The Effects of Stakeholders Management on Risks: An IT Projects Analysis

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Abstract

The literature indicates that inadequate communication with stakeholders and activities' inherent uncertainties are some of the main causes of project failure. Therefore, two essential areas of project management are risk management and stakeholder engagement plan. In this matter, this study aims to evaluate how stakeholders affects project risks and how they relate to project success from the understanding of concepts and management tools. Four factors related to stakeholder management were defined as guides for the creation of eight scenarios, which resulted in different probabilities for three risk variables. Nine interviews with IT projects experts and specialists on project management education were conducted to obtain opinions on the proposed scenarios. The consistency of responses was verified by the Delphi method and by the coefficient of variation. The statistical method of Design of Experiments was applied, using Minitab® software, for the construction of the research instrument and for data analysis. Therefore, the effects of the factors 'stakeholder register', 'stakeholder engagement', 'communication with stakeholders', and 'number of stakeholder groups' on response variables 'negative risk incidence', 'opportunities incidence', and 'development of contingency strategies' were identified. Results show that the engagement and communication with stakeholders have a significant influence in the occurrence of negative risks, in the occurrence of opportunities and in the development of contingency strategies for the analyzed scenarios.

Keywords
Project Management. Stakeholder Engagement. Project Risk Management. Design of Experiments. Delphi Method.

1. Introduction

The development of Project Management (PM) aims at the reduction of risks and efficient use of resources during the project (Kerzner, 2009). The business environment has several challenges such as uncertainties, technologies, and partnerships, among others; therefore, companies search for high effectiveness solutions and strategies to achieve higher project management performance and to adapt to the new market (Ika *et al.*, 2020; Kerzner, 2009).

The inefficient communication between the people involved and the high complexity of tasks are key factors for project failure (Gupta *et al.*, 2019). Hence, the stakeholder engagement and the risk analysis are two main areas of project management. The cooperation between all the stakeholders improves the project development and creates competitive advantages to the company (Luu et al., 2008). Besides that, stakeholders have considerable influence in differents aspects and they must be aligned with strategic goals of the project's crew (Cuppen et al., 2016).

Uncertainties are inherent to any undertaking and it could have both positive and negative effects that should be monitored through the project's life cycle (Wied *et al.*, 2020; Xia *et al.*, 2018). The integration of stakeholders and risks management reduces the conflict of interest, increases the efficiency of resources allocation, improves the management decisions and allows new perspectives for the project. Previous studies demonstrate that stakeholder management and risk management also have a positive impact on cost reduction (Civera *et al.*, 2019; Ika *et al.*, 2020; Xia *et al.*, 2018).

In an Information Technology (IT) environment, projects present high failure rates in consequence of the poor risk management and also organization aspects such as the relations between team members (Butler *et al.*, 2020; Pimchangthong and Boonjing, 2017). Stakeholder engagement along with an action plan for uncertainties are fundamental for a good project development. In comparison to others, IT projects are most likely to be affected by negative risks due to its uncertain environement and the lack of integration between the technical and managerial knowledge (Flyvbjerg and Budzier, 2016; Ko and Kirsch, 2017).

There are several studies on communication and stakeholder engagement methods to improve the participation in strategic decisions and in the identification of internal and external risks of the project (Civera et al., 2019; Xia et al., 2018). Nevertheless, the interaction of the two aforementioned areas is less explored in the PM literature, but even so relevant to increase project success rates.

This research aims to evaluate how stakeholders affect project risks and how they relate to project success from the understanding of concepts and management tools. The driving question for this research is: *What are the effects of stakeholders' management on project risks for Information Technology projects?*

The paper unfolds as follows. The second section presents the literature review on the two main topics. The third section describes the tools and the methods used to gather and analyze data. The fourth portion discusses the results found from the specialists' interview, while last section presents the conclusions and future paths of research.

2. Literature Review

2.1 Stakeholder engagement

A stakeholder can be defined as an organization, a person or a group that affects or are affected by a project decisions, activities or requests (Freeman, 1984; PMI, 2017). The identification and analysis of these agents are essential to project development. The classification of stakeholders is based on their power of influence, on the legitimacy of the relationship between stakeholder and enterprise and on their urgency for results (Aragonés-Beltrán *et al.*, 2017; Barrane *et al.*, 2020). Stakeholders affect differently project activities and goals and so, it is necessary to adapt the management method and team actions to each behavior. The power and influence levels can be studied from graphs so their objectives are aligned with the project crew (Civera *et al.*, 2019; Lobo and Samaranayake, 2020).

Stakeholder engagement is an approach to encourage the involved person/group to participate on tasks and activities, to share knowledge and to help the efficient development of project stages. The engagement management aims to reduce the resistance and increase the collaboration between stakeholders to decrease risks and costs and to improve project quality (Isike and Ajeh, 2017; PMI, 2017; Stock *et al.*, 2021). There are several methodologies and tools to help this process. An example is the agile framework Scrum that is organized into iterative cycles in which a value must be presented to the costumer each sprint to create new discussions on the next step and to enable the stakeholder to opine on the project (Dawn and Yearworth, 2016; Khoja *et al.*, 2010).

2.2 Risk management

A risk is connected with uncertainties inherent to a project and is characterized as the probability of non-achievement of a goal (Kerzner, 2009). Thus, a risk may have positive effects (opportunities) or negative effects (threats) during project development. Therefore, risks must be identified and evaluated so their negative impacts are reduced, and positive impacts are enhanced (Qazi *et al.*, 2021; Xia *et al.*, 2018). Risk identification can be made by analyzing project documents, by the managers' past experiences, by follow-up meetings, by using categorization techniques, such as the RBS (Risk Breakdown Structure), among others (Kwan and Leung, 2011; PMI, 2017). Another frequently used tool is the SWOT (Strengths, Weaknesses, Opportunities e Threats) analysis to have a project overview and to guide the strategic decisions (PMI, 2017).

The matrix of probability and impact and FMEA method (Failure Mode and Effects Analysis) are also tools used to the qualitative evaluation of uncertainties (Carbone and Tippett, 2004; PMI, 2017). Moreover, the EMV (Expected Monetary Value) and the tornado diagram are quantitative tools used in this matter (PMI, 2017). The agile approach does not define a formal procedure to risk management, nevertheless, it considers the uncertainties analysis a continuous step through all the project life cycle (Albadarneh et al., 2015). The risk identification and the action plan creation are made at every follow-up meeting (Tomanek and Juricek, 2015).

3. Methods

3.1 Construction and application of the research instrument

According to previous literature, the interaction between stakeholder management and risk management needs further digging. Therefore, the proposed model aims to measure the effects of stakeholders' factors on risk elements in the IT projects context. The variables are described in the Table 1.

Table 1 - Variables included in the model.

Factor	Independent (x)	Measure
F1	Stakeholder register	Present or absent
F2	Stakeholder engagement	High or low
F3	Communication with stakeholders	High or low
F4	Number of stakeholders groups	Large or small
Response	**Dependent (y)**	**Measure**
Y1	Negative risks incidence	5-point Likert scale
Y2	Opportunities incidence (positive risks)	5-point Likert scale
Y3	Development of contingency strategies	5-point Likert scale

Variables were categorized into two levels of response, as shown in Table 2. These levels were used to create the research questionnaire by using Design of Experiments method (DoE). Literature definitions and experience on project management guided this classification.

Table 2 - Variable levels.

<table>
<tr><th>Factor</th><th>Levels</th></tr>
<tr><td rowspan="2">Stakeholder register</td><td><u>Present</u>: there is a formal documentation describing all stakeholders, with their role (project team, supplier, costumer, etc.), engagement level, influence level on the project, needs and requirements, among others.</td></tr>
<tr><td><u>Absent</u>: there is no formal documentation about stakeholders.</td></tr>
<tr><td rowspan="2">Stakeholder engagement</td><td><u>High</u>: there is stakeholders' active participation on project stages and decisions, on follow-up and execution of tasks, on requirements definitions, among others.</td></tr>
<tr><td><u>Low</u>: stakeholders do not participate on project decisions, only on mandatory situations such as the product requirements definition.</td></tr>
<tr><td rowspan="2">Communication with stakeholders</td><td><u>High</u>: reports, presentations and lessons learned register are present based on communication with stakeholders.</td></tr>
<tr><td><u>Low</u>: there are only notifications about the project development</td></tr>
<tr><td rowspan="2">Number of stakeholders groups: each range of people were considered a group of stakeholders, namely, all members of the project's team form a group named 'project's team', all costumers' representatives form the group 'costumer' and so on.</td><td><u>Large</u>: there are five or more groups of stakeholders involved in the project</td></tr>
<tr><td><u>Small</u>: there are less than five groups of stakeholders involved in the project</td></tr>
</table>

The variables related to project risk were measured using 5-point Likert scale, varying from 1 (very low probability) to 5 (very high probability). The Fractional Factorial Design method 2^{4-1} was applied using Minitab® software to generate eight different scenarios presenting the four factors with fluctuating levels (Montgomery, 2017). The scenarios planning is shown in Table 3.

Table 3 - Fractional Factorial Design (2^{4-1}) guide to the scenarios.

Order	Stakeholder register	Stakeholder engagement	Communication with stakeholders	Number of stakeholders groups	Negative risks incidence	Opportunities incidence	Development of contingency strategies
1	Present (+1)	Low (-1)	Low (-1)	Large (+1)	1-5	1-5	1-5
2	Present (+1)	Low (-1)	High (+1)	Small (-1)	1-5	1-5	1-5
3	Absent (-1)	High (+1)	High (+1)	Small (-1)	1-5	1-5	1-5
4	Present (+1)	High (+1)	High (+1)	Large (+1)	1-5	1-5	1-5
5	Absent (-1)	High (+1)	Low (-1)	Large (+1)	1-5	1-5	1-5
6	Absent (-1)	Low (-1)	High (+1)	Large (+1)	1-5	1-5	1-5
7	Present (+1)	High (+1)	Low (-1)	Small (-1)	1-5	1-5	1-5
8	Absent (-1)	Low (-1)	Low (-1)	Small (-1)	1-5	1-5	1-5

A pilot test was executed with one specialist to ensure clarity and understanding of the instrument. After this validation, nine experts from IT companies and education institutions were contacted by e-mail to schedule meetings for applying the questionnaire. This number is coherent with renowned studies with less than ten experiments and valuable results (Durakovic, 2017; Fukuda *et al.*, 2018). The main information on the experts is described in Table 4.

Table 4 - Expert's information.

Expert	Experience in IT projects (years)	Experience in PM education (years)	Company size (number of employees)
Expert 1	1	2	100
Expert 2	20	-	40
Expert 3	30	-	650
Expert 4	10	-	700
Expert 5	5	3	100
Expert 6	15	4	5000
Expert 7	-	13	40
Expert 8	-	5	40
Expert 9	2	-	1900

The interviews and questionnaire applications were made between August/2019 and September/2019. Experts were asked to analyze each scenario and to define a probability to each response variable, creating seventy-two results (nine participants times eight combinations). The experts' identity and the enterprises were undisclosed for privacy reasons.

3.2 Response consistency

The Delphi method is usually applied to reduce negative influences of group interactions by searching a consensus. The final result is based on all answers without hierarchy (Geist, 2010). According to Jorm (2015), the group should have the following characteristics: (i) Diversity of expertise: the results' quality is better when the group is heterogeneous; (ii) Independence: each participant should have full autonomy to make decisions without the others; (iii) Decentralization: the group should be formed by people from different origins (companies, sector, roles); (iv) Aggregation: the responses coordination and aggregation should follow the method proposed.

The answers from questionnaire were compiled using statistic treatment and comparison between the responses and a reference value. A usual guide parameter is the coefficient of variation (CV). The consensus concept by the Delphi method depends on the type and the research objectives (Jorm, 2015). This paper considers CVs under 0.50 as a consensus (Sampaio *et al.*, 2018).

3.3 Data analysis

The Design of Experiments method is frequently used to identify the impact of multiple variables on the final performance of a product. This method is efficient to study more than one parameter and to use statistical analysis to understand the impact of factors interaction on the result. The Fractional Factorial Design method, 2^{k-p}, takes into account the most relevant scenarios to the analysis and allows a smaller data-base (Montgomery, 2017; Politis *et al.*, 2017). According to Montgomery (2017) and Fettermann et al. (2017), a General Linear Model (GLM) was elaborated to characterize the categorical independent variables and the quantitative dependent variable. The results demonstrate how each factor affects the response variables. Therefore, it is possible to infer the effects of stakeholders management on project risks.

Stakeholder register, stakeholder engagement, communication with stakeholders and number of stakeholders groups were used as the explanatory variables. The dependent variables analyzed were negative risk incidence, opportunities incidence and development of contingency strategies. The factor 'expert's effect' was also analyzed to clarify if the experts' opinions affected the experiment and, consequently, the response variables.

4. Results and Discussion

4.1 Response consistency

The questionnaire application with nine experts generated seventy-two responses with natural variability, thus the coefficient of variation was calculated to each risk variable to measure the divergency degree. The considerable variation of the bold values in Table 5 is noticeable (CV greater than 0.50 on the original values). Analyzing the response database, a higher standard deviation was observed in these items due to a specialist who evaluated these scenarios differently. A second round of discussion was performed with the experts aiming to reduce the discrepancy. The original and updated CVs are shown in Table 5.

Table 5 - Coefficients of variation.

Scenario	Negative Risk	Opportunities	Contingency Stretagies	Negative Risk Updated	Opportunities Updated	Contingency Stretagies Updated
1	0.0923	**0.5467**	**0.6720**	0.0923	**0.3388**	**0.3388**
2	0.2706	0.2357	0.2513	0.2706	0.2357	0.2513
3	**0.6614**	0.1044	0.1462	**0.3388**	0.1044	0.1462
4	0.2846	0.1515	0.1999	0.2846	0.1515	0.1999
5	0.1768	0.3030	0.2400	0.1768	0.3030	0.2400
6	0.2206	0.2972	0.2706	0.2206	0.2972	0.2706
7	0.2586	0.2598	0.2069	0.2586	0.2598	0.2069
8	0.1635	**0.6491**	**0.7216**	0.1635	**0.3750**	**0.3608**

The response consistency was considered sufficient to the study, since all the CVs were under 0.50 (Sampaio *et al.*, 2018). Therefore, the estimated models had satisfactory confidence levels.

4.2 Negative risk incidence (Y1)

Initially, a normality test by the Anderson-Darling method was made for the residue of the negative risk incidence variable (Y1). The hypothesis that the values do not adhere to the normal distribution was rejected by the results (AD=0.583; p-value=0.124). The residues and adjustments are shown in Figure 1.

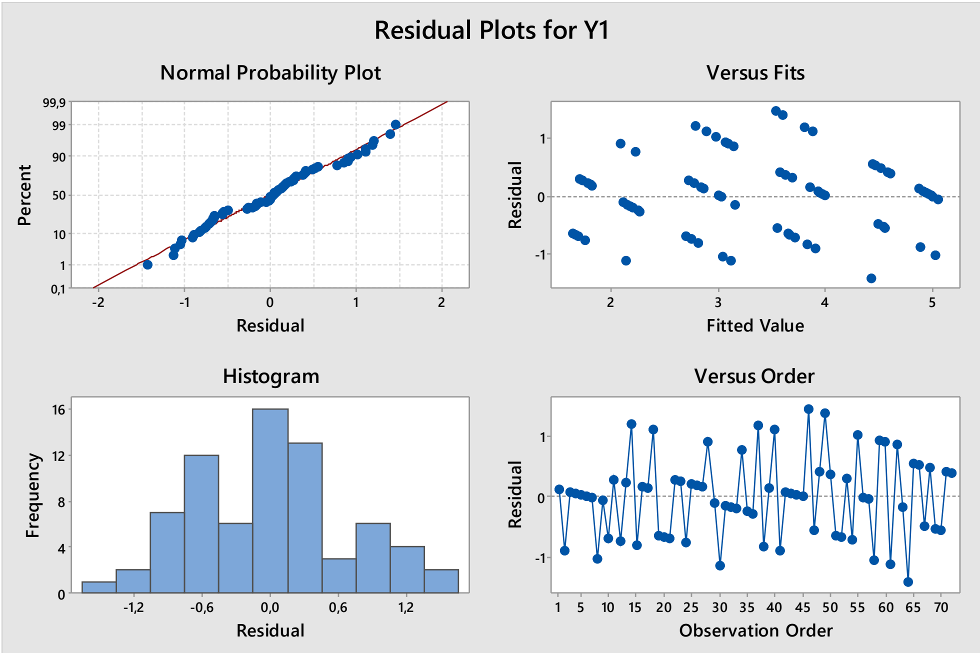

Figure 1- Model fit to the negative risk incidence.

The model presented significant projection capacity (R^2 adjusted = 68.89%) and the results are described in Table 6.

Table 6 - Variance analysis (ANOVA) for the negative risk incidence.

Variables	DF	Sum of the Squares	Mean of the Squares	F-Value	P-Value
Expert	1	0.252	0.2521	0.52	0.473
F1- Stakeholder register	1	0.681	0.6806	1.41	0.240
F2- Stakeholder engagement	1	28.125	28.1250	58.19	0.000***
F3- Communication with stakeholders	1	42.014	42.0139	86.92	0.000***
F4- Number of stakeholders groups	1	7.347	7.3472	15.20	0.000***
Error	66	31.901	0.4833		
Total	71	110.319			
Model projection capacity	R^2:71.08%	R^2 adjusted: 68.89%			

* significant in 10% | ** significant in 5% | *** significant in 1%

The factor 'expert' was not considered significant by the estimated model. It indicates that the participants' answers have no considerable effect on the estimation of negative risks (Y1). Stakeholder engagement (F2), communication with stakeholders (F3) and the number of stakeholders group (F4) affect Y1 and the effects magnitude is shown in Figure 2. Thus, the parameters variation of the low level (-1) to the high level (+1) creates greater impact on the negative risk incidence.

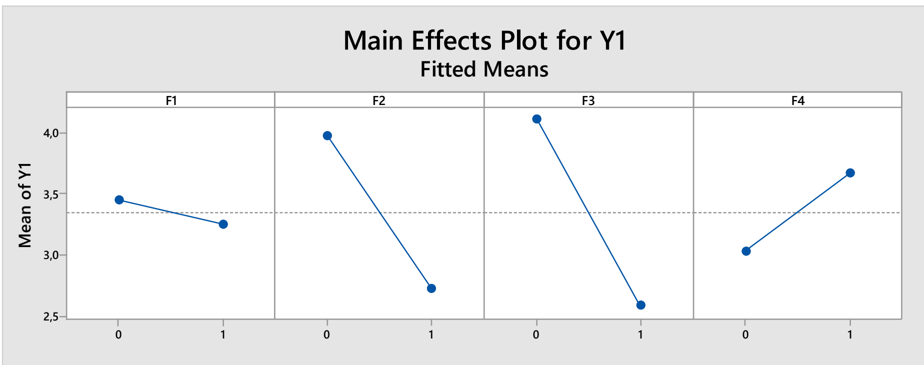

Figure 2 - Factors' effect on the negative risk incidence.

Additionally, the stakeholder register (F1) did not present considerable impact on Y1. According to experts, this factor has no significant effect on the variable analyzed.

4.3 Opportunities incidence (Y2)

The opportunities incidence analysis was similar to the previous, nevertheless, it presented a low adherence to the normal distribution by the Anderson-Darling test (AD=2.218; p-value<0.05). The Box-Cox transformation was applied to enhance the residues; however, the estimated model did not improve the adherence, as shown in Figure 3.

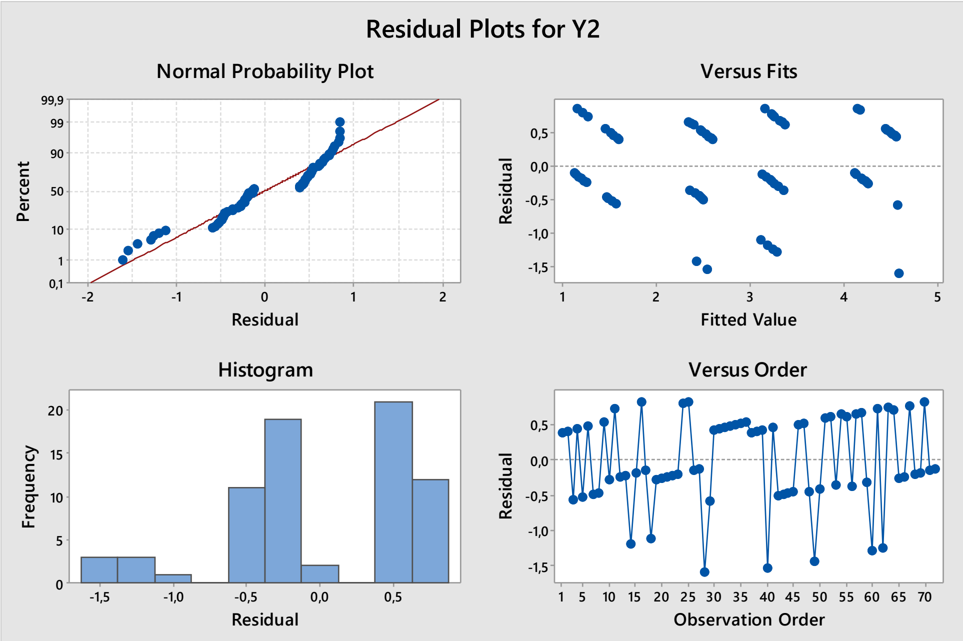

Figure 3 - Model fit to the opportunities incidence.

The estimated model to the opportunities incidence presented confidence level of 73.35% and the results are shown in Table 7.

Table 7 - Variance analysis (ANOVA) for the opportunities incidence.

Variables	DF	Sum of the Squares	Mean of the Squares	F-Value	P-Value
Expert	1	0.169	0.1687	0.39	0.537
F1- Stakeholder register	1	5.556	5.5556	12.69	0.001***
F2- Stakeholder engagement	1	43.556	43.5556	99.51	0.000***
F3- Communication with stakeholders	1	37.556	37.5556	85.81	0.000***
F4- Number of stakeholders groups	1	0.889	0.8889	2.03	0.159
Error	66	28.887	0.4377		
Total	71	116.611			
Model projection capacity	R^2:75.23%	R^2 adjusted: 73.35%			

* significant in 10% | ** significant in 5% | *** significant in 1%

The factor 'expert' was not significant to the opportunities incidence (Y2) estimation. The factors F1, F2 and F3 presented the greater effect on Y2 with p-value under 0.01. According to experts, the variation of the low level to the high level of these parameters increases the probability of opportunities incidence, as shown in Figure 4.

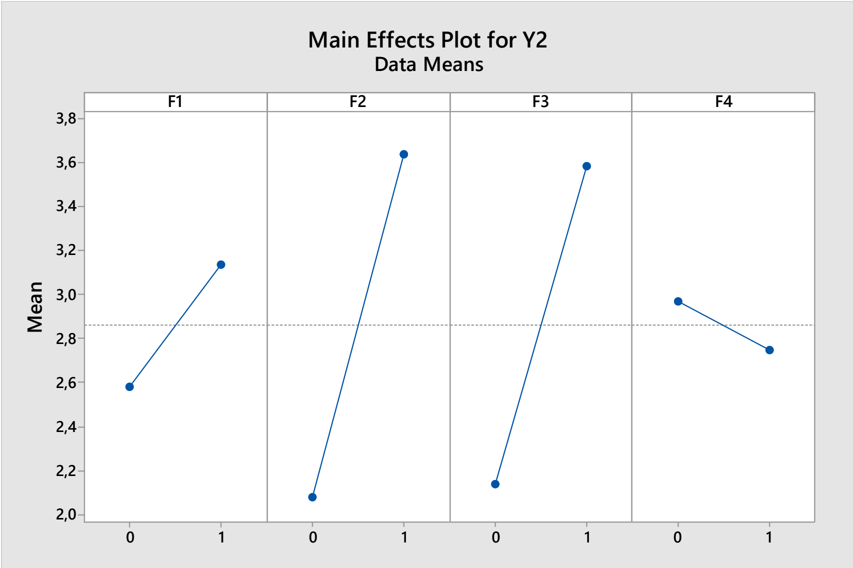

Figure 4 - Factors' effect on the opportunities incidence.

Another bias concerns the number of stakeholders groups, which has not a considerable effect on Y2. According to the experts, this factor is not relevant to the opportunities incidence.

4.4 Development of contingency strategies (Y3)

The development of contingency strategies (Y3) variable was tested and presented residues adherent to the normal distribution by the Anderson-Darling method (AD=0.220; p-value=0.828). The residues and adjustments are shown in Figure 5.

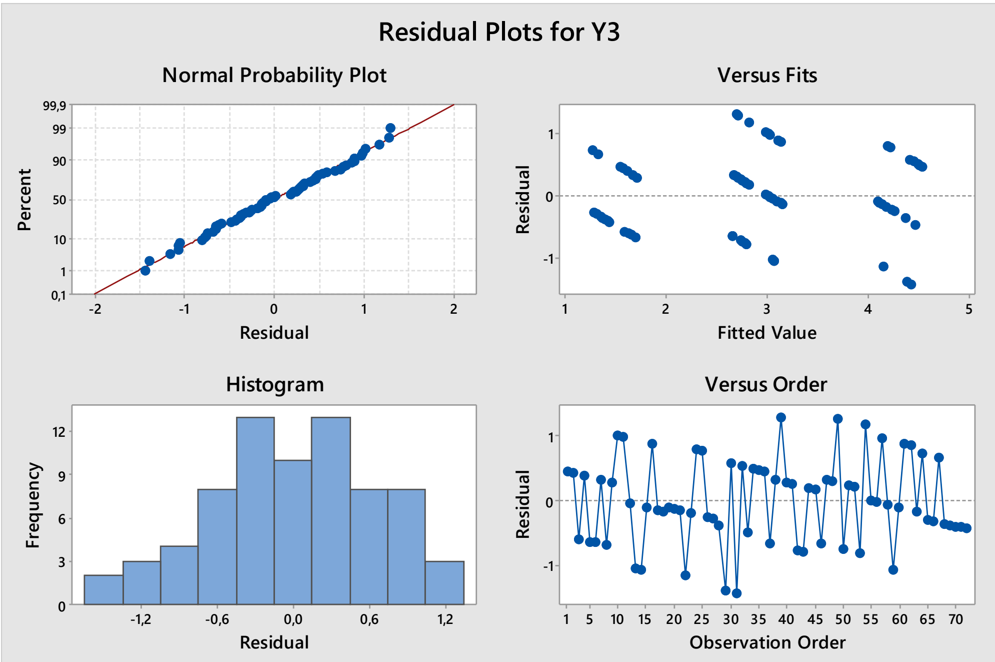

Figure 5 - Model fit to the development of contingency strategies.

The estimated model has a considerable projection capacity of 68.89% and its results are detailed in Table 8.

Table 8 - Variance analysis (ANOVA) for the development of contingency strategies.

Variables	DF	Sum of the Squares	Mean of the Squares	F-Value	P-Value
Expert	1	0.208	0.2083	0.46	0.502
F1- Stakeholder register	1	1.681	1.6806	3.68	0.060*
F2- Stakeholder engagement plan	1	36.125	36.1250	79.04	0.000***
F3- Communication with stakeholders	1	36.125	36.1250	79.04	0.000***
F4- Number of stakeholders groups	1	0.014	0.0139	0.03	0.862
Error	66	30.167	0.4571		
Total	71	104.319			
Model projection capacity	R^2:71.08%	R^2 adjusted: 68.89%			

* significant in 10% | ** significant in 5% | *** significant in 1%

Similar to the previous analysis, the factor 'expert' was not significant by the estimated model to the development of contingency strategies (Y3). The stakeholders engagement and the communication with stakeholders are the most relevant to the Y3 (p-value < 0.01), namely, the positive variation of these factors improve the contingency strategies possibility. Besides that, F1 is significant in 10% indicating a lower influence on Y3, as shown in Figure 6.

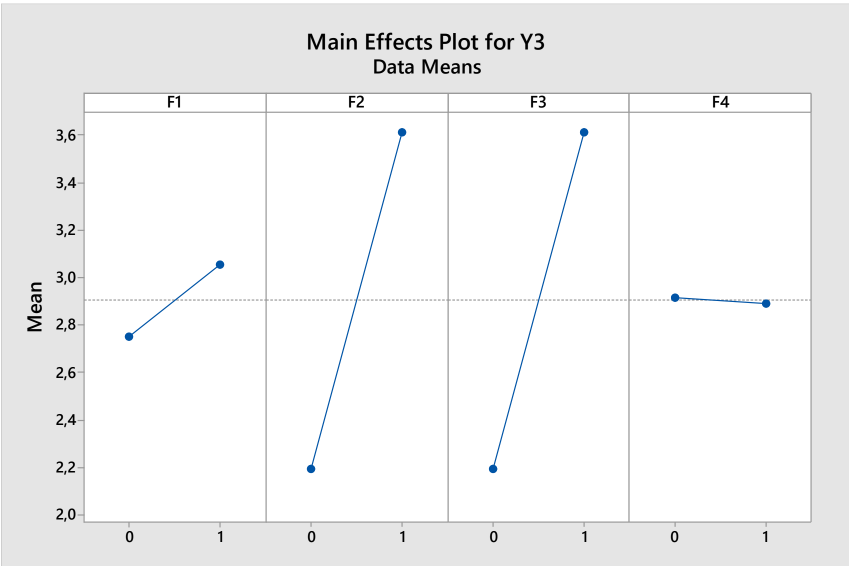

Figure 6 - Factors' effect on the development of contingency strategies.

The number of stakeholders groups presented the lowest impact on Y3. The variable 'contingency strategies' is not affected by this factor on the scenarios elaborated.

5. Conclusion

The inefficient risk management and the miscommunication with the people involved in the project are the main project failure causes (Gupta et al., 2019). The understanding and the integration of these two areas are essential to create innovative solutions and to the IT project effective development (Bernardo *et al.*, 2015; Lehtinen and Aaltonen, 2020; Xia *et al.*, 2018). Using the Design of Experiments method, this paper extended knowledge in this matter by highlighting the impact of stakeholder engagement and communication with stakeholders on negative risk incidence, on opportunities incidence and on development of contingency strategies. According to the experts and to the estimated models, these factors related to stakeholder management present the greater effects on risk management area and, thus, possibly in project success.

The research did not include the synergy between stakeholders and risks, but it is also important to understand the actions that affect both areas simultaneously to increase the probability of project success. The PM also have several branches such as costs, quality, and resources that could be analyzed along with the chosen areas.

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