Risk determination for the implantation process of software systems

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Abstract. From the analysis of software companies in Argentina, weaknesses in risk management have been observed. This impacts in quality management because risk planning is a requirement specified by all standards. As part of a general study about the implantation of software systems, the aim of this work is to analyze the risks associated to such process. This proposal envisages the activities and tasks of the ISO/IEC 12207 standard transition process. For the assessment of the proposed risks, the ISO/IEC 31010 standard is adopted. Furthermore, associated procedures are suggested to either avoid or mitigate risks. The work was tested in a real environment to determine its viability. The case study consisted of the risk analysis of the implantation of the management system module of a multinational company's advertising agency. This revealed flaws in the management of the analyzed risks and provided feedback for the study.

Keywords: software process, implantation process of software systems, risk management, case study, improvement.

1 Introduction

The implantation of software systems is the phase of the development life cycle in which the software product is transferred to the client The implantation process contains practices that tend to pose problems such as the lack of (external) components, incomplete downloads and erroneous implantations [1]. Problems that may occur in the implantation phase are transferred and eventually resolved in the maintenance phase. Some companies usually take months and even years to complete the implantation of a software system in its entirety. This is why an efficient software implantation will considerably save resources in terms of costs and effort. [2].

Software projects are high-risk activities that generate variable performance results [3]. A risk is the probability that a loss will occur. In a software development project, the loss could occur through the decrease in software product quality, the increase in development costs, the delay in completion or a failure, among other losses [4]. A great number of projects lack formal approaches for risk management. The identification of such approaches often depends informally on the skills and the level of expertise of the software administrators [5].

In the context of this research, a conceptual definition of software systems implantation is analyzed due to the varied existing terminology. It is called "Implantation phase and user's acceptance" by the Métrica v3 [6] methodology, "Transition" by the ISO/IEC 12207 standard [7], "Deployment Phase" by the DSDM method (Dynamic Systems Development Method) [8], and "Deployment Flow" by the RUP (Rational Unified Process) [9].

The aim of this work is to enhancethe implantation process of software systems through the comprehensive management of a set of risks (to avoid, to mitigate and/or to transfer).

Section 2 describes the related works, section 3 presents a preliminary proposal of a set of risks for the process under study focused especially on the activities and tasks carried out in such process. Section 4 exhibits a case study aimed at validating the proposal in a real context and finally, section 5 presents the conclusions and future work.

2 Related works

A systematic mapping study (SMS) was performed in accordance with the process proposed by Barbara Ann Kitchenham in [10], available in [11]. As a result of the SMS, it was observed that the most used methodologies, methods and standards dealing with risks management are CMMI [12], PMIBOK [13] and Software Risk Evaluation [14].

For this work, an adequate tridimensional vision of the implantation process is considered [15]: "Process/Product/Person". The so called "*Process*" dimension includes phases or stages, activities and tasks that compose the process of implantation. The "Product" dimension envisages characteristics such as size, complexity, design characteristics, performance and quality level. The "*Person*" dimension includes informatics professionals and system's users.

Based on the SMS results and in order to find out how CMMI [12], PMIBOK [13] and Software Risk Evaluation [14] approach the implantation phase, a comparative analysis was performed through the DESMET method [16] based on the "Process/Product/Person" characteristics. In addition, MAGERIT [17] was added to the study because it is one of the pioneering methodologies in risk management. The comparative analysis is shown in Table 1.

Table 1. Evaluation of methodologies, methods and standards.

Implantation Phase	Methodologies, methods and standards considered			
	CMMI-DEV	PMIBOK	S.R.E.	MAGERIT
"Process" Dimension	YES	YES	YES	YES
"Product" Dimension	NO	YES	YES	YES
"Person" Dimension	NO	NO	NO	NO

The results shown in Table 1 led to the following conclusions:

- All the methodologies, methods and standards (SOFTWARE RISK EVALUATION, CMMI, PMIBOK and MAGERIT) show compliance in the "*Process*" dimension.
- Except CMMI, SOFTWARE RISK EVALUATION, PMIBOK and MAGERIT show compliance in the "*Product*" dimension.
- Finally, the "*Person*" dimension does not show compliance in any of the methodologies, methods and standards analyzed.

3 Risk Proposal

This work focuses on the "*Process*" dimension. This proposal envisages the activities and tasks of the transition process under the ISO/IEC 12207 standard [7] as it is an internationally recognized standard. The risk classification used is the one proposed in [5] with adaptations to this work and to the evolution of software engineering in recent decades. For this work, the adaptation implied that the risks considered comprise the entire life cycle of the software and the research proposal focuses on the implantation process. For risk assessment (see Table 2, VH = Very High, H = High, M = Medium, L = Low, VL = Very Low), the ISO/IEC 31010 standard proposal [18] is adopted as one of the main risk management references for the software industry internationally.

Table 2. Risk Assessment Scale according to the ISO/IEC 31010 standard [18].

RISK		PROBABILITY				
		VL	**L**	**M**	**H**	**VH**
IMPACT	**VH**	H	VH	VH	VH	VH
	H	M	H	H	VH	VH
	M	L	M	M	H	H
	L	VL	L	L	M	M
	VL	VL	VL	VL	L	L

Risk = [Probability * Impact]

The activities considered in the "transition" process of the ISO/IEC 12207 standard are: A1. Implantation preparation, 2. Implantation execution and 3. Management of the results of the implantation. In Table 3, two tasks are presented for each of the activities that are related to a proposed risk.

Table 3. Risks for each activity

Activity	Tasks	Risks
A1 – Implantation preparation	T1 – Identify restrictions of the technology	R1 Little investment in technology
	T2 – Obtain access to the enabled environments, systems or services	R2 Friction between software management and top executives.
A2 – Implantation execution	T3 – Adapt software elements to restrictions	R3 Cost overruns
	T4 – Register requirement compliance	R4 Low user satisfaction
A3 – Implantation results management	T5 – Register results	R5 Lack of specialization
	T6 – Maintain traceability of elements	R6 Inadequate tools and methods

4 Case study

In this section, a preliminary case study is described, following the guidelines proposed in [19]. The main objective is to examine the feasibility of applying the risks set (Table 3) for the process of implanting software systems in a real environment. According to Robson's classification [20], it falls under the scope of exploratory studies.

To achieve the objective, the following research questions (RQ) are defined:

RQ1: Were the risks adequately managed during the software system implantation process activities?

The aim of this question is to obtain information on the risks that were identified in the process execution and the treatment given by the company in order to compare them with the proposal made.

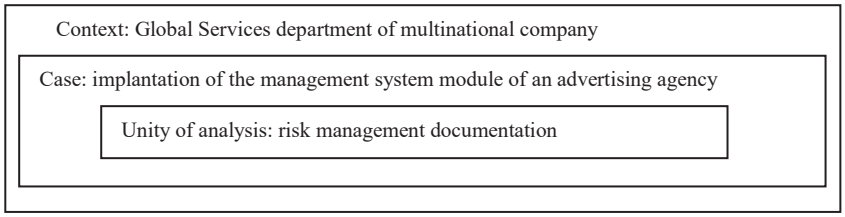
RQ2: How can the implantation process of software systems be improved in this company?

This question attempts to determine the way in which the consultant can enhance its implantation process. For this purpose, it is proposed that a set of risks be identified along with their procedures in order to avoid, mitigate and/or transfer them.

For the case study, data were collected in the Global Services department of a multinational company. This company has been in the Argentine Republic for 20 years and offers professional consulting services. The study focuses on the department mentioned as it carries out the software development projects.

The study is a holistic unique case (Fig. 1) and follows Yin’s classification [21].

Fig. 1. Classification of case studies based on Yin`s definition [21].



For the collection of data on the risks of the implantation executed, a third grade technique was used combined with an independent method according to the classification proposed in [22]. To collect information on risks, a data collection template with a codification scheme was defined according to the template approach mentioned in [21]. The template codification scheme consists of a set of 3 groups, each of them corresponding to the 3 activities of the transition process established in the ISO/IEC 12207 standard [7] (1. Implantation preparation, 2. Implantation execution and 3. Implantation results management). Table 6 presents the extract of the coding scheme for data collection. The results presented correspond to the case study of the management system module implantation of an advertising agency. This system was developed to suit the client.

Table 7 shows the traceability of the documents reviewed for each activity of the transition process under the ISO/IEC 12207 standard [7].

Table 6. Extract of the data collection codification scheme [5]

Group	Category	Description
A1 – Implantation preparation	**R1:** Little investment in technology	Poor investment in technology is endemic in the industry and it affects companies of all sizes.
	R2: Friction between software management and top executives.	Friction between executives is endemic in software projects and it occurs approximately in 30% or 50% of large companies.
A2 – Implantation execution	**R3:** Cost overruns	Cost overruns are endemic in the software field.
	R4: Low user satisfaction	Low user satisfaction is found in between approximately 25% and 30% of business applications.
A3 – Implantation results management	**R5:** Lack of specialization	Lack of specialization is endemic in the software industry.
	R6: Inadequate tools and methods.	Lacking the tools or support for them, or eventually failing to define a clear and documented work methodology known by all the personnel.

The results obtained contribute to validate de preliminary proposal of the whole set of risks, which is part of the research process undertaken in the Master's thesis of the first author of this study.

Table 7. Traceability of reviewed documents.

Documents/ Activities	A1	A2	A3
Work plan	R2		
General Documentation	R1		R6
User requirement		R4	
Change control document		R3	
Project standards	R2		R5
Requirements for the installation environment	R1		
Installation test procedure	R2		R6
Acceptance test procedure		R4	
Smoke test instructions			R6
Data entry instructions			R5
Acceptance test instructions		R4	
Installation script	R1		
Progress report	R2	R3	
Meeting memo	R2		
Smoke test results	R2		
Acceptance test results		R4	
Installation completion report	R2	R4	R5
Training registry		R4	R5

Table 8 presents the assessment of the risks detected as a result of the document analysis.

Table 8: Risk assessment for the case study.

Activity	Risk	Assessment	
A1	**R1**	[Probability (M) * Impact (H)]	H
	R2	[Probability (H) * Impact (H)]	VH
A2	**R3**	[Probability (L) * Impact (H)]	H
	R4	[Probability (VH) * Impact (H)]	VH
A3	**R5**	[Probability (H) * Impact (M)]	H
	R6	[Probability (M) * Impact (L)]	M

The results related to the research questions defined for the case study are presented below:

RQ1: Were the risks adequately managed during the software system implantation process activities?

Based on the documentation analyzed, flaws in the management of risks proposed for the implantation process activities were identified:

- Activity 1 – Implantation preparation: The general documentation of the project and the work plan contain generic information, giving rise to misunderstandings and subjectivities. This is one of the reasons that caused very important delays (shown in the meeting memos) and frictions between different sectors within the organization, because the project standards were not met. In addition, the productive environment did not comply with the necessary

requirements by the estimated date set in the work plan, as shown in the progress reports available.

- Activity 2 – Implantation execution: Ambiguous user requirements along with technical problems, multiple complaints and a very low satisfaction level of final users generated cost overruns. An analysis of the progress reports, change control documents and meeting memos revealed that the client considered cancelling the project on several occasions.
- Activity 3 – Implantation results management. Lack of specialization of the different areas involved and of key users hindered an adequate knowledge transfer and project closure. This is observed in the low attendance to training workshops and in incomplete project completion reports.

RQ2: How can the implantation process of software systems be improved in this Company?

Adequate risk management makes it possible to either avoid risks or have procedures available to mitigate them. Table 9 presents the procedures to avoid, mitigate or transfer each of the risks under study based on the proposal by [5]:

Table 9. Procedures associated to each risk.

Risk (R)	Procedure (P)
R1 – Little investment in technology	P1 – Accurate software measurements are the best preventive method for this type of risk. The methodology is based on adequately managing costs, deadlines and other quantitative and qualitative factors associated to the Organization's technology projects.
R2 – Friction between software management and top executives.	P2 – Once friction is generated between top executives and software management, it is not easy to continue the project properly. Some control approaches introduce radical changes, such as externalization of software management and reduction of the number of applications to be implanted.
R3 – Cost overruns	P3 – As the project moves forward, it becomes increasingly difficult to control the associated costs. Cost overruns can stem from many reasons. The best form of mitigation is a detailed follow-up of the project plan. Any excess in time or resources used may cause cost overruns. Specifically, staff working overtime may be a factor causing the risk.
R4 – Low user satisfaction	P4 – User satisfaction is a complex and multifaceted issue. Some of the seemingly effective preventive measures include usability laboratories and having a user experience specialist. In addition, annual or bi-annual user satisfaction surveys are the basic control mechanism to ensure it.
R5 – Lack of specialization	P5 – A preventive method is to create an inventory of the employees' abilities in the Company and to establish specialization criteria and training study plans based on the project.
R6 – Inadequate tools and methods.	P6 – The most effective approach for preventing inadequate software engineering tools is to conduct surveys and generate metrics of the kinds of tools used by the software industry.

The lessons learned from this case are listed below:

- Method selection: A preliminary validation of a set of risks was required for the "process" dimension of the software system implantation process and their assessment in a real context. The results obtained enabled the analysis of its evolution and refinement; therefore, the method used is considered to have yielded the expected results.
- Collected data. Although the software system implantation process documentation was reviewed in order to analyze how the risks were managed, the case may have been strengthened if the data collected had been complemented with another source or with quantitative data.
- Codification selected. The codification scheme selected for the design of the data collection and analysis template was adequate and it allowed the systematic registration of risk information.
- Results report. Although the case includes two research questions, the work performed is considered to provide an adequate degree of detail for the purposes of understanding the phenomenon under study.

5 Conclusions and future work

A set of risks related to the software system implantation process was presented, with a focus on the "Process" dimension, since the phases or stages, activities and tasks involved in it are particularly interesting. This proposal considered the activities and tasks of the transition process under the ISO/IEC 12207 standard. The proposal of the ISO 31010 standard was adopted in order to evaluate the risks proposed.

A case study was conducted to determine the viability in a real environment. It consisted of the risk analysis of an implantation of the management system module of an advertisement agency which is part of a multinational company that offers professional counselling services. The document analysis revealed risk management flaws, including lack of specialized staff for the project, conflicting interests among the areas involved and failure to comply with the requirements of the installation environment.

The lessons learned from the case showed that the research method used was appropriate for validating the proposal. A set of recommendations were given to the company as a result of the case in order to enhance its software system implantation process in future projects.

The following future lines of work are identified: (a) to further define risks for the "process" dimension, (b) to define the set of risks for the "product" and "person" dimensions, (c) to validate the proposals in different case studies.

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