

Risk management application in a Baja SAE team

Aplicação do gerenciamento de riscos em uma equipe Baja SAE

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Resumo

As técnicas de gerenciamento podem ser muito benéficas para projetos, podendo otimizar recursos humanos, financeiros e de tempo se aplicadas de formas adaptadas aos seus contextos. O gerenciamento de riscos é essencial para um bom planejamento orçamentário, visto a notável necessidade de precaver as possíveis eventualidades que podem vir a surgir e desviar o projeto de seu objetivo. Devido às dificuldades financeiras que impediam seu desenvolvimento, a Equipe Komiketo Baja UFSJ notou a necessidade de um planejamento que gerenciasse imprevistos, uma vez que o orçamento planejado era muito menor que o gasto real, gerando falta de dinheiro em caixa e impedindo a compra de materiais essenciais à equipe. Este artigo mostra como foi o passo a passo da aplicação da gestão de riscos na equipe durante o período de 2019-2020, baseada principalmente no livro PMBOK além de apresentar conceitos como identificação, análise qualitativa, análise quantitativa, planos de ação, controle e monitoramento. Por meio deste estudo pode-se comparar o antes e depois da aplicação, que resultou numa diminuição de 128% (2018-19) para 7% (2019-20) da diferença entre o valor gasto e o planejado. Diversas recomendações foram obtidas para futuras aplicações da equipe e para realização de aplicações similares.

Palavras-chave: Gerenciamento de riscos. Baja SAE. Planejamento Orçamentário, Komiketo Baja.

Abstract

Management techniques can be beneficial for projects and it can optimize human, financial and time resources if applied to adapt to their contexts. Risk management is essential for good budget planning, given the remarkable need to prevent possible eventualities that may arise and deviate the project from its objective. Due to financial difficulties that hindered its development, the Komiketo Baja UFSJ team noticed the necessity to plan that would manage unforeseen events, since the planned budget was lesser than the actual expenditure, creating a lack of cash and preventing the purchase of essential materials for the team. This study presents the application of risk management in the team during the period 2019-2020, based mainly on the book PMBOK. In addition, it will discuss concepts such as identification, qualitative analysis, quantitative analysis, action plans, control and monitoring. Through this study, it is possible to compare before and after application, which resulted in a decrease of 128% (2018-19) to 7% (2019-20) of the difference between the amount spent and the planned amount. Several recommendations were obtained for the team's future and similar applications.

Keywords: Risk Management. Baja SAE. Budget Planning. Komiketo Baja.

1. Introduction

Project management is becoming important in organizations and there is an increase to professional certification of the technique (Martins *et al.*, 2010). According to Larson & Drexler (2010), Carvalho and Rabechini (2011) and Lappe and Spang (2014), and Ribeiro (2015). “project management contributes a lot for the success and quality of projects of all kinds”.

Clarke (1999) also cites: “In a world where changes are becoming more and more important, skills as project management, if used correctly, can prove a useful way for the organizations to manage the changes effectively” (Martins *et al.*, 2010).

Risk management is one of the areas aborted by project management and, according to Salles Jr *et al.* (2010), when preceding the risks by identifying and analyzing it, it is possible to create actions plans for monitoring and control, aiming to minimize or end the risks. Post and Lee (2011) affirm that this technique creates good engineer habits and it avoids that the lack of group experience affects the progress of the project (Ribeiro, 2015).

Project management has become important for professional training and there is an increase of disciplines in this area (Martins *et al.*, 2010; and Camargo, 2018). Projects as Baja SAE allows the applications of project management knowledge, mainly for time, cost and human resources

management, being extremely important for engineers professional training (Ferreira, 2011). Ribeiro (2015) affirms that the method avoids team failure due to the planning of simple stages for engineering application instead of development for long and complex periods.

Komiketo Baja UFS team noticed several problems for assignment and monitoring of its resources until 2019. Therefore, the team proposed to implement and to adapt the risk management to its reality. Traditional application of project management presupposes a stable and predictable scenario, demonstrating problems against the actual instability and unpredictability, where it can influence by environment, technology or markets dynamic (Marques Junior & Plonski, 2011).

The aim of the case study is to demonstrate the risk management in Komiketo Baja UFSJ team and its importance and to obtain results to improve the process, using financial data and bibliographic research.

2. Materials and Methods

2.1 Baja SAE Brazil

Considered one of the most important societies of mobility engineering of the country, SAE promotes technological advances through expositions, student competitions, congresses and others modalities of apprenticeship. *“The Baja SAE BRAZIL programs is a challenge for engineering students that offers a chance to a practical application of the knowledge acquired in classroom, aiming to improve their preparations for job market. When participating the Baja SAE programs, the student develops a real case of design of a off-road vehicles, since its conceptions, detailed project, construction and experiments”* (<https://saebrasil.org.br/programas-estudantis/baja-sae-brasil/>).

2.2 Komiketo Baja UFSJ Team

Komiketo Baja UFSJ team was created in 2008 e since it has been acting in the development of Baja SAE BRAZIL project. The team is divided in three acting areas: mechanics (Structural Calculation, Chassis, Steering, Brakes, Suspension and Powertrain), electric (Electronics) and management (Captaincy, Product Engineering and Marketing). Hence, the team has six nucleus (5S, Editors, Sales, Machining, Welding and Drawing) formed by members of different areas. Team management has one year of duration and it goes from March to March.

One of the management functions is related to finance, aiming to control all team’s budgets, using management and accounting knowledge, developed through the years.

2.3 Project management

According to the Project Management Body of Knowledge (PMBOK, 2017; Farkas, 2018; Rose & Indelicato, 2009), managing a project is to apply knowledge, abilities, skills and techniques to activities to achieve goals, allowing the project execution with effectiveness and efficiency. Project management has ten areas of knowledge, all related as it can be observed in Table 1:

Table 1 – Knowledge areas in project management.

Knowledge area	Definition
Project integration management	It includes necessary processes and activities to identify, define, combine, unite and coordinate several processes and activities of project management in the Project Management Process Groups.
Project scope management	It includes all necessary processes to assure that the project has all and only the needed work to achieve the success.
Project time management	It includes necessary processes to manage the project deadline.
Project cost management	It includes the processes involved in planning, estimations, budgets, financing, cost management and control, in order to finish the project with the approved budget.
Project quality management	It includes the process to incorporate the quality politic in the organization regarding the planning, management and control of the quality requirements for the project and product, according to the expectations of the interested parties.
Project resource management	It includes the processes to identify, acquire and manage the necessary resources to a successful end of project.
Project communications management	It includes the necessary processes to assure that the project information will be planned, collected, created, distributed, stored, restored, managed, controlled, monitored and organized timely and properly.
Project risk management	It includes the conduction processes for planning, identifying and analyzing the risk management, response planning and implementation and monitoring the project risk.
Project procurement management	It includes the necessary processes to buy or acquire products, services or results external to the team project.
Project stakeholder management	It includes the processes required to identify people, groups or organizations that may impact or be impacted by the project, to analyze the expectations of the interested parties and their impact on the project, and to develop proper management strategies for its effective engagement on decisions and execution of the project.

(Source: Adapted from PMBOK, 2017)

2.4 Risk Management

The project risk management is divided in seven steps (Table 2) and it has the aim to potentialize the probability and/or the positive risks impact and to ease the probability and/or the negative risks impact, to optimize the success chances of the project (PMBOK, 2017).

Table 2. Steps for project risk management.

Steps	Definition
Plan Risk Management	Process to define how the risks management activities of a project will occur.
Identify Risks	Process to identify the project individual risks, as well the general risks, and to document its characteristics.
Perform Qualitative Risk Analysis	Process of project individual risks prioritization for posterior analysis or action through the evaluation of its occurrence and impact probability, as other characteristics. The analysis is made with matrices Where the risks are enumerated in a scale of 1 to 5, in accordance with the analyzed factors as impact probability and other qualitative factors.
Perform Quantitative Risk Analysis	It analyzes numerically the risks, impact and effects. The risks probability and its financial impacts are noted and therefore, each risk has a note, hence an evaluated low, medium or high. The most common techniques of quantitative risk analysis are currency value analysis, decision tree and Monte Carlo simulation.
Plan Risk Responses	Process to develop alternatives and to select strategies and actions to lead with the general risks exposition and to treat the project individual risks.
Implement Risk Responses	Process to implement the agreed risk response plans.
Monitor Risks	Process to monitor the agreed plans implementations for the risk response, to follow the identified risks, to identify and analyze new risks and to evaluate the efficiency of the risk process through the project.

(Source: Adapted from PMBOK, 2017)

3. Results

3.1 Justification

Since its creation in 2008, the team expenses did not match with the project reality due to presence of non-predicted high outgoings. Besides, the team did not structure the financial area until they realized the harmful effects in crisis moments. The situation can be related to the following factors:

- i. Most of the financial and material resources came from sponsorship of public notices of services and products, limiting the budget, therefore, they were not accounted (Table 3);

Table 3. Public notices of services and products' values.

Period	Value
2012-2013	R\$ 34,814.46
2014-2015	R\$ 66,724.18
2015-2016	R\$ 33,721.16

(Source: Authors, 2023)

- ii. Lack of knowledge of the project real accounting entries due the absence of control of the cash flow, not having any reliable data about the financial transactions;
- iii. Lack of a definitive tool to store the data due to little adhesion to Google Drive, the official chosen tool;
- iv. Lack of pattern in the used document to store the financial data.

Lack of structure began to create several problems in organization, communication, unnecessary expenses and unforeseen events. Hence, the necessity to start an ongoing restructuring arises.

In 2016, the team identified the need for a great control of the cash flow to optimize the data store and control of accounting entries, once the financial area was responsible for resource store without having a stipulated budget, as cited in (PMBOK, 2017), (Figure 1).

CASH FLOW					
March 2016					
Date	Description	Document	Responsible	Income	Expense
03/11/2016	Previous year balance		Juciely and Marcela	R\$ 7.419,98	
03/11/2016	Sweets	"Auto Serviço Kitzan LTDA" CCF: 227277	Thales		R\$ 12,42
03/11/2016	Copy	"Atual" print shop	Thales		R\$ 13,48
03/15/2016	Money income		Juciely and Marcela	R\$ 560,71	
03/18/2016	Posters	Receipt 190	Thales	R\$ 20,00	
03/26/2016	Flavoured Ice Candy	"Pipocão Atacadista e Distribuidora" CCF: 012790	Thales and Karol		R\$ 48,00
Total				R\$ 8.000,69	R\$ 73,90
Month balance					R\$ 7.926,79

Figure 1. Cash flow model used by the team in 2016.
(Source: Komiketo Baja UFSJ, 2016)

In 2018, the budget started to be estimated based on a shopping list to determine which would be the acquisitions during the year, considering their specifications, priorities and cost (Figure 2).

PURCHASE LIST - WORKSHOP				
ITEM	DESCRIPTION	QTY	COST PER UNIT	AMOUNT
RATCHET	13mm	2	R\$ 21,90	R\$ 43,80
HAMMER	RUBBER Mallet	1	R\$ 20,00	R\$ 20,00
LUBRICANT	-	12	R\$ 6,00	R\$ 72,00
CUTTING DISK	-	30	R\$ 3,00	R\$ 90,00
FLAP DISK	-	5	R\$ 4,00	R\$ 20,00
ZIP TIE	BLACK 350mm	10	R\$ 20,00	R\$ 200,00
SANDPAPER	180 GRIT	20	R\$ 2,00	R\$ 40,00
GRINDING WHEEL	GRINDER	2	R\$ 31,10	R\$ 62,20
STEELBRUSH	GRINDER	2	R\$ 35,00	R\$ 70,00
TOTAL				R\$ 618,00

Figure 2. Purchase list model used by the team in 2018.
(Source: Komiketo Baja UFSJ, 2018)

Compared to budget made with the actual amount spent for the year, it was noted the foreseen budget did not match the project reality, due to presence of high unexpected expenses, which may be caused by atypical situations and influenced a lot in the proposed budget planning, where some important items of the shopping list could not be bought. It can be observed the cash flows and the budgets of 2016-2019 in Figure 3. Figure 4 establishes the relation of the values of the outputs and

the total budget of 2016 - 2019. And, Figure 5 represents the structuring of the budget planning of the team.

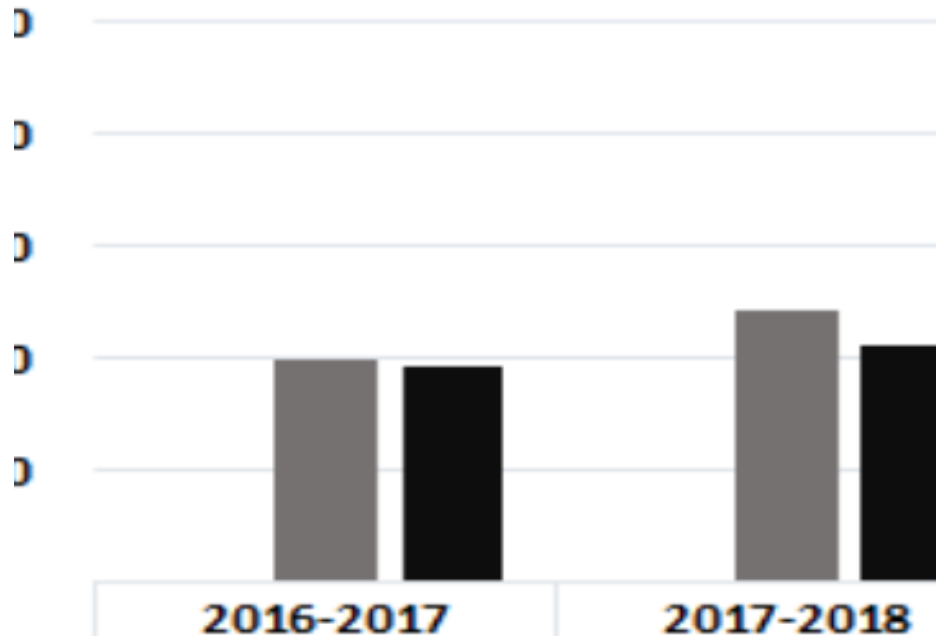


Figure 3. List of budgeted values, collected and expenditures.
(Source: Authors, 2023)

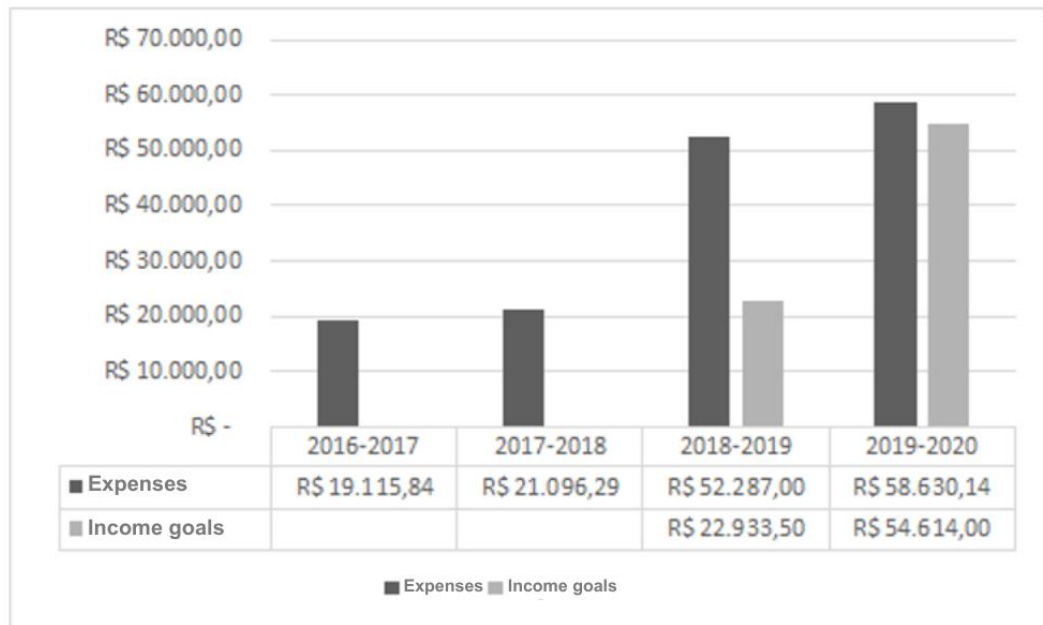


Figure 4. Relation of the values of the outputs and the total budget.
(Source: Authors, 2023)

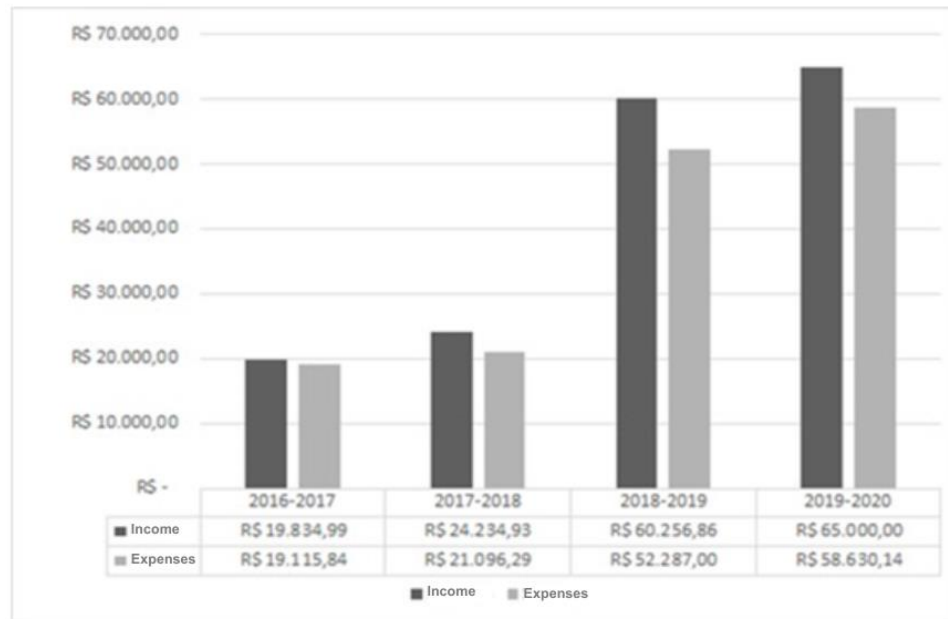


Figure 5. Budget planning of the team.
(Source: Authors, 2023)

3.2 Application

In 2019, using the data, a study was developed about risk management and its team for a better prevention and decision for unforeseen events, aiming for better financial health.

The implementation was divided into five stages: planning, identifying the risks and its characteristics, qualitative analysis, quantitative analysis, responses planning and monitoring, as shown in Figure 6.

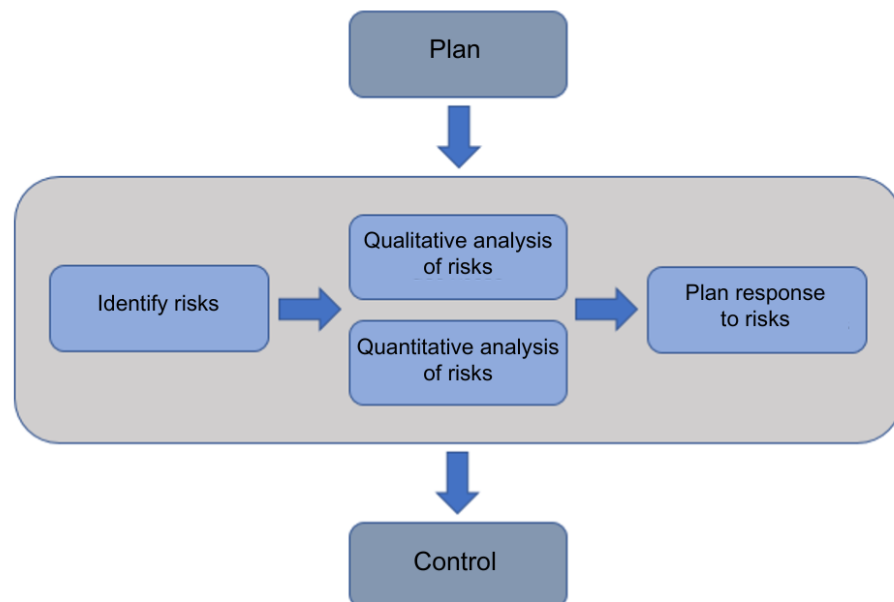


Figure 6. Flowchart of the risk management stages.
(Source: Adapted from Ribeiro, 2015).

The initial planning stage had a study of the risk management and how it would be adapted in the project, analyzing its necessity and reality.

The identification phase was created through a brainstorming to list all possible risks that would be faced in the 2019-2020 administration. The product engineering and the captaincy member were present, therefore, there were members with one year of collaboration, for the effectiveness and creation of experience and data for future applications, and members with three years of collaborations, to obtain reliable data.

Therefore, the qualitative analysis phase started where the risks were classified as threats, which could create some negative impact on the team, or as opportunities, if they could lead to some benefit. Therefore, the risks were categorized as: human resources; technical; from supplier; from communication; operational; political; from market or financial. There were observed their probabilities and impacts based on the team's past histories. The risks were measured in a scale of 1 to 4, being 1 equal to 20% and 4 to 80%.

Thereafter, the quantitative analysis phase was applied, where it measured the financial impact, also based on the team's histories. The Expected Monetary Value (EMV) was implemented through the multiplication of probability and financial impact, obtaining a contingency margin for each risk and, through the sum of all risk values, it is possible to obtain the total contingency margin.

On the fourth stage, the response planning was to draw strategies to be adopted, aiming to avoid, mitigate and transfer to threats or to accept, potentialize and share as opportunities, and posteriorly, determine the respective action plans.

Finally, it performed the monitoring phase which is due to actualization and accumulation of more specific data for next applications, once this was its first application. Table 3 exhibits an example of risk management applied to the team.

RISK MANAGEMENT ANALYSIS										
RISK #	RISK CATEGORY	CLASSIFICATION	DESCRIPTION	PROBABILITY	IMPACT	PROBABILITY %	FINANCIAL IMPACT	CONTINGENCY	MANAGEMENT	ACTION PLAN
1	HR	THREAT	Shortage of man power (machining)	1	4	0,2	R\$ 1.300,00	R\$ 260,00	Transfer	Outsource
2	HR	THREAT	Shortage of man power (welding)	2	4	0,4	R\$ 1.062,00	R\$ 427,20	Transfer	Outsource
3	TECNICAL	THREAT	Machining mistake	4	3	0,8	R\$ 2.285,00	R\$ 1.828,00	Mitigate	CNC and Lathe maintenance
4	TECNICAL	THREAT	Part breakage	3	4	0,6	R\$ 350,00	R\$ 210,00	Prevent	Manufacture spare parts

Figure 7. Example of a risks management quantitative table.
(Source: Authors, 2023)

After calculating the contingency margin and the value of the shopping list determined by the sum of all team sectors and nucleus lists, it obtained the fundraising goal, considering the value as the one the team must fundraise during the 2019-2020 administration for a better financial health and to always have budget for the risks.

Figure 8 represents the risk analysis to assist the risk management team Komiketo Baja UFSJ. In this figure, there are twenty-two risks at the beginning of management, which are: the risk No. 3 (machining error), No. 5 (lack of pipes), No. 6 (welding error), No. 7 (incomplete shopping list), No. 8 (general car component breakdowns), No. 11 (increase of shipping), No. 13 (CNC machining tool breakage), No. 14 (breakage and loss of equipment/tools in general), No. 16 (sponsorship), No. 19 (misallocation of financial resources), No. 20 (dollar price) and No. 21 (internal communication).

RISK MANAGEMENT ANALYSIS												
RISK #	RISK CATEGORY	CLASSIFICATION	DESCRIPTION	PROBABILITY	IMPACT	PROBABILITY %	FINANCIAL IMPACT		CONTINGENCY	MANAGEMENT	ACTION PLAN	
1	HR	THREAT	Shortage of man power (machining)	1	4	0,2	R\$ 1.300,00	R\$ 260,00	Transfer	Outsource		
2	HR	THREAT	Shortage of man power (welding)	2	4	0,4	R\$ 1.062,00	R\$ 427,20	Transfer	Outsource		
3	TECNICAL	THREAT	Machining mistake	4	3	0,8	R\$ 2.285,00	R\$ 1.828,00	Mitigate	CNC and Lathe maintenance		
4	TECNICAL	THREAT	Part breakage	3	4	0,6	R\$ 350,00	R\$ 210,00	Avoid	Manufacture spare parts		
5	SUPPLY	THREAT	Tube shortage	4	4	0,8	R\$ 4.000,00	R\$ 3.200,00	Accept	Look for other suppliers		
6	TECNICAL	THREAT	Welding mistake	4	4	0,8	R\$ 174,00	R\$ 139,20	Mitigate	Train team		
7	COMMUNICATION	THREAT	Purchase list	4	2	0,8	R\$ 3.000,00	R\$ 2.400,00	Prevent	Plan improvement		
8	TECNICAL	THREAT	Part breakage	4	4	0,8	R\$ 300,00	R\$ 240,00	Minimize	Improve project		
9	OPERATIONAL	THREAT	Welding machine malfunction	4	2	0,8	R\$ 1.000,00	R\$ 800,00	Mitigate	Maintenance and better use		
10	OPERATIONAL	THREAT	Lathe malfunction	2	2	0,4	R\$ 600,00	R\$ 240,00	Mitigate	Maintenance and better use		
11	OPERATIONAL	THREAT	Increase on shipping cost	3	3	0,6	R\$ 1.000,00	R\$ 600,00	Prevent	Plan improvement		
12	OPERATIONAL	THREAT	CNC malfunction	4	4	0,8	R\$ 500,00	R\$ 400,00	Transfer	Look for machining sponsors		
13	OPERATIONAL	THREAT	Tool breakage	4	4	0,8	R\$ 500,00	R\$ 400,00	Avoid	Better tools		
14	OPERATIONAL	THREAT	Breakage and loss of tools	4	3	0,8	R\$ 350,00	R\$ 280,00	Avoid	Maintenance and better use		
15	POLITICAL	THREAT	Transport	3	4	0,6	R\$ 10.000,00	R\$ 6.000,00	Transfer	Redefine transport		
16	SUPPLY	THREAT	Sponsors	3	4	0,6	R\$ 4.000,00	R\$ 2.400,00	Avoid	Higher priority		
17	EXTERNAL	THREAT	Import taxes	2	4	0,4	R\$ 10.000,00	R\$ 4.000,00	Mitigate	Look for importation alternatives		
18	SUPPLY	THREAT	Shortage of material	3	2	0,6	R\$ 200,00	R\$ 120,00	Accept	Look for other suppliers		
19	FINANCIAL	THREAT	Poor money allocation	2	2	0,4	R\$ 200,00	R\$ 80,00	Avoid	Better financial plan		
20	MARKET	THREAT	Dollar price	4	3	0,8	R\$ 1.000,00	R\$ 800,00	Accept	-		
21	COMMUNICATION	THREAT	Internal communication	3	4	0,6	R\$ 200,00	R\$ 120,00	Mitigate	Attention		
22	HR	THREAT	Work accident	1	2	0,2	-	-	Avoid	Safety equipment		

Figure 8. Complete table of quantitative risk analysis.
(Source: Authors, 2023).

4. Conclusion

Risk management application in Komiketo BAJA UFSJ team was essential for the expense's predictability during the administration. The study identified 22 risks classified as threats, totalizing a contingency margin of R\$ 24,944.40, as exhibited in Figure 8.

It was concluded from Figure 4, as the budget was unreal to the amount spent, with this initial application has already obtained significant results with the total amount spent being 7% higher than the value budgeted in 2019-2020, while the previous management the amount spent was 128% higher than the budgeted.

As structuring of the team's budget planning, budgets and outputs were more reliable and real, being observed a change of culture as a sense of collections and expenses, enabling a good financial health even with significant expenses for improvements, prototype innovations and team infrastructure maintenance (Figure 5).

However, there were some failures in the risk management application. Despite being aware of which risks could happen during the analyzed time, the real values were not accounted for. Besides, there was a lack of application of action plans for other identified risks, where none of prevention action was taken, even knowing of the probability of the event occurring. The failures found will be an apprenticeship to know what has to be optimized in the study.

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