A Survey on Challenges of Software Project Management

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Abstract - *Recent surveys indicate that software projects have still high failure rates. In order to increase the odds of success, we have to identify the challenges and determine the causes. Management issues, rather than technological issues, are mostly the causes of these failures. We identified 17 possible areas in which the projects may have been challenged. In this study, we present our findings based on a survey on challenges of management of software projects. We conducted the survey in 2007 among 78 software practitioners regarding their last projects. The participants are from different geographical regions of the world.*

Keywords: Software Project Management, Software Project Management Challenges, Software Projects Survey, Empirical Study of Software Projects, Empirical Software Engineering

1 Introduction

There are two well-known studies regarding the failure and successes of software projects [1,2]. These studies also report failure factors and challenging issues in software projects. According to the GAO report (1979) and Standish CHAOS report (1994), which were conducted 15 years apart, software projects are failing significantly. These studies are referenced in software engineering related publications numerous times [13]. However, especially the numbers in Standish Chaos report are being questioned by various researches [3,4,13]. Other studies were conducted (such as [5,6]) and inconsistent results are reported. We believe there are two main reasons for such discrepancies. First, defining success and failure is not an easy task and different stakeholders may have different views [14]. Second, we still lack adequate number of empirical studies.

Due to the inconsistent results and various challenges reported in previous studies, the author conducted a study to investigate the management challenges of software projects. This survey study was conducted as a part of a doctoral research. Most publications on the topic of software project management are based on the experiences of researchers and practitioners (such as [7,8,9,10,15]) rather than empirical studies (such as [11,12,14]). Different studies and researchers identified various issues, for example in [10,11,12,15].

Our primary goal in the study is to find out the challenges faced in the management of software development projects. This study is different from the previous surveys in the sense that it has a broader view and focuses on management areas rather than specific reasons for software project challenges. This is important since it provides guidance for research studies focused on improvements in specific management areas. Most previous surveys were conducted on a specific geographical region while ours has representatives from different regions in the world. This study also includes areas not specifically covered in other studies; for example teamwork, staffing and hiring, configuration management, and support activities. In addition, we did not differentiate between successful and failed projects; therefore, the survey results also include the challenges faced in successful projects.

2 Survey Methodology

We have identified possible 17 areas in which the software projects may have been challenged. These areas are identified through extensive literature search and provided in Figure 4.

The survey instrument was a self-administered questionnaire. The timeframe of the survey study was the beginning of 2007 and the study took around 4 months. The survey participants were invited via e-mails to take a web-based questionnaire prepared with a commercial tool. The random sampling method was applied. Around 400 software development practitioners were invited from all over the world. We did not use any commercial or readily available population sample. The invitations were sent to practitioners from different organizations. The participants included managers at different levels and software developers. Developers were also included since the management decisions closely affect them. Therefore, developers have a sense of what the important issues are in management.

There were 78 responses and the response rate is about 19.5%. We had responses from North America, Europe, Asia, and South America. However, most of the responses are from North America, which produces a significant portion of the software in the world. The survey was conducted with the promise that the identities of the participants would be kept confidential.

We provided a glossary of the terms used in the study to ensure that the survey participants understood the same concepts.

In the first part of the questionnaire, we gathered data on the participant's background. We first asked the participant's past experiences in terms of years in various software development roles, including management. Second, we inquired about the number of projects in which they have participated. We

believe that the results are derived from a good mix of roles and experiences from participating in a different number of projects. Since having a certain role or participation in a certain number of projects may bias the perspective of the participant. 42 respondents out of 78 have participated in less than 15 projects. 36 out of 78 respondents have participated in 15 or more projects. Table 1 provides the participants' experiences in terms of roles. The table includes all of the roles each participant has played during his/her career in software development.

Table 1. Participants' Experiences in Terms of Roles

Roles	Response Count
Project Manager	56
Project Team Leader	49
Requirements Engineer	23
Software Architect	27
Software Designer	24
Software Tester	15
Software Maintenance	18
Software Code Developer	43
Researcher/Scientist	28
Software System Engineer	24
Other	26
Total number of responses	78

In the second part of the questionnaire, we gathered data on the last project in which the survey respondents participated. We asked the following questions:
1. How many people were working in your last software project?
   o 1-10
   o 11-100
   o 101 or more
2. What was the size of your last software project in terms of SLOC (SLOC: Source Lines of Code)?
   o (small)<20,000 SLOC
   o (medium) 20,000 SLOC – 2 Millions SLOC
   o (large) > 2 Millions SLOC
3. What was the type of your organization in your LAST software project?
   o Government
   o Commercial
   o Government-Contract
4. What kind of an application was developed in your last project? (real-time system, web-based, office-type application, operating system etc.)
5. In your last project, in which of the areas did you face challenges?
The participant was asked to select one or more from the areas presented in Figure 4.

Question #4 was open-ended and all other questions are provided with choices. In question #5, two more choices added to the list: "Others" and "The project was smooth in every way."

3   Survey Study Results

The responses to the questions are summarized in the following figures.
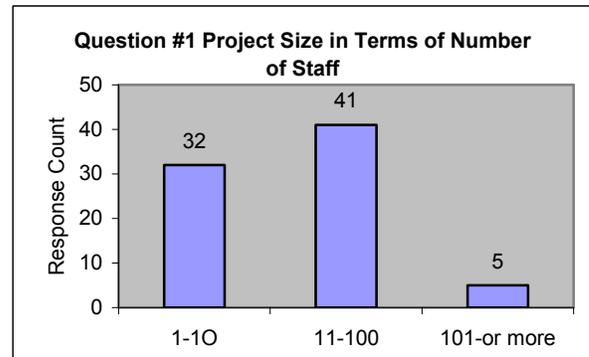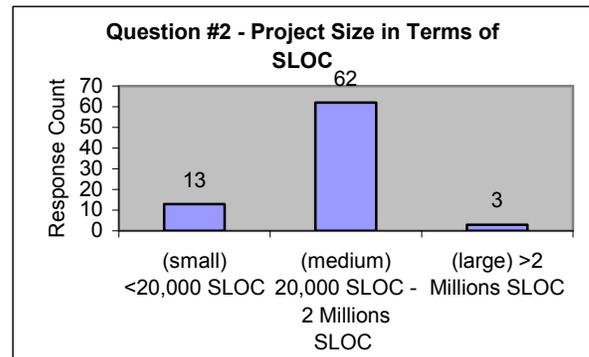

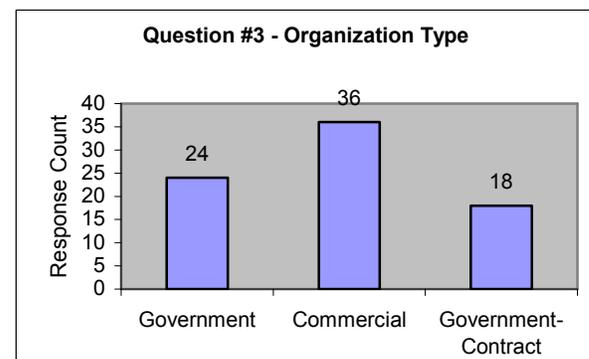Figure 1. Responses to Question #1

Figure 2. Responses to Question #2
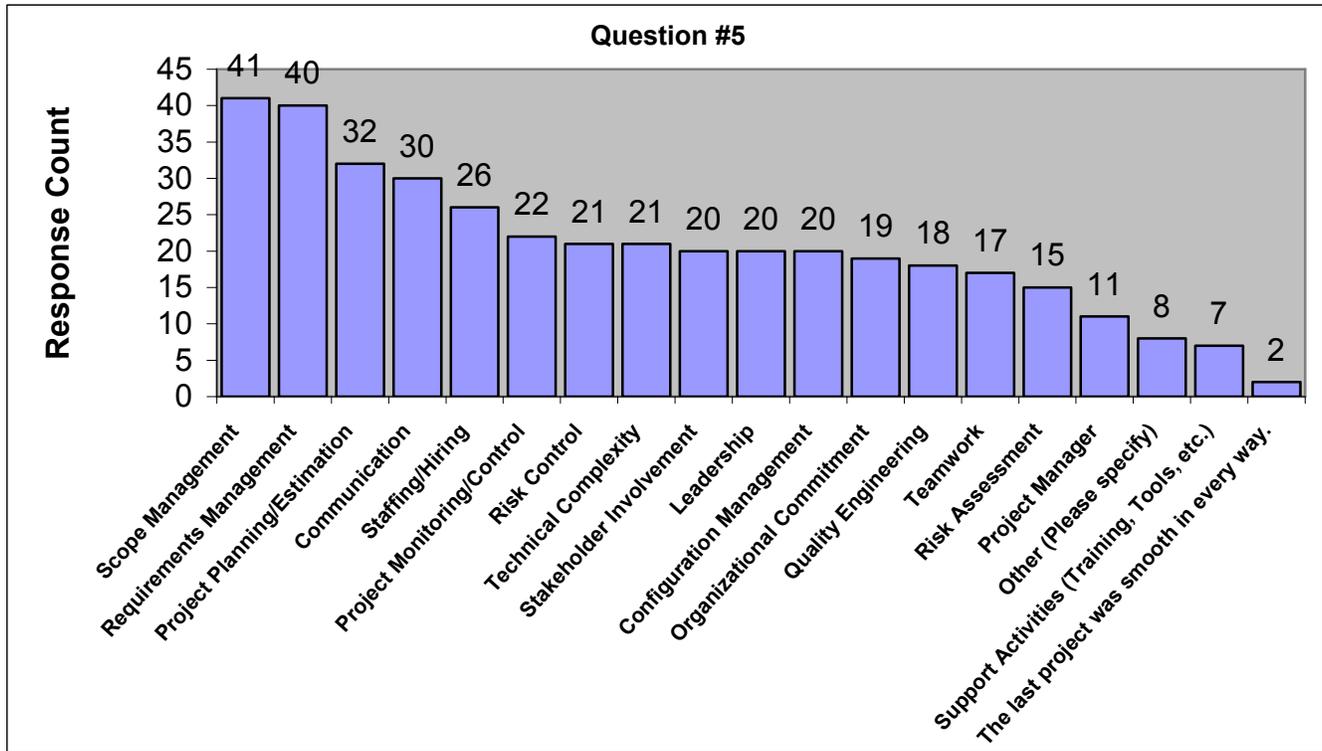

Figure 3. Responses to Question #3

Figure 4. Responses to Question #5

4 Detailed Discussion of Results

Identifying objective criteria for determining whether a project management area is challenged or not, is not an easy task. To capture the challenged project management areas in the broadest sense, a definition of a challenge was not provided to the study participants. Since an inaccurate or insufficient definition of a challenge may lead to losses in the data.

We categorized the projects based on various projects characteristics provided in the choices with questions 1,2 and 3. Therefore, there are nine categories.

The discussions for each challenged areas are presented below in the order in which they are listed in Table 2. We discuss two categories of projects separately: Projects involving 101 or more people and projects having more than 2 million lines of code. We had very limited data on these projects; therefore, comparisons based on this data would not produce meaningful results. The discussions provided below do not include these two categories of projects. Thus, it includes results from the rest of the 7 categories. We compared the categories with each other, for example projects developed by different type of organizations.

Scope Management: In all categories of projects, scope management is observed in the top three as a challenging area. The ratios of number of projects challenged in scope management to total number of projects varies from 61.5% to

41.7%. In short, almost one out of two software projects were challenged in managing the scope.

Table 2. Challenging areas in software projects

Project Management Areas	Response Percentage	Response Count
Scope Management	52.6 %	41
Requirements Management	51.3 %	40
Project Planning & Estimation	41.0 %	32
Communication	38.5 %	30
Staffing & Hiring	33.3 %	26
Project Monitoring & Control	28.2 %	22
Risk Control	26.9 %	21
Technical Complexity	26.9 %	21
Stakeholder Involvement	25.6 %	20
Leadership	25.6 %	20
Configuration Management	25.6 %	20
Organizational Commitment	24.4 %	19
Quality Engineering	23.1 %	18
Teamwork	21.8 %	17
Risk Assessment	19.2 %	15
Project Manager	14.1 %	11
Other	10.3 %	8
Support Activities	9.0 %	7
The last project was smooth in every way.	2.6 %	2

Requirements Management: In all categories of projects, requirements management is observed in one of the top two challenging areas. The ratios vary from 61.1% to 45.8%. Again, almost half of the projects had troubles in managing the requirements.

Project Planning and Estimation: This project management area was also among the top challenges in the list. It is the top item in government projects and half of the projects were challenged in this area. The ratios vary from 50.0% to 30.8%. The ratio in projects having less than 20 KSLOC is 30.8% and it is slightly lower than what is observed in other categories. This is not surprising considering the small size of the application developed.

Communication: Communication, which is not generally covered in other surveys, is also among the top items. We would have expected to see that communication wouldn't be a challenge in smaller project organizations. However, the survey results indicate that there is almost no difference in the ratios observed in projects organizations between those having 1-10 people and those having 11-100 people. In addition, the results show that communication is challenging regardless of the organization type. It is slightly higher in government-contract organizations when compared to other types of organizations. In these organizations, in half of the projects, communication was challenging. In small-sized application projects, it was somewhat lower than the other categories. The ratios vary from 50.0% to 21.3%.

Staffing and Hiring: Staffing and hiring is also one of the areas not generally mentioned in other surveys. In all categories of the projects, staffing and hiring is among the first seven, mostly close to the top. The ratios of number of software projects challenged in staffing and hiring to total number of projects vary from 50.0% to 25.00. In projects developed by government-contract organizations, the ratio is 50% compared to 25% in projects developed by commercial organizations. In order to interpret such results, we believe further study is needed. Studies with higher amount of data and questions related to the causes will provide insights to the subject. Staffing and hiring is related to the number of available practitioners with the necessary skills in the field. We believe that project organizations and managers are limited in providing resolutions to the challenges in this area and this issue extends to education and training in software engineering.

Project Monitoring and Control: Project monitoring and control is another item close to the top of the list. The ratios vary from 33.3% to 22.2%. In all categories of projects, project monitoring and control area is challenging without much difference between project types. While the ratio, 33.3%, is the same in projects developed by government and government-contract, it is the lowest in projects developed by commercial organizations, 22.2%. It is possible to argue such results come from the fact that the first two types of organizations are bounded with many governmental policies and regulations. Therefore, the management team of these projects may have lower autonomy and control over the project. We observed that the ratios in projects those having 1-10 people and 11-100 are very close. The ratio in the former is 28.1% and the ratio in the latter is 29.3%. Also, the numbers in small-sized and medium-sized application projects are close; the former being 30.8% and the latter being 27.4%.

Risk Control: Controlling the project risks is another challenging aspect of software projects. Almost one out of every four projects had difficulty in risk control area. The ratio differs from 38.5% to 24.2%. In only small-sized application projects, it was higher than the others were. In the rest of the categories, the ratios were almost identical (between 24.2% and 27.8%).

Technical Complexity: We would have expected that the ratio regarding technical complexity would be higher in medium-sized application projects. However, the numbers are close in small and medium-sized application projects (23.1% and 25.8%). This may also be due to the limited data we had in small-sized projects. The ratios vary from 34.1% to 12.5%. It is lower in government projects than other categories. We believe further study is needed in order to find the validity of such results and the causes. Various researchers point out very few projects fail due to technical reasons. The survey results are also consistent to some extend with the opinions of these researches.

Stakeholder Involvement: The ratios vary from 38.9% to 15.4%. It is the highest in projects developed by government-contract organizations. The ratio is 25% in the category of government organizations and 19.4 in the category of commercial organizations. The government-contract organizations develop products for government while being a part of commercial world. The high ratio may be interpreted as that this unique situation of government-contract organizations may lead to interface problems between these two worlds. Further research to the causes of such numbers will reveal the possible solution alternatives for the challenges in this area. In most other categories, the numbers are close except in small-sized applications projects category. The ratio is the lowest in this category. We believe, this may be the outcome of having limited data on this category.

Leadership: The ratios vary from 38.9% to 7.7% in the categories of projects. It is the highest in government-contract projects while it is the lowest in small-sized application projects. In other categories, the ratios are close to some extent (28.9% to 19.4%). There is a significant difference between small-sized applications projects and medium-sized application projects. In the former category, it is 7.7% and in the latter, it is 28.9%. We were surprised by such difference and this may be just due to the data set.

Configuration Management: The ratios vary from 33.3% to 15.4%. We did not observe a significant difference in comparing various categories with each other. It is slightly higher in medium-size application projects than small-size application projects (25.8% and 15.4%).

Organizational Commitment: The ratios vary from 44.4% to 13.9%. It was the highest in projects developed by government-contract organizations, while it is the lowest in projects developed by commercial organizations. The difference is quite high and may be significant. We believe

further research will reveal the causes of such difference. It is slightly higher in projects developed with 11-100 people than in the projects developed with 1-10 people (24.4% and 18.6%).

Quality Engineering: The term quality engineering is used instead of quality assurance, because quality assurance is defined as a specific process in most organizations. Quality engineering is a broader term. We wanted to capture quality related challenges in a broader sense. The ratios vary from 33.3% to 12.5%. It is the highest in projects developed by government-contract organizations and it is the lowest in projects developed by government organizations. Most government organizations have to follow specific standards and policies. This may have a positive effect on the projects and is likely to reduce the problematic issues related to quality. However, government-contract organizations are generally encouraged to use such standards and policies. The unique aspect of these organizations, residing in commercial environment and contracted for government projects that have to comply with certain standards, may have made quality related issues more challenging. In other categories, the ratios are close.

Teamwork: The ratios vary from 15.6% to 30.8%. It was the highest in small-sized application projects and there is quite a difference between medium-sized application projects (19.4%). This may be the result of having a limited data set in small-sized application projects. In projects developed by different types of organizations, the ratios are close (16.7%-25.0%). In projects developed with 1-10 people, the ratio is 15.6% while it is being 22.0% in projects developed with 11-100 people.

Risk Assessment: This area is one of the items that are close to the bottom of the list. Controlling the project risks is more difficult than acknowledging and assessing them. The ratios vary from 30.8% to 12.5%, mostly close to low numbers. There is a significant difference between small-size application projects and medium-size application projects (30.4% and 16.1%). It is the highest in small-sized application projects. This may be due to the issue that in smaller applications assessing project risks may have been overlooked.

Project Manager: Project manager's ability and skillfulness is an important factor in software projects and replacement of the project manager during the project seriously affects the project's overall performance [11]. However, in most studies this item is not analyzed. The ratios differ from 22.2% to 0%, mostly close to low numbers. In small-sized application projects, none of the projects was challenged in the project manager area. In projects developed with 1-10 people, the ratio is 6.3%. These are smaller projects and generally, project manager's interaction with the team is higher.

Other: Other challenges mentioned by the participants consist of high turnover rate at prime contractor facility, team turnover, prioritization, micromanagement, distributed funding control, hardware configurations, loss of key personnel, and under funded software safety engineering. Three of the items can be categorized as staff turnover. Having only a few items (a total of 8) in the list indicates that we were able to cover most of the challenging areas.

The last project was smooth in every way: There are only two projects not challenged in any of the areas. Both of them are projects developed with 1-10 people. One of them is a small-sized application while the other is a medium-sized. One of them is developed in a commercial organization and the other is in government. Having only two projects in this category limits our ability to interpret. However, such a low number may indicate that development of software projects are quite challenging.

Projects with 101 or more people involved: There are five projects in this category. Three of them are middle-sized and 2 of them are large-sized application projects. All of them were challenged in some area. One of them was challenged in all areas, and this project was a large scale distributed simulation project developed by a government-contract organization with 101 or more people. One of the projects with l01 or more people involved was challenged only in the stakeholder involvement area. This was a commercial web-based real-time project having more than 2 millions lines of code.

Projects with products of more than 2 millions lines of code: There are three projects in this category. Deriving conclusions from such a limited data set will be meaningless. Note that authors are advised not to include their email addresses.

5   Multivariate Analysis

Almost all the projects had challenges in multiple areas. We conducted analysis to identify the challenged areas that accompany a particular challenged area. For example, more than half of the projects that are challenged in scope management are also challenged in requirements management. Since the goal of the survey study was not to investigate cause and effect relationship, the results should not be interpreted as such. We do not report the areas that are challenged in less than 20 projects out of 78. Because the dataset is limited for these areas, the results may be misleading. These areas are organizational commitment, quality engineering, teamwork, risk assessment, project manager, and support activities.

41 projects out of 78 projects are challenged in scope management. 24 of the projects that are challenged in scope management are also challenged in requirements management. Following tables provides project management areas that are challenged concurrently when a specific area is challenged. We only report the areas when the ratio is over 40%.

Scope Management	100%	41
Requirements Management	58.5%	24
Project Planning/Estimation	43.9%	18
Communication	41.5%	17

Requirements Management	100%	40
Scope Management	60.0%	24
Project Planning/Estimation	52.5%	21
Communication	47.5%	19
Project Monitoring/Control	42.5%	17

Project Planning/Estimation	100%	32
Requirements Management	65.6%	21
Scope Management	56.3%	18
Project Monitoring/Control	53.1%	17
Communication	43.8%	14
Risk Control	40.6%	13

Communication	100%	30
Requirements Management	63.3%	19
Scope Management	56.7%	17
Leadership	50.0%	15
Project Planning/Estimation	46.7%	14
Project Monitoring/Control	40.0%	12
Teamwork	40.0%	12

Staffing/Hiring	100%	30
Requirements Management	46.2%	12
Scope Management	46.2%	12

Project Monitoring/Control	100%	22
Requirements Management	77.3%	17
Project Planning/Estimation	77.3%	17
Scope Management	54.5%	12
Communication	54.5%	12
Risk Control	40.9%	9

Risk Control	100%	21
Requirements Management	66.7%	14
Scope Management	66.7%	14
Project Planning/Estimation	61.9%	13
Communication	52.4%	11
Risk Assessment	47.6%	10
Project Monitoring/Control	42.9%	9
Staffing/Hiring	42.9%	9
Leadership	42.9%	9

Technical Complexity	100%	21
Scope Management	66.7%	14
Staffing/Hiring	47.6%	10
Project Planning/Estimation	47.6%	10
Requirements Management	42.9%	9
Quality Engineering	42.9%	9

Stakeholder Involvement	100%	20
Scope Management	70.0%	14
Requirements Management	60.0%	12
Organizational Commitment	45.0%	9
Communication	45.0%	9
Project Planning/Estimation	40.0%	8

Leadership	100%	20
Requirements Management	75.0%	15
Communication	75.0%	15
Scope Management	65.0%	13
Project Planning/Estimation	60.0%	12
Risk Control	45.0%	9
Configuration Management	45.0%	9
Project Monitoring/Control	40.0%	8
Teamwork	40.0%	8

Configuration Management	100%	20
Scope Management	65.0%	13
Requirements Management	50.0%	10
Project Planning/Estimation	50.0%	10
Leadership	45.0%	9
Communication	40.0%	8
Quality Engineering	40.0%	8

Challenges in scope management, requirements management, and project planning and estimation area accompany challenges at higher rates in all other areas listed above. There are also other noteworthy findings. A significant number of projects that are challenged in project monitoring and control area are also challenged in requirements management and project planning and estimation area. When there are challenges in leadership, requirements management and communication areas are also challenged.

6 Conclusions

The motivation for this study was to obtain an up-to-date survey of software project management challenges. Because there are rapid advances in software development technology, the challenges may change. The results of this survey study were used in guiding a doctoral research. Stating research hypotheses based on outdated survey results and possible invalid assumptions may threaten the validity of studies. It is important to conduct regular surveys of software projects to help researchers state research hypotheses. Furthermore, these survey studies help analyze trends.

The findings of this study are similar to the findings in earlier studies; for example to the findings of [7][11][12]. This finding, itself, is a significant finding. Because it seems like the advances in software development technology are not very effective in solving software project management challenges.

This study covers some areas that are not generally covered in other studies. Teamwork, configuration management, organizational commitment and support activities are among these areas. This study also provides multivariate analyses that will guide other researchers in stating hypotheses for further research with a focus in a specific project management area.

We did not gather data on whether the projects were considered successful or not. We simply gather the experiences of the participants on software projects. There are two reasons. First, defining success is not an easy task. Therefore, in some studies the researchers prefer to ask the participant's perception on project success/failure and conduct analyses based on that (such as [11,14]). If a survey

participant miscategorizes a project as a success instead of a failure, it will affect both results. Second, our research focus was the challenges regardless of the project's outcome. All survey study details can be found in [16].

We do not have a dependent variable in this study. Thus, it is not possible to conduct advanced statistical analyses. This study is important in the sense that it covers most challenging areas in software projects regardless of resulting in a success or a failure. Generally, studies only focus on failure factors or areas challenged when the project is considered a failure. We believe the path to completing projects with higher rates of success starts with correctly identifying challenging areas and providing resolutions. More empirical studies are needed that focus on software project success/failure factors and challenges of managing software projects under similar and different contexts.

7 Disclaimer and Acknowledgements

The views and conclusions contained herein are those of the authors and should not be interpreted as necessarily representing the official policies or endorsements, either expressed or implied, of any affiliated organization or government. We also would like to thank all anonymous participants for their participation.

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