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Risk and sustainability in project management with special reference to the IT sector

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Abstract

This study examines the role of risk analysis in project management, with a focus on sustainability within the information technology (IT) sector. Existing research on agile-managed projects often overlooks the interplay between agile methodologies, risk management practices, and project outcomes. This study emphasizes the critical role of the project team, aligning with the second principle of the Standard for Sustainability in Project Management. Key risk factors identified include technology, hardware, systems, scheduling, and cost. A comprehensive risk management framework for IT projects was developed based on empirical data collected from 233 respondents comprised of 109 expert interviews and 124 survey respondents from structured questionnaires. The model of this study identifies six principal risk domains—organizational culture, schedule/cost, project environment, project team, user/customer, and technological context—which account for 86% of potential risks in IT project lifecycles. Findings highlight that project managers systematically engage in risk recognition, impact assessment, monitoring, and sustainability management. This research contributes both theoretical insights and practical tools to the field of agile IT project risk management.

Keywords: Agile project, Information technology, IT, Project management, Risks, Sustainability, Technology.

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1. Introduction

A significant factor in the recent changes in project management approaches, particularly in the IT sector, is doing business in an environment marked by high levels of instability and reactivity to market demands [1]. Conventional project management techniques may be inadequate and even detrimental to projects with high levels of structural intricacy and uncertainty [2-4]. New patterns in project management are emerging because of these changes and the critique of the conventional approach. This innovative approach, which forgoes overly rigid procedures in support of a more fluid reaction

to shifting circumstances, has been dubbed 'agile project management [4, 5]. This article's focus is on agile IT projects because of the special challenges they present and the literature's recommendations for conducting quantitative and qualitative research to handle those challenges [6]. The first section of this article presents the results of a comprehensive literature review on topics including what influences the success of an IT project, how risks are mitigated, and who is involved in the process. The importance of risk, defined as 'the degree to which a given set of events, either favourable or bad, might have an effect on the project's ultimate outcome,' was also considered. Questions from the questionnaire (124) and results from the structured interview (109) were provided with the methodology and study results. This part includes the findings of the dependability test as well as a description of the principal component analysis (PCA) statistical approach that was used to identify potential IT project risk zones. Findings are presented in the research section, such as a breakdown of how risk is handled on IT projects and an analysis of common risk factors [7]. Thereby, the author addressed the study's research objectives and created an approach for handling risks in agile project management [8]. In the discussion, the study described the model's components in-depth, offering advice for practitioners on the idea of sustainability in the integration, control, and monitoring of projects and a concept for classifying particular risk management actions that contribute to this idea [9].

2. Review of Literature

The foundations of an agile technique of project management were developed around the year 2000 [10, 11]. Agile methods gained popularity in 2001, with many new innovations and broad adoptions [12]. The Agile Manifesto, which includes the 12 guiding principles and four fundamental postulates, was created at that time by the authors of the agile approach to project management [13]. Instead of designing complex processes, this study aimed to identify the processes' key components [14]. Agile techniques, which are founded on the manifesto's precepts, have, therefore, become a strong challenger to more traditional methods of project management and software development [15]. Nevertheless, the significance of project risk management has not diminished over time. The execution of a project, regardless of its state, is not immune to danger. Depending on the character of the undertaking, risks may be significant or negligible, but they should always be acknowledged [16]. Risk is defined as 'the probability of an action occurring that may have negative or positive effects on the implementation of the whole project or/and on its individual parts,' but it will be used here to mean 'risk is defined as the probability of an action occurring that may have negative or positive effects on the implementation of the whole project or/and on its individual parts [17, 18]. Project managers can assess risk and uncertainty by anticipating potential risk combinations and considering how they might impact the project's performance [19]. Procedures for addressing risk and ambiguity are prioritised in sustainable project management [20, 21]. Risk management is now viewed as a part of the overall decision-making process, not as a distinct technical inquiry. Due to the nature of IT project management, the human aspect is a crucial factor to consider in 'risk management for sustainable IT project management [22]. Three fundamental risk management tendencies appear in the agile methodology for handling tasks, depending on how strict or lax the strategy is [23]. Models in the literature on hard agile methods are differentiated using a three-stage risk management strategy (i.e., discovery, analysis of effects, and planning of reactions) under the ongoing supervision of the project's management [24]. With respect to lean-agile practices, there are currently two major schools of thought. The former, while stressing the importance of team leader risk evaluations during project management, fails to offer any real-world risk management solutions [25]. The latter approach considers project risk to be intrinsic and makes use of techniques like prioritisation, open dialogue with the contracting authority, and iterative development to quickly adjust to any changes in the project's requirements, technologies, or scope [26]. When determining objectives, the agile methodology takes risk into account by balancing it with the provision of client value [27]. The theory behind this is that by prioritising the most hazardous and valuable tasks, you can prevent serious issues in the future. A problem with this approach is framing risk as something that might be excessively limiting to the task at hand [28]. For example, not all project hazards are primarily influenced by the manner in which activities are carried out [29]. This paper reviews the literature for suggestions on how to carry out quantitative and qualitative research on IT projects that use an agile approach to project management, considering the unique characteristics of the projects and the inherent risks they typically entail, as well as the agile methodology that is typically used [30]. The agile project management approach heavily depends on human interactions, with an emphasis on open and regular communication between everyone who has an interest in seeing the project through to completion [31]. According to reports on the state of the IT industry and the use of agile methodologies, the project team or individuals working on the project are becoming increasingly important in deciding the total level of risk [32]. The a lack of well-established, methodical methods for managing risks in agile project management. Additionally, a study of earlier research reveals that success factors are frequently motivated by ignoring the human component. The research efforts of this paper were driven by the need to address the paucity of literature on how to 'incorporate a model approach to risk management into an agile project management methodology that values the input of all parties engaged in the project's delivery.' Therefore, the goal of this research is to present a risk management model for IT projects using an agile project management approach.

3. Methodology

The factors that affect whether a project succeeds or fails are compiled from the pertinent literature [33, 34] and include the use of agile project management, the efficiency of risk management, and the participation of important participants in an IT project [4]. According to the existing literature, the human factor in risk assessments for agile-managed projects is frequently minimised in support of processes and procedures [35]. According to a study into the dangers of IT projects managed in an agile manner, the project staff is a significant source of possible trouble [4]. Agile project management practitioners assert that risk analysis is not required when depending on client judgments for decisions like feature selection

and brief iterations as a means of risk mitigation [36]. The importance of the team's overall performance and the specific contributions of each member are emphasised in reports describing crucial success factors for IT initiatives.

3.1. The Following are Some Research Questions That the Article Suggests Examining:

RQ1: To what extent do the following risks influence the project's success?

RQ2: What procedures are employed for risk management, and how is an IT project's risk management evaluated in an agile manner?

The above-mentioned research questions will help us test the hypothesis that 'risk area identification is critical for risk management in an agile approach towards project management' [37].

A strategy for conducting the empirical investigation that would provide the expected outcomes was developed using a generic methodological framework [37, 38]. To address the study's research questions, a questionnaire was used with domain experts to identify which risks had the most bearing on the success of the project overall. Interviews are a common method of collecting qualitative data; the respondents are subjected to a series of questions designed in advance and presented in a certain sequence. The interview guide was organised using both specific advice from experts and broad ideas. The survey had three distinct sections. The first was a metric (five questions). Discussions in the second part focused on detection, evaluation, and stakeholders' management in projects (eight questions). The third included determining threats (ten questions) and quantitative and qualitative techniques for analysing risk (six questions).

A PCA was used to quantify the many risks to IT initiatives [39]. The study was conducted in India, and the researchers used a questionnaire designed for experts to conduct interviews and surveys with the target audience. The interview method contained the following criteria:

- Existing knowledge of agile project management theory and practices in the IT sector,
- All participants with this requirement participated in at least one initiative over the previous five years, and determined
- Whether they led a team or worked on the initiative as a team member, and
- Whether they used a flexible method of project management.

Project team employees and managers from various IT companies were interviewed for a total of 198 subjects using criteria identifying the target population. After checking for errors in the information provided by respondents on the questionnaires, we decided to proceed with the analysis of 109 questionnaires that included usable data (Table 1). The survey's respondents were assured of the survey's confidentiality and the data's intended use, and they were given clear guidance on how to complete the survey through instructions on its purpose, the meaning of words, and how the data would be used.

The study's anonymous questionnaire was disseminated physically at conferences where agile project management is addressed and via a previously assembled email list. It is anticipated that 300 individuals will fit the study's target population [40]. However, 174 individuals finished the survey *and* returned it. Additionally, it was found that 12 of the surveys were not fully completed during the early analysis of the gathered results, which led to the acceptance of 162 records for additional analysis of the gathered data. Thirty-eight questionnaires were discovered to have at least one failing after the chosen characteristics of the target group were confirmed. Results from 124 surveys served as the main source of data for the study Table 1.

Table 1.
Experts' Demographics and Professional Backgrounds in the Study.

Prime Attributes	Category	Number of Experts		Percentage	
		Interview	Survey	Interview	Survey
Number of years of experience	Below 1 year	0	0	0.00%	0.00%
	From 1 to 5 years	68	42	62.38%	33.87%
	From 5–10 years	37	53	33.94%	42.74%
	Above 10 years	4	29	3.66%	23.38%
Completion of projects in the last five years'	Less than 1 project	0	0	0.00%	0.00%
	From 1 to 5 projects	49	59	44.95%	47.58%
	From 5–10 projects	47	51	43.11%	41.12%
	More than 10 projects	13	14	11.92%	11.29%
Participation in building the project	Functions as Project Manager	19	14	17.43%	11.29%
	Functions as Team Leader	21	49	19.26%	39.51%
	Functions as Team Member	69	61	63.30%	49.19%

Since the study is exploratory in nature and cannot test for representativeness (qualitative research), its reliability is presumed. An instrument's reliability is a function of the size of the measurement error inherent to that instrument, which, in successive measurements, develops at random [41]. Further, it is important to verify the internal consistency of the collected data if a rating scale was used in the survey instrument.

Cronbach's alpha determines whether the scale item responses are consistent. According to accepted scholarly research, a dependability number of 0.6 or above is considered acceptable, 0.8 or above is considered very excellent, and 0.9 or above

is considered outstanding [41]. Using the popular Likert scale for describing component results from the structured interview, the questionnaire was consistent across all dimensions (Tables 2 and 3).

Table 2.
Examining the Reliability of Interview and Survey Questionnaire Responses from Subject-Matter Experts.

Description	Estimated Cronbach's Alpha Coefficient value	
	Interview	Survey
Recognition, evaluation and organization of Stakeholders' project	0.79	
Recognition, evaluation and organization of risk in project	0.78	
Evaluating the influence of risk factors in success of project		0.81
On the level of risk in project doing analysis of the influence of key stakeholder group		0.73
Influence of attributes of stakeholders on the project risk level		0.74

4. Results and Discussion

4.1. Identifying Potential Risks to IT Projects

The researchers found 412 possible risk variables within the study's sample of 109 experts. After collecting data, researchers categorised it, eliminated duplicates, and attributed each finding to a predetermined risk factor. Consequently, 207 possible risk variables were identified. The findings were then organised by the characteristics they shared. This generated 24 possible risk factor categories for an IT project using an agile project management methodology.

The procedural presumptions for meeting the prerequisites for engaging in factor analysis include ensuring that the number of variables is reasonable given the sample size [42]. The research suggests that there should be twice as many respondents as there are variables. After conducting the interviews, a total of 24 elements were identified as potential threats to the project's success. These elements were then evaluated using another survey questionnaire. The analysis of survey responses, conversely, included 124 people, or almost four times as many variables.

'The next step is ensuring that the factors can be correctly analysed. Therefore, it is a good idea to look for connections between the factors. Additionally, it is stressed that any variables with weak or no correlation must be removed from the analysis. Based on the reliability and item analysis, which also showed the general location of the correlation between the evaluated variables, four variables with very low values of correlation (below 0.2) were found. It is critical to remember that as the number of variables decreases, the relationship structure of the variables under study will change. To rule out any possible errors introduced during factor analysis, repeated item analysis of the general correlation between the study variables was conducted [43]. This study also led to the discovery of three additional factors that had very little general correlation with the other variables examined. The study set did not include these factors.

Determination of the correlation matrix and Bartlett's sphericity test are two techniques suggested in the literature for examining the dependability of component analysis. If the coefficient number is low, the factors in the study likely have strong correlations [4]. Bartlett's sphericity test yields the same data by testing the null hypothesis.

Hypothesis 1 = The matrix of correlation is a unitary one.

Hypothesis 2 = The matrix of correlation is not a unitary one.

The null hypothesis (H1) is rejected if the p-value is less than 0.05. The calculated value of the empirical Chi^2 in this study is 1764.65. The theoretical Chi^2 was computed using the following assumptions in addition to the p = 0.95, df = 173, obtaining a result of 212.61. Additionally, the real value of Chi^2 is nearly eight times greater than the value predicted by theory. The likelihood of the result is almost nil if the correlation matrix is unitary, as was supposed above. Additionally, H1 must be regarded as incorrect because the investigated data are sufficient for conducting a factor analysis [4].

A factor analysis was performed to better understand and mitigate potential threats to the project's performance. Considering this, 86% of all the possible risks that might occur when an IT project is conducted using agile methods of project management technique are contained inside the risk regions discovered using factor analysis (Table 3). In addition, the proportion of the overall variation of the six components revealed throughout the study corresponds to the influence of each risk area on the project's performance (Table 4).

Table 3.
After Adjusting for Rotation, the Proportion of Variation That Can Be Attributed to Each Particular Component

Factors' Numbering	Eigen Value	Cumulative Factor Value	Percentage of Total Variance	Cumulative Percentage
Factor 1	5.75	5.75	28.29	28.29
Factor 2	2.05	7.80	17.13	45.42
Factor 3	1.19	8.99	18.08	63.50
Factor 4	1.95	10.94	7.73	71.23
Factor 5	1.63	12.57	8.19	79.42
Factor 6	1.21	13.78	6.58	86.00

Table 4.
A Rotation Matrix Generated Using the EQUAMAX Algorithm.

Variables Understudy	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Effective communication among the project team members	0.79	-	-	-	-	-
Involvement of customer or user in development of functionality	-	-	-	-	0.60	-
Effective tools and technology	-	-	-	-	-	0.78
Culture in company	0.76	-	-	-	-	-
Assessment of labour concentration	-	0.85	-	-	-	-
Estimation of resources	-	0.78	-	-	-	-
Absence of particular needs on the user or customer level	0.79	-	-	-	-	-
Communication at the project environment level	0.76	-	-	-	-	-
Misinterpretation related to the need of a customer	0.80	-	-	-	-	-
Sensitivity of the team members	-	-	-	0.80	-	-
Rearrangement of needs	0.60	-	-	-	-	-
Project management techniques and approaches	-	-	0.52	-	-	-
Integration of projects	-	-	0.74	-	-	-
Test environment	-	-	-	-	-	0.63
Business goals	-	-	-	-	0.77	-
Cordial relationship among project team members	-	-	0.78	-	-	-
Estimation of project budget	-	0.72	-	-	-	-
Non-functional needs	-	-	-	-	0.75	-
Cordial relationship between team and project managers	-	-	-	0.57	-	-
Output Variances	5.45	3.76	2.88	2.01	2.09	2.76
Content	0.42	0.41	0.08	0.90	0.11	0.90

The following categories were derived from IT project management literature by analyzing the components of the selected six variables and interpreting the aforementioned sets:

- Factor 1— Organizational culture is a risk for the business that will be carrying out the project (organizational culture).
- Factor 2— Project execution time frame and budget as potential sources of stress.
- Factor 3— Risk factors associated with the project management approach, team structure, and project integration tools and methodologies (project organisational environment).
- Factor 4— Risks stemming directly from the presence of humans, i.e., the team (project team).
- Factor 5— The area of potential harm is determined by the corporate goals, outlook, and user participation in the project.
- Factor 6— Risks associated with the technology being used (technical and technological environment).

4.2. Examining the Methods Employed in IT Projects for Handling Risk'

The research relied on in-depth interviews with industry professionals. Respondents' responses were categorised by their role on the project team to provide an overview of the study findings concerning the detection, evaluation, and management of project risks [44]. Restriction on the acquired test findings was imposed due to the sequential nature of the component procedures that encompass risk management, including identification, evaluation, monitoring, and reaction [35, 45]. The following restrictions are intended as guidelines for the creation of separate process components within the proposed risk management model in agile project management and to provide further context for the research results:

- Most IT projects have a process for identifying potential risk factors.
- A quantitative and qualitative evaluation of the risks associated with a project is routinely performed.
- Frequently, rather than infrequently, major project risks are managed.

4.2.1. Recognising Potential Factors Associated with Risk

Recognising risk entails looking for and documenting everything that may go wrong with the project's execution. This documentation is known as 'risk factors' [46]. The relevant literature refers to a critical approach to risk management, which is implemented as a distinct procedure. Agile approaches take a more relaxed stance, considering risk management as a part of the process rather than an impediment [47]. The significance of this process is shown by the prevalence of agile approaches

that are laser-focused on project management. This is supported by field studies [48]. Figures 1a and 1b display the project planning risks that have so far been identified.

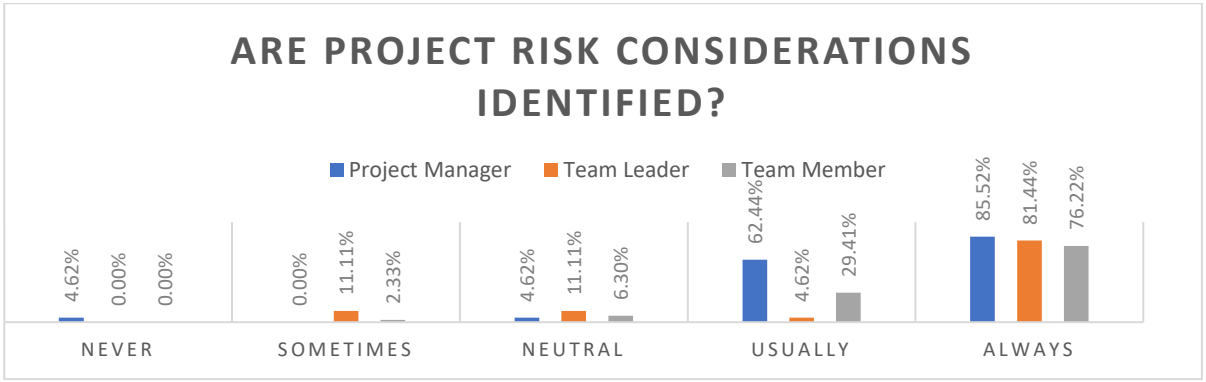

Figure 1a.
Recognition of Potential Risk Factors Required Throughout the Project Planning (n = 109).

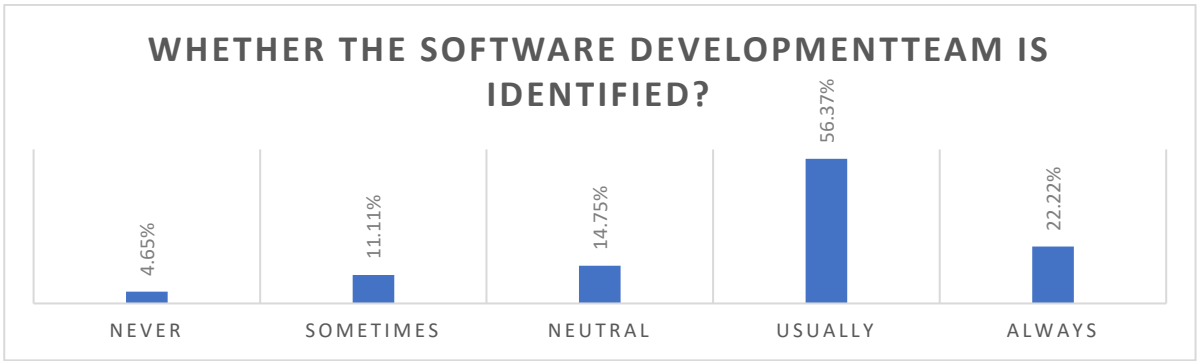

Figure 1b.
Recognition at the Stage of the Software Development Team (n=109).

When responding to criticism, it is important to highlight those light methodologies like Scrum are closely related to project and production team management [49]. Light-approach risk management practices (such as regular meetings, frequent product delivery, and open lines of communication with customers) are also prioritised [50]. Consequently, this aids in mitigating risks associated with the dynamic nature of project environments. Due to the constraints, teams of eight, where there are four individuals, four supervisors, and two managers, could not be investigated [51].

4.2.2. Evaluation of Factors Associated with Risk

In nine instances, value two was assigned to the respondent's response after a thorough analysis of the data from the qualitative and quantitative evaluation of project risk factors (sometimes) [52]. Therefore, there is almost no evaluation of potential risks in these situations. Usually, this is because of the intricacy of the project or because of a superficial use of agile project management (Scrum, for example). This does not include procedures for determining whether risks exist. Any time a review, retrospective, or daily Scrum is performed during implementation, the risk is discovered.

Moreover, 15 respondents said they routinely do both qualitative and quantitative risk assessments. Eleven of the examples stated that risk variables are evaluated only on a qualitative basis. Only one respondent, however, admitted to adopting only the quantitative evaluation.

The results shown in Figures 2a and 2b align with those found in the current literature on the issue, which emphasises the trend away from quantitative assessment in favour of qualitative measures using a simplified risk exposure scale [53]. This is to be expected when considering the short duration of implementation stages, given the time-consuming nature of risk assessment, whereby almost all potential threats associated with the used technology, the complexity of the product, or the efficiency of the team are continuously detected [54]. Due to the constraints, nine team members had to be removed from consideration.

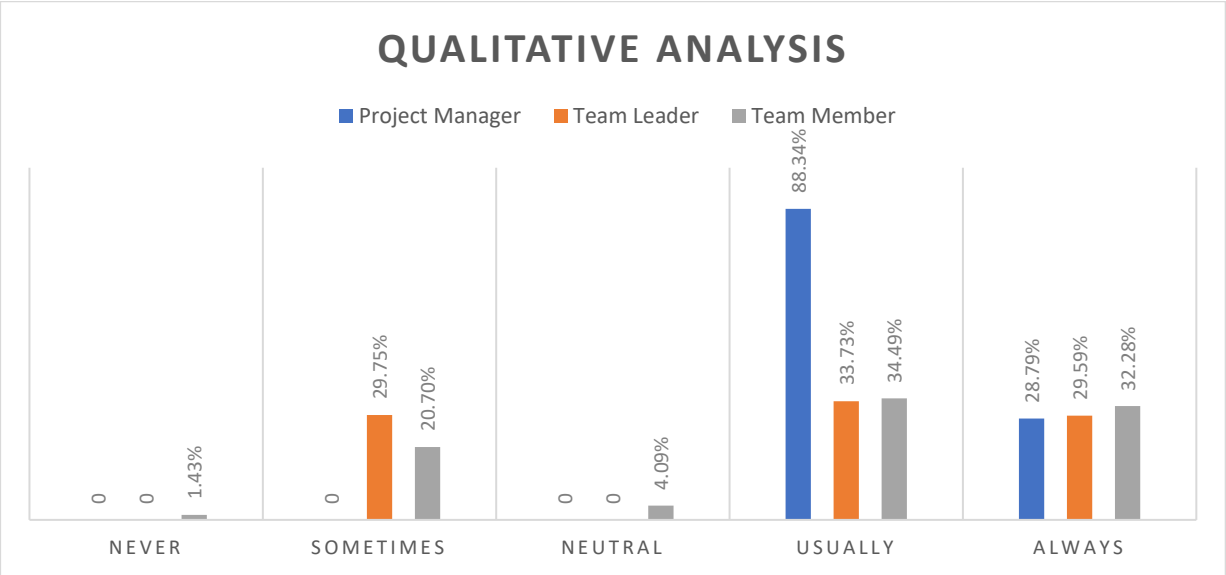

Figure 2a.
Qualitative Analysis.

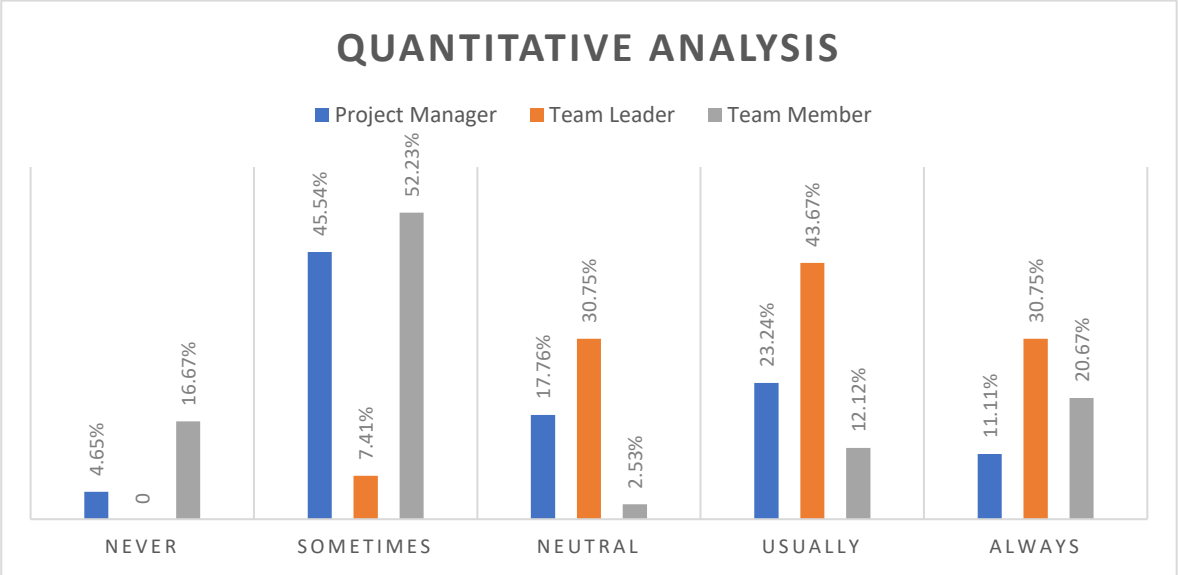

Figure 2b.
Quantitative Analysis.

4.2.3. Controlling Risks While Carrying Out a Project

While describing the risk management process in hard techniques, the literature primarily discusses the management of significant project risks when referencing the foundations provided in the cascade approach [55]. Researchers found that most respondents believed they could handle large risks in most cases [56]. Consequently, it is crucial to emphasise that even if it is suggested to shift away from the project risk management processes in the context of adopting these strategies, executives will likely continue to employ the old methodologies (Figure 3).

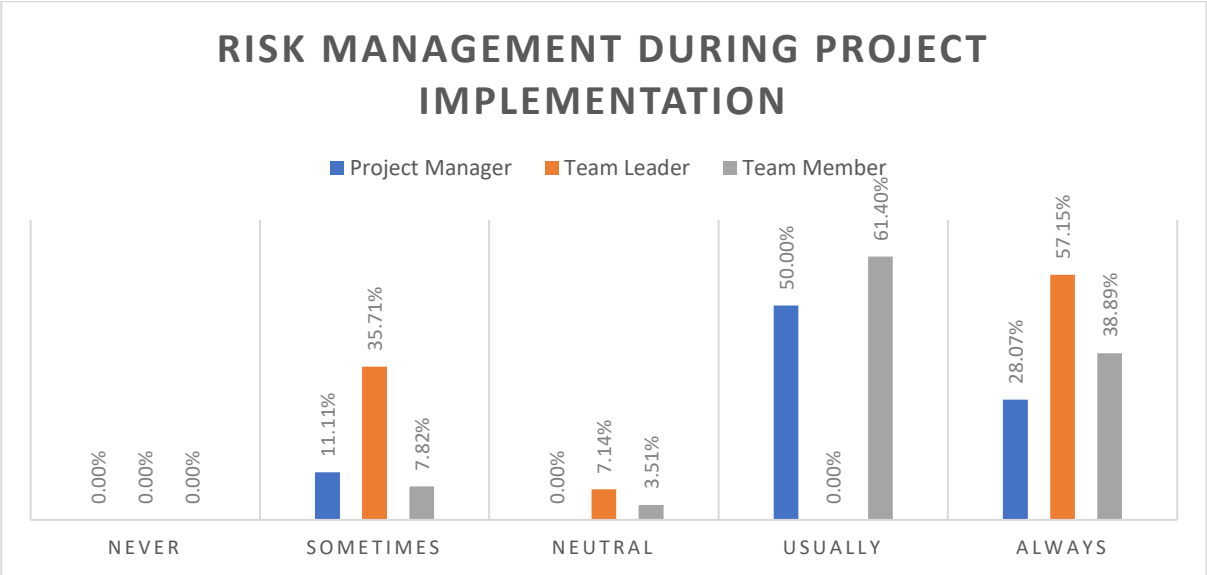

Figure 3.
Risk Management During Project Implementation.

In most situations studied, the software development team is occasionally tasked with monitoring and reacting to risk factors that arise throughout the course of project execution (Figure 4). Many of the experts cited the labour intensity of newly assigned tasks as an explanation for why fewer features should be included in the current iteration when more work is distributed across the team [57].

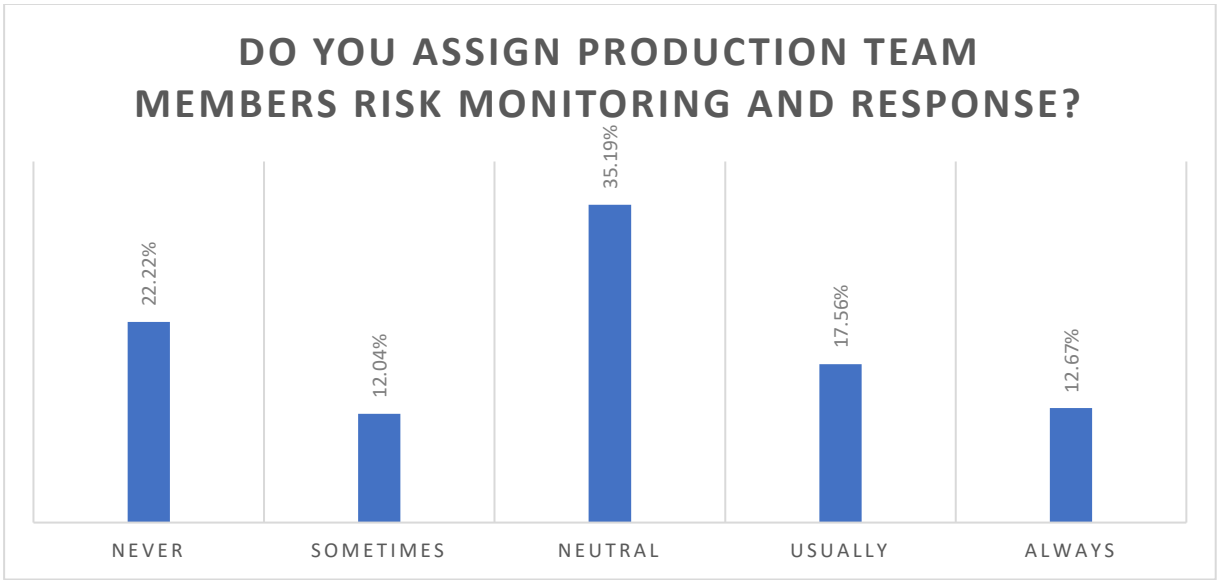

Figure 4.
Risk Monitoring.

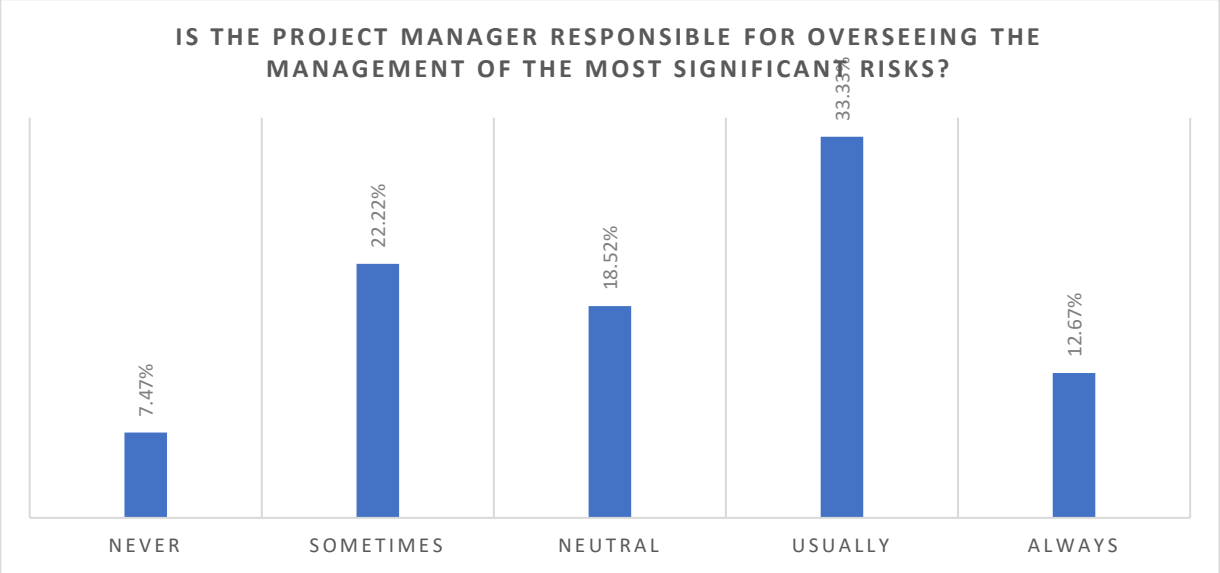

Figure 5.
Responsibility of the Project Manager for Overseeing the Management.

In the surveyed sample, 33.33% of respondents stated this occurs usually, and 22.22% stated this occurs sometimes. The findings also show how important it is to monitor for significant risks and to handle them when they arise in a project (Figure 5). The results show that 7.47% of respondents believe that, in projects where they participate, key risk considerations are not included in the project management process [58]. If the project management level is absent, the team leader must assume full responsibility for any extra risk management procedures [59].

5. Discussion

After reviewing the literature and compiling data from the expert interview questions [35], we settled on the following risk-management model sub-processes:

- Teams working on software development, as well as those working on the project's planning and requirements verification, must conduct the bulk of the risk assessment.
- The effects of potential risks are evaluated at the project and production team levels.
- Action must be taken in response to significant project risks and those that affect the production team directly.
- Project-level risk monitoring as an integrated process.
- Project-level risk management planning is defined as the process through which the selected methodologies, strategies, and responsibilities for managing risks within a project are determined.
- Transparency, here defined as the disclosure of relevant information to those with a direct interest in a project, is bolstered by communication as a connecting and highlighting aspect.

The principal component analysis of IT project risk further confirms the significance of the discussed data [60]. Additionally, an element integrating these risk areas according to the project requirements was selected due to the significance of the number of stakeholder interests expressed in them and the examination of the components contained in the individual risk areas throughout the project implementation process [61]. Figure 6 is a visual representation of the aforementioned IT project risk management methodology and framework.

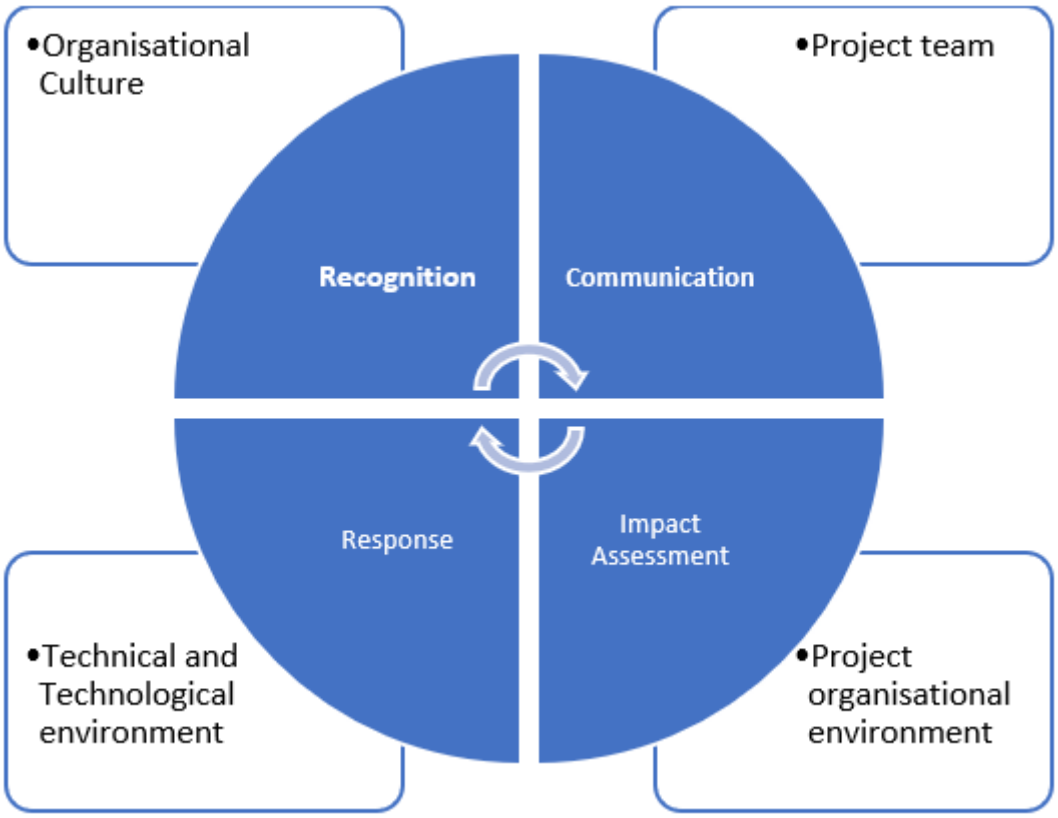

Figure 6.
An IT Project Risk Management Framework.

6. Conclusion and Suggestions

The purpose of this study was to provide a framework for handling risks in agile project management. The stated goal has been accomplished due to the research effort, including the completed empirical study [62]. This article makes both theoretical and practical advances with the research it presents. In particular, the IT project risk management field benefits from this research's insights. The research challenge was formulated after reviewing existing literature that revealed a gap in the existing body of knowledge [63]. The significance of risk analysis on the final outcome of an IT project has been highlighted by studies examining the effectiveness of various approaches to risk management [64]. Results further support the idea that managers and team leaders apply fundamental procedures, including risk factor recognition (identification), impact assessment, and management of important risk factors, when implementing IT projects [65]. Additionally, 67.25% of respondents said that they identify, analyse the effect of, and manage major risk variables in most projects that they are involved in, and they believe risk analysis is crucial to project success [66]. Whether soft or hard agile techniques are used, the development and/or design teams are responsible for identifying and assessing risk factors as part of risk analysis. In light methods (such as Scrum), it is ultimately the team leader's job to oversee risk management for the project [67]. This includes identifying related actions, an analysis of effects, reaction, and monitoring any risk factors, as the Scrum Guide does not explicitly define the (extra) role of a project manager (a major hindrance to its implementation). The project team will be in charge of activities including monitoring and reacting to any problems that may arise as a consequence of the project's execution of major risk factors and direct risks, unless a formal role analogous to that of a project manager (or one with a comparable scope of competence) already exists. Conversely, as is recommended by hard agile approaches, the development team is responsible for tasks linked to risk assessments of the production process, such as software. The empirical identification of the most prevalent classes of IT project risk was another important outcome of this work. Using a well-established study methodology that included in-depth interviews with 109 subject-matter experts, 412 potential risk variables were discovered. A list of 24 possible IT project risk factor groups was created by arranging them sequentially according to the features to which they related and counting the number of similar situations. Through a questionnaire, further study included utilising the survey's data to assess the influence of the discovered and categorised risk variables on the project's success. Moreover, six unique categories of risk management were identified using the principal components technique, which account for 86% of all possible risk variables that may develop over the duration of an IT project. These areas include 'organisational culture, schedule/cost, project organisational environment, project team, user/customer, and technical and technological environment [68]. Therefore, the study's null hypothesis that risk identification is not essential for risk management in agile project management was disproved.' Future investigations by the author will concentrate on validating the created model in practice and validating the influence of selected regions on the expansion of IT project success.

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