

# Multicriteria Decision Model for Information Systems Priorities Based on Business Process Management

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*The paper presents a multicriteria decision model for information system (IS) priorities. The model takes into account Business Process Management approach in order to assign strategic and organizational issues, represented by criteria. Also, technological criteria are considered. The paper presents the IS planning methodology, emphasizing the decision model proposed.*

Field of Research: Management Science, Information System Management

## 1. Introduction

Most of previous approaches to deal with IS priorities have not given adequate importance to strategic aspects. Shin (2001) pointed out several reasons for failures in IS planning. One of these reasons is the lack in connection between strategic objectives and action plans. In this paper a decision model make strategic and organizational connections with the action plan. A particular IS planning methodology (Zachman, 1982), named Business System Planning (BSP), has been applied and adapted in previous work (Almeida et al, 1992). The adaptation has provided a more appropriate way for quantitative analysis regarding priorities assignment of IS. A decision model is built to incorporate the use of the ELECTRE I method. This method allows analysis on the dominance relations amongst IS modules, based on the study of outranking relations, using a non compensatory logic (Roy, 1996; Vincke, 1992; Belton and Stewart, 2002).

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## **2. Literature Review**

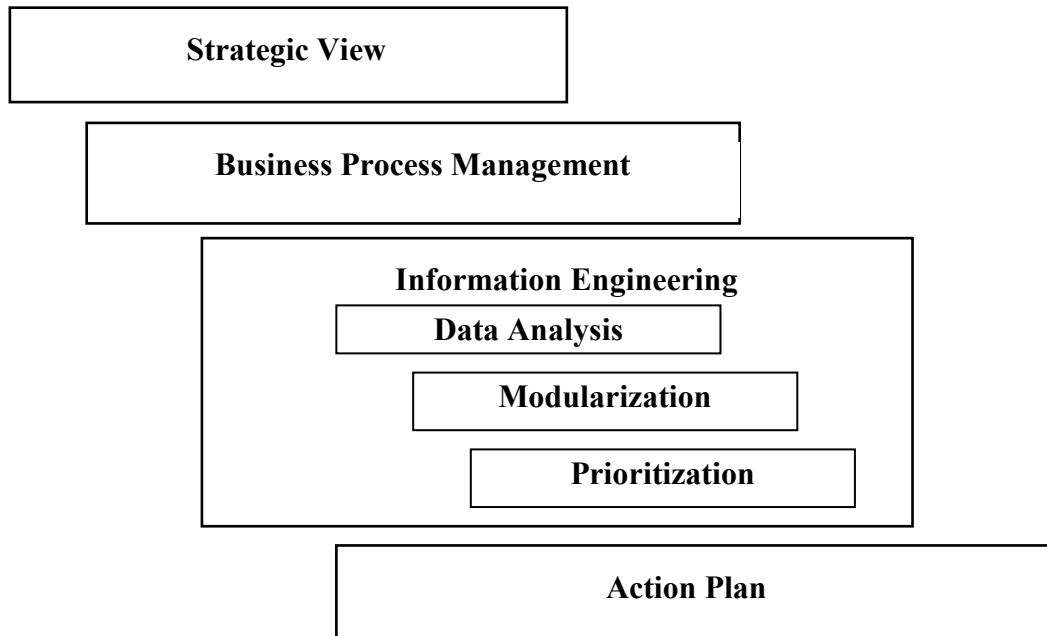
Several methodologies have been reported in literature related to information system (IS) planning (Schniederjans et al., 2004; Ahituv and Neumann, 1983; Doherty et al., 1999; Teo, 2001; Zachman, 1982). Most of this IS planning methodologies do not provide an adequate approach for a quantitative choice of alternatives for implementation. Regarding the Business System Planning methodology, ad hoc procedures have been applied in most cases (Zachman, 1982). Most of these approaches lack formality and rigor for priorities assignment of IS. Several approaches have been found in literature dealing with priorities assignment of IS (Schniederjans et al., 2004; Han et al. 1998; Hares and Royle, 1994). However, most of them are not integrated with an IS planning methodology, which incorporates the whole view of the organization. A Cost Benefit Analysis has been proposed including only tangible aspects to be analyzed (Hares and Royle, 1994). Approaches based on Quality Function Deployment (QFD) has been proposed by taking into account success critical factors to assign priorities for IS (Han et al. 1998; Kim et al., 2000; Min et al., 1999). Martinsons et al. (1999) suggest the use of Balanced Scorecard (BSC) in order to evaluate IS in organizations.

Very few works found in literature deal with multicriteria methods (Belton and Stewart, 2002) to analyze priorities for IS. However, Schniederjans et al. (2004) presented several alternative ways to deal with IS investment, including multicriteria methods, such as: multi-objective programming and Analytic Hierarchy Process (AHP). Regarding the use of Business Process Management (BPM) approach for IS planning, the Business System Planning (BSP) methodology (Zachman, 1982) may incorporate this view based on adapted BSP (Almeida et al., 1992). The BPM approach supplies a framework for Learning and may incorporate Knowledge Management. BPM approach may be applied for exploring the organizational view based on Knowledge (Armistead et al., 1999). In the last few years, a change there has been from data-aware IS oriented to process-aware IS (PAISs) oriented. Process-aware IS allows changes of process without changes in IS (van der Aalst et al., 2007; Weske et al., 2004). In this paper BPM approach has been taken into account for building the multicriteria decision model for IS priorities, considering organizational issues.

## **3. Methodology and Model Proposed**

An IS planning methodology has been adapted to incorporate the decision model. This methodology is based on the "Business Systems Planning" presented by Zachman (1982) and adapted by Almeida et al. (1992). The methodology has been adapted in order to simplify some planning steps and incorporate the decision model. Figure 1 shows the steps applied for the IS planning. A strategic view of the organization is obtained in the first step. The second step is concerned with the application of the BPM approach. Third step deals with information issue, including the priorities assignment. The last step presents an action plan to approach the IS in the organization. This action plan

indicates areas where IS should be improved and is applied to guide software implementation and resources allocation application.



**Figure 1 - Information System Planning**

This paper is mainly concerned with the priorities assignment. To make this part clear some aspects of modularization are presented, as follows. The IS is divided according to two different aspects in:

- Information Service Type (IST) and
- Information Group (IG).

The IST is related to the approach applied on information, such as described in Sprague and Watson (1982). Therefore, following IST can be applied:

- Transactional information systems (also called Electronic Data Processing - EDP);
- Management information systems (MIS);
- Decision support systems (DSS);
- Executive information systems (EIS);
- Information service of office support;
- Information service of process control;
- Information service of graphic support

The IG corresponds to a macro grouping referring to specific processes in the organization. These modules characterize the subjects the IS deal with.

The information system is analyzed based on these two views. The information system modules (ISM) are obtained by combination of IST and IG, according to Table 1.

	IG1	IG2	IG3	IG4
IST1	ISM11	ISM21		ISM41
IST2	ISM12			
IST3				
IST4				
IST5				
IST6				
IST7	ISM17			ISM47

**Table 2 - Information System Modules - ISM**

The prioritization of the whole IS consists in obtaining an evaluation of all ISM's. The objective of the decision model is to assign priorities for the ISM. Evaluations on each ISM for each criterion are obtained and represented through the following matrix by considering criteria(c), IG(m) and IST(r).

$$\|m^{c_{ij}}\| = \begin{bmatrix} m^{c_{11}} & m^{c_{12}} & \dots & m^{c_{1m}} \\ m^{c_{21}} & & & \\ \dots & & & \\ m^{c_{r1}} & \dots & \dots & m^{c_{rm}} \end{bmatrix} \quad (1)$$

The priorities are firstly assigned for the strategic factors and then transferred to the processes and finally to the ISM. The decision model is based on preference modeling based on the preference structure of the decision maker. Thus, a multicriteria method should be applied. In this paper the ELECTRE method is applied in order to make this evaluation.

### 3.1 Multicriteria Decision Method

ELECTRE I method has been applied for priorities assignment. This method concentrates the analysis on the dominance relations amongst alternatives. This method is based on the study of outranking relations, using a non compensatory logic, exploiting notions of concordance. These outranking relations are built in such way that it is possible to compare alternatives.

The DM establishes the relative weights for the criteria and the admissible level p for concordance index and admissible level q for discordance index.

The indexes are obtained through the following relations, considering two actions: a and b (Vincke, 1992; Roy, 1996; Belton and Stewart, 2002):

$$C(a,b) = \frac{\sum(W^+ + 0.5W^-)}{\sum(W^+ + W^- + W^-)} \quad (2)$$

$$D(a,b) = \text{Max} \left[ \frac{(Z_{bk} - Z_{ak})}{Z_k^* - Z_k^-} \right], \text{ for all } k \text{ where } Z_{bk} > Z_{ak} \quad (3)$$

$$\text{outranking relations: } aSb \text{ if } C \geq p \text{ and } D \leq q \quad (4)$$

where:

- $W^+$  corresponds to the sum of weights for criteria where a is preferable to b;  $W^-$  corresponds to the sum of weights for criteria where a = b; and  $W^-$  corresponds to the sum of weights for criteria where b is preferable to a.

- $Z_{ak}$  is the evaluation or utility of action  $a$  related to criteria  $k$ ;  $Z_k^*$  is the best degree of evaluation obtained for criteria  $k$ ; and  $Z_k^-$  is the worse degree of evaluation obtained for criteria  $k$ . In order to facilitate the procedure, the evaluation of alternatives are normalised such that  $Z_k^+ = 1$  and  $Z_k^- = 0$ .

The outranking relation is obtained applying (4) and the procedure to obtain the sub-set of best alternatives, referred to as kernel (Vincke, 1992; Roy, 1996; Belton and Stewart, 2002). The kernel includes a sub-set of alternatives such that any other alternative is outranked by at least one of the kernel and the alternatives of the kernel are incomparable.

### 3.2 Decision Model for Priorities of Information System

An analytical structure extracts from decision makers and analysts relationships among process and IS modules, including IG, IST, and criteria groups to put them together to obtain ISM evaluation.

Decision maker establishes relationship between:

- processes and strategic criteria in (5),
- processes and IG in (6).

$$\|r_{ij}\| = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & & & \\ \dots & & & \\ r_{p1} & \dots & \dots & r_{pn} \end{bmatrix} \quad \sum_{i=1}^p r_{ij} = 1 \quad 0 \leq r_{ij} \leq 1 \quad (5)$$

$$\|ra_{ij}\| = \begin{bmatrix} ra_{11} & ra_{12} & \dots & ra_{1p} \\ ra_{21} & & & \\ \dots & & & \\ ra_{m1} & \dots & \dots & ra_{mp} \end{bmatrix} \quad 0 \leq ra_{ij} \leq 1, \quad \sum_{i=1}^m ra_{ij} = 1 \quad (6)$$

The processes evaluations related to strategic criteria for IG are transferred through a matrix structure in (7), to obtain the IG evaluation according to strategic views.

$$\|sg_{ij}\| = \|ra_{ik}\| \|r_{ij}\| = \left\| \sum_{k=1}^p ra_{ik} r_{kj} \right\| \quad (7)$$

where:

$$\|sg_{ij}\| = \begin{bmatrix} sg_{11} & sg_{12} & \dots & sg_{1n} \\ sg_{21} & & & \\ \dots & & & \\ sg_{m1} & \dots & \dots & sg_{mn} \end{bmatrix} \quad 0 \leq sg_{ij} \leq 1, \quad \sum_{i=1}^m sg_{ij} = 1$$

The processes are evaluated under process criteria ( $P^c_j$ ) and this evaluation is transferred to IG for obtaining IG evaluations according to these criteria as given by (8)

$$\|g^c_j\| = \|ra_{ij}\| \|p^c_j\| \quad (8)$$

IS Experts evaluates IST related to technical criteria  $c$ , obtaining  $t^c_i$ . Then, the IS Experts obtain following matrix. This matrix indicates the degree in which each IG uses each IST.

$$\|at_{ij}\| = \begin{bmatrix} at_{11} & at_{12} & \dots & at_{1m} \\ at_{21} & & & \\ \dots & & & \\ at_{r1} & \dots & \dots & at_{rm} \end{bmatrix} \quad \sum_{j=1}^m at_{ij} = 1$$

Finally, the ISM evaluation for each criterion  $c$  is given by (9). Based on IG and IST evaluations and the degree of contribution of each IST in each IG, the ISM evaluation are given by (9).

$$m^c_{ij} = at_{ij} \cdot t^c_i \quad (9)$$

The evaluation of ISM for criteria  $c$  is given in (9), which corresponds to the matrix in (1). Now the ELECTRE method may be applied. (2), (3) and (4) are applied into the matrix given in (1) and obtained by (9).

For the application of this model following criteria have been considered:

- four strategic criteria: level of services supply, new business opportunities, better quality patterns and staff development;
- two processes criteria: customers commitment and criticism of automatic systems; and
- two technical criteria technological opportunities and relative technology costs.

Several processes have been taken into account to conduct the study, including: basic structure operations, acquisition, technology development, human resources management, corporate support and marketing.

By relating processes and corporate data, the Information Groups (IG) have been found. Following IST have been considered: Transactional Information System (TIS); Management Information System (MIS); Decision Support System (DSS); Executive Information System (EIS).

The combination between IG and IST given the ISM's, which are the IS modules, represent the projects portfolio to be selected for priority considerations in the next action plan.

## 4. Discussion

The model presented incorporate ELECTRE I method in the decision model. Other Multicriteria methods could also be adapted and incorporated within this model. The choice of the multicriteria method is based on several aspects, such as: decision maker preferences and rationality, organizational context, scheduling for the decision process. The model allows the assignment of priorities for IS modules, assisting an action plan concerned with information systems and connected with strategic factors. The results of the prioritization has been applied for the action planning, which consists of selecting the IS modules for future investments.

The emphasis of the decision model is the connection with the organizational processes, including also technological criteria. The proposed decision model provides to business decision makers following results:

- ◆ It allows the use of a very known multicriteria method, such as ELECTRE I;
- ◆ It provides a connection between the business strategy and IS choices.
- ◆ It is integrated with a very well structured IS planning methodology;
- ◆ it allows the overview of multiples objectives of decision makers, once it is based on a multicriteria method;

## **5. Conclusion**

The multicriteria decision model presented takes into account Business Process Management approach in order to assign strategic and organizational issues for information system (IS) priorities. The model also incorporate technological criteria. The ELECTRE I method has been incorporated within the decision model in order to assign priorities for IS modules. This allows assisting an action plan concerned with information systems and connected with strategic factors. The results of the priorities assignment may be applied for an action planning, which consists of selecting the IS modules for future investments. The emphasis of the decision model is the connection with the organizational processes, including also technological criteria. BPM approach for IS planning has supplied inside the adapted Business System Planning (BSP) methodology means for incorporate Knowledge Management of the organization. BPM also, describe the value chain of the business. The paper presented the IS planning methodology, emphasizing the decision model proposed.

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