage analysis of the e-voting process could also prove beneficial in the effective allocation of resources by indicating the optimal combinations of resources in parallel process stages of the multiple channel e-voting process. Finally, the re-engineering of the process could lead to process simplification, which is also a necessity in the deployment of e-voting.

## **7 Future work: Investigating cost efficiencies for e-voting**

The matter of cost is considered to be a defining factor in the deployment of e-voting in all major e-voting reports related to the UK context [Co 02], [Pa 02], [FR 02]. Government organisations need to manage the economic risk of investing in e-voting technology and make a return on their investment. According to the Electoral Commission one of the main reasons for piloting e-voting was to establish whether cost efficiencies can be achieved. Although a lack of a specific methodology to measure and evaluate the cost of all the different e-voting channels and their combinations is formally acknowledged, the Commission does consider paper ballot e-counting as having established its related cost efficiencies, hence the limited number of e-counting pilots in the 2003 pilot schemes [Ec 03]. A further issue is the documentation of the experience gained in this area. Although detailed evaluation reports have been produced with regard to technical, security, legal and accessibility issues, to this date no detailed study has been published with regard to e-voting costs.

The deployment of electronic voting systems requires considerable initial investment, operation and maintenance costs. Alternative combinations of e-voting or e-enabling technologies can result in different financial requirements. The authors therefore suggest that future research is oriented towards producing a cost accounting methodology aiming at estimating and controlling multiple channel electronic voting costs. There is an apparent need to define specific cost metrics so that when one refers to the costs of e-voting there is mutual understanding. Such research would answer e-voting costs criticism which is fostered by the absence of specific cost metrics. The authors also suggest that any cost methodology should not cover e-voting channels alone, but the combination of e-channels with paper-based channels (postal and polling station voting). If a process stage approach is adopted for all the different channels, then common costs can be identified and economies of scale can be calculated for different combinations of multiple channel elections. Possible cost reductions could be identified by allocating costs between the different stages, agents and objects involved in the process. The modelling of the e-voting process could also prove beneficial for the optimum allocation of resources, by representing the alternative options of allocating resources between the parallel stages of different voting channels. Future pilot projects offer an excellent opportunity for such a study according to the scale and the nature of the pilot, providing that precise cost estimates and final costs are kept during the pre-electoral period in a concise, pre-defined format.

The cost deriving from the adoption of e-voting systems and whether this can be considered as justifiable is a matter of policy. In one of the interviews held during the fieldwork of this doctoral research with the Returning Officer of the UK local authority where observations of an e-voting scheme were undertaken, the RO expressed the following opinion on the matter of cost:

*“In the issue of setting this (e-voting adoption) in priority to other priorities, when you’ve got basic services that need to be delivered, it means that members (local councillors) will have to take a very long hard view” adding that “if they have to make a choice between whether they spend money on the voting structure as opposed to spending money on street lights then it becomes a very difficult choice”*

E-voting costs nevertheless should be measured against the expected added value that their deployment will incur in the wider democratic process. Usually, the prospective benefits from the introduction of e-voting technologies are related to the hypothesis that the convenience offered can be used as a counterbalance against voter apathy and therefore increase voter turnout, which in turn legitimises the outcome of the electoral process. A further hypothesis is based on the assumption that young voters who are familiarised to the use of technology in general, are more inclined to participate in the electoral process if presented with the opportunity to use technological means to cast a ballot. However both of the above assumptions remain to be proven. Eventually, if no apparent relationship between e-voting and increased voter turnout is achieved, then the future of e-voting will lay solely upon the cost factor as far as the state is concerned and the trust factor from the voters’ point of view.

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