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INFORMATION SYSTEMS EVALUATION CRITERIA BASED ON ATTITUDES OF GRADUATE STUDENTS

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Abstract

Importance of information systems in supporting business activities and managerial decision making is growing. Decisions related to selecting a suitable information system, including the technological background, human resources, procedures and information belong to one of the most difficult and most responsible ones. As in the case of other types of investments, assets and resources invested into information system should return in a reasonable time. There has been a lot of work done in the research and application of IS evaluation techniques to different kinds of information systems. Such evaluations involve a wide variety of technical and technological considerations made by technical experts, on the other hand impacts on management of the organization or financial impacts can be addressed. The objective of the paper is to reveal the preferences of graduate students related to their information systems evaluation and to propose a general framework for such evaluations. During the experimental period two surveys were carried out within the information systems course – at the beginning when the students were completely uninformed and at the end when the students had the knowledge of individual aspects of information systems, their role within organizations and process of information systems evaluation. The former survey used a simple scoring method whereas the latter relied on formal usage of the Analytical Hierarchy Process. The results show the differences in opinions of the students between these two surveys. Presented criteria hierarchy as well as the importance of individual evaluation criteria can be used for demonstration of attitudes of graduate students of management study programs and as a general framework for information systems evaluation.

Key Words

information systems, evaluation, multi-criteria analysis, Analytical Hierarchy Process

Introduction

Importance of information systems (IS) in supporting business activities and managerial decision making is growing as a response to the need for maximizing return on investments, reducing time to market and satisfying stakeholder needs (Wei, Chien, Wang, 2005). Information systems often significantly shape the work of organizations (Renkema, Berghout, 2005), therefore the decisions related to selecting a suitable information system, including the technological background, human resources, procedures and information belong to one of the most difficult and most responsible ones (Irani, 2002).

Organizations are investing into information systems in order to exploit benefits from implementation of information technologies (Chatzoglou, Diamantidis, 2009). As in the case of other types of investments, invested assets and resources should return in reasonable time. Therefore many researches focus on financial evaluation of information systems investments and economical evaluation of such projects (Irani, 2002; Chen, Doumeingts, Vernadat, 2008; Thouin, Hoffman, Ford, 2009).

Although information systems are one of the drivers in achieving competitive advantage (Wiseman, 1985) and not only financial aspects are important, assessment of all implications of the information systems infrastructure by companies is full of difficulties (Irani, 2002) on both operational and fundamental levels (Homburg, 2008). Good theoretical background together with decision support might facilitate this complicated process.

The objective of the paper is to reveal the preferences of graduate students of management curriculum related to information systems evaluation, to show how their attitudes can change as the result of increased knowledge of information systems field and to propose a general framework that can be used as a basis for evaluations of the same or similar type.

Material and Methods

Evaluating information systems

There has been a lot of work done in the research and application of IS evaluation techniques to different kinds of information systems. There exist methodologies for evaluating information systems in various industries (Yusof et al., 2008). Different topics are also differently important in different phases of information systems development life cycle. Many criteria for evaluating information systems in individual stages of systems development life cycle are discussed e.g. by Díez and McIntosh (2009). The why, who, when, what, and how approach for evaluation information systems was introduces by Yusof, Paul, Stergioulas (2005). Heo and Han (2003) developed six variables measuring the information systems performance – system quality, information quality, information usage, user satisfaction, individual impact, and organizational impact. Chatzoglou and Diamantidis (2009) measure the performance using three parameters – productivity (in supply chain, business planning, human resources and customer support), coordination (in data and process management and human resources) and information ability (in customer support and data and process management). For overview of other evaluation methods see e.g. Wei, Chien, Wang (2005).

It might seem favorable to adopt a generic framework for evaluating information systems of various types. However, application of specific evaluation criteria in contrast to generic criteria can lead to deeper understanding and thus to better manageability and project success. The wide variety of technical

and social factors also complicates the evaluation process and therefore the search for a generic evaluation framework becomes very difficult, if not impossible (Irani, 2002). As the consequence, in some fields (e.g. public administration) is the IS evaluation an issue complicated more than in other fields (Homburg, 2008).

There exist many aspects that can be evaluated on information systems. On one hand, there can be mostly technical and technological evaluations made by technical experts, on the other hand, impacts on management of the organization or financial impacts can be addressed. For several types of information systems the majority of evaluations use system-centered approach assessing e.g. the algorithms, and omitting the user or organizational perspectives (Wang, Forgionne, 2006). The perspectives of IS evaluation may include concerns of individual groups of stakeholders as defined e.g. in Boonstra (2006), Boonstra, de Vries (2008), or ANSI/IEEE 2000. Different types of stakeholders view the system from different perspectives. An important part of IS evaluation are the opinion of its users. Only in the case they accept the system the IS can bring benefits to the organization (Borovits, Giladi, 1993). However, other important groups are the managers and owners of the organization. These subjects are responsible for organizations success and economical outcomes. Information systems as one of the most valuable business resources can play a significant role in this field. Returns of information systems investment therefore depend on how much the information system participates in the strategic role of the organization (Heo, Han, 2003).

It is usually impossible to evaluate an information system using one measure, e.g. financial, because there exist also non-financial consequences that cannot be easily expressed e.g. in monetary terms. More generally, it is not possible to compare all consequences on an equal basis (Renkema, Berghout, 1997).

Analytical Hierarchy Process

Because of the complexity of IS evaluation one single criterion that would be generally agreed by all involved parties will rarely exist. It is also often very difficult to identify all important factors influencing decisions and to assess the impact of all these factors. There will also always be a part of subjectivity in evaluating information systems (Gremy, Fessler, Bonnin, 1999). Therefore it is necessary to adopt a methodology that is able to deal not only with objective information but also with the subjectivity.

Creating a structure is usually the first step in organizing, representing and solving a problem. A proper structure can help not only in understanding but also in visualizing the problem. A hierarchy, as one of the possibilities of representing structures, is a powerful way of classifying the information in order to understand the complexity of the world (Saaty, Shih, 2009). Organizing the goals and criteria of evaluation into a hierarchy can also help in aligning with the competitive strategy and goals of the organization (Wei, Chien, Wang, 2005).

The Analytical Hierarchy Process (AHP) is a decision making tool with possible applications in many fields. Its main methodological strength is the ability of rendering a complex problem (system) into a form of a structured hierarchy. This hierarchy covers all possible alternatives, evaluation criteria and the general objective (Lipovetsky, 1996). The result of such process is a single overall score for ranking decision alternatives. AHP is one of the mostly used tools for multiple criteria decision making. It was used in almost all applications related to decision making (Vaydia, Kumar, 2006). AHP has also wide utilizations in many fields related to information systems (Salmeron, Herrero, 2005).

The Analytical Hierarchy Process is a theory proposed by Saaty (1980) that is used for measuring relative variables on absolute scales of both quantifiable and non-quantifiable criteria. It is based on pair wise comparisons, which is a natural way of decision making (Ozdemir, Saaty, 2006). The quantification of preferences regarding two criteria A and B from the criteria hierarchy can be found in Tab. 1.

Value	Meaning
1	A is equally important as B
3	A is slightly more important than B
5	A is strongly more important than B
7	A is very strongly more important than B
9	A is extremely more important than B

Table 1: Scale for pair wise comparisons for AHP method

It is generally possible to use also values 2, 4, 6, and 8 as well as real numbers to specify the comparisons very finely and precisely. The same principle is later used for comparison of two alternatives A and B from one perspective represented by a criterion.

After all pairs of criteria and alternatives are evaluated simple calculations based mostly on matrices are carried out to get the relative importance of each individual criterion and overall evaluations of all alternatives (see Saaty, 1980).

Making decisions in groups

To achieve a decision in a group, group members need to accept the judgment of the group (Saaty, Vargas, 2007). Individual members of the group can have different importance, thus different weights can be assigned to their decisions or preferences. The group can achieve a consensus on both hierarchy and judgments. In the case of nonsuccess, the group can vote for the results or choose a compromise. If it is not possible, the judgments of individuals can be synthesized (Lai, Wong, Cheung, 2002). To aggregate the judgments of individuals a synthesizing function that fulfills several conditions (separability, unanimity, homogeneity and power condition) must be used. According Basak and Saaty (1993) only the geometric mean satisfies all these conditions (plus the reciprocity) and therefore is used to synthesize judgment matrices in a group of equally important individuals (Vaydia, Kumar, 2006).

Experiment

In this paper, the focus in information system evaluation is aimed at the early stages of the systems development life cycle since it is likely that after leaving the university, the students can participate in a process of selection of an information system/subsystem. Because of the major of the students (economics and management) the evaluations were performed from the perspective of managers and users of the information system, without excessive focus on e.g. technical and implementation details. The objective was to build a framework for evaluating and considering alternatives of information systems rather than to select or recommend a particular product from several alternatives (the reason was a big number of available information systems and vendors as well as the inability to do the evaluation in a particular organization) and also to demonstrate how formal techniques could help in understanding and solving problems, not only in educational process.

The group of evaluators was formed of students of the Information systems course (about 25 students). These students

were almost at the end of their five-years studies and they were expected to be employed in managerial positions where they could play a significant role (decisive, advisory or consultative) in the process of IS implementation or innovation. The first part of the experiment started at the very beginning of the course, even before the first meeting. The objective of this first part was to identify the opinions and attitudes of people who were not influenced by theoretical aspects of information systems project and impacts of information systems on organizations. The students were not presented any existing evaluation framework and they needed to decide only according their judgments. The students, however, had some experience as regular users of various information systems (at least the information system of their university) and possibly with evaluations of projects of different nature. The results of this first part of the experiment should show that without enough relevant information and without having a proper framework and methodology for evaluation the results have the tendency of providing inappropriate conclusions.

The second part of the experiment was carried out at the end of the course after the students became more informed about the information systems field thanks to the information systems classes where they got acquainted with many areas related to information systems, such as enterprise and information systems architectures, information systems development approaches, systems integration, frequently used applications or economical aspects of information systems. To improve the decision making process, a formal technique (Analytical Hierarchy Process) was used to capture and clearly structure the preferences of the students.

When information systems should be evaluated from multiple perspectives it was necessary to select those criteria and assign relative importances to them. First, the students individually prepared several criteria and grouped them into several categories, according their feelings and opinions. Such the criteria also reflected their gained knowledge during the course. The criteria were later discussed during the class so they could be explained, clarified and understood by all participants. Based on the categories of criteria that were created by the students, one aggregated set of categories, as well as their structuring into a hierarchy was identified (the results see in Fig. 1). Using the scale from Tab. 1 the relative importances of individual criteria were quantified based on pair-wise comparisons.

For finding the outcomes of the group decision making process (during creation of the criteria hierarchy as well as during criteria importance quantification) a consensus reached after discussion was considered. It was assumed that all members of the group were equal so that it was not necessary to assign more weight to the opinions of some group members.

Based on the results of criteria quantifications and using the method described by Saaty (1980), normalized weights for individual criteria on all levels of criteria hierarchy were obtained (see the results in Tab. 3).

Results

The identified criteria of students' evaluation and the quantification of their importance at the beginning of the course can be found in Tab. 2. The importances were rated using a number on the scale 1 – 10 where 1 means "the least important" and 10 means "the most important". The same value could be assigned to more criteria which meant that these criteria had the same importance. The scores in Tab. 2 were obtained as the average from the scores obtained from individual students. Costs, Complexity and user friendliness, Speed of implementation, Security and safety, Covering all agendas, Good accessibility, access from the Internet, Support from manufacturer, services and Integration with other systems, openness, adaptability, modularity were identified by at least about a half of the students. Other criteria were mentioned very rarely (some criteria only once) and therefore some of them, especially very unusual, were removed from the list.

Criterion	Frequency among all evaluations	Average ranking
Stability and efficiency	Very low	9.5
Security and safety	Very high	9
Covering all agendas	Very high	9
Complexity and user friendliness	High	8
Matching company needs	Middle	8
Good accessibility, access from the Internet	Middle	7.5
Costs	Very high	7.5
Speed of implementation	Very high	7
Support from manufacturer, services	High	7
Multiple lang./national environment for multinational companies	Very low	6.5
References, evaluation of supplier	Middle	6
Integration with other systems, openness, adaptability, modularity	High	6
Benefits	Very low	5
HW and other system requirements	Low	4

Table 2: Criteria and their importance on scale 1 (least important) to 10 (most important) and frequency identified at the beginning of the IS course

In the class at the end of the course, the criteria for IS evaluation were arranged into a hierarchy. Before that, the students first reconsidered the criteria they identified at the beginning and

they also identified other criteria that had become important for them after they had an insight to the information systems domain (some of these criteria naturally did not appear in their evaluations at the beginning). The students also individually proposed a hierarchy of their criteria. The hierarchies of all students were then aggregated and based upon the group consensus the hierarchy that is shown in Fig. 1 was developed.

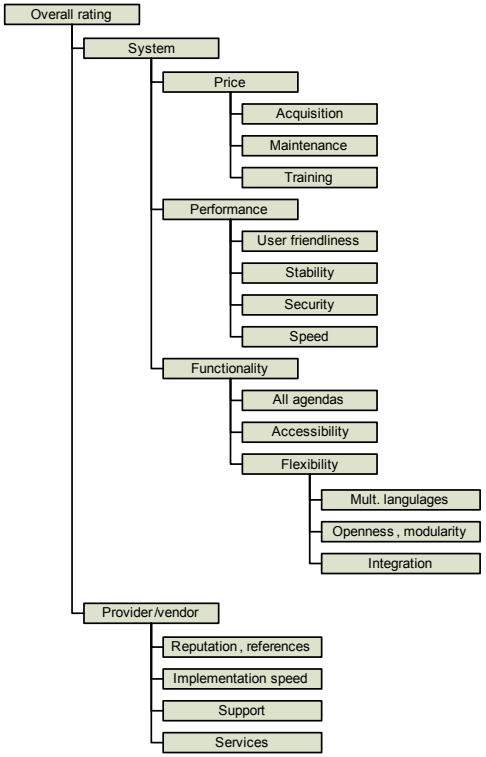

Figure 1: Aggregated hierarchy of criteria for IS evaluation identified at the end of the course.

The hierarchy had two major branches, one of them focused on the information systems as core products, another one was aimed at the vendor or provider of the product and related services. The hierarchy provided a better insight into the overall evaluation and enabled better focusing on some of the criteria. Some criteria, e.g. the costs were also decomposed into several subcategories after the students realized all economical implications in the IS project.

The results of quantification of all criteria from the criteria hierarchy can be seen in Tab. 3. The weights assigned to each criterion can be later used for evaluation of a particular set of information systems after considering their characteristics. The weights were calculated using the Saaty's method based on students' preferences that were captured in the class and adjusted using a group consensus. Because of the large quantity of evaluations, criteria comparisons, and calculations, only the final results are presented here.

Although it is difficult to compare results obtained using the Saaty's method (see Tab. 3) and the simple scoring method (see Tab. 2), several differences as well as common outcomes can be discovered. They are discussed in section Discussion.

System 0.833	Price 0.123	Acquisition	0.286	
		Maintenance	0.612	
		Training	0.102	
	Performance 0.557	User friendliness	0.130	
		Stability	0.333	
		Security	0.531	
		Speed	0.057	
	Functionality 0.320	All agendas	0.331	
		Accessibility	0.120	
		Flexibility 0.549	Multiple languages	0.102
			Openness	0.532
			Integration	0.366
Provider 0.167	Reputation, references		0.090	
	Implementation speed		0.135	
	Support		0.360	
	Services		0.415	

Table 3: Weights of IS evaluation criteria calculated using Saaty's method

Discussion

At the beginning the students were not able to identify all important criteria although all of them had several experiences with various types of information systems. Also the sets of criteria were often very different within the group of students. However, it was usually possible to merge several criteria into one class to reduce the length of the criteria list.

It was also interesting to observe that some of the criteria were evaluated relatively consistently (e.g. Complexity and user friendliness, Security and safety, Matching company needs, Covering all agendas) whereas others had very different rankings among the students (e.g. Speed of implementation, Integration with other systems, openness, adaptability, modularity).

The first important fact from the final evaluation was that the information system itself was strongly more important than the subject providing it and the services and activities related to the information system. Also the services and support provided by the IS vendor became more important in comparison to other vendor related issues after the pair wise analysis of criteria. Thus, the relative importance of speed of implementation, reputation and references of supplier decreased in comparison to the initial evaluation criteria importance and service and support gained their significances.

Security, stability, user friendliness and coverage of all important agendas were still the most important criteria, which was the result of the fact that the system and its performance were seen as the most essential. Openness of the system, its adaptability and modularity became more important than at the beginning, which could be attributed to the awareness of the position of information systems in organizations, their importance and

positive role in gaining competitive advantage and facing the changes in external and internal environment.

Costs of the information system were evaluated as quite important and also by almost all students at the beginning. However, later, after the students realized the nature of costs related to the information systems life cycle and became familiarized with frameworks for costs classification, the information systems related costs were split into three groups – acquisition costs, maintenance costs and training costs. The importance of maintenance costs and their impact of overall rating were identified as the most significant.

Conclusion

The objective of the paper was to reveal the preferences of graduate students related to their information systems evaluation, to show how their attitudes can change as the result of increased knowledge of information systems field and to propose a general framework that can be used as a basis for evaluations of the same or similar type. During the experimental period two surveys were carried out within the information systems course – at the beginning when the students were completely uninformed and at the end when the students had the knowledge of individual aspects of information systems, their role within organizations and process of IS evaluation. The former survey used a simple scoring method whereas the latter relied on formal usage of the Analytical Hierarchy Process.

The results show that within the time between these two surveys the opinion of the students regarding several criteria has changed. Some criteria, e.g. openness of the system, its adaptability and modularity become more important, which is in correspondence with current trend in information system design – the systems need to be constantly and smoothly re-engineered to respond to changing market demand and technological evolution (Chen, Doumeingts, Vernadat, 2008). On the other hand, some criteria that were related to the systems as well as to the provider (vendor) of the information system have lost on their importance as a consequence of clear structuring of the problem of IS evaluation.

Presented criteria hierarchy as well as the importances of individual evaluation criteria can be used for demonstration of attitudes of graduate students of management study programs and as a framework for information systems evaluation. However, it is always necessary to consider company characteristics during the process of evaluation of candidate information systems. Adopting only common evaluation criteria can lead to delay in IS implementation and under-performance of the system (Wei, Chien, Wang, 2005).

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