EVOLIS : A Framework for Evaluating Evolution of Information Systems

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Abstract

While there has been extensive research in the field of software evolution, to date little research has been carried out as to the management of these evolutions in a business context. This research in progress proposes a framework that helps information systems managers to interpret present state of the system, to understand its past and to predict its future. The framework addresses both the users' perspective of the system and how well it supports the business activities. The benefits of the framework are twofold. First, it gives managers a tool for assessing the impact of a change from either the users and the business/IS perspective. Managers can use this framework to design a strategy for information system evolution. Second, the framework allows the study of information systems evolution by revealing, through the repeated use of the framework, specific evolution patterns. This research is conducted using a design science approach in information systems.
Keywords: IS evolution, Framework, IS strategy, Evolution patterns, Design science

Résumé

Malgré les recherches approfondies dans le domaine de l'évolution logicielle, à ce jour peu de recherches ont été menées quant à la gestion de ces évolutions dans un contexte d'affaires. Cette recherche en cours propose un environnement aidant les gestionnaires du système d'information à interpréter l'état actuel du système, à comprendre son passé et à prédire son avenir. Cet environnement tient compte à la fois du point de vue des utilisateurs et également de la manière avec laquelle le système d'information soutient les activités commerciales. Les avantages de l'usage de cet environnement sont de deux ordres. Premièrement, il permet aux gestionnaires d'évaluer l'impact d'un changement dans le système d'information à la fois du point de vue des utilisateurs mais également selon une approche de couverture opérationnelle. Ceci permet la conception d'une stratégie d'évolution du système d'information. Deuxièmement, l'environnement autorise l'étude de l'évolution des systèmes d'information en révélant, grâce à son utilisation répetée, des modèles spécifiques d'évolution. Cette recherche est conduite selon une approche design en systèmes d'information.
Mots-clés : Evolution des SI, Framework, Stratégie des SI, Modèles d'évolution, Design science

1 Introduction

The rapid change occurring in business environments in response to evolving markets leads to a considerable amount of change in business processes. In order to cope with changes and new market opportunities, the information systems (IS) that support these processes should be able to evolve in an adequate way.

This paper is structured as follows. After this outline we present the field of IS evolution and the research question we want to answer. Then in Section 2, we expose the research the methodology selected to conduct this study, namely design science in IS. Section 3 presents the framework we are building and the current state of our work. Finally, the expected contributions and the future activities of this research are presented in Section 4.

1.1 Evolution of Software Systems

The term evolution, in relation to software systems, has various interpretations depending on stakeholders' view.

To define evolution independently from subjective interpretations and to captures characteristics of evolution in software systems; following Lehman and Ramil (2001), we consider IS evolution as a process of discrete progressive changes over time in architecture, workflows, features or functionalities of IS. For instance, an ERP system typically evolves by regularly adding new transactions, processes and views on business processes during its life cycle. Lehman (1980) called such software systems the *E-type* systems (E for Evolving).

Several researchers described the evolution of *E-type* systems. To compare and categorize evolutions of such systems, three decades ago, Lientz and Swanson (1980) proposed a software maintenance typology that distinguishes among perfective, adaptive and corrective maintenance activities. More recently, Chapin et al. (2001) refined this typology into 12 different types of software changes. Moreover, they distinguished whether these changes are categorized as software maintenance or evolution. This work categorizes software changes on the basis of their purpose (i.e. the *why* of software change). Buckley et al. (2005) take a complementary view of the domain; indeed, they focus on technical aspects by creating a taxonomy (i.e. the *when, where, what* and *how* of software change). On another side, Lyytinen and Newman (2008) describe and analyze the dynamics of IS change. They propose a model that uses socio-technical event sequences and their properties to explain how a change outcome emerged.

These results provide a strong basis to classify software evolution according to each dimension cited above but do not address the effects of evolutions. In fact, little research has been carried out as to the impact in terms of IS management. To shed light on this area, this research investigates the consequences of changes regarding variations in terms of alignment between the business and the IS, integration among components of the IS, technological opportunities, user acceptance and cost of IS.

Concretely IS managers have to lead and to manage the evolution of the IS of their organization. In order to accomplish this task, they need to identify and to control the elements provoking an evolution of the system and their consequences.

Consequently, the main research question of this study is: "What kind of tool, and what should this tool encompass to help IS managers monitoring and leading the evolution of IS?"

2 Methodology: Design Science Approach

To answer this question, and therefore to carry out this research, we use a design science approach in IS. According to Hevner et al. (2004), design science *"creates and evaluates IT artifacts intended to solve identified organizational problems"*. In order to perform it, the research process follows the general design research cycle described in Kuechler and Vaishnavi (2008).

A design science research in IS must fit in the framework described by Hevner et al. (2004) (see Fig. 1) and must follow their seven guidelines to conduct a design science research. To summarize, the design science research produces artifacts, in our case a framework (named EVOLIS) (Guideline 1), which must be relevant to a given business problem, here the management of IS evolutions (Guideline 2). The artifact must yield utility and then must be evaluated (Guideline 3). The design science research must provide clear contributions in the areas of the design artifact (Guideline 4). This research must rely on the application of rigorous methods for the creation and the evaluation of the artifact (Guideline 5). In design science, the search process is inherently iterative whereby the search for an effective artifact requires to use available means while satisfying laws in the environment (Guideline 6). Finally, the design science research must be communicated to both technical and management audiences (Guideline 7).

As shown in Fig. 1, Hevner et al. (2004) present the framework of design research with three distinct cycles: the relevance cycle, the design cycle and the rigor cycle. Relevance is achieved by supporting business needs through the design of a tool to manage IS evolutions. Design is realized by building and evaluating the framework. Rigor is reached by appropriately applying existing foundations and methodologies to design and to build the framework EVOLIS.

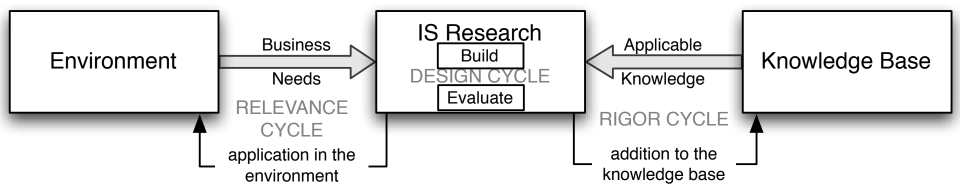

Figure 1: Design science research framework adapted from (Hevner et al., 2004)

The design and the development of the EVOLIS framework is an iterative process. To design the framework, we rely on existing literature and on practitioners' feedbacks. The development of the framework will be based on case studies and practitioners' interviews to refine and demonstrate the use of this framework. The evaluation of EVOLIS will be qualitative, principally based on practitioners' feedback, satisfaction surveys and case studies. We will determine whether IS managers are willing to adopt the EVOLIS framework to evaluate the evolution of their IS and to use it as part of their IS strategy.

3 The EVOLIS Framework

IS evolution will invariably occur and can be caused by a large variety of factors: bugs that needs to be fixed, users that wish to have new functionalities, new market opportunities that require new software features, performance standards that the system must reach, technical changes in the environment with which the system must interact, obsolescence of applications, and so on. To face these evolutions managers in charge of IS have to make choices, for example to prioritize changes, deployments and projects. To take these decisions, IS managers and CIO need to have a "big picture", a dashboard of the IS they are managing. This dashboard should indicate in which state is the IS currently, to which state it should evolve and what were its previous states.

Thus, after discussions with experts, we conclude that one answer to this question can be to create a framework to evaluate the effects of IS evolution. In other words it must be able to characterize the impact of changes according to predefined criteria in order to help managers to refine and to organize their IS strategy according to the business strategy.

Consequently, the framework design should cover the following specifications:

- It should be understandable and usable for managers.
- It should address users' perceptions of the system and their efficiency using the system.
- It should take into consideration objective factors such as the maturity level of technology used, the alignment of the solution with the business and its level of integration, thus how well the IS support the business.
- It should report the overall cost of the IS.

3.1 The Framework in Detail

The EVOLIS framework can be depicted as a canvas consisting of 5 blocks: IS/Users Fit, Technology, IS Integration, Alignment with the business and Cost, as illustrated in figure 2.

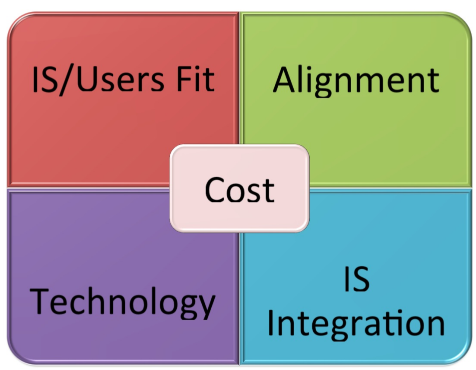

Figure 2: The 5 building blocks of the EVOLIS framework

3.1.1 Business/IS Alignment

Research has shown that IT-business strategic alignment contributes to higher levels of organizational performance (Chan et al., 1997). The main purpose of the

Business/IS Alignment block is to describes the fit between business processes and IS processes. It also reflects on the scope of the IS, whether it is extended by the evolution and whether the evolution addresses core business functionalities or support functionalities. Luftman (2000) proposed a framework called strategic alignment maturity (SAM). This framework proposes five conceptual levels of alignment maturity. These maturity levels are composed of six key areas: communication, competency and value measurement, governance, partnership, scope and architecture, and skills. These areas form not only mechanisms, but also criteria we will use to measure achievement of a maturity level (Sledgianowski et al., 2006). Another interesting approach to study the alignment between business and IS is to focus on the dynamics of alignment. Sabherwal and Chan (2001) study how does the alignment evolve over time. They point out that the punctuated equilibrium model provides a good perspective for viewing the dynamics of alignment. This work on evolution of alignment is valuable for our research as we plan to observe not only a static alignment, but also the alignment over time.

3.1.2 IS/Users Fit

Users are important in terms of evolution; actually, many researchers mention that key incentives of evolution are feedbacks and change propositions coming from the end users (Tuan et al., 2007). The IS Fit with Users is measured using both subjective and objective approaches. The users' satisfaction with the IS is measured using the well known perceived usefulness and perceived ease of use (TAM (Davis, 1989)). These two variables determine whether users accept or reject an information technology. Perceived usefulness is defined as the degree to which a user believes that using the modified system would enhance job performance. Perceived ease of use is described as the degree of ease with which a person uses the modified system. Consequently, these two variables enable us to measure the perceived benefits or losses of a change. Islam et al. (2010) propose a lightweight instrument to measure users' satisfaction and service quality experienced by the users. This instrument provides a great indication on the introduction of a new service. On the other side, the objective performance of users is calculated using measures such as efficiency and effectiveness to perform tasks.

3.1.3 IS Integration

The IS integration block evaluates the level of integration of the IS. It measures the delta between the past IS and the changed IS. There are different types of IS integration evolution, namely an evolution of integration among components of the system, among business functionalities, or an integration with systems outside of the company, etc. The literature provides many frameworks related to enterprise application integration (EAI), the most known are the Brown's Conceptual Model of Integration (Brown, 1994), Zachman's Enterprise Architecture Framework (Zachman, 1999) and Cummins Framework (Cummins, 2002). An article of Losavio et al. (2005) made a thourough comparison of these EAI frameworks. We are currently analyzing these frameworks to determine the most appropriate aspects for analyzing IS evolution.

3.1.4 Technology

When it comes to IS evolution, hardware and software platforms play a critical role. Costs incurring from using an inappropriate technology could be significantly increased whether a change is required. The Technology block encompasses notions like the degree of innovation, anticipation, flexibility, scalability, portability and so on of IS components.

3.1.5 Cost

The cost (value) of the IS is an important element for IS managers. Both academic and practitioners agree with the fact that IS investments should be carefully justified, measured and controlled. In practice, many traditional techniques are used to evaluate the "cost-benefits" of IS investments for example the Return On Investment (ROI), the Payback Period (PP), the Internal Rate of Return (IRR) and so on (Milis and Mercken, 2004). We believe that the four previous EVOLIS blocks must be evaluated in parallel with the cost function of the IS. We do not specify a particular technique to evaluate the cost-benefit ratio of evolutions. Nevertheless, we recommend not to forget to include in the cost calculation the risk related to IS projects.

3.2 Temporal View of Evolution

The use of the EVOLIS framework after each evolution of the system provides a temporal view of system evolution. IS managers can observe the evolution of each building block state. According to these indications and the priorities, the use of EVOLIS also helps managers to design the strategy of IS evolution. The framework acts as an indicator to determine in which direction the system should evolve.

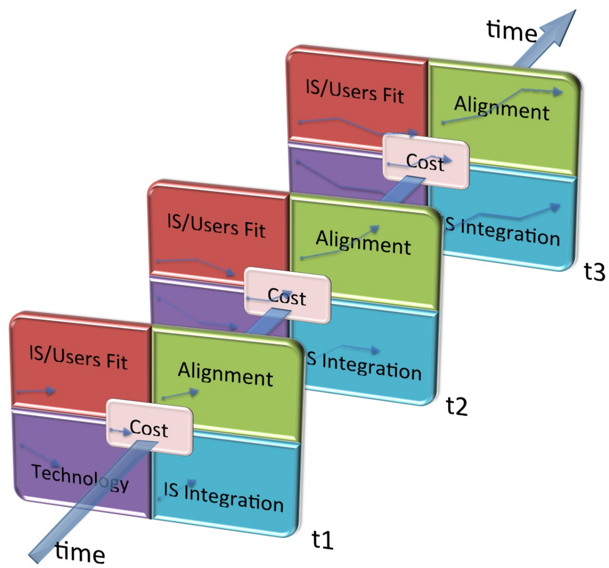

Figure 3: Multiple uses of the EVOLIS framework with the temporal evolution of each building block.

Figure 3 represents graphically the repeated use of EVOLIS and the record of each building block state. It becomes possible to observe the evolution of each building block and to compare it with others. Consequently, a temporal view allows us to identify specific evolution patterns of the IS.

4 Conclusion

This research proposes a framework that helps IS managers to identify and to control the elements provoking an evolution of the system and their consequences. This framework helps managers to evaluate and to characterize the impact of changes according to 5 criteria: IS/Users Fit, Technology, IS Integration, Alignment with the business and Cost. Another contribution of this research is that it integrates in the same framework criteria and measures which are usually addressed separately, with the purpose of building a kind of evolution scorecard. Moreover, the repeated use of this framework adds a temporal dimension to each criterion and provides a temporal view of system evolution. This view can help managers to design the strategy of IS evolution by indicating in which direction the system should evolve. Furthermore, a temporal view clearly identifies specific evolution patterns of the IS.

This research is conducted using a design science approach in IS (Hevner et al., 2004). As this research is on going, the framework is currently built relying on existing research and on practitioners' feedbacks to define the right constructs and metrics. The evaluation of this research will be qualitative, principally based on practitioners' feedback and satisfaction surveys. To evaluate our framework on different levels, we plan to test it with case studies on past IS evolution and then with a real business application.

As this research is in progress, further work needs to be done to establish precisely the components of each building block and the possible limitations related to its implementation.

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