

Analysis and Improvement of the Requirements Elicitation Process Based on ISO 31000

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Abstract. Requirement elicitation is one of the most critical stages in the software development process, demanding a high level of accuracy as it aims to identify and thoroughly understand customer needs. This article seeks to analyze the current requirement elicitation process in a company operating in the information technology development sector. Based on this analysis, the study aims to identify, evaluate, and mitigate the risks involved, following the guidelines of the ISO 31000 standard, to support the organization in its operational and strategic decisions. To achieve the proposed objectives, an exploratory research methodology was adopted, applied in nature, and using a qualitative approach. Data collection techniques included document analysis within the company and brainstorming sessions. The results enabled the identification of the main risks associated with the requirement elicitation process. Finally, this research proposed a redesign of the elicitation model (TO-BE), resulting in significant improvements in the practices of the studied organization.

Keywords: Requirements Elicitation · Software Development · ISO 31000 · Risk Mitigation

1 Introduction

Software development is a complex activity, involving numerous unpredictable and difficult-to-control factors, such as technological innovations and constant changes in client requirements. This complexity causes a large portion of software development projects to exceed their planned schedule and budget, in addition to failing to meet client expectations in terms of functionality and quality [1].

Requirements elicitation techniques are essential to support requirements engineers in gaining a better understanding of the needs of users and stakeholders [14].

Given this scenario, in recent years there has been a growing interest among IT companies in the use of agile methodologies, with the primary objective of minimizing the problems constantly encountered in software development, such as: poorly defined

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scope, requirement changes that directly impact the project's schedule and cost, and failure to meet client expectations.

It is also known that agile methodologies are innovative and iterative methods that support change and offer improvements in various aspects of systems and application development projects. However, their use in an unstructured and/or incomplete manner involves risks, which are greater for some organizations and projects [2].

According to research conducted by the Standish Group, approximately 43% of technology development projects tend to fail. Studies have shown that requirements defects are among the main sources of failure, accounting for 32.65%. This aspect has been neglected in requirements engineering and is generally considered a potential problem that can negatively affect projects [3].

A software requirement is a system property that must be identified and detailed by the analyst with the utmost precision and assertiveness. These requirements aim to automate parts of tasks, support an organization's business processes, correct flaws in existing software, or control devices. Interactions between users, business processes, and systems are often inherently complex. Therefore, risk management becomes essential in the requirements elicitation phase, considering that it involves a complex combination of contributions from various individuals working at different levels within an organization who are, in some way, directly involved in or connected to the environment in which the software will be implemented and used [2].

According to ISO 31000 – Risk Management, risk is the effect of uncertainty on objectives. The ISO also defines risk management as a set of coordinated activities to direct and control an organization with regard to risks and to create and protect value [4].

In this context, this research aims to apply the requirements elicitation process based on the ISO 31000 guidelines, with emphasis on risk identification, analysis, evaluation, and treatment. The goal is thereby to contribute to the company and those involved, offering a more assertive work process that adds value to the client, aligned with the use of agile methods.

This article is structured in six sections. The first presents a brief introduction that contextualizes the topic within the proposed research. The second section explores the most relevant works found in the literature; using the adapted TEMAC, sources related to the difficulties encountered in the requirements elicitation phase were identified. The third section provides a literature review, highlighting relevant authors on ISO risk management in the requirements elicitation process, as well as the Failure Mode and Effect Analysis (FMEA) tool. The fourth section addresses the methodology applied in the research, detailing the methods and structure adopted. The fifth section presents the results obtained. Finally, the sixth and last section proposes improvements to the requirements elicitation process and presents the final considerations.

To carry out a literature review, an adaptation of TEMAC was proposed with the objective of providing a list of important authors on the researched topic. For this purpose, the indexed databases Scopus and Web of Science were used. Initially, the search strings Requirements Elicitation, Risk management, Agile, and software development were applied to the filters. The period applied in the filter was the last ten years, in order to ensure that the observed facts were the most current within the literature. The

search on the Web of Science database returned 23 documents, including articles and journals, and 11 on the Scopus database. Exclusion was based on repeated articles and those classified in the research area of “Software design”, as well as terms outside the scope of the research, such as “Project management”, among others. As a result, 8 and 5 remained, respectively, totaling 13. After this bibliographic refinement process, this information was applied in the VOSviewer software, aiming to generate the visualization of bibliometric networks, where it is possible to verify the terms with the highest occurrence and relevance in the related articles.



Fig. 1. Bibliometric Network (Source: Elaborated by the authors, 2024)

The keywords found in the bibliometric network presented in Fig. 1 relate the main term "Requirements Engineering", followed by two equally important terms: Risk management and Requirements Elicitation, which are central subjects of this research. The term, whose translation is requirements engineering and requirements elicitation, was analyzed in the most widely used studies as research sources, that is, the main literature on the central topic of this study.

It is important to note that there are not many works related to risk management in the requirements elicitation phase available in the scientific databases searched. The largest collection found is linked to risk analysis in the software development process. However, the references cited above contain important information that contributed significantly to the development of this study.

2 Literature Review

2.1 Process Management

To support the requirements elicitation process, it is possible to use some process mapping methods for the area or even for the organization that requires an automated solution to improve company operations. One example is the Business Process Model and Notation (BPMN), which allows, through process notation, documenting the current workflow of the requirements elicitation process or even enabling redesign in order to propose improvements to the existing process. Many organizations use business process models to document business operations and to formalize these requirements in software engineering projects [5].

The use of BPM aims to understand and explore the processes carried out in an organization, measure them, and provide continuous improvement cycles for the organization's evolution. Along these lines, process mapping consists of the analysis ("AS-IS"), providing a detailed view of the process in question, showing the relationship between inputs, outputs, and the tasks performed. There are various ways to externalize and document the intellectual process for business process modeling, such as:

- Business Process Model and Notation (BPMN): A standard created by the Object Management Group (OMG®), approved as an American National Standards Institute (ANSI) standard, includes a simple and limited set of non-standardized symbols [6].
- Event-driven Process Chain (EPC): Considers events as triggers for a process step.
- Unified Modeling Language (UML): maintained by the OMG®, consists of a standard set of technical diagramming notations oriented toward describing the requirements of information systems.

There is a growing trend in the importance of modeling. Specification languages such as UML and BPMN are applied in the majority of software engineering projects today. However, each one has its application at specific stages of the software engineering process. When studying some works on the use of BPM in requirements elicitation processes, it was identified that one of the most widely used notations is BPMN, when the focus is on modeling the software process as a whole. The methodology for implementing process modeling in an organization is divided into four phases: Planning, Mapping and Analysis, Monitoring and Control, and Performance Evaluation. The proposal of this research is somewhat simpler, suggesting the identification, analysis, and evaluation of risks based on the current process (AS-IS) of requirements elicitation and the development of a process redesign proposal (TO-BE) for mitigating the identified risks [6].

2.2 SCRUM

In the game of Rugby, the "Scrum" is the way to restart the game after a foul. All players position themselves in a human huddle to compete for the ball. It is a play in which a team of eight members works together to move the ball forward in the opponent's field and achieve their single objective: the Goal.

The term Scrum was first associated with development by Hirotaka Takeuchi and Ikujiro Nonaka in the book "The New Product Development Game". The authors highlight the importance of adopting a development approach where the entire team works as a unit to achieve a common goal. In 1995, Ken Schwaber formalized Scrum for software development projects based on Toyota's Lean system [7].

In the Scrum framework, teams work as a highly integrated unit with each member playing a well-defined role and the entire team focusing on a single objective – product delivery. It eliminates unnecessary, inadequate, and bureaucratic control practices, concentrating on the essence of the process of building information systems.

Scrum is quite objective, having clear goals, a well-defined team, flexibility, commitment, and cooperation; and its learning curve is relatively low. Although Scrum is a methodology from the exact sciences field, it draws heavily from the humanities, and this must be taken into account at all times. Its pillars are:

Transparency. Significant aspects of the process must be visible to those responsible for the results. This transparency requires aspects defined by a common standard so that observers share a common understanding of what is being seen.

Inspection. Scrum users must frequently inspect Scrum artifacts and progress in order to detect variations. This inspection should not, however, be so frequent as to interfere with the actual execution of tasks. Inspections are most beneficial when performed diligently by inspectors specialized in the work being verified.

Adaptation. If an inspector determines that one or more aspects of a process have deviated outside acceptable limits, and that the resulting product would be unacceptable, the process or the material being produced must be adjusted. The adjustment must be made as quickly as possible to minimize further deviations.

According to its author Schwaber (2014), Scrum is not a predictable process; it does not define what to do in every circumstance. It is used in complex work where it is not possible to predict events and offers a framework and a set of practices that makes everything visible. This allows the team to have an accurate view of the facts throughout the project and, if necessary, make the appropriate adjustments to achieve their goals. This is one of Scrum's strengths: "Adaptability and Flexibility" [8].

Scrum is not a "miracle worker" and much less will it offer a "ready-made recipe" to solve all your problems. The only certainty is that these problems will be identified more easily. Being a framework, it will serve as a guide of best practices to achieve your objective.

Scrum prescribes four formal Events, contained within the limits of the Sprint, for inspection and adaptation:

- Sprint Planning Meeting – Objective: Held at the beginning of each Sprint to align everything that will be done so that the final product meets the needs of the end client.
- Daily Scrum Meeting – Objective: A short daily meeting for everyone to speak about the previous day, any problems that will need to be resolved, and what they intend to do that day.
- Sprint Review Meeting – The team involved in the project presents to the group the functionalities that were implemented during the focused Sprint. The Review is an accountability ceremony where the team presents the progress of this sprint to the Product Owner and other project stakeholders.
- Sprint Retrospective – At the restart of the cycle, using the learnings of this Sprint to plan the next one. It lasts on average one hour and takes place at the end of each Sprint.

3 Risk Management and ISO 31000

3.1 Risk Management

Risk Management is an essential component of project management, focused on identifying, evaluating, and responding to uncertainties that may affect project objectives. This edition adopts an approach based on principles and performance domains, emphasizing the importance of proactively managing uncertainties to optimize project outcomes [15].

The term risk is generally used to describe adverse events with a known probability, where uncertainty is found to be an element related to confidence in risk management and arises from a lack of knowledge and, therefore, has an unknown probability.

Risk can be considered anything that impacts an organization's objectives. Organizations of all types and sizes face internal and external influences and factors [2].

The 7th edition of the PMBOK® Guide highlights that risk management is not an isolated activity, but must be integrated throughout the entire project life cycle, promoting a culture of proactivity and continuous improvement. By adopting this approach, organizations can increase the probability of success of their projects, delivering consistent value and meeting stakeholder expectations [14].

One of the factors that can lead to the materialization of a risk is the exploitation of flaws or vulnerabilities, which often arise from the absence of adequate controls. Vulnerabilities consist of a set of weaknesses or internal factors that can be exploited by threats, generating the potential for incidents to occur, that is, undesired events [15].

Proactive risk management should be applied with the objective of protecting organizational assets—everything that has value to the organization, such as people, processes, environment, technology, information, and communication. This approach, in accordance with ISO 31000 guidelines, aims not only to mitigate risks, but also to strengthen organizational resilience and promote a strategic vision that supports the sustainability and success of the organization.

3.2 ISO 31000

ISO 31000 is an international standard developed by the International Organization for Standardization (ISO), which provides principles, guidelines, and a framework for risk management in any type of organization. The standard is widely recognized and used across various sectors as a reference for identifying, evaluating, treating, and monitoring risks in a systematic and effective manner [16].

The main characteristics of the ISO are:

- Objective: To help organizations manage risks proactively in order to achieve their strategic and operational objectives, create value, and protect assets and resources.
- Principle-Based Approach: The standard is built on principles that promote the integration of risk management into organizational culture and decision-making processes.
- Flexibility and Adaptability: Unlike certifiable standards, such as ISO 9001, ISO 31000 does not require strict compliance, but offers guidelines that can be adapted to the specific needs of each organization.
- Universal Applicability: It can be implemented in organizations of all sizes, sectors, and maturity levels in risk management.

ISO 31000 is structured in three main parts: Principles, Structure, and Process.

The first step of the process consists of establishing the context, which is divided into external and internal, listing a brief summary of the organizational objectives, since it is the risks of these objectives that, if not achieved, must be managed internally; the

organization has its organizational structure analyzed, as well as its responsibilities, processes, and systems. As for the external context, evaluations regarding the legal, social, financial, technological, and economic environments, among others, as well as the organization's relationship with stakeholders, also known as stakeholders, their perception and their values [2] (Fig. 2)



Fig. 2. Risk Management Process (Source: ISO 31000)

Identification of Risks. After establishing the context, it is necessary to identify **the** risks, that is, to find, recognize, and record the risks. This step must be based on the identification of risk sources, impact areas, events (including changes in circumstances), and their potential causes and consequences (Fig. 3).

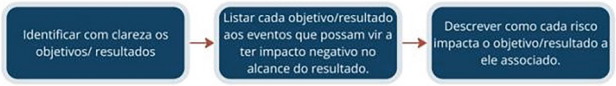


Fig. 3. Risk Identification (Source: Elaborated by the authors, 2024)

It is understood that the risk identification process is critical, given that an unmapped risk cannot be analyzed later, which can directly impact the failure of proactive risk management as a whole (Figs. 4 and 5).

Risk Analysis. Risk analysis refers to the development of an understanding of the risk and the determination of the risk level, as well as the measurement of the probability of the risk becoming an incident and the associated consequences.

Evaluation of Risks. Risk evaluation consists of comparing the estimated risk levels with risk criteria defined when the context was established, in order to determine the significance of the level and type of risks.



Fig. 4. Decisions in risk evaluation (Source: Adapted from ISO 31000)

Risk Treatment. Involves planning and carrying out actions to modify the risk level. The risk level can be modified through risk response measures that mitigate, transfer, or avoid these risks.



Fig. 5. Decisions in risk evaluation (Source: Elaborated by the authors, 2024)

Monitoring and Critical Review. Involves monitoring and verifying the performance or status of elements of risk management, which may encompass the policy, activities, risks, risk treatment plans, controls, and other matters of interest.

Continuous Improvement. Continuous improvement involves the enhancement or adjustment of aspects of risk management assessed during monitoring. It can be understood in two dimensions: one relating to the organization's own Risk Management System and another related to the monitoring results on the effectiveness of risk treatment, which is the responsibility of risk managers.

3.3 Failure Mode and Effect Analysis (FMEA)

Failure Mode and Effect Analysis (FMEA) was first developed as a formal method in design methodology in the 1960s by the aerospace industry due to its obvious reliability and safety requirements (SANKAR and PRABHU, 2001). Its use subsequently spread to other industries, such as automotive and oil and gas (PALADY, 1997). Failure Mode and Effect Analysis (FMEA) has long been used as a planning tool during the development of processes, products, and services. In the development of FMEA, the team identifies failures and actions that can reduce or eliminate the potential failure from occurring. Input is sought from a broad group of experts in design, testing, quality, product line, marketing, manufacturing, and the client to ensure that potential failure modes are identified.

FMEA is then used during the deployment of the product or service for troubleshooting and corrective action. The standard FMEA process evaluates failure modes for occurrence, severity, and detection. The multiplication of these values leads to what is known as the risk priority number [11].

The FMEA method translates, in a logical and systematic sequence, the evaluation of the possible ways in which a system or process is most subject to failure. FMEA considers the severity variables (S) of failures, the frequency with which they occur (O), and how they could be detected (D). Thus, based on these three indexes: severity, occurrence, and detection, the method leads to a prioritization of which failure modes of the product or service may cause the greatest risk to clients and to the organization itself [11].

From Table 1, it is possible to demonstrate how the severity, occurrence, and detection variables can be classified and related to each project, product, and industry.

Table 1. Severity and Failure Index (Source: Carbone, 2004)

Severidade e Índice de Falha		
Pontuação	**Descrição**	**Impacto no sistema ou processo**
10	Perigo sem aviso	1
9	Perigo com aviso	2
8	Funcionamento muito insatisfatório	3
7	Funcionamento insatisfatório	4
6	Redução moderada na capacidade do sistema	5
5	Impacto menor	6
4	Impacto mínimo	7
3	Leve incomodidade	8
2	Nenhuma consequência significativa	9
1	Nenhum impacto	10

Table 1 demonstrates the severity classification of a risk, where number 1 is considered very low and number 10 is highly dangerous according to the criterion. Table 2 demonstrates the classifications for the occurrence of failure or risk.

Table 2. Analysis Criteria for Failure Occurrence Index (Source: Adapted from FORD MOTOR COMPANY, 1988)

Critério de Análise para Índice de Ocorrência das Falhas		
Pontuação	**Descrição**	**Capacidade de detecção**
1	Falha sempre detectada	A falha é prontamente identificada
2	Alta probabilidade de detecção	A falha é facilmente detectável.
3	Boa probabilidade de detecção	A falha geralmente é identificada, mas nem sempre.
4	Média probabilidade de detecção	A falha pode ser detectada, mas depende de fatores.
5	Detecção ocasional	A falha é detectada em algumas situações.
6	Baixa probabilidade de detecção	A falha é raramente identificada.
7	Muito baixa probabilidade de detecção	A falha é detectada somente em casos excepcionais.
8	Dificuldade significativa para detectar	A falha é extremamente difícil de identificar.
9	Falha praticamente indetectável	É improvável que a falha seja detectada.
10	Falha impossível de detectar	A falha não pode ser detectada por nenhum meio.

In Table 2, it can be seen that the classification of the occurrence of a risk can be represented by a failure rate where 1 is considered almost impossible and 10 is extremely likely to occur. The classification criteria for Failure Detection are listed in Table 3, showing the failure indexes ranging from 1 to 10.

Thus, Table 3 highlights the classification regarding the possibility of detecting a failure or risk, ranging from 1, almost certain (easily detected), to 10, which are considered almost impossible to detect (difficult). The most widely used procedure to measure the risk associated with each failure mode is the multiplication of the scores obtained for the severity (S), occurrence (O), and detection (D) classifications. This results in a scale ranging from 1 to 1000 points, with 1 representing very low risk and 1000 a highly critical risk. This score is called the risk priority number (RPN), expressed as:

$$RPN = O \times S \times D$$

Table 3. Analysis Criteria for Failure Detection Index (Source: Adapted from FORD MOTOR COMPANY, 1988)

Critério de Análise para Índice de Ocorrência das Falhas		
Nível de Ocorrência	**Descrição da Taxa de Ocorrência**	**Índice de Ocorrência (O)**
Extremamente Alta	≥ 1 falha em 2 tentativas	10
Muito Alta	1 falha em 3 tentativas	9
Alta	1 falha em 8 tentativas	8
Moderada	1 falha em 20 tentativas	7
Significativa	1 falha em 80 tentativas	6
Baixa	1 falha em 400 tentativas	5
Muito baixa	1 falha em 2.000 tentativas	4
Rara	1 falha em 15.000 tentativas	3
Muito rara	1 falha em 150.000 tentativas	2
Quase impossível	1 falha em 1.500.000 tentativas	1

Where: RPN: Risk Priority Number, O: occurrence; S: severity; D: detection.

In this way, risk management, as a key component in the requirements elicitation process, through the use of the aforementioned methods and tools, will make it possible to establish a balance between the evaluated risks and their possible mitigation.

Based on the theoretical framework analyzed in this section, the methodology and research structure will be proposed in the next section.

4 Methodology

4.1 Research Method

The methodological proposal was based on conducting research with an exploratory objective, aiming to provide greater familiarity with the subject studied. The strategy employed was a case study, with an applied nature and a qualitative approach. According to Piovesan and Temporini (1995), this type of research aims to understand the variable being studied in its literal form, as it presents itself, along with its meaning and the context in which it is inserted. For this work, a Brainstorming model was followed, as it is a technique used to stimulate creative thinking and generate new ideas from a formal process that can be used in a structured or unstructured manner. Its main objective is to generate a high number of ideas in a creative and efficient way and, above all, free from criticism, and it is widely used in risk identification and problem solving (Fig. 6).

In order to propose a coherent study, we carried out the verification and analysis of the artifacts (documents) from the software development projects regarding the requirements elicitation phase, in addition to conducting Brainstorming sessions.

4.2 Research Structure

The research was structured in four stages, starting with the documentary research of the software development projects owned by the company. In the initial stage, potential risks were identified based on the current requirements elicitation process (AS-IS), along with the conduct of a Brainstorming session in which two professionals from the company



Fig. 6. Research Classification (Source: Elaborated by the authors, 2024)

who hold the position of project manager participated. The FMEA method was used, in which several process failures were presented [11].

After this study, the identification, analysis, evaluation, and treatment of the risks listed as critical in the process in question were carried out. Below is the figure showing the research structure of this study:



Fig. 7. Research Structure (Source: Elaborated by the authors, 2024)

At the end of this stage illustrated by Fig. 7, a process modeling technique was applied in Bizagi, based on the BPMN notation. In this way, it was possible to apply the risk management process, through the proposed research methodology and structure, which will be further detailed in Sect. 5.

5 Results and Discussion

5.1 Context Establishment

The company studied is a corporation, 100% Brazilian, and privately held. Founded in 2010, it operates in the IT market with a focus on developing customized solutions.

Its mission is to be a prosperous business group in the IT segment, providing success to clients, employees, and shareholders, through an innovative, genuine, and achievable vision. Its vision is to provide clients, through qualified human resources and powerful management tools, with the means to achieve their objectives while adding value to the business.

Its value chain is divided into: Strategic Processes, Core Processes, and Support Processes, as shown in Fig. 8

As the central object of this process illustrated in Fig. 8, with respect to the company's Value Chain, the end-purpose process has the macro-process "Develop Software". It

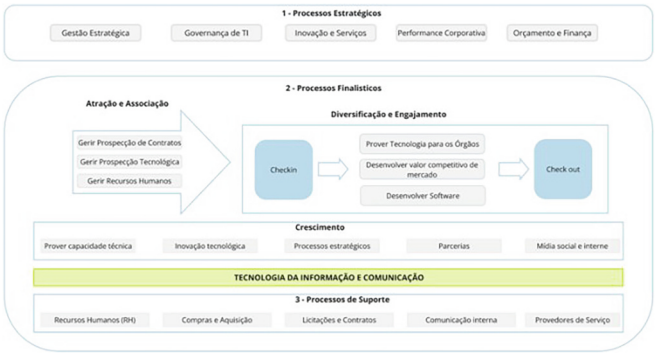


Fig. 8. Value Chain (Source: Elaborated by the authors, 2024)

was possible to detail and reach the requirements elicitation process, where a process is being used by the company, and it was possible to describe the main stages through the modeling of this process.

According to Fig. 9, it was possible to interpret the figure and identify the risks from the modeled process (AS-IS).

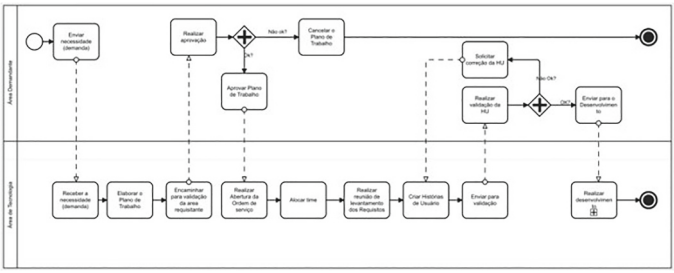


Fig. 9. AS-IS Mapping (Source: Elaborated by the authors, 2021)

5.2 Risk Management – Identification

A documentary research of the company's projects regarding the requirements elicitation phase represented by the process in Fig. 9 was conducted. Based on this study and the historical analysis of the projects, Brainstorming was carried out with the participation of two senior project managers in software project management. In this Brainstorming session, problems were identified in some of the events of the requirements elicitation process. After identifying these failures, it was possible to carry out the risk identification.

As shown in Table 4, the events that had one or more problems/failures and risks that were identified are listed.

Table 4. Risk Identification (Source: Prepared by the authors)

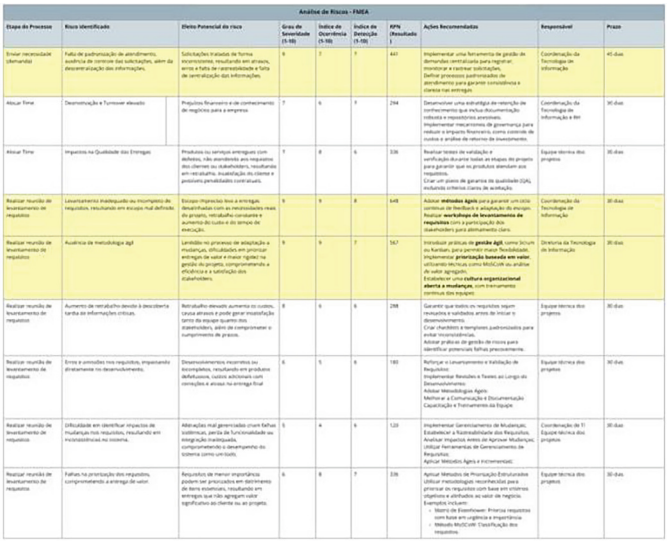
PROCESSO DE ELICITAÇÃO DE REQUISITOS		
Evento	**Problema**	**Risco Identificado**
Enviar necessidade (demanda)	• Atualmente não há uma ferramenta de gestão de controle de solicitações (demanda). Abertura de demanda ocorre atualmente via e-mail e Teams.	• Falta de padronização de atendimento, ausência de controle das solicitações, além da descentralização das informações.
Receber a necessidade (demanda)	• Por ter mais de um canal de entrada de solicitação, pessoas diferentes atuam na mesma demanda. Causando duplicidade e retrabalho.	• Retrabalho, perda de prazos junto aos clientes, causando insatisfação é um sentimento de desorganização e amadorismo por parte da empresa.
Elaborar Plano de Trabalho	• Não há muito detalhamento para elaboração do documento que estima prazo e custo.	• Por vezes não há detalhamento na solicitação para que seja criada uma proposta com escopo definido, orçamento e prazo factível de ser executado. Além disso não há padronização do formato do documento e nem em sua escrita. Esses problemas causam dúvidas e falta de clareza no plano de trabalho elaborado pela empresa.
Encaminhar para validação da área requisitante	• Caso a área requisitante não concorde com o Plano de trabalho poderá realizar o cancelamento sem nenhum ônus. Com isso a empresa não é remunerada pelo trabalho realizado.	• Todo o trabalho realizado e as horas gastas pelo ou pelos profissionais que elaboraram o Plano de trabalho não é pago pela contratante. Causando prejuízo à empresa.
Alocar Time	• A empresa não possui squads ou equipes dedicadas para lidar com diferentes tipos de projetos, operando exclusivamente sob demanda. Sempre que uma ordem de serviço é aberta, os integrantes do time são selecionados sem critérios claros. Essa abordagem apresenta sérios problemas, como dificuldades na curva de aprendizado, ausência de gestão estratégica de competências (skills) dos profissionais e aumento do turnover, causado pela desmotivação decorrente da falta de estrutura e alinhamento.	• Baixa Eficiência Operacional • Dificuldade na Curva de Aprendizado • Falta de Continuidade e Conhecimento Acumulado • Falta de Gestão de Competências (Skills) • Desmotivação e Turnover Elevado • Impactos na Qualidade das Entregas • Aumento de Conflitos Internos • Riscos Financeiros e Atrasos • Dificuldade na Gestão de Recursos • Falta de Inovação e Crescimento
Realizar reunião de levantamento dos Requisitos	• Ausência de processo e método na etapa de descoberta. • Excesso de atividades para os analistas de requisitos • Ausência de repasse de conhecimento dos projetos aos analistas • Falta de um plano de comunicação apontando os envolvidos e os responsáveis pelo projeto • Ausência de uma ferramenta de acompanhamento e repositorio dos artefatos elaborados • Ausência de uma matriz de rastreabilidade dos requisitos mais complexos.	• Levantamento inadequado ou incompleto de requisitos, resultando em escopo mal definido. • Falhas na identificação de stakeholders e suas necessidades. • Aumento de retrabalho devido à descoberta tardia de informações críticas. • Dificuldade para alinhar expectativas e prioridades entre a equipe e os clientes. • Sobrecarga de trabalho, levando à queda na qualidade das análises e entregas. • Atrasos no cronograma devido à baixa capacidade de entrega. • Desmotivação e aumento do turnover dos analistas devido ao estresse. • Erros e omissões nos requisitos, impactando diretamente no desenvolvimento. • Aumento do tempo necessário para que novos analistas atinjam produtividade. • Dependência de poucos profissionais, criando vulnerabilidade em caso de turnover. • Diminuição da colaboração e alinhamento entre os times. • Aumento do risco de não conformidade com as expectativas dos stakeholders ou reguladores. • Dificuldade em identificar impactos de mudanças nos requisitos, resultando em inconsistências no sistema. • Falhas na priorização dos requisitos, comprometendo a entrega de valor.

From the identification and analysis of the workflow scenarios, it was possible to identify the problems, and from this the related risks were reached.

5.3 Risk Management – Analysis and Evaluation

In order to propose the analysis and evaluation of risks, FMEA was used, through the analysis of failure modes, which translates into reliability and quality control, as the documentation enables the organization to recognize potential failures in the process in advance, and if they happen to occur, have sufficient tools to resolve them in the best way possible. For the construction of the failure modes, the main risks described in Table 5 were considered:

Table 5. Failure Mode and Effect Analysis (Source: Prepared by the authors)



Análise de Riscos - FMEA								
Etapa do Processo	Risco Identificado	Efeito Potencial do risco	Grau de Severidade (1-10)	Índice de Ocorrência (1-10)	Índice de Detecção (1-10)	RPN (Resultado)	Ações Recomendadas	Responsável	Prazo
Enviar necessidade (demanda)	Falta de padronização de atendimento, ausência de controle das solicitações, além da descentralização das informações.	Solicitações tratadas de forma inconsistente, resultando em atrasos, erros e falta de rastreabilidade e falta de centralização das informações.	6	7	9	441	Implementar uma ferramenta de gestão de demandas centralizada para registrar, monitorar e rastrear solicitações. Definir processos padronizados de atendimento para garantir consistência e clareza nas entregas.	Coordenação da Tecnologia de Informação	45 dias
Alocar Time	Descontratação e Turnover elevado	Prejuízos financeiro e de conhecimento de negócios para a empresa	7	6	7	294	Desenvolver uma estratégia de retenção de conhecimento que inclua documentação robusta e repositórios acessíveis. Implementar mecanismos de governança para reduzir o impacto financeiro, como controle de custos e análise de retorno de investimento.	Coordenação da Tecnologia de Informação e RH	90 dias
Alocar Time	Impactos na Qualidade das Entregas	Produtos ou serviços entregues com defeitos, não atendendo aos requisitos dos clientes ou stakeholders, resultando em retrabalho, insatisfação do cliente e possíveis penalidades contratuais.	7	8	6	336	Realizar testes de validação e verificação durante todas as etapas do projeto para garantir que os produtos atendam aos requisitos. Criar um plano de garantia de qualidade (QA), incluindo critérios claros de aceitação.	Equipe técnica dos projetos	30 dias
Realizar reunião de levantamento de requisitos	Levantamento inadequado ou incompleto de requisitos, resultando em escopo mal definido	Escopo imprevisto leva a entregas desalinhadas com as necessidades reais do projeto, retrabalho constante e aumento do custo e do tempo de execução.	9	9	8	648	Adotar **métodos ágeis** para garantir um ciclo contínuo de feedback e adaptação do escopo. Realizar **workshops de levantamento de requisitos** com a participação dos stakeholders para alinhamento claro.	Coordenação da Tecnologia de Informação	30 dias
Realizar reunião de levantamento de requisitos	Ausência de metodologia ágil	Lentidão no processo de adaptação a mudanças, dificuldades em priorizar entregas de valor e maior rigidez na gestão do projeto, comprometendo a eficiência e a satisfação dos stakeholders.	9	9	7	567	Introduzir práticas de **gestão ágil**, como Scrum ou Kanban, para permitir maior flexibilidade. Implementar **priorização baseada em valor**, utilizando técnicas como MoSCoW ou análise de valor agregado. Estabelecer uma **cultura organizacional aberta a mudanças**, com treinamento contínuo das equipes.	Diretoria da Tecnologia da Informação	30 dias
Realizar reunião de levantamento de requisitos	Aumento de retrabalho devido à descoberta tardia de informações críticas.	Retrabalho elevado aumenta os custos, causa atrasos e pode gerar insatisfação tanto da equipe quanto dos stakeholders, além de comprometer o cumprimento de prazos.	8	6	6	288	Garantir que todos os requisitos sejam revisados e validados antes de iniciar o desenvolvimento. Criar checklists e templates padronizados para evitar inconsistências. Adotar práticas de gestão de riscos para identificar potenciais falhas precocemente.	Equipe técnica dos projetos	30 dias
Realizar reunião de levantamento de requisitos	Erros e omissões nos requisitos, impactando diretamente no desenvolvimento.	Desenvolvimento incorreto ou incompleto, resultando em produtos defeituosos, custos adicionais com correções e atrasos na entrega final	6	5	6	180	Reforçar o Levantamento e Validação de Requisitos: Implementar Revisões e Testes ao Longo do Desenvolvimento. Adotar Metodologias Ágeis Melhorar a Comunicação e Documentação Capacitação e Treinamento da Equipe	Equipe técnica dos projetos	30 dias
Realizar reunião de levantamento de requisitos	Dificuldade em identificar impactos de mudanças nos requisitos, resultando em inconsistências no sistema.	Alterações mal gerenciadas criam falhas sistêmicas, perda de funcionalidade ou integração inadequada, comprometendo o desempenho do sistema como um todo.	5	4	6	120	Implementar Gerenciamento de Mudanças: Estabelecer a Rastreabilidade dos Requisitos: Analisar Impactos Antes de Aprovar Mudanças: Utilizar Ferramentas de Gerenciamento de Requisitos: Aplicar Métodos Ágeis e Incrementais:	Coordenação de TI Equipe técnica dos projetos	30 dias
Realizar reunião de levantamento de requisitos	Falhas na priorização dos requisitos, comprometendo a entrega de valor.	Requisitos de menor importância podem ser priorizados em detrimento de itens essenciais, resultando em entregas que não agregam valor significativo ao cliente ou ao projeto.	6	8	7	336	Aplicar Métodos de Priorização Estruturados Utilizar metodologias reconhecidas para priorizar os requisitos com base em critérios objetivos e alinhados ao valor de negócio. Exemplos incluem: - Matriz de Eisenhower: Prioriza requisitos com base em urgência e importância. - Método MoSCoW: Classificação dos requisitos.	Equipe técnica dos projetos	30 dias

For a better understanding of Table 5, a description of each field follows:

- Process Stage: Which stage of the project is being evaluated.
- Risk: Identification of the current risk.
- Potential Effect of the Problem: Expected impact if the problem occurs.
- Severity Level: Classification of the severity of the problem (1–10).
- Occurrence Index: Probability of the problem occurring (1–10).
- Detection Index: Probability of the problem being detected before causing impact (1–10).
- RPN (Result): Multiplication of the three indexes (Severity × Occurrence × Detection).
- Recommended Actions: Suggested measures to mitigate the identified risk.
- Responsible: Person or team responsible for implementing the actions.
- Deadline: Estimated time to carry out the proposed actions.

Based on these reports and the analysis of failure modes and effects, the Risk Priority Number (RPN) values were calculated, with the highest values highlighted in yellow rows. The RPN of 648 was assigned to the risk "Inadequate or incomplete requirements gathering, resulting in a poorly defined scope"; the risk "Absence of agile methodology" obtained an RPN of 567; and the risk "Lack of standardization in request handling, in addition to the decentralization of information" had an RPN of 441.

The objective of this stage was to define the level of the identified risks, as well as to prioritize them for treatment. As input in this process, risk records and the probability and impact matrix were used, which contains the score calculation for each risk. To define the risk level, three evaluation levels were used, namely:

- Range 01 (green color): represents the risks with the lowest level of relevance in relation to the analysis performed. For this level, the risk must have a score between 0.1 and 0.9.
- Range 02 (yellow color): represents the risks with an intermediate level of relevance in relation to the analysis performed, but which require a degree of attention for evaluation. For this level, the risk must have a score between 1 and 2.1.
- Range 03 (red color): represents the risks with a high level of relevance in relation to the analysis performed and indicates a critical point that must be considered in the risk evaluation. For this level, the risk must have a score between 2.5 and 4.5 [12].

For a better understanding, the method used will be represented in Table 6.

Table 6. Risk Level Table (Source: Adapted from ISO 31010)

PROBABILIDADE						
	90%	Média	Média	Média	R05 - Ausência de Métodos Ágeis	R04 - Levantamento de requisitos inadequado.
	70%	Baixa	Média	R3 - Impactos na Qualidade das Entregas	R9 - Falhas na priorização dos requisitos	R01- Falta de padronização de atendimento (ausência de ferramenta).
	50%	Baixa	Baixa	Baixa	R7 - Erros e omissões nos requisitos, impactando diretamente no desenvolvimento.	R6 - Aumento de retrabalho devido à descoberta tardia de informações críticas.
	30%	Baixa	Baixa	Baixa	R8 - Dificuldade em identificar impactos de mudanças.	R9 - Falhas na priorização dos requisitos.
	10%	Baixa	Baixa	Baixa	Baixa	Média
		Muito Baixo	Baixo	Moderado	Alto	Muito Alto
		IMPACTO				

As presented in Table 6, three risks represent a high level of relevance in relation to the analysis performed and were indicated as critical in their evaluation; in yellow, six risks with an intermediate level of relevance in relation to the analysis performed were analyzed and evaluated.

Thus, Table 7 shows the evaluation and treatment plan for the identified risks.

Table 7. Risk Analysis and Evaluation (Source: Prepared by the authors)

Análise e Avaliação dos Riscos						
Risco	**Tipo**	**Probabilidade**	**Impacto**	**Ação**	**Medidas**	**Medida(s) Aprovada(s)**
Falta de padronização de atendimento, ausência de controle das solicitações, além da descentralização das informações.	Negativo	Alto	Alto	Implementar uma ferramenta de gestão de demandas centralizada para registrar, monitorar e rastrear solicitações. Definir processos padronizados de atendimento para garantir consistência e clareza nas entregas.	Elaborar proposta de redesenho do processo (TO-BE) Aquisição de uma ferramenta de gestão de demandas.	x
Desmotivação e Turnover elevado	Negativo	Alto	Moderado	Desenvolver uma estratégia de retenção de conhecimento que inclua documentação robusta e repositórios acessíveis. Implementar mecanismos de governança para reduzir o impacto financeiro, como controle de custos e análise de retorno de investimento.	Desenvolver uma estratégia de retenção de conhecimento com documentação eficiente e implementar mecanismos de governança para controle de custos e análise de retorno sobre investimento	x
Impactos na Qualidade das Entregas	Negativo	Alto	Moderado	Realizar testes de validação e verificação durante todas as etapas do projeto para garantir que os produtos atendam aos requisitos. Criar um plano de garantia de qualidade (QA), incluindo critérios claros de aceitação.	Realizar testes de validação e verificação em todas as etapas do projeto e criar um plano de garantia de qualidade (QA) com critérios claros de aceitação.	
Levantamento inadequado ou incompleto de requisitos, resultando em escopo mal definido.	Negativo	Alto	Alto	Adotar **métodos ágeis** para garantir um ciclo contínuo de feedback e adaptação do escopo. Realizar **workshops de levantamento de requisitos** com a participação dos stakeholders para alinhamento claro.	Elaborar uma proposta de redesenho do processo (TO-BE) Realizar a adoção de algum framework ágil. Realizar a implantação do Upstream nos projetos.	x
Ausência de metodologia ágil	Negativo	Alto	Alto	Produzir práticas de **gestão ágil**, como Scrum ou Kanban, para permitir maior flexibilidade. Implementar **priorização baseada em valor**, utilizando técnicas como MoSCoW ou análise de valor agregado. Estabelecer uma **cultura organizacional aberta a mudanças**, com treinamento contínuo das equipes.	Elaborar uma proposta de redesenho do processo (TO-BE) Realizar uma transformação ágil na empresa	x
Aumento de retrabalho devido à descoberta tardia de informações críticas.	Negativo	Alto	Moderado	Garantir que todos os requisitos sejam revisados e validados antes de iniciar o desenvolvimento. Criar checklists e templates padronizados para evitar inconsistências. Adotar práticas de gestão de riscos para identificar potenciais falhas precocemente.	Implantação de Upstream na etapa de levantamento de requisitos. Aquisição de ferramenta de controle e execução dos projetos.	
Erros e omissões nos requisitos, impactando diretamente no desenvolvimento.	Negativo	Alto	Alto	Reforçar o Levantamento e Validação de Requisitos; Implementar Revisões e Testes ao Longo do Desenvolvimento; Adotar Metodologias Ágeis; Melhorar a Comunicação e Documentação Capacitação e Treinamento da Equipe	Implantação de Upstream na etapa de levantamento de requisitos. Aquisição de ferramenta de controle e execução dos projetos.	
Dificuldade em identificar impactos de mudanças nos requisitos, resultando em inconsistências no sistema.	Negativo	Alto	Moderado	Implementar Gerenciamento de Mudanças; Estabelecer a Rastreabilidade dos Requisitos; Analisar Impactos Antes de Aprovar Mudanças; Utilizar Ferramentas de Gerenciamento de Requisitos; Aplicar Métodos Ágeis e Incrementais;	Aquisição de uma ferramenta (Wiki) onde possa ser centralizada as informações, documentos dos projetos.	x
Falhas na priorização dos requisitos, comprometendo a entrega de valor.	Negativo	Alto	Moderado	Aplicar Métodos de Priorização Estruturados Utilizar metodologias reconhecidas para priorizar os requisitos com base em critérios objetivos e alinhados ao valor de negócio. Exemplos incluem: • Matriz de Eisenhower: Prioriza requisitos com base em urgência e importância. • Método MoSCoW: Classificação dos requisitos.	Realização de transformação ágil. Capacitação dos profissionais Plano de ação junto ao RH para Política de Certificações aos profissionais.	x

Based on this evaluation, it was possible to assist the company studied, identifying the highest risks that should have a decision made in response to them.

5.4 Improvement Proposal

As a way to mitigate or even eliminate the risks identified in the requirements elicitation process (AS-IS), the modeling of the process redesign in question (TO-BE) was proposed, in order to optimize the previous process and resolve various failures identified in the process.

The improvement of the current requirements elicitation process is based on good risk management and the quality and continuous improvement process, minimizing the risk factors such as:

- F01 – Lack of effective communication among stakeholders (clients, analysts, developers).
- F02 – Inexperience or lack of training in the requirements analysis team.
- F03 – Lack of structured agile tools and methods to capture and document requirements.
- F04 – Limited or nonexistent participation of stakeholders in the elicitation process.
- F05 – Insufficient deadlines or pressure to accelerate this critical stage of the project.

These threats can cause negative impacts on organizational objectives, as listed below:

- R04 – Inadequate requirements gathering.
- R05 – Absence of Agile Methodologies.
- R01 – Lack of standardization in service delivery (Absence of a tool).

Based on the risks, their factors and impact, focusing on the quality of requirements elicitation, prioritizing the mitigation and elimination of risks, and continuous improvement in the process, the TO-BE process represented by Fig. 10 was created.

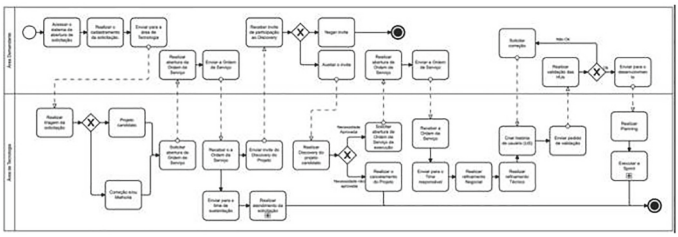


Fig. 10. TO-BE Mapping (Source: Elaborated by the authors, 2021)

Through the TO-BE approach, an optimized strategy was proposed for the acquisition and use of a centralized tool for opening service requests, which eliminated the duplication of entries coming from various channels in the company's technology area. This change brought greater control and traceability, reduced operational failures, and optimized the workflow.

In the proposed solution, the company adopted a demand management tool that, upon receiving requests from end-user requesters, automatically performed a triage based on the type of request. This functionality allowed for the creation of an area dedicated exclusively to supporting legacy systems, which optimized the service delivery process. As a result, professionals were able to work with greater focus and peace of mind in developing their activities, which increased productivity and the quality of the delivered results.

Another fundamental point was the implementation of an agile methodology, with a focus on the requirements gathering phase, introducing the Discovery practice in the requirements elicitation phase (Upstream). This approach enabled a deeper understanding of the needs on the part of the intervening areas and the technology team, promoting alignment from the very beginning of the project.

Important new stages were incorporated into the process, such as:

Business Refinement: In this phase, the Product Owner (PO) carries out a detailed survey of all business rules together with the requesting area, ensuring clarity and completeness.

Technical Refinement: Carried out in collaboration with the technical part of the team, that is, the Dev Team. This step allows for the validation of technical aspects and the feasibility of requests, aligning technical expectations with business needs.

After the completion of the refinements, it was possible to create the User Stories, ensuring that the requirements were properly defined. This practice played a crucial

role in mitigating risks related to incomplete or incorrect requirements, contributing significantly to improving the quality of deliverables.

In the TO-BE process, one of the main proposed activities was the organization of the Service Order (SO) opening flow, which previously lacked a formal process. The absence of this structure caused losses for the company, since some work performed was not formalized, which resulted in a lack of payment from the client area.

Regarding the processes that precede requirements elicitation, it was defined that they will be reviewed and redesigned to address the identified gaps. One example is the improvement of the process for signing and recording Service Orders. It was established that the prerequisite for executing any activity linked to a project will be the formal opening and signing of the Service Order, ensuring alignment between the parties and the formalization of commitments.

The agile methodology adopted by the teams was SCRUM, with all ceremonies being followed rigorously. This implementation brought greater efficiency, providing more assertive deliveries, both in terms of the quality expected by the client and in meeting the established deadlines. After the elicitation and approval of the requirement by the requesting area, it was forwarded to the Product Owner (PO) responsible for the development team. The PO, together with the team, performed the Sprint Planning ceremony, ensuring the execution of the stories included in the sprint.

To mitigate the risks of requirement changes during or after development, a Squad of test analysts (QA) was created to assist the PO in testing. This team was responsible for validating the User Stories (US), ensuring that deliveries were aligned with the specified requirements, reducing errors and rework.

Another relevant point was the adoption of a tool that streamlined the work of the development team: Trello. This tool provided greater control over the execution of the user stories included in the sprint, in addition to facilitating the management of the demands of the support team.

Additionally, team integration, combined with the use of appropriate tools and methodologies, raised the level of organization, predictability, and stakeholder satisfaction in the software development process. These improvements promoted a collaborative and efficient environment, ensuring value delivery to the client and the success of the projects.

6 Conclusion

Our objective was achieved, as we sought to analyze the risks in the requirements elicitation phase and propose improvements to the current process of the company in question.

We concluded, through this study, that it is possible to manage risks during the requirements elicitation process. We performed a detailed analysis of the current process (AS-IS) to identify, analyze, evaluate, and treat the risks involved. During this analysis, we identified critical points that highlighted the significant need for efficient risk management.

To this end, we developed and applied a risk management model specific to the elicitation phase. We used various mechanisms, such as benchmarking with company

experts and the analysis of documented projects, to identify the risks involved. Based on these efforts, we were able to propose contingency actions that could be implemented as internal controls.

In addition, we conducted a bibliographic review to explore possible methods of risk analysis and evaluation that could be applied in the context of requirements elicitation. In response to the risks identified in the AS-IS process, we recognized the need to redesign the process to an improved state (TO-BE), which was redesigned and presented to the company. It is important to highlight that the organization's needs are dynamic and evolving.

Therefore, we believe that the process redesign can be constantly monitored, evaluated, and improved, ensuring efficient risk management in the requirements elicitation phase.

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