Study on Risk Approaches in Software Development Projects

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Risk approaches in project development led to the integration in the IT project management methodologies and software development of activities and processes of risk management. The diversity and the advanced level of the used technologies in IT projects with increasing complexity leads to an exponential diversification of risk factors.The purpose of this research is to identify the level of the risk approach in IT projects both at the IT project management and software development methodologies level and the level of the perception of IT project managers, IT managers and IT analysts in Romanian IT companies. Thus, we want to determine the correlation between the use of a project management or software development methodology and the overall level of risk perceived by the project managers using these methodologies.

Keywords: *Risk, Software Development, IT Projects, Project Management, Methodologies*

1 Introduction

With the increasing level of complexity of IT projects for software development, associated risks have increased. This has generated increasing interest in the risk approach both in terms of research, and that of professional standards for IT project management and software development.

In recent researches, we noticed the relationship between risk and IT project performance, and the relationship between risk and performance of IT project management [1]; [2]; [3]; [4]; [5]; [6].

The diversity and the advanced level of the used technologies in IT projects with increasing complexity leads to an exponential diversification of risk factors. The recent IT approaches of complex projects such as Smart Cities are quite eloquent in this context [7].

Focusing on risk is more than just a formal act. This focus is required in ensuring the performance of software development projects. The relationship between risk and performance of software development projects is positive [6];[8].

In this context, focusing on performance requires mandatory use of risk management methods in the management of IT projects. Risk factors are represented by any element or condition that can negatively or positively affect the project throughout its life cycle, but especially the final outcome of the project.

IT projects risks have many shapes, making it difficult to measure, and are divided into several dimensions: users, requirements, complexity of project, planning and control, project team, organizational environment [1]; [2]; [9]; [10]; [11].

Risk management is an iterative process of risk identification, analysis and risk assessment, risk response planning, monitoring and control of risk response and is conducted throughout the project life cycle [11].

Practical experience indicates that the use of a formal and structured process for handling expected or unexpected risk events minimizes unpredictable events, costs, delays, stress or misunderstandings. In the last decade [12], standards for project management have become comparable on structure and content.

Analyzing each methodology, we can observe how the risks are approached in IT projects. Thus, **PMBOK (Project Management Body of Knowledge)** is known as a standard methodology in project management and it is developed by PMI. In this methodology, the risk approach occurs within "Risk management" domain applied in the planning and control of the project [13].

The risk approach in the **CMMI framework (Capability Maturity Model Integra-**

tion)focuses on improving processes that provide essential elements of effective processes to the organizations [14]. CMMI addresses risks in the level 3 of maturity ("Defined").

RUP (Rational Unified Process)[15] is a customizable methodology framework project, which is primarily focused on software development.

From large projects to condensed projects, RUP enables organizations to develop projects quickly and to provide high quality modeling according to specific requirements. Also, it addresses processes by focusing on risks that processes are exposed to in software development [16].

PRINCE2[17]; [18]; [19] is an acronym for "Projects in Controlled Environments". Originally designed as a complete system of standard principles of project management for information systems and information technology projects, its use is particularly expanding more and more in projects of British government departments and agencies.

The methodology is independent of its application, such as: IT software development, marketing, constructions or change management. Specific methods, such as product development methods, or domain specific standards can be applied in PRINCE2 teams.

This way, the method is generally applicable to any project. PRINCE2 provides a higher level than necessary disciplines in the project, outlining a flexible project language design that fits multidisciplinary project teams. Likewise, the methodology treats risk management within projects, quality management and change control.

System Development Life Cycle (SDLC)[20] is essentially a waterfall methodology. For many projects dealt with SDLC, the methodology style and trend often rely on the completion of a subsequent phase of the current one. Naturally, many of them are monolithic, time consuming and some of the contemporary methodologies call them giant dinosaurs of project methodologies. Being an old methodology, SDLC is not focused on risks in software development activities.

The**Agile** methodologies are a group of software development methods based on incremental and iterative development. They provide new ways to develop complex software and systems [21]. Within Agile methodologies, requirements and solutions are evolving through collaboration between self-organized, multi-functional teams.

They use adaptive planning, evolutionary development and delivery systems, project classification in a fixed period of time and encourage fast and flexible response to inherent changes.

The most popular agile methodologies are:

- Extreme Programming.
- Rapid Application Development
- Scrum
- Adaptive Software Development
- Crystal Clear
- Feature-Driven Development
- Dynamic Systems Development Method
- Lean development.

Agile methodologies do not address the risks as distinct and formal elements in software development phases.

SSADM (Structured Systems Analysis and Design Methodology) is an open software development methodology that addresses systems analysis and design in a top-down manner and aims to ensure design accuracy and compliance with all functional requirements of the system. In software development through SSADM, risks are not treated explicitly and formally.

In the analyzed literature and practice, we have not identified any study to analyze the correlation between risk approach both at the best-practice methodologies in IT project management or software development level and the practice level, and the perception of overall risk level of projects run using these methodologies.

The purpose of this research is to identify the level of the risk approach in IT projects both at the IT project management and software development methodologies level and the level of the perception of IT project managers, IT managers and IT analysts in Romanian IT companies. Thus, we want to determine the correlation between the use of a project management or software develop-

ment methodology and the overall level of risk perceived by the project managers using these methodologies. The research is limited to the IT companies in Romania.

We have two main objectives:

(1) The first one is to conduct a comparative analysis of the IT project management or software development methodologies considering their formal way to treat risks.

(2) The second objective is to determine the perception of IT project managers, IT managers and IT analysts of the overall level of risk in software development projects carried out using a methodology.

The research results confirm that the use of a methodology for IT project management or software development focused on the risk approach leads to a lower overall risk perception from the users' point of view.

We structured the paper in 5 parts. In the introduction, we performed an analysis of the literature on risk approach in terms of IT project management or software development methodologies. In the second part, we presented the research methodology. In the third part, we made a comparative analysis of methodologies and presented the findings. In the fourth part, we performed the analysis and interpretation of data on the perception of IT project managers, IT managers and analysts regarding the overall level of risk in the most recent completed IT project. In the fifth part, we presented the conclusions of this study.

2 Research Methodology

Research problems

(1) We propose a comparative analysis of the most used IT project management methodologies and software development methodologies considering the risks in projects.

(2) Also, we propose an analysis of the IT managers' perception of risks in projects that use these methodologies in Romanian IT companies.

Research design

The research methodology consisted of two stages:

- the analysis of literature related to risk approaches in IT project management and software development methodologies;
- applying an online questionnaire with questions about the methodology used in the most recent completed IT project.

Sample, population or subjects

The target population for the empirical analysis consisted of project managers, IT managers and IT analysts, and the sample was derived from a combination of the convenience method and the snow-ball method on a 361 company database between the 10th of June 2012 and the 11th of July 2012.

We received 108 answers (28.35%), out of which we validated 106, from 72 companies (19.95%).

Instrumentation and materials

The questionnaire was developed in Google-Docs and the data were processed using Microsoft@ Excel 2007 and IBM@ SPSS 19.

Variables in the study

The variables in this study are the methodologies used in IT projects and the overall risk in IT projects.

Each methodology represented by a nominal variable and the overall risks variable, as perceived by the respondents, was on a 5-point Likert scale (5 being the highest degree, 1 being the lowest degree).

Data analysis

We performed a univariate descriptive analysis to compare the means (average score on the Likert scale) of the overall risk for the project managers that use a project management or software development methodology.

3 Findings on Risk Approaches in Methodologies

Our research was focused on the following methodologies:

- PMBOK (Project Management Body Of Knowledge) [13];
- CMMI [14];[22];
- RUP (Rational Unified Process) [15];
- PRINCE2 [17]; [18]; [19];
- System Development Life Cycle (SDLC) [20];
- Agile Methodologies (Extreme Programming; Rapid Application Development; Scrum; Adaptive Software Devel-

opment; Crystal Clear; Feature-driven development; Dynamic systems development method; Lean development) [21]; [23];
- SSADM [23].

The selection of these methodologies was developed considering their level of use in utilization developing software projects. To identify and analyze how project management methodologies and software development methodologies approach risks, we conducted a descriptive analysis of their content.

A methodology contains the following main elements: roles, skills, activities, techniques, tools, teams, deliverables, standards and quality measures [24].

Methodologies are needed differently depending on project size (team size, project scope), system criticality and project priorities.

Common elements of the analyzed methodologies are:
- Information System life cycle;
- Software product;
- Size of the organization;
- Technology used;
- Specific situations for individual projects.

General phases of an IT project, regardless of development methodology used are [25]: conception, development, implementation and maintenance.

Considering the analyzed methodologies and the objectives of our research, we performed a comparative analysis of their focus on risks, controls and performance. Table 1 presents the results of the analysis.

To substantiate and develop this analysis we performed an analytical study of the stages, phases and processes of each methodology and we focused on the attitude towards risk, control and performance in project development and implementation, and the difficulty of the methodology implementation, resources needed to implement methodology and project size to which the methodology would be appropriate.

Table 1. Comparative analysis of methodologies [own development]

Methodology	Risk focus	Control focus	Performance focus	Implementation Difficulty	Resources needed	Project size
PMBOK	✓	✓	✓	Easy	Medium	Large
CMMI	✓	✓	✓	Difficult	Many	Large
RUP	✓	✓	✓	Difficult	Few	Medium
PRINCE2	✓	✓	-	Easy	Medium	Medium, Large
SDLC	-	-	-	Medium	Medium	Medium
Agile	-	-	-	Easy	Few	Small
SSADM	-	-	✓	Medium	Medium	Small

4 Findings on IT Managers' Perception of Risks

We asked the respondents to indicate what project management or software development methodology they applied in their most recent completed IT project. The results are shown in Figure 1.

We also asked the respondents to indicate the level of risk in the most recent completed IT project.

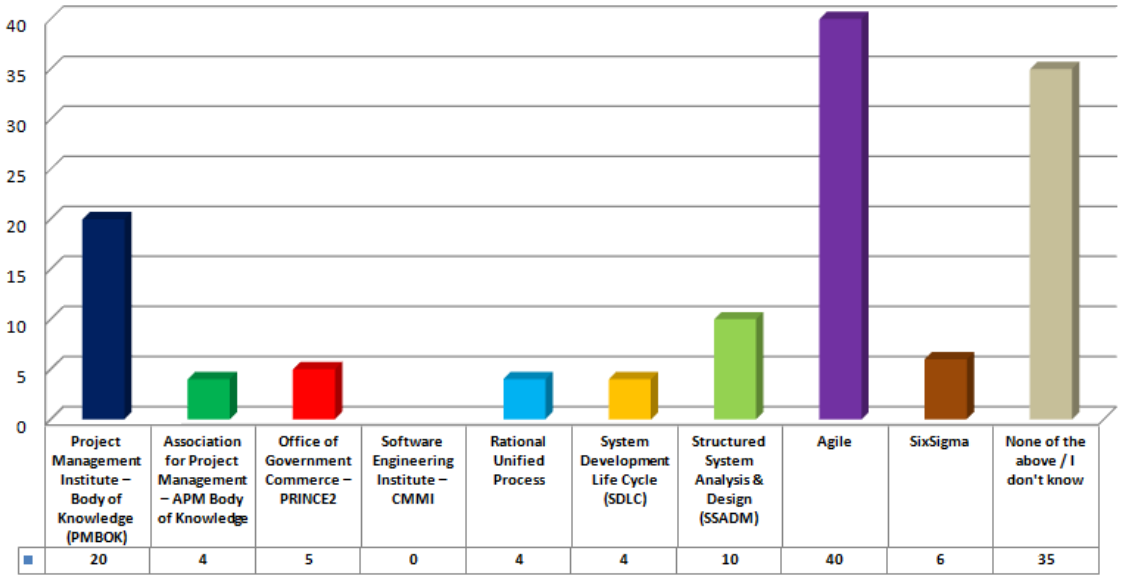

Fig. 1. The project management / software development methodology applied [own development]

We can see that 35 respondents, representing 33% out of the total 106, did not apply any methodology, standard or framework for project management or software development. PMBOK was the most used project management methodology (19%) and the Agile methodologies were the most used software development methodologies (38%). Also, no project manager used the CMMI process improvement for software development.

We performed the compare means test in SPSS in order to see the relationship between using a methodology, framework or standard for project management or software development, and the overall level of risk in the most recent completed IT project.

The results are shown in Table 2, Figure 2 and Figure 3.

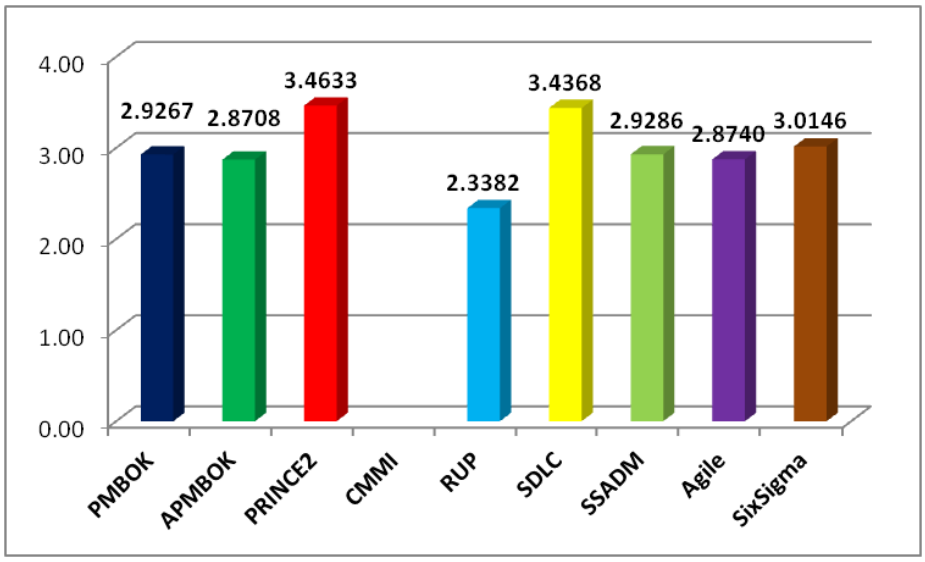

Fig. 2. Overall level of risk when using different methodologies [own development]

The overall level of risk in the project manager's perception ranges from 2.3382 to 3.4633, and we can say that it is medium, because the minimum value was 1 (low risk) and the maximum level was 5 (high risk).

Table 2. Overall risk when using different methodologies [own development]

Code	Variable		Mean	N	Std. Deviation
16.1	**PMBOK**	Yes	**2.9267**	20	.68700
16.2	**APMBOK**	Yes	**2.8708**	4	.66369
16.3	**PRINCE2**	Yes	**3.4633**	5	.86571
16.4	**CMMI**	-	**-**	-	-
16.5	**RUP**	Yes	**2.3382**	4	.54091
16.6	**SDLC**	Yes	**3.4368**	4	.73051
16.7	**SSADM**	Yes	**2.9286**	10	.73408
16.8	**Agile**	Yes	**2.8740**	40	.44508
16.9	**SixSigma**	Yes	**3.0146**	6	.35584
		Total	2.9144	106	.61212

The risk is below medium (mean=2.9267) when using the PMBOK methodology and it confirms the fact that it is focused on risks.

The overall risk of projects using the CMMI process improvement could not be measured because there were no project managers that use the CMMI process improvement in the selected sample.

The overall project risk is higher than medium when using the PRINCE2 methodology (mean=3.4633). According to our previous literature study, the PRINCE2 methodology is focused on project risks and it helps minimizing them, although the level of risks is above medium.

The project risk is low (mean=2.3382) when using the RUP framework and it confirms the fact that it focuses on risks.

The overall risk is high when using the SDLC development methodology (mean=3.4368), and it confirmed the fact that it is not focused on risks.

OVERALL_RISK * 16.1

OVERALL_RISK

16.1	Mean	N	Std. Deviation
0	2.9116	86	.59776
1	2.9267	20	.68700
Total	2.9144	106	.61212

OVERALL_RISK * 16.2

OVERALL_RISK

16.2	Mean	N	Std. Deviation
0	2.9161	102	.61349
1	2.8708	4	.66369
Total	2.9144	106	.61212

OVERALL_RISK * 16.3

OVERALL_RISK

16.3	Mean	N	Std. Deviation
0	2.8873	101	.58961
1	3.4633	5	.86571
Total	2.9144	106	.61212

OVERALL_RISK * 16.4

OVERALL_RISK

16.4	Mean	N	Std. Deviation
0	2.9144	106	.61212
Total	2.9144	106	.61212

OVERALL_RISK * 16.5

OVERALL_RISK

16.5	Mean	N	Std. Deviation
0	2.9370	102	.60595
1	2.3382	4	.54091
Total	2.9144	106	.61212

OVERALL_RISK * 16.6

OVERALL_RISK

16.6	Mean	N	Std. Deviation
0	2.8939	102	.60204
1	3.4368	4	.73051
Total	2.9144	106	.61212

OVERALL_RISK * 16.7

OVERALL_RISK

16.7	Mean	N	Std. Deviation
0	2.9129	96	.60255
1	2.9286	10	.73408
Total	2.9144	106	.61212

OVERALL_RISK * 16.8

OVERALL_RISK

16.8	Mean	N	Std. Deviation
0	2.9390	66	.69628
1	2.8740	40	.44508
Total	2.9144	106	.61212

OVERALL_RISK * 16.9

OVERALL_RISK

16.9	Mean	N	Std. Deviation
0	2.9084	100	.62479
1	3.0146	6	.35584
Total	2.9144	106	.61212

Fig. 3. Detailed overall risk when using different methodologies [own development]

The risk is medium when using the SSADM methodology (mean=2.9286), and although it is not focused on risks, it is focused on performance, thus the level of risk is considered to be below medium.

The risk is below medium (mean=2.8740) when project managers use Agile methodologies for software development, although the Agile methodologies are not focused on risks. Projects that are run using Agile methodologies are mostly small projects (usually under 6 months and with a small project team). This involves low levels of risk and explains the low overall level of risk obtained as a result.

There were project managers that used other methodologies or guides than the ones analyzed in the first part of our research: APM-

BOK (4 respondents) and SixSigma (6 respondents). The overall level of risk was below medium – APMBOK (mean=2.8708) and above medium – SixSigma (mean=3.0146).

5 Conclusions

Risk is an increasingly essential element in software development. Risk approaches, considering project management and software development methodologies in correlation with their users' perception is a current need in order to increase the performance of IT projects. This approach provides an accurate picture of how the using methodologies leads to minimizing risks in IT project management and software development.

In our study the overall level of risk is below medium for IT projects carried out using a methodology for project management or software development, so we can conclude that there is a direct and positive correlation between the use of a methodology and the overall risks in IT projects.

The methodologies that focus on risks (PMBOK, RUP and PRINCE2) determine relatively low and medium levels of overall risk in IT projects, and the methodologies that are not focused on risk (SDLC, Agile and SSADM) determine medium levels of overall risk in IT projects.

The main limits of this research are: the sample size, the sampling technique, the reluctance of the target population to fill out the questionnaire.

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References

[1] K.-S. Na, J. T. Simpson, X. Li, T. Singh, K.-Y. Kim, "Software development risk and project performance measurement: Evidence in Korea", *The Journal of Systems and Software*, no. 80, 2007, p. 596-605.

[2] W.-M. Han and S.-J.Huang, "An empirical analysis of risk components and performance on software projects", *The Journal of Systems and Software*, no. 80, 2007, p. 42-50.

[3] P. L. Bannerman, "Risk and risk management in software projects: A reassessment", *The Journal of Systems and Software*, no. 81, 2008, p. 2118-2133.

[4] J.-C. Chen and S.-J. Huang, "An empirical analysis of the impact of software development problem factors on software maintainability", *The Journal of Systems and Software*, no. 82, 2009, p. 981-992.

[5] K.D. Bakker, *Dialogue on Risk. Effects of Project Risk Management on Project Success*, University of Groningen, Groningen, Netherlands, 2011.

[6] L. Jun, W. Qiuzhen and M. Qingguo, "The effects of project uncertainty and risk management on IS development project performance: A vendor perspective", *International Journal of Project Management*, 29, 2011, 923–933.

[7] L. Batagan, "Smart Cities and Sustainability Models", *Informatica Economică* vol. 15, no. 3, 2011, p. 80 – 87.

[8] J. J. Jiang and G. Klein, "Software development risks to project effectiveness", *The Journal of Systems and Software*, no. 52, 2000, p. 3-10.

[9] L. Wallace, M. Keil and R. Arun, "How software project risk affects project performance: an investigation of the dimensions of risk and an exploratory model", *Decision Sciences* 35 (2), 2004, p. 289–321.

[10] L. Wallace, M. Keil and A. Rai, "Understanding software project risk: a cluster analysis", *Information & Management*, no. 42, 2004, p. 115-125.

[11] O. Didraga, *Managementul performant al riscurilor proiectelor informatice in firmele de IT din România* - teză de doctorat, UVT, Timisoara, 2012.

[12] F. Ahlemann, F. Teuteberg and K. Vogelsang, "Project Management Standards – Diffusion and Application in Germany and Switzerland", *International Journal of Project Management*, 2009.

[13] ***, Project Management Institute. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fourth Edition*, Project Management Institute, ISBN: 9781933890517, 2008.

[14] R. E., Fairley, *Managing and Leading Software Projects*, IEEE Computer Society, John Wiley & Sons, New York, 2009.

[15] P. Kruchten, *The Rational Unified Process*. 3rd Edition, Pearson Education Inc., Boston USA, 2004.

[16] G. Booch, J. Rumbaugh and I. Jacobson, *The Unified Modeling Language User Guide*, 2nd Edition, Addison Wesley, Boston, 2005.

[17] ***, Office of Government Commerce. *PRINCE2*, 3rd Edition, The Stationary Office, Londra, 2002.

[18] M. Mocanu and C. Schuster, *Managementul Proiectelor – ed. a II-a*, ALL BECK, București, 2004.

[19] ***, Central Computer and Telecommunications Agency, *Managing Successful Projects with PRINCE2*, - electronic manual, Key Skills Limited, 1999.

[20] P. Rob, C. Coronel and K. Crockett, *Database systems. Design, Implementation & Management*. Cengage Learning EMEA, London, 2008.

[21] T. Dybå and T. Dingsøyr, "Empirical studies of agile software development: A systematic review", *Information and Software Technology*, no. 50, 2008, p. 833-859.

[22] ***, Software Engineering Institute (2006, August 20). *CMMI Models and Modules*. http://www.sei.cmu.edu/cmmi/models/.

[23] I. Năftănăilă, *Direcții de Perfecționare a Managementului Proiectelor din Domeniul Tehnologiei Informațiilor*, A.S.E. București, 2007.

[24] J. Charvat, *Project Management Methodologies: Selecting, Implementing and Supporting Methodologies and Processes for Projects*, John Wiley & Sons, Hoboken NJ, 2003.

[25] I. Întorsureanu, *Managementul proiectelor software*, A.S.E., București, 2003.

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