



Ashfaq Ahmad*

Nisar Ahmad†

Nadia Malik‡



Impact of Risk Determinants on the Perceived Performance of Software Projects in Emerging Economies

Vol. V, No. IV (Fall 2020)

Pages: 48 – 59

p-ISSN: 2708-2474

e-ISSN: 2708-2482

L-ISSN: 2708-2474

Abstract

Effective control of risk factors ensures the performance of projects in any industry. Risk factors can influence software projects of any size and type. This research aims to identify and examine different risk factors associated with projects in the software industry. The relationship between Software Project Risks (SPRs) and Perceived Project Performance (PPP) measures is determined. This study is based on a survey approach, and a questionnaire is used to record opinions and responses from 199 software professionals working in the Pakistan software industry. The results showed that the association between SPRs and PPP measures is statistically significant, and there exist a positive relationship. It is concluded that an increase in understanding of SPRs can increase PPP measures used to evaluate the software project. The results will help researchers and professionals in understanding the impact of different risk factors on software projects' perceived performance.

Key Words: Risk Factors, Perceived Project Performance, Project Risk Management, Software Industry

Introduction

Risk has been accepted as a concept and discussed over several decades. Every project in any industry, no matter how well managed, faces risks. It is evident from the literature that most scientific disciplines have accepted risk as a concept, but there is still no single, agreed definition of risk. This results in an ambiguous situation in which each professional has their own definition and perspective related to risk (Kaplan & Garrick, 1981; Lemos, 2020). Risk is a shared concept that cannot be addressed directly due to its derived nature and dependence on context, objectives, and other project parameters. Risk can also be seen from five dimensions, including results, probability, significance, impact, and coverage (Henley & Kumamoto, 1996). Risk has also been defined as a deviation from objects due to an uncertain event (ISO, 2009). Moreover, the risk was also vaguely described as the likelihood of an unforeseen event with some negative consequences (Boholm, 2019).

Risk management has become important for the success of all types of projects. Risk has become a key focus of every organization due to its importance (Hillson & Simon, 2020). It is, therefore, worth investigating the conflicting concepts of risk analysis and risk management. One way of dealing with risk is to look at it from a different perspective instead of taking the risk as a concept (Šotić & Rajić, 2015). Project Management Institute (PMI) provides guidance for effective project management at PMBoK (Project Management Body of Knowledge), which confirms that the project manager must be competent in risk management knowledge and risk management processes. PMBoK defined project risk as a positive or negative impact of an uncertain condition on the project (PMI, 2017). Despite various software risk management methodologies, there is still a high failure rate for software projects (Hsieh et al., 2018; Zahid et al., 2018). If the rate of risk factors increases, the software project's performance becomes more difficult to manage. A study summed up the analysis of 250 software projects. Only 25 projects were labelled successful, 175 were found to have failed, and 50 of them fell into the bucket of troubled projects (Shakir & Nørbjerg, 2015). The chances of success of software projects increase through the proper implementation of risk management processes (Willumsen et al., 2019). Risk has not been much discussed in the literature, and the performance of risk management strategies has also not

*Associate Professor, Hailey College of Commerce, University of the Punjab, Lahore, Pakistan.

†Assistant Professor, Hailey College of Commerce, University of the Punjab, Lahore, Punjab, Pakistan. Email: nisar@hcc.edu.pk

‡Department of Management Sciences, COMSATS University Islamabad, Islamabad Pakistan.

appeared to be satisfactory. It has been noted that project management alone is not sufficient to ensure the success of any project. Project management, together with the proper implementation of risk management, is considered vital to the management of projects in the software industry ([Bannerman, 2008](#); [Tavares et al., 2019b](#)).

A study carried out a risk assessment and prioritization of the risks faced by software projects during the different phases of the project development process, taking into account the probability and impact of their occurrence ([Bilal et al., 2020](#)). A study also analyzed the results of 139 software projects and concluded that at least two types of project risks could influence project performance: objective risks and resilience risks. Objective risks negatively impact all aspects of project performance ([Han, 2014](#)). It is necessary to develop a good understanding of the project's risk factors and how they influence the project's performance to develop a risk assessment tool. Project performance has been hindered by the lack of a validated project risk assessment tool and the lack of theory to explain the relationship between project performance and the different dimensions of software risk ([Wallace et al., 2004](#); [Pimchangthong & Boonjing, 2017](#)).

Success factors for software projects are closely linked to risk factors ([Ibraigheeth & Fadzli, 2019](#)). A methodical review showed that understanding these critical factors helps in decision making to improve software projects ([Yaseen & Ali, 2019](#)). The relationship between risk and performance is clear and obvious. Any type and category of risk, if not properly managed, jeopardize the performance of the project ([Garousi et al., 2019](#)). [Junior & Carvalho \(2013\)](#) assumed that the perception of the project's success did not affect risk management. Based on the data analysis, it was concluded that the assumption was not true and that risk management had a positive impact on the project's performance. Information and Communication Technology (ICT) organizations in Nairobi, Kenya, have realized the importance of risk management practices for projects and their key role in ICT projects' success. Results reported that risk management techniques were adopted to improve project performance ([Kinyua et al., 2015](#)).

Existing literature on project management practices reported that cost, time, and scope processes were among the most commonly used. Human resource management and procurement management processes have also frequently been used. While quality management, communication, and risk management processes have been used less frequently ([Papke-Shields et al., 2010](#); [Owuori et al., 2020](#)). Several studies have reported the need to investigate the risk assessment further to develop successful software projects ([Bilal et al., 2020](#); [De Araújo Lima et al., 2020](#)). Project performance is more crucial to software projects than others because of their unique nature. Flexible risk management is needed for the best project performance profile. Most project managers use risk management that directly affects project performance by identifying and managing risks effectively. This study reports on some of the important issues that needed to be addressed. Specifically, this study examines how different risk factors affect PPP measures for software projects.

Literature Review

Many industries have been affected by risk, which caused the project failure rate to increase and have revolutionized this area of study over the others ([Willumsen et al., 2019](#); [De Araújo Lima et al., 2020](#)). Existing literature on failed projects revolves around risk, but so far, no clear and accurate understanding of the term "risk" has been presented. This conflict in defining the term risk is obvious from any professional and scientific point of view. Moreover, risk remedies and solutions are based on how risk is defined ([Lemos, 2020](#)). Risk is something that, if it appears, has a bad impact on an individual's life. If the risk were known, everyone would try their best to avoid its appearance by taking some responsive action. Risk response provides some benefits for individuals, but its downside also has consequences when it is difficult to respond ([Kliem & Ludin, 2019](#)). Risk is a shared concept that can be affected by several factors. It has been referred to as a subject of debate, investigation, nervousness, and assumptions. Existing literature has reported that humans have created the concept of risk; in reality, there is no such thing as risk ([Rausand, 2013](#)).

Risk decision-making focuses not only on risk on its own but also on evaluating all options, each with a certain level of risk of its own dimension ([Singh et al., 2020](#)). Project managers need to understand the nature of the risk to the success of the project. Companies may use a defined risk list, but later, an organization should draw up a proper risk list for its in-house projects ([Garousi et al., 2019](#)). According to existing literature, risks and their management have an impact on the success of ICT projects. Literature published between 1980 and 2012 has been studied in ICT project management, and research shows that risk management is a vital and inherent component of project management ([Tavares et al., 2019a](#)). A study carried out a quantitative analysis of risk management's effectiveness in ICT projects for Romanian ICT companies ([Didraga, 2013](#)). Risk

management practices are necessary; no parent organization is public or private. Much better outcomes of software projects can be achieved by developing an understanding of risk management practices and risk management practices ([Carlsson-Wall et al., 2019](#); Tereso et al., 2019).

It has been reported that organizations need to adopt flexible risk management models and approaches, along with ongoing project management. In addition, continuous changes and improvements in risk management and project management techniques are important task for the organization ([Müller et al., 2019](#)). High-risk software project activities produce dynamic and uncertain outcomes ([Cividino et al., 2019](#)). Several studies have reported that most software projects have been labelled as unsuccessful based on time, cost, or scope. A huge amount of time and cost has been wasted every year on failed and problematic projects ([Zahid et al., 2018](#)). There are many models and processes available in the literature to cope with risks. [Boehm's risks \(Boehm, 1991\)](#) and PMI's PMBOK (PMI, 2017) are among the most prominent software engineering techniques.

Professional believes that risks are unavoidable in the light of the creative approach to ICT projects. Risk prevention is critical to improve performance and reduce cost overruns in ICT projects (Kliem & Ludin, 2019). The influential environmental parameters and risk measurements have been recognized in the Indian software development industry through component testing. The risks identified were the same as those identified by previous researchers. (Sharma & Gupta, 2012). Risk determination is a key step towards perfectly evaluating and controlling risk in a project of either medium, small, or large organizations ([Reed & Angolia, 2020](#)). Some research reviews show general risk factors, but very few researched specific risk factors for different applications. Yet, no one has focused on finding risk based on firm size (Sharif & Basri, 2014).

Software organizations with virtual project teams face several unique risks than software organizations with co-located project teams physically located in a single location (Morrison-Smith & Ruiz, 2020). Managing software development becomes more troublesome whenever projects' complexity and size are expended ([Dingsøyr et al., 2019](#)). Positioning the risk probability helps managers discover and organize high-risk events that allow managers to use appropriate means to deal with these events to reduce the risk (Willumsen et al., 2019). In particular, project risk management has a more significant impact on project success factors than the expected productivity, which is more limited in its impact. It has been found that the estimation of project management is less relevant to project competence (Mir & Pinnington, 2014). The Capability Maturity Model (CMM) was used by many organizations when the poor ICT project plan was considered to be the root cause of the project's failure ([Kabir & Rusu, 2016](#)).

Poor understanding and risk management lead to ICT projects' failure, which is a costly problem and has not been fully addressed in almost 30 years. Project managers in the software industry need to understand better how project risks affect project performance, leading to project failure. Many factors, such as understanding the business environment, using risk management techniques, and focusing on uncertainties, can impact project performance. Soft skills also have an important role to play in managing risks. Project performance can be significantly improved by alleviating and avoiding risks ([Gupta et al., 2019](#)). A study explored the potential impact of different risk management exercises on the success of ICT projects. Organizations have identified four unique impacts; Activity, Observation, Desire, and Connection impacts. Activity impacts, implying that risk management practices strengthen the different organizations to move forward and make these activities more sustainable ([De Bakker et al., 2012](#)).

Project planning is a key factor in the success of the project. The review of the ICT projects showed that project planning had influenced success based on different project risks. The results showed that the built-in level of risk planning was rather high, moderate, or low, with a different impact on the project's success. Project managers need to emphasize if there is a high level of risk to meet the success of the project ([Ahimbisibwe et al., 2015](#)). Four key concepts, including Risk Examination and Organizational Management and Network Theory with Indexing Concept, have been used to establish positive, negative, or neutral impacts of risk management strategies on ICT projects' outcomes. Results have shown that many organizations in Kenya have realized the importance of risk management and are finally starting to implement risk management to improve performance, financial savings, and productivity (Kinyua et al., 2015).

The negative impact of risk on performance is more prominent in the project's activities and tasks, which are more crucial to the success of the project (Pimchangthong & Boonjing, 2017). Researchers have proposed processes and techniques to reduce the unforeseeable and potential risks inherent in vital activities, as these qualities may increase the risk effect (Liu & Wang, 2014). Some strategies support team members with a risk mitigation plan from a project performance perspective. This helps to ensure the performance of the project if the risks are managed effectively.

After collecting data from 139 software projects, it was concluded that two types of software risks could, by any means, influence the performance of projects. It has been reported that the strategies adopted are based on risk-centric preferences and realized performance preferences. (Han, 2014). In the light of the observational evidence presented to date, it has been concluded that how project management specialists focus on project-related risks is likely to have a greater impact on the success of ICT projects than risk mitigation (Kliem & Ludin, 2019; Reed & Angolia, 2020).

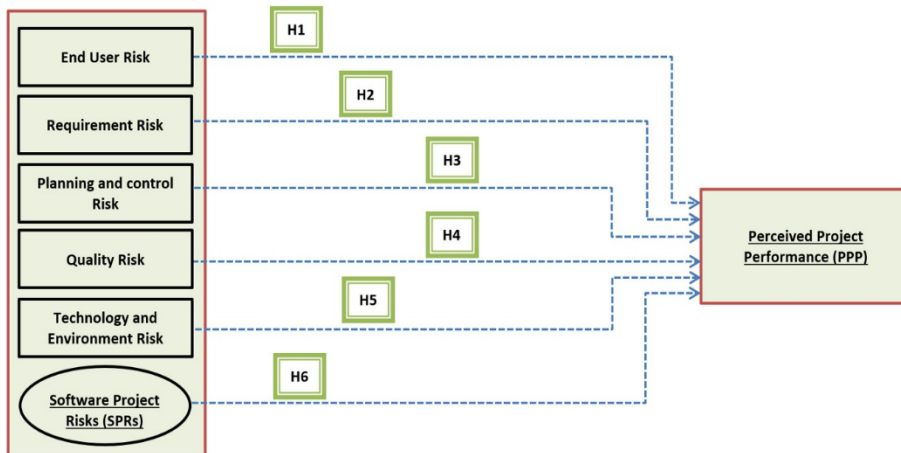


Figure 1: Theoretical Framework and Research Model

Figure 1 enables to devise the following research hypotheses being investigated in this study:

- H1:** There is a statistically significant association between End User risk and PPP in the software industry.
- H2:** There is a statistically significant association between Requirement risk and PPP in the software industry.
- H3:** There is a statistically significant association between Planning and Control risk and PPP in the software industry.
- H4:** There is a statistically significant association between Quality risk and PPP in the software industry.
- H5:** There is a statistically significant association between Technology and Environment risk and PPP in the software industry.
- H6:** There is a statistically significant association between SPRs and PPP in the software industry.

Research Method

This research is based on a survey approach to examine SPRs and their impact on PPP measures. The study population included professionals working in the software industry in Pakistan. The size of the sample is 199 professionals. The research instrument is a structured questionnaire. An easy response technique, i.e., Google forms, is used to maximize the number of respondents involved. The questions related to risk assessment are based on the risk identified by Reed and Knight (2010), Armuphaptrairong (2011), and Sharif and Basri (2014). Similarly, questions for measuring project perceived performance are based on the United States Department of Energy (DOE) measures (2002). 5-point Likert scale is used for risk assessment and PPP measures to indicate the extent to which respondents agree or disagree as 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4 = Agree, 5= Strongly agree. In addition, demographics have also been recorded. Data organization and statistical data analysis, i.e., frequency distribution, reliability, descriptive statistics, Pearson's correlation, and linear regression, is performed using SPSS to test the validity of the hypotheses.

Results of Analysis

Respondents' personal properties are considered by distributing the 199 respondents among the different categories like age, education, etc. The demographics of respondents are reported in Table 1.

Table 1. Demographics of Respondents

Category	Label	Frequency	Percent
Gender	Male	167	83.9
	Female	32	16.1
	Total	199	100.0
Marital Status	Single	173	86.9
	Married	26	13.1
	Total	199	100.0
Age of Respondent	20-25 Years	121	60.8
	26-30 Years	65	32.7
	31-35 Years	13	6.5
	Total	199	100.0
Monthly Income (Rs.)	21,000-40,000	68	34.2
	40,001-60,000	47	23.6
	60,001-80,000	45	22.6
	80,001-1,00,000	8	4.0
	1,00,001 and above	31	15.6
	Total	199	100.0
Education level	BS	153	76.9
	MS	45	22.6
	Others	1	.5
Number of hours worked (per week)	Total	199	100.0
	Less than 40 hrs.	63	31.7
	40 hrs.	82	41.2
	More than 40 hrs.	54	27.1
	Total	199	100.0

The results reported in Table 1 show that 83.9% of respondents are male, and 16.1% of respondents are female. 86.9% of respondents are single, and 13.1 % are married. 60.8 % of respondents are 20–25 years, 32.7% are 26 – 30 years, and 6.5% are 31–35 years concerning age. 34.2% respondents earn 21,000–40,000, 23.6% earn 40,001–60,000, 22.6% earn 60,001–80,000, 4.0% earn 80,001 to 1,00,000 and 15.6% earn 1,00,001 and above per month. Based on education level, 76.9% of respondents are BS, 22.6% of respondents are MS, and only 0.5% are holding other degrees. 31.7% of the respondents have to work for less than 40 hours, 41.2% of the respondents have to work exactly 40 hours, and 27.1% of the respondents have to work more than 40 hours per week. From the above results, we can conclude that most of the software professionals working in the Pakistan Software Industry are male by gender, single in marital status, 20–25 years of age, earn 20,000–40,000 per month, and hold BS degrees work for 40 hours per week. The reliability test results for each SPRs and PPP measures are shown in Table 2. Cronbach's alpha is calculated as a result of a reliability test representing how reliable data is for conducting statistical analysis and conclusions associated with the data. The Cronbach's alpha value for 100% reliable data is 1.0. The values and data are as good as it is closer to 1.0. The value alpha > 0.9 is excellent, alpha > 0.8 is good, alpha > 0.7 is acceptable, alpha > 0.6 questionable, alpha > 0.5 is poor and alpha < 0.5 is unacceptable (George, 2011). The Cronbach's alpha value for each SPRs and PPP measures are mentioned in Table 2, along with several items. The minimum value of Cronbach's alpha for SPRs and PPP measures is above 0.7. Based on Cronbach's alpha values, we can say that the data is acceptable and significantly reliable for data analysis and statistical inference.

Table 2. Reliability Statistics for SPRs & PPP

Category	Cronbach's Alpha	N of Items
End User Risk	.721	3
Requirement Risk	.702	3
Planning and Control Risk	.709	4
Quality Risk	.818	4
Technical and Environmental Risk	.792	8
Perceived Project Performance (PPP)	.898	26

The descriptive statistics give a general analysis of means and standard deviation for each SPRs, and PPP measures are shown in Table 3. The mean tells the center point of any data, whereas the standard deviation tells about how the data is distributed across the mean. The other values included in the descriptive analysis for each SPRs and combined PPP measures are skewness and kurtosis. The combined descriptive statistics for SPRs and PPP measures are represented in Table 4. The mean value for combined SPRs ranges from 3.0 to 3.8, whereas the overall mean value for PPP measures is 3.3.

Table 3. Descriptive Statistics for SPRs & PPP

SPRs & PPP	Mean	Std. Dev.
End-User Risk		$\alpha = 0.721$
You have faced User's resistance to change for software projects	3.32	.936
You have developed the wrong user interface for software projects	2.62	1.080
You have faced a lack of adequate user involvement for software projects	3.14	.990
Requirement Risk		$\alpha = 0.702$
You have faced late changes to requirements for software projects	3.88	.877
You have faced continually changing requirements for software projects	3.84	.837
You have faced unclear system requirements for software projects	3.85	.809
Planning and Control Risk		$\alpha = 0.709$
You have experienced unrealistic time estimates for software projects	3.65	.962
You have experienced unrealistic cost estimates for software projects	3.54	.908
You have experienced inadequate estimation of required resources for software projects	3.39	.897
You have experienced poor project planning for software projects	3.44	.982
Quality Risk		$\alpha = 0.818$
You have faced shortfalls due to externally supplied components for software projects	3.11	1.022
You have faced shortfalls due to externally performed tasks for software projects	3.08	.934
You have faced real-time performance shortfalls for software projects	3.05	1.074
You have faced poor quality deliverables for software projects	3.12	1.181
Technical and Environmental Risk		$\alpha = 0.792$
You have faced a high level of technical complexity for software projects	3.26	.995
You have faced unidentified technical constraints for software projects	2.89	1.123
You have faced the team's lack of general expertise for software projects	3.40	1.039
You have experienced conflict among team members for software projects	3.37	1.129
You have experienced resource contention within infrastructure for software projects	3.30	.828
You have experienced an unstable organizational environment for software projects	3.16	.899
You have experienced a lack of top management commitment to the software projects	3.28	1.097
You have experienced geopolitical issues for software projects	2.48	1.352
Perceived Project Performance (PPP)		$\alpha = 0.898$
Software Project tasks are completed according to planned ones	3.39	.930
Software Project major milestones are met according to planned ones	3.61	.863
Revisions to the approved project plan are incorporated if necessary	3.51	1.019
Changes to customer requirements are incorporated within the permissible time	3.28	1.055
Project completion deadlines are honored/followed	3.19	1.073
Revisions to cost estimates are incorporated if necessary	2.93	1.128
Amount of money spent according to the budgeted amount	3.28	1.102
Return on investment (ROI) is satisfactory	3.67	1.164
Defects identified through quality activities are addressed	3.84	1.047
Test case failures compared with the number of cases planned	3.41	1.049
The extent of customers satisfaction for the selected software projects	3.12	1.045
Customers/User frequently reuse software system	3.29	1.108
Project compliance with Enterprise Architecture model requirements	3.71	.940
Project compliance with Interoperability requirements	3.44	.962
Project compliance with Software standards	3.63	.830
For web site projects, compliance with Style Guide	3.44	1.139

Project compliance with Persons with disabilities	3.08	.990
Project compatible with Standard desktop platform	3.50	1.077
Software project developed can easily be upgraded	3.32	1.033
Software project developed is maintainable	3.71	1.066
The system will be available/working when needed (uptime)	3.41	1.160
System functionality meets customer's / user's needs	3.38	1.117
Absence of defects (that impact customer)	3.16	1.120
The system ensures ease of learning and use	3.47	1.063
Procurement cost are controlled according to guidelines	3.15	.880
Fewer maintenance costs for software project	3.25	1.014

Table 4. Computational Descriptive Statistics for SPRs & PPP

SPRs & PPP	Mean	Std. Dev.	Skewness		Kurtosis	
			Statistic	Std. Error	Statistic	Std. Error
End User Risk	3.0285	.80387	.093	.172	-.971	.343
Requirement Risk	3.8576	.66612	-.666	.172	-.042	.343
Planning and Control Risk	3.5038	.68556	-.173	.172	-1.142	.343
Quality Risk	3.0867	.84966	-.190	.172	-.979	.343
Technological and Environmental Risk	3.1426	.68177	-.529	.172	-1.077	.343
Software Project Risk	3.3238	.45933	-.091	.172	-.846	.343
Perceived Project Performance	3.3908	.55191	-.634	.172	-.486	.343

The Pearson Correlation analysis is applied to identify any significant relationship between SPRs and PPP measures. To apply the Pearson correlation, we can first have to check the violation of two assumptions (homoscedasticity & linearity) by creating a scatter plot graph. The results of the Pearson Correlation are shown in Table 5. As $N = 199$ (number of observations) is the same for all values involved in the Pearson correlation, it is not mentioned in the results table. It also shows that there are no missing data or values. Out of 6 correlations, the significance value for 4 of them is less than over alpha value (0.05 & 0.01), so we can say that the correlation is significant for those four relations.

By viewing the results, we can say that the direction of the relationship is positive as there is no negative sign with r values (Pearson Correlation Coefficient). After determining the direction of the relationship, we can assess the strength of the relationship. If $0.10 < r < 0.29$ there is "small" strength in the relationship, for $0.30 < r < 0.49$ the strength of relationship is "medium" and if $0.50 < r < 1.0$ the strength of relationship is "large" (Cohen, 2013).

For H1, the association of End User Risk with PPP Measures, the r -value is greater than 0.10 but less than 0.29. The value of significance is greater than the alpha value (0.05). So, for H1, the relation is positive in direction, small in strength, and statistically insignificant. H2 measures the association of Requirement Risk with PPP Measures. It is clear from the r -value and significance value that there is no significant relation between Requirement Risk and PPP Measures. H3 measures the association of Planning and Control Risk with PPP Measures, the r -value is 0.667, and the significance value is $P\text{-Value} < 0.0005$, which less than alpha (0.05) and even for alpha (0.01). It is concluded that there exists a positive relationship having large strength and statistically significant for Planning and Control Risk with PPP Measures. The coefficient of determination for H3 is 44.4 % that is Planning and Control Risk helps explain 44.4 % of the variance in PPP Measures. H4 measures the association between Quality Risk and PPP Measures. The value of r is 0.299 and significance value is $P\text{-Value} < 0.0005$ which is less than alpha (0.05 & 0.01). It is concluded that the relationship between Quality Risk and PPP Measures is positive in direction, having little strength, and statistically significant. The coefficient of determination for H4 is 8.9 % that is Quality Risk helps explain 8.9 % of the variance in PPP Measures. H5, measure the association of Technological and Environmental Risk with PPP Measures. As the r -value is 0.430 and the significance value is $P\text{-Value} < 0.0005$, it is concluded that there is a statistically significant positive

relation having medium strength. The coefficient of determination for H5 is 18.4 % that is Technological and Environmental Risk helps explain 18.4 % of the variance in PPP Measures.

Lastly, H6 measures the collective association of all above mention SPRs with PPP Measures. The r-value is 0.500, and the significance value is P-Value < 0.0005. It is concluded that there is a statistically significant strong and positive relationship exists between SPRs and PPP Measures.

Table 5. Pearson Correlation Statistics for SPRs & PPP

Category	End-User Risk	Requirement Risk	Planning & Control Risk	Quality Risk	Technological & Environmental Risk	SPRs	PPP	
End User Risk	Correlation	1	.307**	.337**	-.047	.278**	.605*	.133
	Sig. 2-tailed		.000	.000	.506	.000	.000	.062
Requirement Risk	Correlation	.307**	1	.134	-.020	.045	.444*	.056
	Sig. 2-tailed	.000		.059	.782	.524	.000	.430
Planning and Control Risk	Correlation	.337**	.134	1	.352**	.669**	.784*	.667*
	Sig. 2-tailed	.000	.059		.000	.000	.000	.000
Quality Risk	Correlation	-.047	-.020	.352**	1	.355**	.558*	.299*
	Sig. 2-tailed	.506	.782	.000		.000	.000	.000
Technological & Environmental Risk	Correlation	.278**	.045	.669**	.355**	1	.738*	.430*
	Sig. 2-tailed	.000	.524	.000	.000		.000	.000
SPRs	Correlation	.605**	.444**	.784**	.558**	.738**	1	.500*
	Sig. 2-tailed	.000	.000	.000	.000	.000		.000
PPP	Correlation	.133	.056	.667**	.299**	.430**	.500*	1
	Sig. 2-tailed	.062	.430	.000	.000	.000	.000	

** . Correlation is significant at the 0.01 level (2-tailed).

The coefficient of determination for H6 is 25%, representing that SPRs help explain 25% of the variance in PPP measures. In addition, to concluding associations of SPRs and PPP measures, Table 5 also shows the association between various risk factors. It is concluded that the association between various risk factors is statistically significant, and there exists a positive relationship between them, which means an increase in one risk factor can cause an increase in the rest of the risk factors. For example, End-User Risk is positively associated with Requirement Risk, etc. The regression analysis determines if a predictor or Independent Variable (IV) SPR Factors successfully predicts Dependent Variable (DV) PPP Measures. The outcomes of regression analysis are shown in Table 6, Table 7, and Table 8. In ANOVA Table 7, the Significance value (P-Value) is P-Value < 0.0005, which is less than alpha (0.05). It is concluded that the model is significant, and SPR Factors can predict PPP Measures. The F-Value from ANOVA table is F (1,197) = 65.700, P < 0.0005. The Model Summary is shown in Table 6. By analyzing Adjusted R Square, it is concluded that 25% of the variance in PPP Measures (DV) is explained by SPR Factors (IV).

Table 6. Model Summary for Regression Analysis of SPRs and PPP

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Durbin-Watson
1	.500a	.250	.246	.47915	2.062

a. Predictors: (Constant), Software Project Risk

b. Dependent Variable: Perceived Project Performance

Table 7. ANOVA^a for Regression Analysis of SPRs and PPP

Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	15.084	1	15.084	65.700	.000b

Residual	45.228	197	.230
Total	60.312	198	

a. *Dependent Variable: Perceived Project Performance*

b. *Predictors: (Constant), Software Project Risk*

The results for the Coefficients of the model are shown in Table 8. The Coefficients are based on t-statistics to determine the significance by comparing the model's slope with a slope of zero. The t-statistics, $t = 8.106$ with sig. P-Value < 0.0005 , it is concluded that the SPR Factors (IV) are significant, which means it has a predictive ability for PPP Measures (DV). The equation for the line written by analyzing Table 8 is $Y = 1.39 + 0.6 * X$.

Table 8. Coefficients for Regression Analysis of SPRs and PPP

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error				Beta	Tolerance
1	(Constant)	1.394	.249	5.603	.000		
	Software Project Risks	.601	.074	8.106	.000	1.000	1.000

a. *Dependent Variable: Perceived Project Performance*

In previous regression analysis, all SPRs are collectively analyzed to predict the percentage variance in PPP measures. The regression analysis results for individual risk factors are shown in Table 9, Table 10, and Table 11. In ANOVA Table 10 for the individual risk factor, the Significance value (P-Value) is P-Value < 0.0005 , which is less than alpha (0.05). It is concluded that the model is significant, and individual Risk Factors can also predict PPP Measures. The F-Value from ANOVA table is $F(5,193) = 32.572$, $P < 0.0005$. The Model Summary is shown in Table 9. By analyzing Adjusted R Square, it is concluded that Risk Factors explain 44% of the variance in PPP measures (DV) (IVs), including End User Risk, Requirement Risk, Planning and Control Risk, and Quality Risk, Technological and Environmental Risk.

Table 9. Model Summary^b of SPRs and PPP

Model	R	R Square	Adjusted R Square	Std. The error of the Estimate	Durbin-Watson
1	.676 a	.458	.444	.41168	2.368

a. *Predictors: (Constant), Technological and Environmental Risk, Requirement Risk, Quality Risk, End-User Risk, Planning and Control Risk*

b. *Dependent Variable: Perceived Project Performance*

Table 10. ANOVA^a of SPRs and PPP

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	27.602	5	5.520	32.572	.000b
Residual	32.710	93	.169		
Total	60.312	98			

a. *Dependent Variable: Perceived Project Performance*

b. *Predictors: (Constant), Technological and Environmental Risk, Requirement Risk, Quality Risk, End-User Risk, Planning and Control Risk*

The results for the Coefficients of a model for the analysis of individual risk factors are shown in Table 11. From the results and by seeing the P-Value, it is concluded that End User Risk, Requirement Risk, Quality Risk, Technological and Environmental Risk doesn't help to predict PPP Measures. Whereas only Planning and Control Risk appeared to predict PPP Measures. The t-test statistic for Planning and Control Risk, $t = 9.354$ with P-Value < 0.0005 , it is concluded that only Planning and Control Risk (IV) is significant, which means it has the predictive ability for PPP Measures (DV). The equation for the line written by analyzing Table 11 for Planning and Control Risk is $Y = 1.59 + 0.56 * X$.

Table 11. Coefficients^a SPRs and PPP

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.591	.231		6.881	0.000		
End User Risk	-.060	.041	-.088	1.460	.146	.778	1.285
Requirement Risk	-.006	.046	-.008	-.136	.892	.898	1.114
Planning and Control Risk	.563	.060	.700	9.354	.000	.502	1.991
Quality Risk	.040	.038	.061	1.040	.300	.814	1.228
Technological and Environmental Risk	-.029	.059	-.035	-.483	.629	.526	1.901

^a. Dependent Variable: Perceived Project Performance (PPP)

Discussion and Conclusion

Software professionals working in various software organizations adopt certain risk management standards to overcome ICT project risks. In addition to risk management practices, several activities to measure PPP are performed regularly. This research focuses on identifying any significant relationship between risk factors and perceived performance measures for software projects. This study is based on a survey approach, and a questionnaire is used to record opinions and responses from 199 software professionals working in the Pakistan software industry. Statistical analysis is performed on collected data collected from the survey to conclude results. The results show that the association between experienced SPRs and PPP measures is statistically significant. A positive relationship between them implies that an increase in faced SPRs can lead to an increase in PPP measures. The relationship between end-user risk and user requirements with perceived performance measures for software projects is not statistically significant. Whereas the relationships of planning and control risk, quality risk, the technological and environmental risk with perceived performance measures for software projects are statistically significant. ICT organizations considered effective and ongoing project risk management practices to identify and control risk factors for better project performance. This study also finds a positive impact on risk management practices on the performance of ICT projects. It implies that an understanding of the nature of loss exposure is a pre-requisite for the success of ICT projects in the software industry. Similar results are reported by the earlier studies. For example, [Garousi et al. \(2019\)](#), [Kliem and Ludin \(2019\)](#), [Tavares et al. \(2019a\)](#) emphasized that the recognition and management of various risks relating to planning, quality, technology, and environment are essential for the success of ICT projects. Like prior studies [Singh et al. \(2020\)](#), [Morrison-Smith and Ruiz \(2020\)](#), [Reed and Angola \(2020\)](#), we suggest projecting management specialists to take certain measures for the mitigation of project-related risks. Further, the results will help them analyze how one risk can influence and give rise to other potential risks, improving and keeping PPP on track. This research will also provide practitioners with criteria for evaluating their project performance, which helps them in their self-assessment and highlights the problematic risk factors. Based on the findings of this study, we proposed focus group panel studies for identifying the effective measures and practices to be followed for controlling the various risk inherited in planning, maintaining quality, introducing new technologies and their environmental concern in the software industry.

References

- Ahimbisibwe, A., Tusiime, W., & Tumuhairwe, R. (2015). The moderating influence of inherent project risk on the relationship between project planning and perceived project success. *International Journal of Supply Chain Management*, 4(3), 69–77.
- Arunphaptrairong, T. (2011). Top ten lists of software project risks: Evidence from the literature survey. Proceedings of the International MultiConference of Engineers and Computer Scientists, 1, 1–6.
- Bannerman, P. L. (2008). Risk and risk management in software projects: A reassessment. *Journal of Systems and Software*, 81(12), 2118–2133.
- Bilal, M., Gani, A., Liaqat, M., Bashir, N., & Malik, N. (2020). Risk assessment across life cycle phases for small and medium software projects. *Journal of Engineering Science and Technology*, 15(1), 572–588.
- Boehm, B. W. (1991). Software risk management: principles and practices. *IEEE Software*, 8(1), 32–41.
- Boholm, M. (2019). How do Swedish Government agencies define risk? *Journal of Risk Research*, 22(6), 717–734.
- Carlsson-Wall, M., Kraus, K., Meidell, A., & Tran, P. (2019). Managing risk in the public sector—The interaction between vernacular and formal risk management systems. *Financial Accountability & Management*, 35(1), 3–19.
- Cividino, S., Egidi, G., Zambon, I., & Colantoni, A. (2019). Evaluating the Degree of Uncertainty of Research Activities in Industry 4.0. *Future Internet*, 11(9), 196.
- Cohen, J. (2013). Statistical power analysis for the behavioral sciences. Academic press.
- De Araújo Lima, P. F., Crema, M., & Verbano, C. (2020). Risk management in SMEs: A systematic literature review and future directions. *European Management Journal*, 38(1), 78–94.
- De Bakker, K., Boonstra, A., & Wortmann, H. (2012). Risk managements' communicative effects influencing I.T. project success. *International Journal of Project Management*, 30(4), 444–457.
- Didraga, O. (2013). The role and the effects of risk management in I.T. projects success. *Informatica Economica*, 17(1).
- Dingsøyr, T., Falessi, D., & Power, K. (2019). Agile development at scale: the next frontier. *IEEE Software*, 36(2), 30–38.
- DOE. (2002). Basic Performance Measures for Information Technology Projects. <https://www.energy.gov/sites/prod/files/cioprod/documents/PerMeasTech-V3-011502.pdf>
- Garousi, V., Tarhan, A., Pfahl, D., Coşkunçay, A., & Demirörs, O. (2019). Correlation of critical success factors with success of software projects: an empirical investigation. *Software Quality Journal*, 27(1), 429–493.
- George, D. (2011). SPSS for windows step by step: A simple study guide and reference, 17.0 update, 10/e. Pearson Education India.
- Gupta, S. K., Gunasekaran, A., Antony, J., Gupta, S., Bag, S., & Roubaud, D. (2019). Systematic literature review of project failures: Current trends and scope for future research. *Computers & Industrial Engineering*, 127, 274–285.
- Han, W.-M. (2014). Validating differential relationships between risk categories and project performance as perceived by managers. *Empirical Software Engineering*, 19(6), 1956–1966.
- Henley, E. J., & Kumamoto, H. (1996). Probabilistic risk assessment and management for engineers and scientists. IEEE Press (2nd Edition).
- Hillson, D., & Simon, P. (2020). Practical project risk management: The ATOM methodology. Berrett-Koehler Publishers.
- Hsieh, M.-Y., Hsu, Y.-C., & Lin, C.-T. (2018). Risk assessment in new software development projects at the front end: a fuzzy logic approach. *Journal of Ambient Intelligence and Humanized Computing*, 9(2), 295–305.
- Ibraigheeth, M., & Fadzli, S. A. (2019). Core factors for software projects success. JOIV: *International Journal on Informatics Visualization*, 3(1), 69–74.
- ISO. (2009). Risk Management: Principles and Guidelines. ISO.
- Junior, R. R., & Carvalho, M. M. de. (2013). Understanding the impact of project risk management on project performance: An empirical study. *Journal of Technology Management & Innovation*, 8, 6.
- Kabir, M., & Rusu, L. (2016). I.T. project development using capability maturity model. *Information Resources Management Journal (IRMJ)*, 29(4), 35–48.
- Kaplan, S., & Garrick, B. J. (1981). On the quantitative definition of risk. *Risk Analysis*, 1(1), 11–27.
- Kinyua, E., Ogollah, K., & Mburu, D. K. (2015). Effect of risk management strategies on project performance of small and medium information communication technology enterprises in

- Nairobi, Kenya. *International Journal of Economics, Commerce and Management*, 3(2), 1–30.
- Kliem, R. L., & Ludin, I. S. (2019). Reducing project risk. Routledge.
- Lemos, F. (2020). On the definition of risk. *Journal of Risk Management in Financial Institutions*, 13(3), 266–278.
- Liu, S., & Wang, L. (2014). Understanding the impact of risks on performance in internal and outsourced information technology projects: The role of strategic importance. *International Journal of Project Management*, 32(8), 1494–1510.
- Mir, F. A., & Pinnington, A. H. (2014). Exploring the value of project management: linking project management performance and project success. *International Journal of Project Management*, 32(2), 202–217.
- Morrison-Smith, S., & Ruiz, J. (2020). Challenges and barriers in virtual teams: a literature review. *S.N. Applied Sciences*, 2, 1–33.
- Müller, R., Drouin, N., & Sankaran, S. (2019). Modeling organizational project management. *Project Management Journal*, 50(4), 499–513.
- Owuori, P. J., Ngala, M., & Obwatho, S. (2020). Project Management Practices, Corporate Governance and Sustainability: A Critical Literature Review. *Journal of Human Resource & Leadership*, 4(2), 30–47.
- Papke-Shields, K. E., Beise, C., & Quan, J. (2010). Do project managers practice what they preach, and does it matter to project success? *International Journal of Project Management*, 28(7), 650–662.
- Pimchangthong, D., & Boonjing, V. (2017). Effects of risk management practices on I.T. project success. *Management and Production Engineering Review*, 8.
- PMI, A. (2017). Guide to the Project Management Body of Knowledge (PMBok Guide), Newtown Square, PA, USA: Project Management Institute. Inc.
- Rausand, M. (2013). Risk assessment: theory, methods, and applications (Vol. 115). John Wiley & Sons.
- Reed, A. H., & Angolia, M. G. (2020). Risk management usage and impact on information systems project success. In *Start-Ups and SMEs: Concepts, Methodologies, Tools, and Applications* (pp. 1065–1084). IGI Global.
- Reed, A. H., & Knight, L. V. (2010). Project risk differences between virtual and co-located teams. *Journal of Computer Information Systems*, 51(1), 19–30.
- Sharif, A. M., & Basri, S. (2014). Risk assessment factors for SME software development companies in Malaysia. 2014 International Conference on Computer and Information Sciences (ICCOINS), 1–5.
- Sharma, A., & Gupta, A. (2012). Impact of organizational climate and demographics on project specific risks in context to Indian software industry. *International Journal of Project Management*, 30(2), 176–187.
- Singh, V., Schiebener, J., Müller, S. M., Liebherr, M., Brand, M., & Buelow, M. T. (2020). Country and sex differences in decision making under uncertainty and risk. *Frontiers in Psychology*, 11, 486.
- Šotić, A., & Rajić, R. (2015). The review of the definition of risk. *Online Journal of Applied Knowledge Management*, 3(3), 17–26.
- Tavares, B. G., da Silva, C. E. S., & de Souza, A. D. (2019a). Practices to improve risk management in agile projects. *International Journal of Software Engineering and Knowledge Engineering*, 29(03), 381–399.
- Tavares, B. G., da Silva, C. E. S., & de Souza, A. D. (2019b). Risk management analysis in Scrum software projects. *International Transactions in Operational Research*, 26(5), 1884–1905.
- Tereso, A., Ribeiro, P., Fernandes, G., Loureiro, I., & Ferreira, M. (2019). Project management practices in private organizations. *Project Management Journal*, 50(1), 6–22.
- Wallace, L., Keil, M., & Rai, A. (2004). How software project risk affects project performance: An investigation of the dimensions of risk and an exploratory model. *Decision Sciences*, 35(2), 289–321.
- Willumsen, P., Oehmen, J., Stingl, V., & Gerdali, J. (2019). Value creation through project risk management. *International Journal of Project Management*, 37(5), 731–749.
- Yaseen, M., & Ali, Z. (2019). Success Factors during Requirements Implementation in Global Software Development: A Systematic Literature Review. *International Journal of Computer Science and Software Engineering*, 8(3), 56–68.
- Zahid, A. H., Haider, M. W., Farooq, M. S., Abid, A., & Ali, A. (2018). A critical analysis of software failure causes from project management perspectives. *VFAST Transactions on Software Engineering*, 13(3), 113–119.