Effects of project team characteristics on financial success of projects

data driven research at a software service company

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Effects of Project and Team Characteristics on Financial Success of Projects

Data driven research at a software service company

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~ Opportunities don’t often come along. So, when they do you have to grab them. ~

Audrey Hepburn

Keywords:

Factors influencing project success, service industry, corporate system data, predicting project success

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Preface

This master thesis study is the final part to complete the master Innovation Sciences. It marks the end of my career as a student, and, at the same time, it marks the beginning of my career as a young professional. During the past months I have discovered my interests in using corporate systems data to analyze business processes. Although, sometimes the amount of data to process gave me a headache. Luckily I had support of many, without them this thesis would not have been as it is today.

First, I would like to thank Rob Wiek, my company supervisor, for the opportunity to conduct my research at the firm. I had a wonderful time at the office and I enjoyed the discussions we had about data analysis and the possible contribution of my research. One of my personal learning goals was to develop programming skills and to combine raw data from different corporate systems to analyze projects. I think I can say, these goals have been achieved.

Secondly, I would like to thank my first supervisor Chris Snijders, for his thoughts on project research and data analytics. Especially when I got stuck with the endless bunch of available literature, he gave me insightful directions. Above all, he consistently challenged me to improve my work and helped me to use Stata to preprocess and analyze the data. I would also like to thank my second supervisor, dr. Gerrit Rooks for his useful feedback on my thesis and suggestions for improvement. I must admit that his feedback made me realize it was time to get out of the data and to interpret the results more.

Next to my supervisors, I would like to thank Karin and Aleid, for proofreading my thesis, discussing the topic, and giving me the confidence to finish this thesis. Your input certainly increased the quality of this study. A special thanks to Koen for the support and encouragement during this challenging and demanding research journey. Lastly, I would like to thank my friends and family for their unconditional trust in my capabilities. The last two years have not been a glorious ride, it rather was a rollercoaster with ups and many downs. Thank you for taking this rollercoaster with me.

Juliëtte

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Abstract

In the literature many factors have been hypothesized to predict project success, but few empirically corroborated effects. This study aims to find empirical evidence for such effects in the context of knowledge intensive business service firms (KIBS). Contrary to the typical questionnaire-designed studies, this study uses data extracted from the database system of the firm under research. The results show, first, that 16.9% of the variance in financial project success could be explained. Interestingly, closer inspection of the data shows that project with an extreme loss or profit are responsible for over 45% of the financial project success. This has important theoretical and important practical implications. Academic project research should be cautious with research on which team and project characteristics are valuable *on average* for financial project success. Instead it might benefit from a focus on the factors that determine which projects are going to be extremely favourable or extremely detrimental. Likewise, project based firms should consider whether their profit margin stems from a couple of strong outlier projects, or is based on the larger stream of average projects. They should determine their project management policy accordingly.

Introduction

Project success is vital for knowledge intensive business services (KIBS) to survive. Successful projects contribute to the creation of additional corporate value, and sustained long-term value creation is the ultimate measure of corporate success (Cooke-Davies, 2002). The effectiveness of a firm partly depends on the success of their projects (Milosevic & Patanakul, 2005), since an increase in project success translates directly into an improved bottom-line (Cooke-Davies, 2002).

Driven by urgent need of firms to deliver successful projects, and the relatively high failure rate of projects, in several sectors scholars have identified and listed factors that are related to project success (e.g. Belassi & Tukel, 1996; Cooke-Davies, 2002; Pinto & Slevin, 1987). Examples of mentioned success factors are top-management support, adequate financial support, having a competent project manager, having a proper goal definition, and using a decent scheduling process. Although some of these studies have been executed decades ago, recent studies still use these factors to broaden and refine the understanding of the topic (Müller & Jugdev, 2012). This illustrates the notion that research on factors that affect project success continuously evolves (Müller & Jugdev, 2012).

Despite the effort of many theoretical and empirical studies, results are mixed: there is only limited agreement and consensus among researchers on factors that influence project success in general, both theoretically and empirically (Fortune & White, 2006). Moreover, the measurements of factors and project success still suffers from a lack of clarity (Mir & Pinnington, 2014). An explanation for the mixed results and lack of clarity could be that studies aim to find factors that fit all

projects, whereas in reality projects are diverse and differ within an organization, between organizations, and between sectors. Consequently, for project research at the firm-level success factors should be identified and coupled to the type of projects, the type of firm, and the type of sector. This might not completely prevent mixed results, but it certainly adds to consistency within the research field.

Results are not only mixed, but research has traditionally also been executed mainly within the manufacturing industry. However, over the last decades the service industry has become a key component of most industrialized economies (Lessard, 2014; Strambach, 2001; World Bank, 2016). Until now only few studies have researched projects within the service industry. This is why this study focusses on factors that influence project success for a firm in the service industry.

Furthermore, a major shortcoming of the project research is the limited empirical evidence for hypothesized success factors, and the empirical studies that do exist are based on self-reported questionnaires. This has as a consequence that results may suffer from different biases. For example, the respondents could feel as if they are evaluating personal work, which might influence the respondent's answers. Next to this, such survey data often consider effects "in general", or "on average within the focal firm", instead of having a focus on separate transactions and variations within projects. Data from corporate systems, used for this study, offer a solution to these biases.

The main aim of this study is to empirically assess factors that have effect on project success, thereby answering the research question:

"What are the effects of project and team characteristics on financial project success?"

Additionally, this study aims to predict which factors increase the probability of a project to become highly profitable. The results presented are based on data extracted from corporate systems of a Dutch KIBS firm, providing rich and accurate data, including data on "extreme" projects (in terms of loss or profit). This study is a first attempt in studying factors that influence project success based on data from corporate systems. Moreover, it is discovered that the outlier projects have a considerable impact on the analyses. This finding is striking and has implications for both theory and practice.

The remainder of this study is as follows. Section 1 offers a review of the literature that identifies the factors that have been argued to impact project success. Section 2 describes the method of this study: data collection and pre-processing, level of analysis, measures, and data analysis procedure. The data analysis includes also a discussion of the outlier projects because of the practical and theoretical contribution in this study. Section 3 describes the construction of variables, and section 4 presents the main findings. This study concludes with a conclusion and discussion in section 5.

1 Theoretical Background

This study investigates factors that influence project success for knowledge intensive business services (KIBS). KIBS are mainly concerned with providing knowledge-intensive inputs to the business processes of other organizations, including public and private sector clients (Muller & Doloreux, 2009). KIBS cover a wide range of services, including environmental services, legal services, accounting services, and software services (den Hertog, 2000). Clients are typically involved in the co-production of these service, and provider-client exchanges tend to be of a relational rather than transactional nature (Lessard, 2014).Although the term KIBS already exists for over 15 years, most studies are theoretical, and only a few empirical. The majority of research on KIBS firms focuses on the innovativeness of KIBS, their innovativeness in relation to other (manufacturing) companies, or the diffusion of knowledge between the KIBS company and their clients (Muller & Doloreux, 2009). The literature body on factors that influence project success for KIBS firms is small. Similar to project research in other industries, the existing literature lacks empirical evidence for hypothetical success factors.

This study aims to empirically assess factors that have effect on project success. To identify factors that may, in theory, influence project success, the literature was reviewed both for KIBS and for projects in general. In this section the main findings are presented. After a first assessment of literature a list with search terms was formed. Keywords used were “software project performance”, “project success”, “team diversity project performance”, “factors influencing project success”, “critical success factors” (and variations on these terms). Database search engines used for the review are ScienceDirect, Google Scholar, and JSTOR. For the review of factors that influence project success, both theoretical and empirical studies are included.

In general, theoretical studies provided a deeper understanding on the proposed effect of factors on project success (e.g. why is it important to have support of top management support). Empirical research provided a deeper understanding of metrics and methods used. Empirical studies most promising for this research derived from studies focused on projects in general, or on software projects. Section 1.1 describes the most prominent articles on factors for project success. An overview of all factors that are argued to influence project success is presented in table 1. Thereafter, the factors included in the study are presented. Due to the length of the list, a selection had to be made; only the factors that were available from the corporate systems of the KIBS were included. To clarify, factors that existed in the literature and could also be extracted from the corporate systems of the target company were included in the model to predict project success.

1.1 Identification of factors influencing project success

Research regarding factors that influence project success evolved since the 1980s, the aim of most studies was to *identify factors* that theoretically could have an effect on project success (Müller & Jugdev, 2012). Recently, the flow of research papers identifying new sets of factors has slowed, but reference to, and use of factors has not diminished (Fortune & White, 2006; Müller & Jugdev, 2012).

Pinto and Slevin (1987) analyzed and compared five different lists of factors that theoretically have an effect on project success. They conclude that the following factors have a positive effect on project success: clearly defined goals, competent project manager, top management support, competent project team members, sufficient resource allocation, adequate communication channels, control mechanisms, feedback capabilities and responsiveness to clients.

Belassi and Tukel (1996) elaborate on the study of Pinto and Slevin (1987), and include two additional lists of factors that have an effect on project success in the comparison. They conclude that most of the lists merely include factors related to the project manager, and to the type of organization the project belongs to. According to them, project characteristics, characteristics of team members, and factors external to the project seem to be ignored. There are many factors which are neither controlled by project managers nor by organizations which are critical for project success. Therefore, Belassi and Tukel (1996) suggest to include factors regarding the project, and add include six project characteristics they believe have influence on project success: size of the project, value of the project, uniqueness of project activities, density of a project network, the project life cycle, and the urgency of the project. Belassi and Tukel (1996) acknowledge it is impossible to come up with all possible factors that might affect project outcome, but show that the identification of the *groups* to which the critical factors belong would be sufficient for better evaluation of projects. The rationale behind this classification is that project managers would then have a clear understanding of which aspects of projects might be critical for successful completion (Belassi & Tukel, 1996). The framework developed by Belassi & Tukel (1996) is divided in the following groups: 1) factors related to the project, 2) factors related to the project manager and team members, 3) factors related to the organization, and 4) factors related to the external environment. The framework of Belassi & Tukel (1996) relies on (combined) factors identified by Martin (1976); Locke (1984); Cleland and King (1983); Sayles and Chandler (1971); Baker, Murphey, and Fisher (1983); Pinto and Slevin (1989); Morris and Hough (1987). A summary of the identified factors is given in table 1, including whether the factor is empirically tested in other studies (Fortune & White, 2006), and an indication whether data is available at the firm under research.

Table 1

Factors that influence project success presented by group

Group	**Factors**	**Empirically Tested in Other Studies (Fortune & White, 2006)**	**Data Available at the Firm under Research**
Project characteristics	Size	Yes, but anecdotal	Yes
	Value	Yes, but anecdotal	Yes
	Uniqueness of project activities	Yes, but anecdotal	No
	Density of project network	Yes, but anecdotal	No
	Life cycle	Yes, but anecdotal	Yes
	Urgency	Yes, but anecdotal	No
Team characteristics	Technical Background	Yes, but anecdotal	No
	Communication Skills	Yes	No
	Trouble shooting	Yes	No
	Commitment	Yes	No
	Composition	Yes, but anecdotal	Yes
Project manager related	Competence	Yes	No
	Commitment	Yes	No
	Ability to delegate authority	Yes	No
	Ability to tradeoff	Yes	No
	Ability to coordinate	Yes	No
	Perception of his role & responsibilities	Yes	No
Organization related	Top management support	Yes	No
	Project organizational structure	Yes	No
	Project champion	Yes	No
	Functional champion	Yes	No
	Availability of resources	Yes	No
External environment related	Client involvement	Yes	No
	Competitors	No	No
	Sub contractors	Yes	No
	Political environment	Yes	No
	Economical environment	Yes, but anecdotal	No
	Technological environment	Yes	No
	Nature	Yes	No

Additional to the overview presented in table 1, a recent review on 63 publications related to factors that influence project success reveals that most empirical studies have focused on the effect of project management on project success (Fortune & White, 2006). Hereby neglecting the effects of project characteristics and team characteristics composition on project success although they may have an effect on project success as well (Mir & Pinnington, 2014).

To conclude, factors that theoretically have an affect on project success can be classified in five groups. Factors related to project characteristics, factors related to team characteristics, factors related to the project manager, factors related to the organization, and factors related to the external environment. This study focuses on the effect of factors related to project characteristics and team characteristics.

Project characteristics

Characteristics related to the project are often neglected in the literature as being factors that influence project success, whereas they constitute one of the essential dimensions of project performance (Belassi & Tukel, 1996). Factors like the value of a project, the size of a project, the uniqueness of project activities (vs. standard activities), the density of a project network, the urgency of a project outcome, and the project life cycle all determine the outcome of a project, and therefore project success (Belassi & Tukel, 1996).

Team characteristics

Among other industries, teamwork in software projects has been long acknowledged as the crucial criterion for the successful design and deployment of software projects (Liang, Liu & Lin, 2007). In search of factors for successful team performance, various personality characteristics of team members are studied by researchers (Jehn & Bezrukova, 2004; Liang, Liu & Lin, 2007). Similar, and opposing, views on the optimal team composition exist among researchers. For example, group researchers, and diversity theorists have proclaimed the benefits of diversity in workgroups (Cos *et al.*, 1991; Jehn, 1995; Guzzo and Dickson, 1996). While Byrne's (1971) similarity-attraction theory suggested that similarity in value, demographics, and interaction are favored virtues in team composition as they help maintain effective work environments. Another element that could affect project success is the geographic dispersion of teams (Keil, Lee, & Deng, 2013; Scott-Young & Samson, 2008). Co-location of team-members promotes team identity, group cohesion, increased group responsibility, and ready access to informal and task oriented communication (Scott-Young & Samson, 2008). Contrary, increased distance between team-members can delay decision-making, and intensify any existing team personality difficulties (Allen, 1986). Although opposing views regarding co-location of teams exist, the general consensus in the literature is still that co-location benefits

project team outcome with increased proximity (Scott-Young & Samson, 2008). A review of 40 years of diversity research shows that the effect of diversity on team performance are mixed. There were no consistent main effects between team diversity and organizational performance (Williams and O'Reilly, 1998). Based on the findings in previous research it can be concluded that team characteristics can affect project success, but it depends on the context what the sign of the effect will be.

Factors included in study based on available data and the literature review

In the literature, many more factors that have an influence on project success are proposed than are measured in the present study. One reason is because of the available data at the firm. An overview of the variables included in this study is given in Figure 1. For all variables it is proposed that these could predict financial project success. The effect of eight variables on financial project success will be investigated. No sign to possible effects are proposed because the studies that have examined the influence of project factors on project success reported mixed and opposing views, and no general consensus is agreed upon researchers (Fortune & White, 2006).

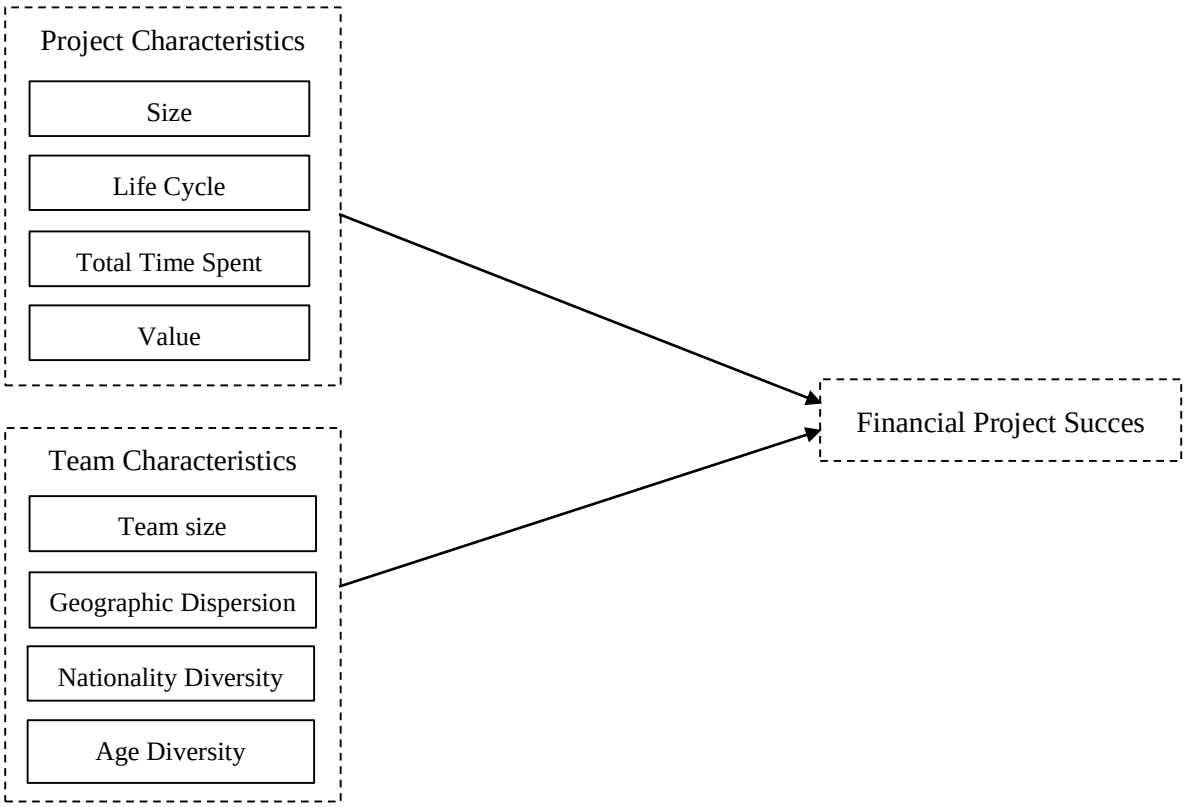

Figure 1. Schematic overview of proposed factors that influence financial project success

2 Data and Method

This section is organized in four parts. Section 2.1 describes the data collection procedure: including the available data and selected databases for analysis. Section 2.2 elaborates on the pre-processing, and merger of datasets. In section 2.3 the level of analysis is discussed. Section 2.4 elaborates on the data analyses, outliers, and the unexpected extra analyses due to the major effects of outliers in this study.

2.1 Data collection

To identify the effects of project and team characteristics on financial project success I analyzed 184 projects of a full service internet company. The firm is specialized in developing open source software solutions. Services include software and strategy consultancy, interaction design, application building (mobile and web), content management systems (e.g. corporate websites, intranet, portals), and concept and realization of e-commerce solutions. The main focus of the firm is to provide solutions for the business to business industry, which is approximately 70% of the customer portfolio. The core activities of the firm are delivering knowledge and intangible assets to their customers, these characteristics make that the company is project driven, hence the firm is a KIBS. The final dataset used for the analyses is composed of several other datasets. In total 242 projects were available, however this reduced to 184 projects due to missing financial data for 58 projects.

Available data at the firm

The research draws upon data from web-based ERP and CRM systems used by the firm to manage all processes within the firm. The firm uses these systems to manage processes regarding projects, customers, human resources, financials and internal communication. JIRA is used to manage projects, Bamboo and Bitbucket are used to deploy code for testing and review code by developers, OrangeHRM is used to manage employee information, Harvest and AFAS are used to manage financials. Pandadoc is used to manage contracts and proposals, SugarCRM and Sharpspring are used to manage customer information, Zimbra is used to manage mail and agenda's, and lastly Confluence is used to manage internal communication and collaboration. JIRA, OrangeHRM, Harvest, and AFAS are coupled which makes it possible to switch between them via the same interface. Figure 2 shows the systems used by the firm by category.

Figure 2. Overview systems used by the firm to manage projects, financials, CRM and employees

To identify the systems that contain data which can be used to calculate the measures for this study, the flow of a project through the firms' processes is mapped. The breakdown of a project, taken in consideration the phases of a project and the systems used is shown in Figure 3. A project starts within the firm after sales has sold a project to the customer. After a first exploration with the customer on the wishes and needs, the project flows to the design phase, hereafter to the development phase, after this to the test phase and lastly the project goes online. Each phase consists of multiple tasks and those are performed by the responsible employees. In all phases the project team works in close cooperation with the customer. The phases 'design', 'develop', 'test', and 'online' are iterative processes that, in some cases, require several adjustments before it is finished. At the same time, it is possible to perform the 'develop' and 'test' phase partly parallel.

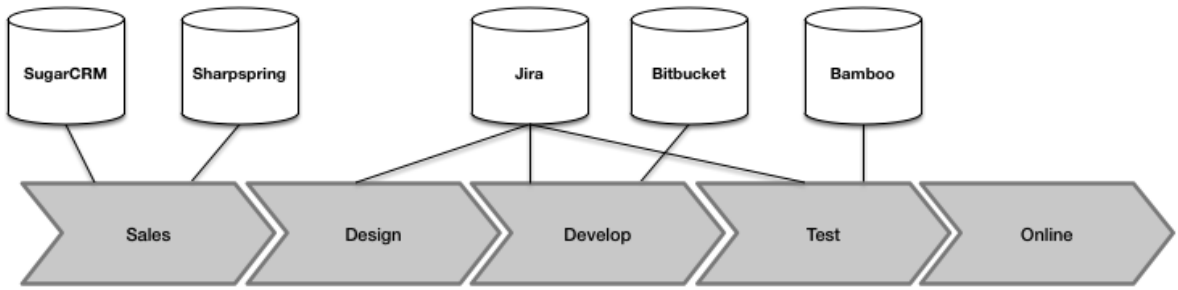

Figure 3. Project phases within the firm combined with systems used

Selected databases

Now the available data, the phases of a project, and the different systems are identified it can be decided which systems store relevant data regarding the objective of this study. The theoretical background and conceptual model are used as primary criteria since this provides also input for the

calculation of measures. Another criteria is that data in the systems should be on project level, or it should be possible to aggregate data on project level. From these requirements it follows that the following systems will be used to collect data: Jira, OrgangeHRM, and AFAS and Harvest. Jira is chosen because it provides information on the tasks (issues) within a project, time spent on tasks, type of tasks, employees that worked on a task and, the customer of the project. The data from Jira can be used to calculate variables on projects and teams of a project. OrangeHRM is chosen because it provides characteristics on employees of The firm, which can be used to calculate team variables. AFAS and Harvest are chosen because those systems capture financial data on invoices of projects. These invoices are used to calculate financial performance on project level. SugarCRM and Sharpspring are not chosen because the customer information has not been consistently added, therefore the data is not reliable. Bitbucket and Bamboo are not selected since those systems are specifically focusing on the code written and testing of this code for tasks within a project. Since those tasks are stored in Jira and Bitbucket and Bamboo are support systems for completing tasks. The actual registration on progress of a task is stored in Jira. Table 2 gives an overview of the three datasets including the data source, the type of data, a description of the data, and initial number of variables.

Table 2

Overview of raw data: data source, data type, and description

Data source	**Type of data**	**Description**	**# of Rows**	**# of variables**
Jira	Issues	Issues are tasks within a project. An issue tells the type of work, how many hours are spend on the issue and who worked on the project (among many other things).	39,184	85
AFAS and Harvest	Financial	Information about invoices send by the firm. This includes invoices to customers, as well as internal invoices.	16,142	32
OrangeHRM	Employee	Information on employees of the firm. Such as, experience level, age, contract start date, contract end date, role ate The firm, and nationality.	235	18

The collected data are not on project level, this results in the fact that for each dataset the data has to be aggregated to the project level. Figure 4 gives an overview of the lower level data, the grey background display the systems with their data, the white areas display the needed data. The UML diagram reads as follows: an employee has one to many (1 … *) tasks to work on, and an issue can have zero to many (0 … *) employees working on an issue. An employee can be part of zero to many project teams, and a project team consists of 1 to many employees. A project team has one to many projects, and a project has one project team. A project has zero to many issues, and an issue belongs to one project. A project has one customer, and a customer can have one to many projects. A project has one to many invoices, and an invoice is for one project. An invoice is coupled to one customer, and a customer can have zero to many invoices.

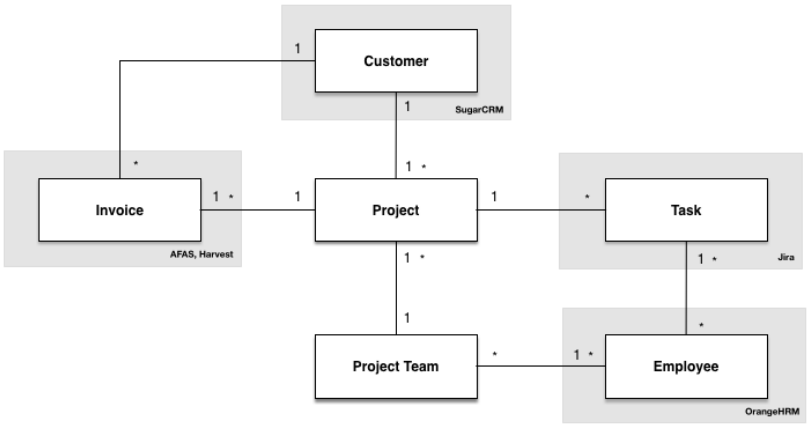

Figure 4. UML diagram; objects with grey background are datasets

In conclusion, the firm uses ten systems to manage processes, three of those systems provide data that form the basis for analysis. These systems are Jira, OrangeHRM, and AFAS and Harvest. For those systems it is decided to export the raw data, which resulted in three datasets. Raw data is chosen because it gives the opportunity to create variables on project level without losing essential information. This is of added value since none of the systems provide information on project level, i.e. the raw data is on a lower level which requires data aggregation. In the OrangeHRM dataset one row is one employee, for the Jira dataset one task (issue) is one row, and for the Harvest and AFAS dataset one row is one invoice. The variables in the dataset are thus per employee, per task or per invoice. The employees that worked on tasks within a project form the basis for the calculation of team variables, the invoices per project form the basis for the project performance measures and for the customer information, and the issues of a project form the basis of project variables.

2.2 Pre-processing datasets

Since the data from the datasets were not on project level several procedures prepared the datasets for merger on project level, and for analysis. First, datasets were cleaned, and missing values were added. The *employee dataset* had missing values for the variables nationality and gender, those were added. The *issue dataset* had 66 variables (out of 85) with more than 70% missing values. Most of those variables had values such as 'missing', 'not applicable', 'no permission', or other technical notes, therefore these variables were deleted. For a few variables ambiguity arose on the added value of a variable. For those variables, the firm was consulted and together with two project managers it was decided whether or not to keep the variable. Next to this, issues that are not related to projects for customers are deleted. The *financial dataset* required most adaptions. This included: manually add data points necessary to combine financial data on project level, drop invoices that are not related to projects, extract project codes from other columns than the standard one, change negative values that must have been positive and vice versa. All adaptions, (re)calculations, and added data points are documented, and discussed with the financial manager of the firm. This is done in order to validate the adaptions made, and to secure the modifications resulted in improved data accuracy and reliability. After the procedures for the financial dataset were completed it was possible to calculate financial variables per project code.

Second, to merge the datasets each dataset had a unique identifier. First, the *issues dataset* and *employee dataset* were merged, with employee first and last name as unique identifier. This gave the opportunity to calculate project characteristics and team characteristics. After the calculations were done and the variables calculated the *combined issue* and *employee dataset* were aggregated on project level. After this aggregation it was possible to merge the the combined dataset with the financial dataset with 'project code' as unique identifier.

2.3 Level of analysis

The final multilevel dataset was created by matching the datasets on project level. To clarify, in the dataset one row refers to one project and contains the following information: issues per project, team characteristics, financial outputs and customer information per project. The rationale behind aggregation of data on project level is that the focus of this research is to analyze the influence of project characteristics on project performance. Besides that, the firm is a project-based company, so the projects are the core of the company and therefore analysis on project level is desired. A lower level of analysis, on issue level, could be an option, however the impact of one single issue relatively to all issues within a project is not reliable and financial information on issue level is not accurate. A higher level of aggregation, on circle level (the self-steering departments of the firm), provides useful insights in the (project) performance per circle, but not for project level characteristics. Another

possibility is to analyze on team level, however project teams within the firm differ, so this level of analysis is not stable enough.

2.4 Data analysis and detecting outliers

Proposed factors were tested with multiple regressions and logistic regression using STATA 14.0. This section first describes the performed analyses with corresponding dependent variables. Second, the outliers of the dataset are discussed including remedies to control for the effects of the outliers.

Three multiple regression analyses and one logistic regression were executed. For the multiple regressions the Y-variable were defined as 'earnings per hour', for the logistic regression the Y-variable is binary and values were defined as 'extreme positive earnings per hour projects' (1), or 'all other projects' (0). Extreme earnings per hour projects were the outlier projects that had 'earnings per hour' at least three standard deviations higher than the mean of earnings per hour. The logistic regression was a post-hoc analysis executed because data examination revealed that the dataset contained outliers. To test the possible effect of these outliers on the regression models three multiple regression analyses were executed. Regression model 1 had outliers included and regression model 2 had outliers excluded, and regression model 3 had two dummy variables included that correct for the outliers.

Data examination on the projects show that extreme values on one or more variables might influence the prediction models, resulting in less generalizable models. These outliers cannot simply be removed from the analyses, because they still correspond to valid project characteristics. Although it may be that these projects are rare observations, they still could be representative projects for the firm. Therefore, each project was analyzed to examine if projects had an extreme value on one or more of the variables. A value was defined as an extreme value if the value was at least three standard deviations higher or lower than the mean. Six projects were found that had extreme values on one or more variables. Table 3 shows the values of the independent and dependent variables for the outlier projects. A few similarities were observed for these projects. For example, for these projects it was found that the number of issues within the project were less than the average number of issues within a project. This indicated that the projects with less issues are different from projects in general. Moreover, the total hours spent on the project were less than the average total hours spent on a project. A closer examination on the dependent variable revealed that some projects had extreme positive earnings, while other projects had extreme negative earnings. To be more precise, the dependent values of the outlier projects showed that five projects had extreme positive earnings per hour, and one project had extreme negative earnings per hour. Overall, it seems that these outlier projects could have an effect on the regression analyses. Given this, since the data is extracted from the corporate systems of the firm, it could be that these outlier projects are special, but representative cases. Subsequently, regression model 3 will have two additional variables to model the outlier

projects. One variable represents the five outlier projects that have extreme positive earnings per hour, the other variables represents the outlier project that has extreme negative earnings per hour. The construction of the independent, dependent and additional outlier project variables is described in section 3.

Table 3

Outlier projects values for independent variable

	Project code (ID)					
Variable	12	33	35	39	95	155
Issues Within Project	2	5	5	12	1	1
Core Team Size	1	2	2	4	1	1
Total hours spent	8.00	40.00	13.75	17.42	9.00	3.00
Project Duration (days)	200	210	120	513	74	0
Team Location Diversity	0	0.69	0	0	0	0
Team Nationality Diversity	0	0	0	0.562	0	0
Team Age Diversity	0	0.39	0.27	0.24	0	0

Note: the dependent variable values are omitted because these values are sensitive to the firm; the independent variable 'average hourly rate' is omitted because these values are sensitive to the firm

3 Measurements

In this section the construction of the empirical variables is discussed. First I elaborate on the dependent variable, financial project success, and then on the construction of the explanatory variables, including the additional variables that model the outliers. Thereafter the descriptive results of the variables are shown.

Financial Project Success

Financial project success is defined as the 'earnings per hour'. This is the profit or loss divided by the total hours worked on the project. A positive value indicates financial profits per hour, a negative value indicates financial losses per hour, and a value equal to zero indicates projects that are break-even (no profit or loss per hour). 'Earnings per hour' is a continuous variable. In 23 per cent of the projects (43 out of N = 184) earnings per hour were above zero [variable: EARNINGS PER HOUR].

Size

The size of a project is defined as the sum of the issues within a project. Note that not every issue within a project had time registered. For these issues it was assumed that the corresponding task of the issue was not executed by a team member. To cope with the 'zero time spent issues', the sum of issues within a project contained *only* issues with time registered: [NR OF ISSUES]. The construction of this measure is adopted from Tukel and Rom (1998) as the number of activities appear to be a reliable indicator for the size of a project.

Life Cycle

The life cycle (duration) of a project is defined as the number of *days* between the first registered issue and the last solved issue. The first registered issue is taken as the start of the project, and the last solved issue is taken as the end of a project. Project duration range from 0 days to 1277 days: [PROJECT DURATION]. The construction of this measure is adopted from Tukel and Rom (1998).

Total Time Spent

The total time spent on a project is the sum of the time (in hours) registered per issue within a project. Every team member registers the amount of time spent on an issue: [TOT HOURS SPENT]. The construction of this measure is adopted from Tukel and Rom (1998).

Value

The value is defined as the 'average hourly rate' per project. This is calculated by the total amount (€) invoiced divided by the sum of hours invoiced. The variable is a proxy for the revenues per hour per project: [AVERAGE HOURLY RATE]. Note that between the 'total time spent' of a project and the 'sum of hours invoiced' a difference could exist. This difference occurs because (sometimes) employees work more hours on a project, while these "extra" hours cannot be invoiced; and vice versa. This is reflected in the dependent variable 'earnings per hour'.

Team Size

Team size is defined as the number of employees that worked on issues within a project. Each issue within a project is created by an employee, the unique names occurring within a project are counted: [TEAM SIZE]. Note that a few issues were created by 'identities' that did not occur in the employee data file: these names corresponded with clients. These individuals were not counted as team members.

Nationality Diversity

Nationality is a categorical variable. Typically, in the treatment of categorical variables, the entropy-based index is used to derive an aggregate measure of diversity (Ancona & Caldwell, 1992; Jehn & Bezrukova, 2004). The entropy index takes into account how team members are distributed among the possible categories of a variable. The measure is shown below:

$$\text{Diversity } = -\sum_{i=1}^{\text{n}} P_i(\ln P_i)$$

Where P represents the fractional share of team members assigned to a particular grouping within a given characteristics and i is the number of different categories represented on a team' (Jehn & Bezrukova, 2004, p. 712): [NATIONALITY DIVERSITY].

Geographical dispersion

Geographic dispersion reflects the co-location of the team members. The location is, similar to nationality, a categorical variable. Therefore, the entropy index is applied, to create an aggregate measure on the degree of geographical dispersion: [GEOGRPAHICAL DISPERSION]

Age Diversity

Age is a continuous variable. A common used procedure to create an indicator for group age diversity is to calculate the coefficient of variation (the standard deviation of the selected attribute divided by its mean) (Ancona & Caldwell, 1992; Jehn & Bezrukova, 2004): [TEAM AGE DIVERSITY].

Extreme positive hourly earnings

The extreme positive hourly earnings variable is a dummy variable that has value 1 for the extreme positive outlier projects, and 0 otherwise. For this study the cut off value was earnings per hour at least three times the standard deviation higher than the mean of hourly earnings: [EXTREME POS HOURLY EARNINGS].

Extreme negative hourly earnings

The extreme negative hourly earnings variable is a dummy variable that has value 1 for the extreme negative outlier projects, and 0 otherwise. For this study the cut off value was earnings per hour at least three times the standard deviation lower than the mean of hourly earnings: [EXTREME NEG HOURLY EARNINGS].

3.1 Descriptive statistics

Table 4 presents descriptive statistics including means, standard deviations of the variables used in the multiple regression and logistic analyses. Table 5 shows the correlations for the variables used in the analyses.

Table 4

Descriptive statistics of the variables as used in the multiple regression and logistic regression analyses

Variable	**N**	**Mean**	**S.D.**	**Min.**	**Max.**
Earnings per hour	184	-19.74	65.05	-297.72	329
Issues Within Project	184	105.95	194.88	1	1759
Average Hourly Rate	184	87.93	8.49	40.42	95
Total hours spent	184	678.88	1,500.17	3	14,786.17
Project Duration (days)	184	502.02	362.60	0	1277
Team Size	184	5.06	3.64	1	18
Team Geographical Dispersion	184	.32	0.36	0	1.27
Team Nationality Diversity	184	0.16	0.28	0	1.24
Team Age Diversity	184	0.19	0.10	0	0.39

Table 5

Correlations between the variables as used in the multiple regression and logistic regression analyses

Variable		**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Earnings per hour	(1)	1.00								
Issues Within Project	(2)	-0.14*	1.00							
Team Size	(3)	-0.24***	0.61****	1.00						
Total hours spent	(4)	-0.14*	0.81****	0.55****	1.00					
Average Hourly Rate	(5)	-0.03	-0.22***	-0.19***	-0.09	1.00				
Project Duration (days)	(6)	-0.33****	0.42****	0.62****	0.31****	-0.40****	1.00			
Team Geographical Dispersion	(7)	-0.17**	0.33****	0.50****	0.25****	-0.17**	0.38****	1.00		
Team Nationality Diversity	(8)	-0.05	0.41****	0.24****	0.36****	-0.17**	0.16**	0.22**	1.00	
Team Age Diversity	(9)	0.036	0.10	0.28****	0.05	-0.03	0.27****	0.27****	0.19**	1.00

*Legend: *P<0.10; **P<0.05; ***P<0.01; ****P<0.001.*

4 Results

This section is organized in two subsections. Section 4.1 describes the results of the multiple regression analyses, standardized beta coefficients are mentioned in the text. Three regression analyses are performed to analyze the possible effect of the outlier projects, the results are shown in Table 6. Regression model 1 has all projects included, regression model 2 has the outlier projects excluded, and regression model 3 has two dummy variables included to capture the outlier projects (as described in section 2.4). It is discovered that financial project success is explained by a relative small number of projects (e.g. the outlier projects). Because this was unexpected, a post-hoc analysis is performed by means of a logistic regression. The aim of the logistics regression is to explore which explanatory variables increase the probability of a project to have extreme positive 'earnings per hour'. Results of the logistic regression are presented in section 4.2.

4.1 Multiple Regressions

Regression model 1, with all projects included, showed that 16.9% of the variation in the financial project success was explained by the variables included in the model (R^2 = 0.169). The variable 'average hourly rate' had a negative significant effect on financial project success (β = -0.204, *p* =.009). This indicated that an increase of the hourly rate results in a decrease of the earnings per hour. The variable 'project duration', had a negative significant effect on financial project success (β =-.415, *p* =.000). This indicated that an increase in 'project duration' results in a decrease of the earnings per hour. The variable 'team age diversity' had a positive significant effect on financial project result (β = 0.179; *p* =.019). This suggested that the earnings per hour will increase if the variance in age of project team increased. The size of the standardized beta coefficients indicated that 'project duration' had relatively the highest impact, thereafter the variable 'average hourly rate' followed by the variable 'team age diversity'. All other project and team variables were non significant, thus in contrast to the expectations, appear to have no influence on financial project success.

Regression model 2, with the outlier projects excluded, showed that 20.0% of the variation in the financial project success was explained by the variables included in the model (R^2 = 0.200). Excluding the outlier projects from the regression analysis resulted in an improvement of the explanatory power of the regression model. Regarding the (standardized) beta coefficients of the variables, and the significance levels of the variables also differences were observed. The 'team geographical dispersion' was was not significant in regression model 1, but is significant in regression model 2 (β = -0.150, *p* =.071). This indicated that an increase in the geographical dispersion of team members (team members are less co-located) decreases the earnings per hour. The variable 'average hourly rate' remained significant (β = -0.181, *p* =.022), and (standardized) beta coefficient increased.

Compared to regression model 1, excluding the outlier projects resulted in a smaller negative effect of average hourly rate on the earnings per hour. The variable 'project duration' remained significant (β = -0.462, *p* =.000), and the standardized beta coefficient decreased. The variable 'team age diversity' remained significant (β = 0.128, *p* =.091), and the (standardized) beta coefficient decreased. All other project and team variables remained non significant.

To conclude, the results from regression of model 1 compared to the results of regression model 2 indicate that it does make a difference to include outlier project. The explanatory power of the regression model increased, and in addition to other significant variables, the variable 'geographical dispersion' had a significant effect on earnings per hour. The (standardized) beta coefficients slightly changed for the variables that were significant in regression model 1 and regression model 2. Based on regression model 1 and 2, the outlier projects appear to have an influence on the regression models. Therefore, regression model 3 is designed with two dummy variables included that model the outlier projects (detailed descriptions are presented in section 2.4 and section 3). To recall: the dummy variable 'extreme pos hourly rate' captures the outlier projects with extreme positive hourly earnings. The dummy variable 'extreme neg hourly rate' captures the outlier project with extreme negative hourly earnings.

Regression model 3 showed that 64.3% of the variation in earnings per hour can be explained by the variables in the model (R^2 = 0.643). Compared to regression model 1, the dummy variables for the outlier projects increased the explanatory power of the regression model with 47.4%. The dummy variable 'extreme pos hourly earnings' had a positive significant effect on the earnings per hour (β = 0.622, *p* =.000). This indicates that a project that is an outlier project with extreme positive earnings, the earnings per hour increase. The dummy variable 'extreme neg hourly earnings' had a negative significant effect on the earnings per hour (β = -0.312, p =.000). This indicates that a project that is an outlier project with extreme negative earnings, the earnings per hour decrease. The variables 'average hourly rate' was significant and had a negative effect (β = -0.128, *p* =.014). The variable 'project duration' was significant and had a negative effect (β = -0.317, *p* =.000), the standardized beta coefficient increased. The variable 'team age diversity' was significant and had a positive effect (β = 0.102, *p* =.044), the standardized beta coefficient decreased. Whereas in model 2 'team location disparity', in model 3 the variable is non significant (β = -0.078, *p* =.152). All other project and team variables were non significant.

Table 6

Multiple Regression Models. Dependent Variable = Earnings per Hour

	Model 1			**Model 2**			**Model 3**		
Variable	B	β	*p*	B	β	*p*	B	β	*p*
Number of Issues	0.023	0.069	0.600	0.027	0.122	0.346	0.028	0.084	0.325
Average hourly rate	-1.563	-0.204	0.009**	-0.909	-0.181	0.022**	-0.979	-0.128	0.014**
Total hours spent	-0.002	-0.044	0.714	-0.003	-0.112	0.353	-0.003	-0.064	0.420
Project Duration	-0.074	-0.415	0.000**	-0.055	-0.462	0.000**	-0.057	-0.317	0.000**
Team size	-0.536	-0.029	0.788	0.289	0.024	0.821	0.017	0.001	0.990
Team geographical dispersion	-16.752	-0.093	0.259	-17.706	-0.150	0.070*	-14.013	-0.078	0.152
Team nationality diversity	-7.240	-0.031	0.690	-1.192	-0.008	0.921	-5.954	-0.025	0.619
Team age diversity	112.001	0.179	0.019**	54.262	0.128	0.091*	63.98	0.102	0.044**
Extreme pos hourly earnings							248.133	0.622	0.000**
Extreme neg hourly earnings							-275.604	-0.312	0.000**
Constant	142.372		0.011	76.08		0.039	81.999		0.027
N	184			178			184		
R^2	0.169			0.200			0.643		

*Legend: B = regression coefficient; β = standardized regression coefficient; *p<0.10; **p<0.05.*

Model 1: All cases included

Model 2: Outlier projects excluded

Model 3: All cases included and two dummy variables to model outlier projects included

4.2 Logistic Regression

As the multiple regressions results show, the outlier projects have a substantial effect on the explanatory power of the multiple regression models. Therefore, a post-hoc binary logistic regression is conducted to predict the probability of a project to be(come) an extreme financial success (profitable project). The dependent variable 'earnings per hour' is transformed to a binary variable: the five per cent most profitable projects (N = 11) are coded 1, and all other projects (N = 173) are coded 0. Table 7 presents the results of the estimates for the coefficients, odds ratio, and the p-values of the explanatory variables. The logistic model with all variables included performed better than the null model with the intercept only (-2LL = 46.27). The variable 'total hours spent' had a significant negative effect on the probability of an extreme profitable project (p =0.019). This implies that an increase of the amount of hours spent on a project decreases the probability of an extreme financial success project. The duration of a project had a significant negative effect on the probability of an extreme profitable project (p =0.015). This indicates that an increase of days between the first and last solved issue (e.g. a project is spread over more days), results in a decrease on the probability of an extreme profitable project. The nationality diversity of a team had a significant positive effect on the probability of an extreme profitable project (p =0.032). This implies that an increase of nationality diversity increases the probability of an extreme profitable project.

Table 7

Logistic Regression Model. Dependent Variable = Earnings per Hour

		Model	
Variable	Coeff.	Odds Ratio	*p*
Number of Issues	0.023	1.024	0.701
Average hourly rate	-0.081	0.922	0.302
Total hours spent	-0.043	0.958	0.019*
Project Duration	-0.012	0.988	0.015*
Team size	0.448	1.566	0.356
Team geographical dispersion	1.897	6.663	0.366
Team nationality diversity	6.899	991.310	0.032*
Team age diversity	7.807	2457.992	0.063
Constant	6.114	452.122	0.395
N		184	

Model Fit	-2LL	Sig.
Intercept only	0.00	
Final	46.27	0.000

Goodness-of-Fit	χ^2	Sig.
Pearson	72.06	1.000
Deviance		

5 Conclusion and Discussion

The purpose of this study was to empirically examine the effects of factors on financial project success. To investigate this, project and team characteristics of 184 projects from a knowledge intensive business service (KIBS) firm were analyzed. The data was extracted from the corporate systems of the firm. Contrary to most other findings, this study showed that the revenues of projects can be explained by a small number of projects. The effect sizes of the significant variables are small, and the other team and project variables have non significant effects on financial success of projects.

The multiple regression results showed that project duration, average hourly rate, and team age diversity have an effect on financial project success. It was found that the project characteristics project duration and average hourly rate have a negative effect on the earnings per hour of a project. The higher the revenue per hour per project, the less profit was made on the project per hour spent on the project. Also, the higher the project duration, the less profit was made on the project per hour. The team characteristic team age diversity has a positive effect on the earnings per hour of a project. This indicates that the higher degree of age diversity, results in the financial profit to increase. Contrary to the findings in the literature, project size, total time spent on a project, team size, and nationality diversity did not have an effect on financial project success. The present study does not find convincing empirical effects of the tested factors, although these factors have been argued to have an effect on project success. This suggests that the project characteristics and the team characteristics are not that much an added value in explaining project success, even when a different method of data collection is used to test the effects of factors. Future research may focus on factors from other categories, for example factors related to the project manager or factors related to the environment, that could influence project success.

A contribution of this study is that the results add empirical evidence on understudied factors that influence project success (project and team characteristics). It is found that by including team and project characteristics 16.9% of financial project success can be explained. Whereas until now, most studies focused on predicting project success by examining the effects of project management (Fortune & White, 2006; Mir & Pinnington, 2014).

A comparison of the three regression models shows that the effects of the variables remained stable across the three regression models for the variables that were already significant in the first regression model with all projects included. However, the variable geographical dispersion had a significant negative effect on financial project success when the outlier projects were excluded from the multiple regression model. This indicated that a higher degree of team members working in different locations, results in less financial profits. This negative impact of a decrease in co-location can be explained by a decrease in group responsiveness which delays decision-making and could jeopardize financial results (Scott-Young & Samson, 2008). An explanation for the significant result of geographical dispersion when the outlier projects are excluded could be that the outlier projects

moderate the effect of geographical dispersion. This is reflected in the result of the third regression, with dummy variables for the outlier project included, because this resulted in a non significant effect for geographical dispersion.

An unexpected finding was that a small set of projects (*N = 6)* had a major effect in explaining the revenues of a project. Results showed that, after modelling for the outlier projects, the explanatory power of the regression model increased with 47.4%. This finding is surprising, since most other empirical studies reported results to be on average the same for projects within one firm. However, the present study shows that projects and their contribution to revenues of the firm differ within the firm itself. Most probably this finding occurred because the measurements used in this study are based on data extracted from corporate systems instead of the self-reported questionnaires. The contribution of this study clearly is the different method used to collect data. The present study revealed that the values of team and project characteristics are highly diffuse, and extreme values are common rather than an exception. Based on this finding it may be interesting for future research to focus on determining which projects are going to be extremely favourable or extremely detrimental. A start for this type of research is made in the present study by incorporating the post-hoc logistic regression analysis.

The logistic regression indicated that the probability of a project to have extreme positive earnings is negatively influenced by the total time spent on a project and the project duration. An extreme positive earnings project is less likely to occur if the time spent on a project increases. In addition, an extreme positive earnings project is also less likely to occur if the duration of a project (in days) increases. The negative effects of these variables could occur because the outlier projects seem to be relatively small in terms of the hours spent on the project and the duration of the project (in days). Apparently, these projects tend to be smaller than the projects on average which could be beneficial for the earnings of a project. Projects that consist of less activities usually require less resources, and, in general, are less complex (Tukel & Rom, 1998). These characteristics might increase the probability of a project to have extreme profitable earnings. From a managerial point of view these smaller projects can be thought of as quick wins. To clarify, projects with less activities need less resources to perform the activities, these projects might be less complex and therefore require less coordination which could contribute to the financial success of the project.

Another important managerial implication is that project based firms should consider whether their profit margin stems from a couple of strong outlier projects, or is based on the larger stream of average projects. Project based firms should identify the projects that account for the high contribution on revenues of the firm and should consider the added value of projects that might jeopardize revenues. In line with this, different set of factors that influence project success could be considered by management to monitor the performance of different type of projects. As shown in this study, even within one firm, projects differ. This implies that the management of the firm might

divide projects in categories based on the project characteristics and team characteristics of the project.

To conclude, the results of this study showed that the effect sizes of the team characteristics measures and the project characteristics measures on financial success of projects are small, and these factors do not appear to explain financial success of projects to a great extent. Contrary to the hypothesized effects of team factors and projects factors in the literature, the present study concludes that the added value of including these factors in examining project success is low. Despite these findings, one unexpected finding is that the corporate system data revealed the outlier projects. This gave the opportunity to analyze the effects of the outlier projects on the financial success of projects. This in depth analysis showed that the outlier projects contribute to a large part of the overall revenues of the firm under research. The large effect of the outlier projects to financial success of projects gives directions for future research and has several managerial implications.

Limitations

This study has a number of limitations, and provides some meaningful directions for future research.

A first limitation is that although the project data is based on detailed and accurate data extracted from corporate systems of the firm, the study was conducted in only one organization based in the Netherlands (knowledge intensive business service firm). It may be that the effects of the outlier projects found in this study are not representative for other knowledge intensive business firms or firms within other sectors. Therefore, an obviously interesting question is whether the results of the present study can be replicated using data collected from other firms within the same sector, and firms within other sectors. In particular, because the results in this study diverge from the general tendency that the effect of factors on project success can be measured *on average* (Liang, Liu, Lin, & Lin, 2007; Mir & Pinnington, 2014; Scott-Young & Samson, 2008).

In addition, although the sample of this study was a random selection, the dataset was a subset of the total number of projects executed by the firm. Due to missing financial data for 48 projects the final dataset was reduced to 184 project instead of 232 projects. This reduction, and therefore loss of information, could bias the generalizability of the results for the firm under research. However, the current sample consisted of projects from each department and from the different locations of the firm. Therefore, the results can be generalized for the firm under research.

A second limitation is the operationalization of the project success variable. In this study project success was measured in terms of financial success (earnings per hour). While it is suggested that project success should be measured across multiple dimensions to reflect all stakeholders involved in the project (Lipovetsky, Tishler, Dvir, & Shenhar, 1997; Shenhar, Dvir, Levy, & Maltz, 2001). Stakeholders of a project are, for example, the project team, the project manager, the

subcontractors, and the client. In general, it appears that the stakeholders place different emphasis on factors that influence project success. The project team may perceive a project successful if schedule goals are met, whereas the client may perceive a project to be successful if the clients' needs are met. Therefore, it is suggested that project success should be assessed in terms of project team satisfaction and/or the client satisfaction, in addition to financial success measures (Lipovetsky et al., 1997). Especially for KIBS firms it could be interesting to include client satisfaction as a dimension of project success, because clients of these firms are typically highly involved in the co-production of the services delivered by KIBS, and the clients' contribution is integral to project success (Lessard, 2014; Muller & Doloreux, 2009). These described interactions between employees of the firm and the client, were also observed at the firm under research. Several clients worked part-time at the location of the KIBS firm, and employees of the KIBS firm occasionally worked at the location of the client. Unfortunately, the dataset of the present study did not contain values that were related to team satisfaction and/or client satisfaction. Future research could elaborate on this study by including non financial success dimensions such as, measuring projects success in terms of client satisfaction or in terms of team satisfaction

A third limitation of this study is that constructing the variables was more complex and time consuming than expected. A substantial part of the time available for this study was dedicated to ensure that the data was valid, the data was reliable, and the data could be merged on project level. The main reasons for this were the complexity of the dataset, the data was collected from multiple corporate systems, and the considerable amount of time needed to pre-process the data. Despite the time consuming efforts, the results of this study showed that the outlier projects explain, to a large extent, the success of a project. This result would probably not have emerged when a self-reported questionnaire had been used. So, the efforts taken to collect the data and to construct the variables did provide more insights about projects in the real world. Nevertheless, future research that is going to use data from corporate systems should be aware of the time consuming and the complexity of data collection and data preparation.

A fourth limitation of this study is the method used to investigate the effects of team and project characteristics on project success. In this study a direct effect of project and team characteristics on financial project success was examined. It could be that the project management style (Mir & Pinnington, 2014) moderates the effects of project and team characteristics on financial project success. Mir and Pinnington (2014) found that the project management style has an effect on the chances of a project to become a success. Future research may include the project manager style in combination with the project and team characteristics to investigate the effect of the inclusion of project management.

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