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ANALYSIS OF THE IMPACT OF RESEARCH PROJECTS RISKS IN THE KPIS

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Uncertainty is in the DNA of every project. The uncertainty is even a more critical factor when referring to research projects, and thus, risk management becomes a relevant aspect for the success of these projects. On the other hand, the benefits of using key performance indicators (KPIs) for managing projects are widely recognized in the literature. In fact, the usage of KPIs for project management is considered as a success factor itself. However, risks in a project can have direct impact on the target results and threaten the success of the project. Indeed, it is vital for project managers to evaluate and clearly understand the damages each risk could cause on the key performance of the project. The main focus of this study is to assess the impact of all identified risks on KPIs in research projects. After analyzing the literature, possible risks in research projects are identified, the effective KPIs based on S.M.A.R.T rule are developed, and finally, the impact of each risk on KPIs in research projects is evaluated. Finally, the conclusions and future research works are introduced.

Keywords: *Research projects; KPIs in research projects; risks in research projects; KPI*

ANÁLISIS DEL IMPACTO DE LOS RIESGOS DE PROYECTOS DE INVESTIGACIÓN EN SUS KPIS

La incertidumbre está en el ADN de cada proyecto y es un factor crítico cuando se refiere a proyectos de investigación y, por lo tanto, la gestión de riesgos se convierte en un aspecto relevante para el éxito de estos proyectos. Por otro lado, los beneficios de usar indicadores clave de rendimiento (KPI) para dirigir proyectos es ampliamente reconocido en la literatura. De hecho, el uso de KPI para la gestión de proyectos se considera un factor de éxito en sí mismo. Sin embargo, los riesgos en un proyecto pueden tener un impacto directo en los resultados objetivo y amenazar el éxito del proyecto. Por ello, es vital para los directores de proyectos evaluar y comprender claramente los daños que cada riesgo podría causar en el desempeño del proyecto. El objetivo de este estudio es evaluar el impacto de los riesgos identificados en los KPI en los proyectos de investigación. Después de analizar la literatura, se identifican los posibles riesgos en los proyectos de investigación, se desarrollan los KPI efectivos basados en la regla S.M.A.R.T y, se evalúa el impacto de cada riesgo sobre los KPI en los proyectos de investigación. Finalmente, se presentan las conclusiones y futuros trabajos.

Palabras clave: *Proyectos de investigación; KPIs en proyectos de investigación; riesgos en proyectos de investigación; KPIs*

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Introduction

KPIs enable the project manager to compare the actual performance with estimated performance in different aspects, such as efficiency, effectiveness and quality (Eckerson, 2010). On the other side, the risks in a project directly impact on the target results of the project. Indeed, it is vital for project managers to evaluate and clearly understand the damages each risk could cause on the performance of the project which has a direct impact on the success and achievement of project objectives. Therefore, this work firstly aims to identify potential risks in research projects. According to Lee (2007), most of project managers and research teams focus on the risks related to technical aspects of the research projects rather than other risks which can have significant impact on the success of the projects. It is essential to take all types of risks into consideration. Thus, risk identification can help project managers and the project team to develop effective risk responses. After identifying all the potential risks, this work develops a set of effective KPIs, specifically for research projects. The best practice to develop KPIs is to develop them jointly with stakeholders who are involved in the project and get them to agree upon the selected KPIs (Denley, 2015). In order to develop KPIs for research projects, this work adopts the S.M.A.R.T rule. The next important step which is the main focus of this study is to analyse the impact of all identified risks on KPIs in research projects. Project managers should always keep an eye on the risks which have high impact on the most important performances of the project. In addition, this work describes the basic concepts such as risk identification and KPIs in research projects.

1. Research Approach

The research approach adopted in this paper is based on qualitative data analysis; mainly reviewing research from journal articles, case studies, surveys and books. It elaborates all the basic concepts at first, then it identifies possible risks and develops effective KPIs for research projects. Finally, this work analyses the impact of risks on KPIs in research projects followed by conclusion and further potential research area.

2. Literature Review

3.1 Risk Identification

All projects can confront several risks through their lifecycle (Dumbravă & Iacob, 2013). One of the primary tasks of the project manager and the project team is to identify and detect the possible individual risks throughout the project lifecycle (Lavanya & Malarvizhi, 2008). There are different tools and techniques to identify risks which are introduced in PMBoK 6th edition (Project Management Institute, 2017). These tools and techniques are: expert judgment, brainstorming, checklists, interviews, root cause analysis, assumption and constraint

analysis, SWOT analysis, document analysis, facilitation, prompt lists and meetings. The key point is collecting information about all possible angles of the project, then detecting and identifying risks as much as possible. The risks can be identified through experiences from previous projects, customers, clients, suppliers and other sources as well.

3.2 KPIs in Projects

A KPI is a measurable indicator which helps project managers to track the performance of the project (Rozner, 2013). Kerzner (2017) defines a KPI as ''high-level snapshots of how a project is progressing towards predefined targets, as this is more suitable for projects.'' Without KPIs, project managers can only do the guesswork to know if the project is performing effectively. Project managers need KPIs, as KPIs provide a quick glance about the project and help them instantly discern the status of the project (Rozner, 2013). The quickest way of getting information about project performance is to use a KPI dashboard. The best practice to develop KPIs is to develop them jointly with stakeholders who are involved in the project and get them to agree upon the selected KPIs (Denley, 2015). In order to develop KPIs for research projects, this work adopts the S.M.A.R.T rule. According to Kerzner (2017), the development of KPIs based on S.M.A.R.T rule should be as follows:

- **S**pecific: a KPI should be clear and concentrated on performance of goals and targets.
- **M**easurable: it should be possible to indicate the KPI quantitively.
- **A**ttainable: the target KPI should be achievable and reasonable.
- **R**elevant: the KPI must be directly relevant to the work being done.
- **T**ime based: it should be possible to measure the KPI in a given time.

3. Research Method

The main goal of this study is to assess the impact of identified risks on KPIs in research projects. However, an evaluation and analysis of the impact of the risks on KPIs without identifying risks and development of KPIs is not possible. Therefore, firstly the potential risks in research projects must be identified. This work identifies sources, in which individual risks could arise. The potential risk in research projects are as follows:

Figure 1: Potential risks in research projects

Areas of Risk	Risk Events
Scope	Change in scope of the project
Quality	The result of the project doesn't have a sufficient quality
Technology	Defect or insufficient technology
Research Feasibility	Low chance of achieving the outcomes
	The proposal of the research is overly ambitious
Requirement	Change or unrealistic requirement by customer
Research Integrity	Material are plagiarised
	Wrong research data
	Unjustified claims by researcher with no data support
Top management support	Lack of top management support
Approval	Delay in financial approval
Research Team	Low quality researcher
	Researchers with inadequate training
	Problem with finding adequate numbers of researcher
	Unrealistic expectation of researchers
Research methods and process	Lack of alignment between research methods and process and research design and protocol
	No documentation and loss of data

Procurement	Availability or delivery of supplies by suppliers
Contract	Contractual conflicts related to intellectual property (patent, copyright and etc.)
Market	Competitors in market
	Ineffective promotion of research's result to target market
Customer satisfaction	The outcomes of the project don't meet the customer's expectations
Reputation	Loss of reputation by project failure
Financial	Inefficient or lack of funding
Server	Loss of data due to server failure
Facility	Inappropriate facilities for research
Ethic	Breach in confidential areas or information of organization or project

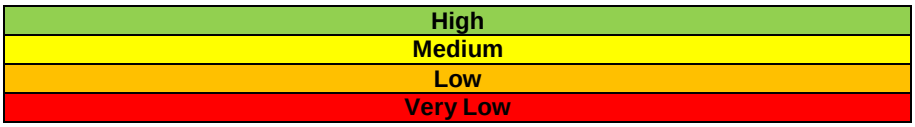
The identification of the potential risk areas and events in research projects has been done based on a literature review. David Baccarini (2011) summarizes different authors that have established categories for the risk events, in order to provide a high-level perspective of the nature of risks in research projects.

The next step is to develop a set of effective KPIs, specifically for research projects. This work develops KPIs based on S.M.A.R.T rule for research projects which are defined and grouped into the related categories. The KPIs intend to gather critical aspects of a research project. The 10 KPIs in research projects are as follows:

Research Project Feasibility KPI

1. **Technical Feasibility:** this KPI can be used before the approval and also during the research project. It indicates the achievability of the project and whether the project proposal has a low or high chance of success achievement. It is very crucial for the project manager to ensure the feasibility of the project, especially technical feasibility. Indeed, it is difficult to measure the feasibility of the project, However, it is yet possible to qualitatively represent how feasible the project is.

Figure 2: qualitative representation of project feasibility



Research Project Quality KPIs

2. **Percentage (%) of Researchers with More Than 5 Years of Experience or PhD Degree:** in research projects, researchers or project team members play a crucial role. Therefore, this KPI can help project managers to have an understanding and logical expectations of the team.

3. **Quality of Research Infrastructure:** another essential KPI for a research project is the quality of the research infrastructure. It can impact the quality of both, project management and project results. Same as technical feasibility, measuring the quality of research infrastructure is complex.

Figure 3: different levels of quality in research infrastructure

Research Project Schedule KPIs

4. **Schedule Performance Index at the time (SPI_t):** it helps the project manager to understand if the project is behind or ahead of the planned project schedule at the time of monitoring. It provides the project manager an early warning about the status of the project (Salari, et al., 2014). The formula for SPI_t is: SPI_t = ES/time at the moment; where ES stands for Earned Schedule.

Research Project Financial KPIs:

5. **Cost Performance Index (CPI):** this KPI helps the project manager to understand if the project is behind or ahead of project budget (Lukas, 2012). An early notification can help the project manager to rescue the project and get back on track (Reichel, 2006). The formula for CPI is: CPI = EV / AC; where EV stands for Earned Value and AC Actual Costs.

Research Project Risk KPI

6. **Number of High Probability Risk with High Impact**: research projects involve many risks. Therefore, risks specially risk with high probability and impact which can turn to major issues for the project, must be continuously identified and monitored, otherwise they can harm the project or even cause the termination of the project. This KPI provides awareness for the project manager about fatal risks which have high probability of occurrence. The project manager must be always highly aware of those risks.

Research Project Alignment with Customer Requirement KPI

7. **The Percentage (%) of Project Objective Achievement:** the project must deliver what the customer exactly wants. This KPI can help project managers to monitor if the project is delivering the right deliverables and avoid any extra works which bring no value for the customers. The project manager must always align the project's progress with the customer requirements.

Research Project Outcome KPIs

8. **Time to Market:** the objective of research projects is usually to deliver the product on time with the planned functions at calculated costs to the market maturity, thus, this KPI indicates the speed of project result's delivery to the market.
9. **The Percentage (%) of Knowledge Applied in Industry:** research projects are the type of project which create the most amount of new knowledge, thus it is essential to determine how much of the created knowledge is shared and used in industries and how much of the knowledge is limited and remained in the project.
10. **Number of Disseminations:** this KPI illustrates how much of the research project, particularly knowledge, is published and introduced to the society. Number of conferences, journal articles, patents or other publications regarding the research project represent the number of disseminations in the research projects.

Next, the analysis of the impact of each identified risk on all KPIs in research projects is detailed. The KPIs are listed based on their priority. In order to make it explicit, server and facility risks are grouped as 'infrastructure' risks. The evaluations are as follows:

1. **The impact of risks related to scope:**

KPIs	Type of Impact	Severity
Technical feasibility	Negative	Medium
% of project objective achievement	Negative	Very High
Time to market	Negative	Very High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	Negative	Low
Number of high probability risk with high impact	Negative	Medium
Schedule Performance Index at the time (SPI_t)	Negative	Very High
Cost Performance Index (CPI)	Negative	Very High

% of knowledge transformed to industry	Negative/Positive	Medium
Number of disseminations	Positive	Medium

2. Risks related to quality of management, components or results:

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	Negative	Very High
Time to market	Negative	Very High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	Negative	Very High
Number of high probability risk with high impact	Negative	Medium
Schedule Performance Index at the time (SPI_t)	Negative	Medium
Cost Performance Index (CPI)	Negative	Medium
% of knowledge transformed to industry	Negative	Low
Number of disseminations	Negative	Very Low

3. The impact of risks related to technology

KPIs	Type of Impact	Severity
Technical feasibility	Negative	Very High
% of project objective achievement	Negative	High
Time to market	Negative	High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	Negative	High
Number of high probability risk with high impact	Negative	Very High
Schedule Performance Index at the time (SPI_t)	Negative	High
Cost Performance Index (CPI)	Negative	High
% of knowledge transformed to industry	Negative	Medium
Number of disseminations	Negative	Very Low

4. The impact of risks related to research feasibility

KPIs	Type of Impact	Severity
Technical feasibility	Negative	Very High
% of project objective achievement	Negative	Very High
Time to market	Negative	Very High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	Very High
Schedule Performance Index at the time (SPI_t)	Negative	Very High
Cost Performance Index (CPI)	Negative	Very High
% of knowledge transformed to industry	Negative	Very High
Number of disseminations	Negative	Very High

5. The impact of risks related to requirement

KPIs	Type of Impact	Severity
Technical feasibility	-	No impact
% of project objective achievement	Negative	Very High
Time to market	Negative	High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	Negative	Low
Number of high probability risk with high impact	Negative	Medium
Schedule Performance Index at the time (SPI_t)	Negative	Very High
Cost Performance Index (CPI)	Negative	High
% of knowledge transformed to industry	Negative/positive	Medium
Number of disseminations	Negative/positive	Low

6. The impact of risks related to research Integrity

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	Negative	Very High

Time to market	Negative	Very High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	High
Schedule Performance Index at the time (SPI_t)	Negative	Very High
Cost Performance Index (CPI)	Negative	Very High
% of knowledge transformed to industry	Negative	High
Number of disseminations	Negative	Very High

7. The impact of risks related to top management support

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	Negative	Medium
Time to market	Negative	Medium
% of researchers with more than 5 years of experience or PhD degree	Negative	Very High
Quality of research infrastructure	Negative	Very High
Number of high probability risk with high impact	Negative	Medium
Schedule Performance Index at the time (SPI_t)	Negative	Medium
Cost Performance Index (CPI)	Negative	Medium
% of knowledge transformed to industry	-	No Impact
Number of disseminations	Negative	Medium

8. The impact of risks related to approval

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	Negative	High
Time to market	Negative	Very High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	High
Schedule Performance Index at the time (SPI_t)	Negative	Very High
Cost Performance Index (CPI)	Negative	Very High
% of knowledge transformed to industry	-	No Impact
Number of disseminations	-	No Impact

9. The impact of risks related to research Team

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	Negative	Very High
Time to market	Negative	High
% of researchers with more than 5 years of experience or PhD degree	Negative	Very High
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	High
Schedule Performance Index at the time (SPI_t)	Negative	Very High
Cost Performance Index (CPI)	Negative	Very High
% of knowledge transformed to industry	Negative	Medium
Number of disseminations	Negative	Medium

10. The impact of risks related to research methods and process

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	Negative	Very High
Time to market	Negative	High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	High
Schedule Performance Index at the time (SPI_t)	Negative	High
Cost Performance Index (CPI)	Negative	High
% of knowledge transformed to industry	Negative	High
Number of disseminations	Negative	Very High

11. The impact of risks related to procurement

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	Negative	Medium
Time to market	Negative	Medium
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	Negative	Very High
Number of high probability risk with high impact	Negative	Low
Schedule Performance Index at the time (SPI_t)	Negative	Medium
Cost Performance Index (CPI)	Negative	Medium
% of knowledge transformed to industry	-	No Impact
Number of disseminations	-	No Impact

12. The impact of risks related to contract

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	-	No Impact
Time to market	-	No Impact
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	Low
Schedule Performance Index at the time (SPI_t)	-	No Impact
Cost Performance Index (CPI)	-	No Impact
% of knowledge transformed to industry	Negative	Very High
Number of disseminations	Negative	Very High

13. The impact of risks related to market

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	-	No Impact
Time to market	Negative	Very High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	Medium
Schedule Performance Index at the time (SPI_t)	-	No Impact
Cost Performance Index (CPI)	-	No Impact
% of knowledge transformed to industry	Negative	High
Number of disseminations	Negative	High

14. The impact of risks related to customer satisfaction

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	-	No Impact
Time to market	-	No Impact
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	Medium
Schedule Performance Index at the time (SPI_t)	-	No Impact
Cost Performance Index (CPI)	-	No Impact
% of knowledge transformed to industry	Negative	High
Number of disseminations	Negative	Medium

15. The impact of risks related to reputation

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	-	No Impact
Time to market	-	No Impact
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	Very Low
Schedule Performance Index at the time (SPI_t)	-	No Impact

Cost Performance Index (CPI)	-	No Impact
% of knowledge transformed to industry	Negative	Very High
Number of disseminations	Negative	Very High

16. The impact of risks related to financial

KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	Negative	High
Time to market	Negative	Very High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	Negative	High
Number of high probability risk with high impact	Negative	High
Schedule Performance Index at the time (SPI_t)	Negative	Very High
Cost Performance Index (CPI)	-	No Impact
% of knowledge transformed to industry	-	No Impact
Number of disseminations	-	No Impact

17. The impact of risks related to infrastructure

KPIs	Type of Impact	Severity
Technical feasibility	Negative	Very High
% of project objective achievement	Negative	High
Time to market	Negative	High
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	Negative	Very High
Number of high probability risk with high impact	Negative	Very High
Schedule Performance Index at the time (SPI_t)	Negative	Very High
Cost Performance Index (CPI)	Negative	Very High
% of knowledge transformed to industry	-	No Impact
Number of disseminations	-	No Impact

18. The impact of risks related to ethic

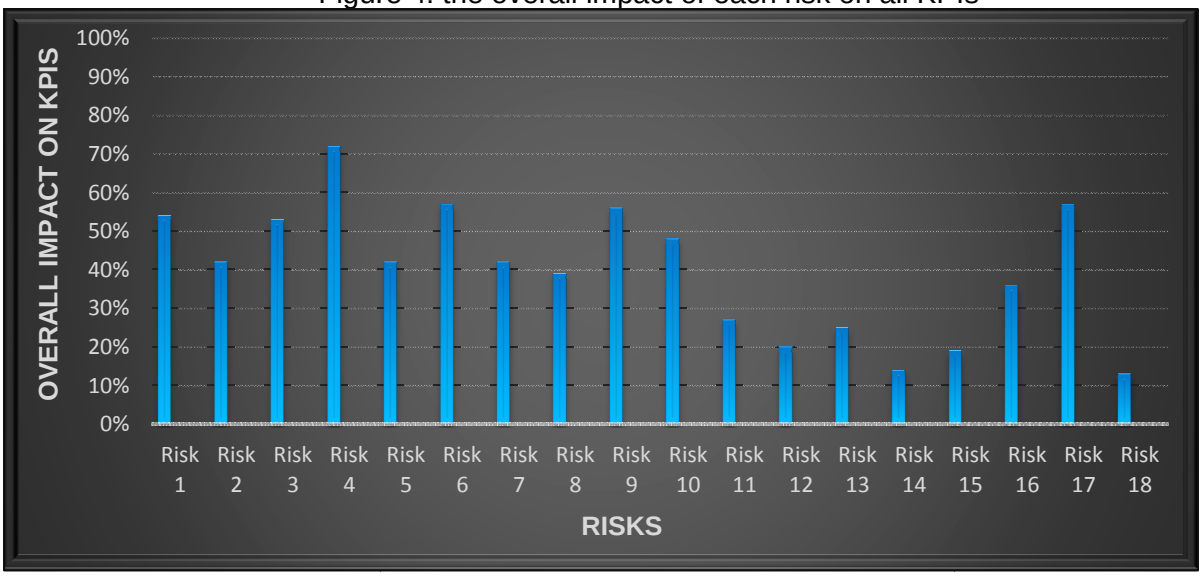
KPIs	Type of Impact	Severity
Technical feasibility	-	No Impact
% of project objective achievement	-	No Impact
Time to market	-	No Impact
% of researchers with more than 5 years of experience or PhD degree	-	No Impact
Quality of research infrastructure	-	No Impact
Number of high probability risk with high impact	Negative	Very Low
Schedule Performance Index at the time (SPI_t)	-	No Impact
Cost Performance Index (CPI)	-	No Impact
% of knowledge transformed to industry	Negative	High
Number of disseminations	Negative	High

In the evaluations above, the impact of all risks on each KPI in research projects is indicated. The evaluations show two main elements: the severity and type of impact. It is important to mention that not all risks are negative. Indeed, a risk is defined as an uncertain event which could have either have negative or positive impact on the project. Negative risks must be prevented, and positive risk must be captured.

4. Research Results and Discussion

To achieve the results which are represented in figure 4, the impact of each risk on all KPIs is separately evaluated. Figure 4 represents the percentage each risk can affect in the different KPIs of research projects. Indeed, it is an indicator which helps project managers to clearly understand the damages each risk could cause on the key performance of a project.

Figure 4: the overall impact of each risk on all KPIs



According to figure 4, risks related to feasibility (Risk 4), infrastructure (Risk 17) and research team (Risk 9) have the highest impact on the KPIs, respectively. While risks related to ethic (Risk 18) have the lowest impact on the KPIs. Project managers should always keep an eye on the risks which could impact the most on the most important performances of the project. The highest impact on the KPIs are related to feasibility. This risk has a very high impact on all KPIs, except on KPIs related to percentage of researchers with more than 5 years of experience or PhD degree KPI and quality of research infrastructure. The risks related to feasibility can have a significant impact in research projects therefore, the project manager must plan a set of strategies before this risk occurs. The recommended strategies are to carefully assess the project feasibility (feasibility study) and get confirmation for initiating the project from all stakeholders involved in the project when kick it off. The second risk which has the highest impact on the KPIs is the risk related to infrastructure. This risk has a very high impact on the KPIs such as technical feasibility, quality of research infrastructure, number of high probability risk with high impact, schedule performance index at the time (SPI_t) and cost performance index (CPI). The next risk which also has high impact is the risk related to research team. This risk has very high impact on KPIs such as percentage of project objective achievement, percentage of researchers with more than 5 years of experience or PhD degree, schedule performance index at the time (SPI_t) and cost performance index (CPI). In fact, research team is an essential resource for research projects, the success of the project is considerably depended on them, indeed. The team plays a major role in the project and if they do not have an adequate training or have low quality, they can highly affect the processes and results of the project, which could also cause major problems such as delay in the project, overruns, low quality results and even termination of the project.

On the other hand, risks related to ethic have the lowest impact on KPIs. Ethic risks have only high impact on KPIs such as percentage of knowledge transformed to industry and number of disseminations. However, they must be taken into consideration. In fact, project managers should not ignore the risks with lower ranking in the project, but give less priority to them (Baccarini, 2011).

5. Conclusions

The risks in a project have different sources and root causes. According to Lavanya & Malarvizhi (2008), one of the primary tasks of a project manager and the project team is to identify and detect the possible risks throughout the project lifecycle. Risks can have significant impact on the KPIs of a project and prevent the project from success. Thus, the

aim of this work is to analyse the impact of risks on the KPIs of research projects. In order to do that, all potential risks in research projects are identified. Afterwards, a set of effective KPIs for research projects are developed and finally the impact of each risk on all KPIs is individually evaluated. Results show that risks related to feasibility, infrastructure and research team have the highest impact on the KPIs, while risks related to ethic have the lowest impact on KPIs.

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