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Designing and Building Modern Information Systems; A Series of Decisions to Be Made

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Abstract

This paper aims at surveying several critical aspects in the process of creating modern information systems, such as: methods utilized to build the system and to select the IT platform, integration into the target enterprise and evaluation of the process.

Keywords: change model, decision-making, information systems, legacy systems, methodology, standards.

1 Introduction

A plethora of models and corresponding solving methods have been devised (and reported in the technical literature) with the view to get optimal solutions for the academic test-problems or real-world control and management applications. In many cases, in practical applications, a necessary condition to make the models and the corresponding solvers utilised is to incorporate them into information systems (IS). At the same time, during the process of creating and implementing an information system, a series of decisions should be made which consist in the choice of the most adequate alternative concerning several critical aspects, such as system orientation, composition of the team, method to be adopted, IT&C (information technology and communication) platform to be utilised and so on. This paper aims at surveying several methodological and practical aspects of designing effective (usable, useful and used) information systems.

The remaining part of this paper is organized as it follows: first, several factors which may influence the decisions meant to create and implement information systems in organizations are discussed; subsequently, several design and implementation critical aspects are reviewed, such as the design approach adopted, the selection of the IT&C tools, integration problems and evaluation. Throughout the paper the emphasis will be put on decision alternatives and evaluation criteria.

2 Influence Factors

Several factors influence the process of designing and implementing an information system, such as: people involved, the orientation and the purpose of the system, the organisational content, standards utilised and so on (Filip, 2007). Those influence factors should be taken into consideration, when a decision on introducing and creating an information system is to be made.

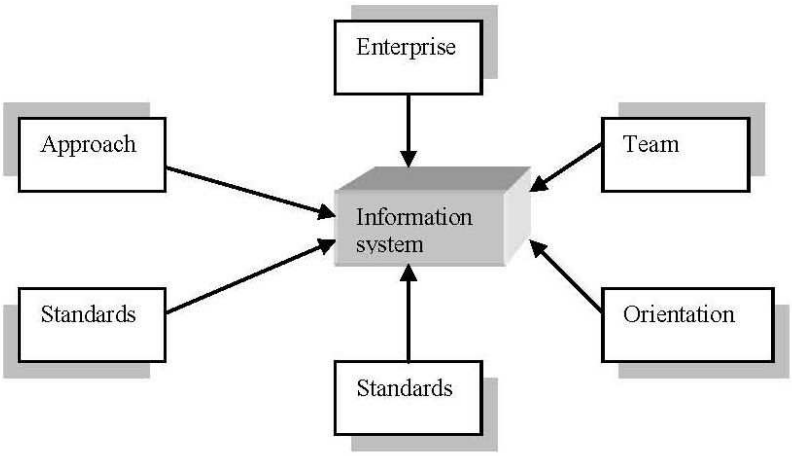

Figure 1. Influence factors (from (Filip , 2007))

The *people involved* in the *information system* (IS) construction form a virtual team who aim at obtaining the best solution for the allocated resources (time, manpower, money). The team should include the following classes of people: a) "clients", b) designers, and c) constructors/ providers of IT platform. The members of the "client" class include the project "sponsor" (a manager) and the project "champion" who represents the interests of the future direct ("hands-on") or indirect ("beneficiary") users of the system. While the "project champion" possesses the necessary knowledge in the application domain, the "project sponsor" is empowered to accept or reject the project and to allocate the necessary resources. The *designer* can be a group of people of the organization or/and from a consultancy firm who master the design techniques and who are aware of the IT&C (Information Technology and Communication) products which are available on the market. The *constructor/IT provider* can adapt and alter the IT products to be utilised.

The information system may *be oriented* to serve a certain generic class of users ("roles") or to help a specific group of persons with names, identities and IT skills ("actors"). Its *purpose* might be to facilitate and make more comfortable the work of the users or to promote the change. There are several steps of cooperation between users and designers which are recommended in *the normative model of the change* (Kolb, Frohman, 1970) and can be observed in the process of creating an information system, such as:

- Pioneering (to evaluate the needs and necessary competences);
- Acceptance (to establish the objectives);
- Diagnosis (to collect the data, define the problem and evaluate the necessary resources);
- Planning (to set up the work plan and allocate the corresponding resources);
- Action (to design and implement the information system and train its users);

- Evaluation of the process and results.

The *organisation* where the information system is to be implemented may create a context which strongly influences the solution and the process of the system building. There might be constraints caused by a) the insufficient IT&C knowledge and skills of the future users and b) scarce available data or/and limited internal data access rights of the external consultants. Several integration problems may show up caused by the "legacy IT systems" or/and the operating procedures permitted within the organisation.

Standards, which are, sometimes, overlooked by the designers, must play a central role in design. The *International Standard Organisation* (ISO) provides adequate documents which can set the stage for useful, usable and used solutions. The standards for *usable* (traditionally called "user-friendly") interfaces, such as those of the series *ISO 9241* ("Ergonomics of Human – System Interaction"), are recommended and can contribute to obtaining a user-centered solution. The quite recent standards, such as *ISO 9241-171.2008* ("Guidance in Software Accessibility") and *ISO 9241-151.2008* ("Guidance WWW User Interface"), are of a particular importance in the context of modern information systems. A comprehensive analysis of the design methods to be utilized in the low-cost interface design is given by Suduc (2010). A desirable alternative to the low-cost interface is the *intelligent interface* (Cojocaru, 2007).

Also, there are other aspects which may influence the IS construction process, such as previous experience, competitors' moves, legislation and, the most serious one, available budgets and intended due dates.

3 Approaches

There are various approaches to designing, building and implementing an information system. They can be grouped in accordance with several *criteria*, such as:

- IT&C platforms which will be utilised (general-purpose products or integrated suites/generators/shells);
- Place for construction (within the target organisation or at the consultant's site);
- Method utilised (the lifecycle method or the evolving/adaptive design which is based on the use of the prototype).

The *lifecycle*-based method implies several steps, such as system analysis, design, implementation, and operation which are carried out in sequential ("cascade") manner. It also assumes the procedures are strictly observed and the solutions adopted are well documented. It is, consequently, recommended for large-scale applications.

The *prototype*-based method (Shelley, Cashman, Rosenblatt, 2010) is based on the remark that 80% of the design ideas in the field are wrong. Consequently, the method aims at permitting 20% of the resources be spent in the early stages of design and construction for identifying the 80% wrong ideas, so that the remaining 80% of resources should be utilized to implement the remaining 20% of ideas which are supposed to be correct. A decision choice should be made between the "throwaway" prototype and the "evolving" one (Sprague, Carlson, 1982).

There are a few *basic principles* which are to be observed when adopting the prototype-based method, such as:

- The process starts with approaching the most critical problems of the target organisation, so that the user's confidence be gained as early as possible;
- The early requirements can be formulated in collaboration with the user in a "quick and dirty" simplified manner;
- The information system is developed in several cycles which must be as short as possible and the cost of the first version is very low, in order not to lose the user's interest and confidence;

- The evaluation of the effects of the usage of the preliminary version is carried out on a permanent time basis.

The *evolutive* (adaptive/incremental/iterative) method allows for obtaining a good usable solution, probably well customized, even though the information on organisation and the context are scarce and uncertain. On the other hand, the methods may lead to the tendency to continually modify the solution or, on the contrary, to adopt an imperfect or incomplete one. In (Filip, 1995, 2007), the story of constructing *DISPATCHER®*, a family of Decision Support Systems (DSS) meant to assist the production control decisions made in the context of the process industries is described. *DISPATCHER®* project started in early 80'es as an optimization model and software for scheduling. Since then, under the pressure of users' changing needs and improving IT skills, specific characteristic features of target enterprises and product developments and availability in the field of IT&C, the system evolved towards a complex solution which includes constituents based on AI (*Artificial Intelligence*) and can support new tasks and usages (Fig. 2).

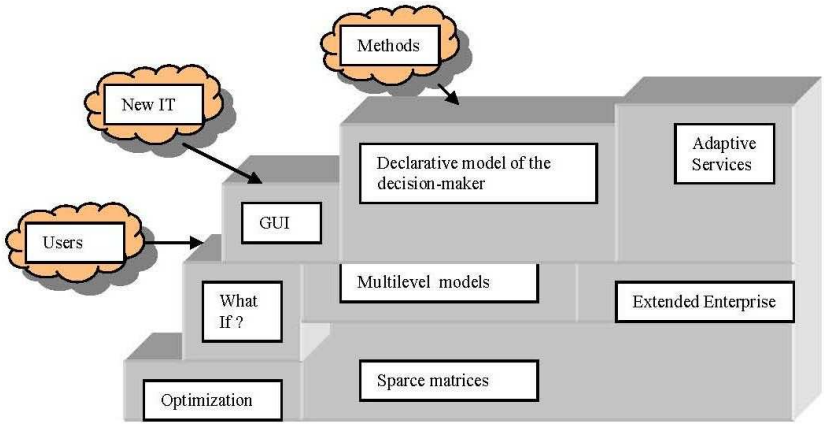

Figure 2. Building up the DISPATCHER

4 Selection of the IT&C tools

The selection of the IT&C tools should be viewed as a *multi-attribute decision-making* (MADM) problem (Gaindric, 1998; Filip, 2005; Resteanu, Somodi, Alexe , 2007) The criteria to be used in selection and ranking the possible IT&C products which can be found on the market can be grouped as it follows:

- *Adequacy* (accuracy of expected results, robustness to errors and low quality uncertain input data, unsatisfactory long response time);
- *Quality of implementation* (scalability, flexibility, easy integration with the "legacy systems", functional transparency, documentation completeness);
- *Delivery quality* (price and delivery time, provider's general reputation, low magnitude of needed adaptation, degree on dependence on the technical assistance from the provider's specialists for implementation and use).

A sound choice can be helped by a MADM technique. This may be a method which utilizes cardinal values of the attributes (for example, the *Aggregation utility function*) or ordinal scores (e.g. *Borda's method*). A systematic methodology for software evaluation and selection through the usage of MADM is proposed by Moriso and Tsoukias (1997). Comprehensive on line help can be obtained from specialized consulting firms as *Technology Evaluation Centers*-TEC (2011).

5 Integration

In many cases a new information system should be integrated into the existing or planned IT&C infrastructure of the target organization. Several *principles* are recommended for *technical integration,* such as (Vernadat, 1996):

- Adopting an "open system" architecture;

- Neutralizing the information by using standardized data formats;
- Semantic unification.

There are, however, several new problems which can show up due to *non-technical causes,* for example:

- *Wrong orientation* of the solution which does not facilitate solving the central problems of the organization, this may be associated with *informational opacity* (the system provides more/less than necessary outputs);
- *Functional opacity* which means that he user is not aware how the system works'
- Frustration of the "hands-on" user due to a long time or an insufficient/excessive number of functions.

6 Evaluation

The *main principles* to be observed in the process of designing, building and implementing an information system, for instance:

- Evaluation is necessary in all long processes to support making a decision choice from the possible alternatives (continuation, giving up, allocating some additional resources and so on);
- The content and the degree of detail of evaluation depend on several factors, as the following: a) the project scope, b) technical complexity, c) duration and cost of the project, d) the person who requested the evaluation;
- Involving the designer into the evaluation team is necessary in the case of a large project.

As previously stated, the evaluation is meant to support a decision-making process. Consequently, a set of *evaluation criteria* should be set up, namely:

- Impact on the efficiency of users' professional performance and quality of life (intellectual development, possible additional stress caused, comfort of performing the task;

- Implementation and further running costs.

There are several methods which can be utilized for evaluation, for example: a) benefits/cost analysis, though the NVP ("net present value") of the investments, b) value analysis, c) "rating and scoring", d) event logging and so on.

7 Conclusion

The activities of designing and implementing an information system form, in practical applications, a process which may include many decisions to be made, at different stages. There are several critical aspects, both the technical and non-technical, which should be taken into consideration. Among the main aspects which might cause problems are the evolution of the technical constituents associated with the increased requirements for the solution quality of the users who are ever more informed and skilled. This paper was also a plea for using the standards in the process of designing and building information systems.

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