



A Management-Centric Approach to Software Development: The Role of KPIs in Ensuring Project Success

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Abstract: Software development is rapidly changing and firms can only become competitive if they keep their software project effective in the ever-changing and growing world of software development. To attain this achievement, the main factor is conscientious measurements and performance assessment of the project by using Key Performance Indicators (KPIs). These tools are vital in helping stakeholders and project managers supervise progress, identify potential hazards, and make decisions accordingly. The current study focuses on the relationship between KPIs and measurement and software initiative performance. The objective is to explore the most effective method in project performance improvement, and process optimization, and successfully guarantee software project completion by considering different tools that may influence results. It is not only important for researchers to embrace KPIs and metrics. Importance of the software is essential but it is need for firms to focus on these aspects to attain success in a rapidly changing dynamic.

Keywords: Software Project Metrics, Key Performance Indicators (KPIs), Project Success.

Introduction

The industry of software development is changing at a massive speed and evolving day by day, in this regard, firms can attain a dominant position if they have successful completion of software projects. To attain effective project management exhaustive measurement and project process evaluation are necessary. This can be possible by using Key Performance Indicators (KPIs) and metrics of software projects. These are the basic tools that facilitate shareholders and managers to analyze progress, find out possible challenges, and then make appropriate decisions. The current study underlines the relationship between measurement tools like KPIs and metrics, and software project

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success. The prime objective is to explore the impact of these tools on project results and it also helps to identify the best ways to execute projects, attain successful software initiatives, and process optimization. As we know there is a significant importance of software development in the economy globally, thus understanding the impact of the implementation of KPIs and measurement is determining for both organizations and academic studies to glow in the dynamic field.

It has been observed that software development has completely changed in the past few decades. As technology is evolving day by day it made software development an essential part of business operations, the development of products, and providing services across different industries. Firms believe that they can attain their competitive edge by having competitive software, thus it makes it more difficult to maintain the success of software projects. To manage the project, there are certain challenges such as tight deadlines, changing requirements, and limited resources. To resolve these problems stakeholders and project managers rely on Key Performance Indicators and software project Metrics as the main tools to analyze, evaluate, and supervise projects to make them successful. Whereas, the current study highlights the significant impact of KPIs and metrics in software and its impact on project success.

The usage of KPIs and Software Project Metrics to attain effective management of project software is one of the main challenges that an organization may face. On the other hand, these tools are important to increase project oversight and visibility, selecting the most relevant metrics, applying them effectively, and then they put in a parallel position with project goals can be a difficult task to consider. Additionally, there is insufficient knowledge available regarding how different KPIs and software metrics affect project results, which helps the firm to make appropriate decisions and boost its management project strategies. This study underlines the practical implementation of KPIs and metrics and analyzes the significance of project success.

The main objective of the current study is to find out the Key Performance Indicators (KPIs) and software project metrics that impact the success of project software development. An extended and detailed research work is needed to analyze the use, difficulties, selection, and best practices of these tools is important for this attempt. The final destination is to propose actionable outcomes for the organization that ultimately help to grow their software project management and also increase their rate of successful software projects.

Literature Review

Key Performance Indicators (KPIs) are important to analyze software project management and also offer a guaranteed success in the software project. In this regard, research done by Zhang and Babar (2017) in the study "Key Performance Indicators for Software Development Projects: A Software Process Domain Analysis," discusses about application of the software process and the impact of project success.

The hybrid approach of project management that involves both traditional and modern methodologies is rapidly increasing. Nyfjord, et al., (2020) conducted a research "Metrics for Hybrid Software Development Projects", which primarily deal with the usage of metrics in project management specifically hybrid. This study enlightened hybrid project management applications and their influence on project success.

To discuss more about Agile methodology, Aziz, and Li (2015) focused on project success and agile metrics. Agile is rapidly gaining success due to its ability and flexibility to change as per requirements. This study highlights the extent to which agile metrics can be beneficial for project success. With time technology is changing and getting advanced, number of automatic tools have been proposed that help to report and track KPIs and project metrics. Tools like Azure DevOps, Jira, Trello, and agile practices of project management data by providing real-time data. Researchers claim that these tools help make data collection simple but it also it also helps to understand data, increase visualization, and allow the team to make quick actions take appropriate decisions, and make adjustments where necessary (Costa et al., 2018).

The integration of Key Performance Indicators (KPIs) in software project management has been extensively studied, highlighting their critical role in monitoring performance, guiding decision-making, and ensuring project success. KPIs serve as quantitative measures that evaluate project performance against expected outcomes, confirming the achievement of objectives (Virginia Tech IT, n.d.). In Agile software development, the selection and application of appropriate KPIs are vital for assessing team performance and project progress. Pham and Neumann (2024) identified challenges in using performance metrics within Agile teams, such as a lack of transparency and standardization, as well as insufficient accuracy. The research emphasized the need for a repository of widely used performance metrics and provided implications for practitioners and researchers to address these challenges.

The adoption of DevOps practices has further influenced the use of KPIs in software project management. The DevOps Research and Assessment (DORA) group identified four key metrics—Change Lead Time, Deployment Frequency, Change Failure Rate, and Mean Time to Recovery (MTTR)—as essential for assessing team performance. These metrics help organizations understand the impact of their practices and risk factors on performance, enabling targeted improvements (DORA, 2020).

A systematic literature review by Unterkalmsteiner et al., (2023) examined evaluation strategies and measurements used to assess the impact of Software Process Improvement (SPI) initiatives. The study found that while quality was the most measured attribute, there was a scarcity of long-term measurements, such as customer satisfaction and return on investment. The authors highlighted the need for more comprehensive evaluation approaches that consider both short-term and long-term impacts of SPI initiatives.

The selection of appropriate KPIs is crucial for effective performance measurement in software projects. Antoli (2022) provided an overview of possible KPIs for evaluating software process efficiency, emphasizing the importance of choosing metrics that align with organizational goals and project objectives.

In project-based organizations, the application of lean principles and techniques has been proposed to identify KPIs that enhance performance. A study by Guo et al., (2020) discussed the justification and proposal of using lean principles to identify KPIs, aiming to improve efficiency and effectiveness in project-based settings.

The implementation of KPIs in software development processes has been explored in various organizational contexts. For instance, Poth et al., (2020) reported experiences of introducing new KPIs at Volkswagen Financial Services AG, highlighting the practical challenges and benefits of KPI implementation in large organizations.

Another important part of project management is data-driven decision-making. Research conducted by Yilmaz and Demirörs (2019) explored the impact of metrics-driven decision-making in their research work i.e. "The Role of Metrics-Driven Decision Making in Software Project Success." This work mainly focused on software project metrics and their impact on process decision-making and as a result enhanced project success.

Based on the above-discussed literature review following are the hypotheses that have been proposed:

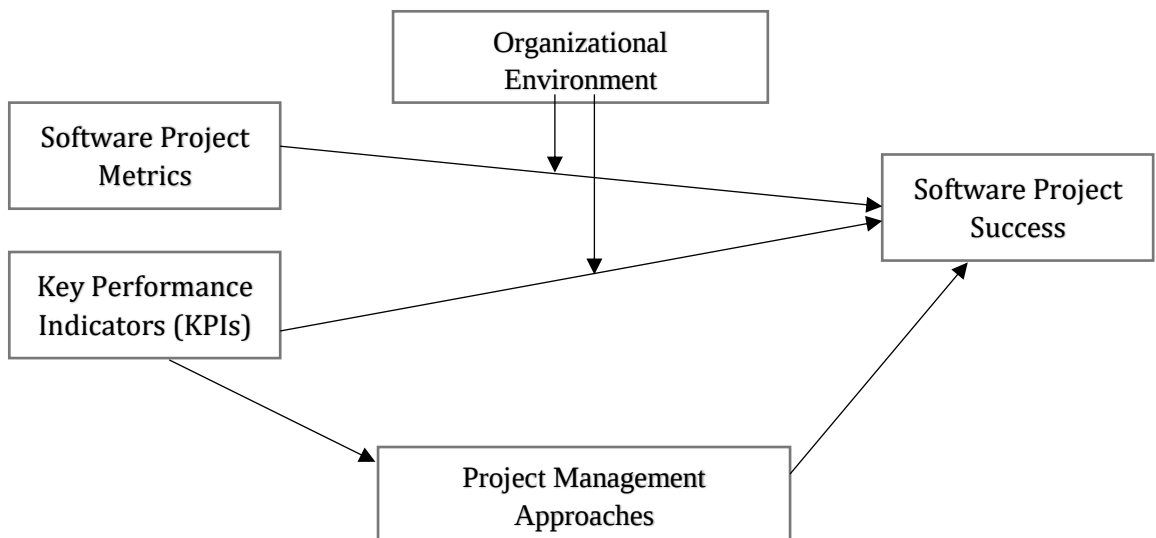
H1: There is a negative and no significant impact of Software Project Metrics and Key Performance Indicators (KPIs) on the overall success of software projects.

H2: Software Project Metrics and KPIs are positive and significantly influence and contribute to the overall success of software projects.

H3: Project Management Approaches by organization affects the success rate of software projects.

Conceptual Framework

Figure 1
Conceptual Framework



Research Methodology

Research design includes the methodology as a whole which means it deals with specific research questions and test hypotheses. It also covers the methods, procedures, and different techniques to collect data and analyze the data including sampling strategies and sources of information.

To gather the most relevant and updated information about the target audience and research topic, a mixed-method approach is most suitable, by using a research platform that possesses a good reputation like Google Scholar, PMI, Elsevier, and other high-rank journals of management. The first step is to focus on the literature review in detail to plan methodology, it involves agile, traditional, waterfall, and many other hybrid approaches. The current study mainly focused on the article published in Elsevier and PMI.

A research approach is a strategic and systematic framework to answer various research questions. The process has covered numerous parts such as hypotheses development, collection of data, and then analysis of the data.

Through the detailed analysis of the literature review, the development of a survey questionnaire is done to be filled by project managers in the Pakistan software sector and IT. Each response related to the project facilitates the project manager to have information about the characteristics of the project, practices, methodologies, and success factors also incorporates every other factor that may influence the outcomes of the project. The number of respondents reached to 100 responses.

The study used SmartPLS to test the hypotheses that included the direct, mediated and moderated relationships.

Data Analysis

Respondent Analysis

Table 1
Respondent Statistics

Respondent Information	Description	Frequency	Percent
Gender	Male	84	84.00 %
	Female	16	16.00 %
	Not disclosed	-	-
Age	Less Than 25 Years	24	24.00 %
	25 Years to 30 Years	47	47.00 %
	31 Years to 35 Years	19	19.00 %
	36 Years to 40 Years	07	7.00 %
	More than 40 Years	03	3.00 %
Experience in Software Projects	Less than 01 Year	27	27.00 %
	01 to 03 Years	34	34.00 %
	04 to 06 Years	23	23.00 %
	07 to 10 Years	09	9.00 %
	More than 10 Years	07	7.00 %
Qualification	Intermediate	12	12.00 %
	Bachelors	47	47.00 %
	Masters	41	41.00 %
Role	Business Analyst	18	18.00 %

	Content Marketing	02	2.00 %
	Design Team Member	04	4.00 %
	Design Team Lead	05	5.00 %
	Development Team Member	21	21.00 %
	Development Team Lead	14	14.00 %
	QA Team Member	06	6.00 %
	QA Team Lead	01	1.00 %
	Sales Agent	03	3.00 %
	Project Manager	25	25.00 %
	Production Head	01	1.00 %

The above-mentioned table shows complete information about the respondent's traits and demographics within the framework of current research that analyzes the Key Performance Indicators (KPIs) and software project metrics impact on project success. We can see from the above table the gender distribution of the respondents i.e. 16% are female and 84% are male.

As for pet age distribution, 47% of the respondents are from the age group of 25-30, and 19% are from the range of 31-35 following closely behind. Furthermore, the respondents with software project experience from 1-3 years 34%, whereas 14% have master's degrees.

Moreover, the occupation has various categories such as members of development teams (21%), business analysts (18%), and project managers (25%) among others. These categories provide massive information about the respondent pool and offer further analysis of the project in the software sector.

Descriptive Analysis

Table 2

Descriptive Statistics

Name	Mean	Median	Standard deviation	Excess kurtosis	Skewness
KPI1	3.915	4	0.728	0.152	-0.416
KPI2	3.859	4	0.658	0.455	-0.375
KPI3	3.754	4	0.733	0.021	-0.346
KPI4	3.774	4	0.69	-0.158	-0.128
SPM1	3.824	4	0.817	-0.185	-0.442
SPM2	3.643	4	0.867	-0.317	-0.308
SPM3	3.688	4	0.772	-0.179	-0.318
SPM4	3.719	4	0.839	-0.082	-0.402
OE1	3.588	4	0.857	-0.29	-0.347
OE2	3.628	4	0.816	-0.28	-0.445
OE3	3.739	4	0.738	0.223	-0.52
OE4	3.673	4	0.795	0.193	-0.49
PMA1	3.618	4	0.76	-0.265	-0.197
PMA2	3.732	4	0.692	0.364	-0.506
PMA3	3.447	4	0.854	-0.471	-0.272
PMA4	3.588	4	0.71	-0.144	-0.229
SPS1	3.513	4	0.82	-0.231	-0.26
SPS2	3.372	3	0.881	-0.795	-0.048
SPS3	3.226	3	0.927	-0.835	0.107
SPS4	3.256	3	0.913	-0.6	-0.092

The above table shows Descriptive statistics that were obtained from the questionnaire filled out by the participants. The distribution of the data shows symmetrical distribution as shown in statistical analysis. It is distinguished by negative skewness and the low-level value of kurtosis. The value of skewness indicated by the leftward tail usually ranges from -0.506 to 0.107, it also computes asymmetry of the distribution. Even when the skewness is minor and unnoticeable and close to 0 it shows primary symmetrical distribution.

Kurtosis helps to measure the Flatness and Peakedness of the distribution and compare it with normal distribution. The acceptable value of Peakedness is -0.835 to +0.455 ignore the deviation from normality. When kurtosis is near 0 than it indicates that there is a moderate degree of Peakedness and have no extensive characteristics.

The mean values of all the items are around 3, it presents the central tendency of the data i.e. the average data is around the mean value. The standard deviation is below 1, showing variability or spread of the data. If the Standard deviation is small it shows that it is closer to the mean value this, shows limited variability in the distribution.

We can conclude that data distribution is approximately normal, with slight negative skewness and slight Peakedness.

Collinearity Diagnosis

Collinearity diagnosis is essential to explore the relationship between interpreting results and predictor variability and make sure to have reliability and stability in the model. It also facilitates researchers to make appropriate decisions about model specifications, selection of variables, and techniques of data analysis. A variance inflation factor VIF is a measurement tool to check Collinearity, if the value is above 5 then it shows high Collinearity, and if ranges from 1-5 then it shows moderate Collinearity in the data.

Table 4.3 shows that the VIF value ranges from 1.546 to 1.765 for all the constructs this variable is moderately correlated.

Table 3
VIF Values

Constructs	VIF
Key Performance Indicators	1.546
Organizational Environment	1.77
Project Management Approaches	1.765
Software Project Metrics	1.676

Convergent Validity

Table 4

Convergent Validity

	Cronbach's alpha	Composite reliability	Composite reliability	Average variance extracted
Key Performance Indicators	0.904	0.906	0.933	0.777
Organizational Environment	0.856	0.86	0.902	0.698
Project Management Approaches	0.793	0.799	0.865	0.616
Software Project Metrics	0.878	0.880	0.917	0.734
Software Project Success	0.873	0.874	0.913	0.725

The table confirms strong reliability and validity of the study's key factors, as all Cronbach's alpha and composite reliability values exceed the acceptable threshold of 0.7. The average variance extracted (AVE) values are above 0.5, indicating that each factor effectively captures its intended concept. Overall, the results ensure that the measurement model is robust, consistent, and suitable for analysis.

Discriminant Validity

Table 5
Fornell Larcker Criterion

	Key Performance Indicators	Organizational Environment	Project Management Approaches	Software Project Metrics	Software Project Success
Key Performance Indicators	0.882				
Organizational Environment	0.455	0.836			
Project Management Approaches	0.449	0.595	0.785		
Software Project Metrics	0.525	0.504	0.502	0.857	
Software Project Success	0.533	0.577	0.642	0.511	0.851

The above table of Fornell Larcker Criterion shows that the discriminant validity is assured. As all the values in the diagonal are above the corresponding values.

Hypotheses Testing

The following section hypotheses testing in three sub sections including direct, mediated and moderated relationships.

Figure 1

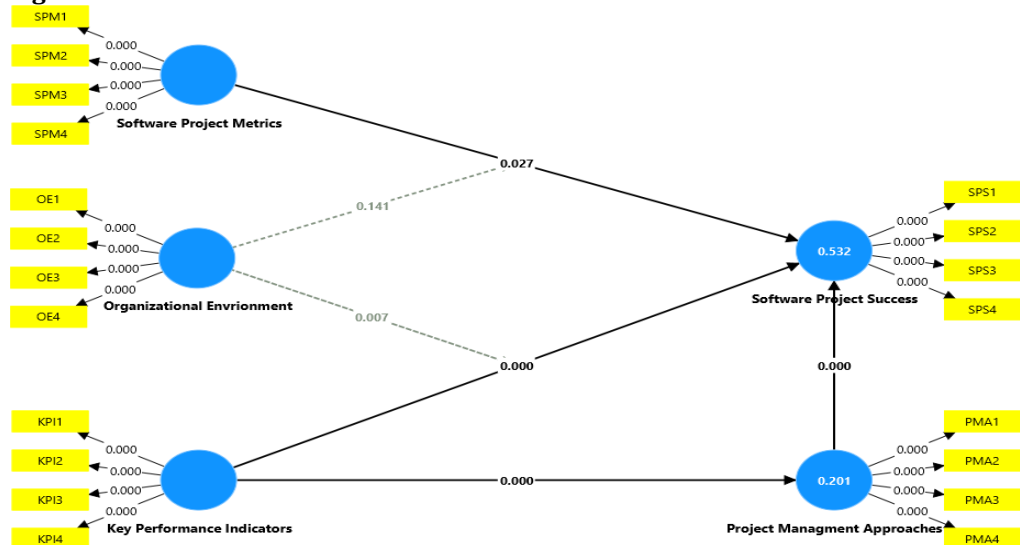


Table 6
Direct Relationships

Path	Coefficient	P values	Results
Key Performance Indicators → Project Management Approaches	0.449	0.000	Supported
Key Performance Indicators → Software Project Success	0.394	0.000	Supported
Organizational Environment → Software Project Success	0.196	0.000	Supported
Project Management Approaches → Software Project Success	0.367	0.000	Supported
Software Project Metrics → Software Project Success	0.101	0.027	Supported

The above table provides the summary of direct relationships hypothesized by the study framework. The results show that all relationships are positive and significant with the p-values greater than 0.05. Hence it can be said that all direct relationships are supported.

Table 7
Mediated Relationship

Path	Coefficient	P values	Result
Key Performance Indicators → Project Management Approaches → Software Project Success	0.165	0.000	Supported

The study provides only one mediated relationship that was the mediation of project management approaches between the relationship of key performance indicators and software project success.

Table 8
Moderated Relationships

Path	Coefficient	P-value	Result
Organizational Environment x Key Performance Indicators → Software Project Success	0.093	0.007	Supported
Organizational Environment x Software Project Metrics → Software Project Success	-0.051	0.141	Not Supported

The above table provides two hypothetical relationship that are based on moderation of organizational environment. The interaction of organizational environment and key performance indicators has a positive impact on software project success and this relationship is also significant. The interaction of organizational environment and software project metrics has insignificant impact on the software project success.

Summary of Hypotheses

The above section of hypotheses testing provides the information about the hypotheses testing and all the hypotheses are found to be supported except the one moderated relationship. Hence this study provides insights into the project management success and the key performance indicators.

Findings and Recommendations

As technology is changing very fast firms are always paying attention to having successful software development projects. The current study has enlightened two main aspects of software projects i.e. usage of Organizational Knowledge Management (OKM) and effective risk management. We analyze these factors by Key Performance Indicators (KPIs) and software project metrics to check project success.

Conclusion

The current study analyzes the impact of software project metrics and key performance indicators (KPIs) on project success and treats them as separate independent variables. The finding shows that there is no significant relationship between KPIs and software project metrics on the success of projects. The sample was collected from project managers of software industries in Karachi, Pakistan. It further suggests that a hybrid approach of project management that involves both agile and traditional methodologies can be most appropriate for negotiating the complexities of the project environment. The current study underlines the importance of adaptability, flexibility, and collaboration in project management. It shows how KPIs and software project metrics are beneficial to improve the success of the project. Project managers are highly encouraged to contribute to the success of the project. The research is unique as it provides distinctive findings and analyzes the way in which KPIs and metrics work for the project success handled and led by project managers of software industries in Pakistan.

The Limitation and Implication of the Study

The Constraint of the study the outcomes may be narrow to the precise situations of the study. The collection and analysis of software project metrics and KPIs may be independent, with several organizations using different methods ranging in their points. This may impact the similarity and scope of the results. This study observes project management procedures in Pakistan and shows that Software Project Metrics and KPIs completely influence project success in this situation. It endorses that organizations and project managers in Pakistan use a hybrid approach to project management. Further research should examine the effectiveness of this hybrid technique through other businesses or segments in Pakistan, taking into account cultural or environmental sides that may affect project progress.

Recommendation

Managers should discover industry-specific development in software project management, as diverse sectors might have exclusive problems and chances. This research can support comprehending the enduring impact of current risk management and Organizational Understanding Management on software project progress. Seeing the impact of cultural influences on these applies can offer perceptions for worldwide distributed groups.

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