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# Risk management in large-scale information system projects

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## Abstract

This article deals with project management in information systems, whose relevance lies in the vital importance of these systems in modern companies. Information systems are essential for decision making and data management in today's interconnected world. Project management, on the other hand, coordinates elements such as scope, resources, costs, schedules and risks to achieve defined objectives. The systems development life cycle (SDLC) structures the process, encompassing phases such as scope definition, planning, execution, monitoring and closure. These phases are integrated with risk management, which identifies, evaluates and mitigates threats and opportunities. Mitigation strategies act before adversity, while contingency planning prepares for the unforeseen. That is why risk management is integrated throughout the project life cycle to anticipate and address challenges. The combination of both aspects is critical in a constantly evolving technology environment. In addition, organizational culture and communication play a critical role. A culture of awareness and accountability, transparency in communication and active stakeholder participation are essential. Training and continuous adaptation allow learning from past experiences and improving practices.

**Keywords:** artificial intelligence, blockchain, process automation, paradigm shift, systems integration.

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## 1. Introduction

In today's digital era, information systems have emerged as fundamental pillars that drive efficiency, innovation and competitiveness in organizations. In a world characterized by digital interconnectedness and information fluidity, these systems act as a solid foundation that enables organizations to manage data, make informed decisions, and stay in tune with changing market demands [1]. Therefore, the successful implementation of these systems is not an isolated event; on the contrary, it is forged through carefully planned and executed projects.

Where organizations face the challenge of having a mechanism by which to adopt this technology, that under a relevant analysis of the daily activities that are developed, it will be possible to obtain the different requirements to meet the needs of the organization [2].

Currently, there are different ways in which an organization can design or implement its systems, including self-development, or opt for one that has already been developed. In this context, globally recognized norms and standards become guidelines that point organizations in the right direction, providing quality and safety. Among them we have the PMBOK (Project Management Body of Knowledge) provides a robust structure for project management [3]; COBIT 2019, focuses on information technology governance [4]; ITIL (Information Technology

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Infrastructure Library) establishes best practices for IT service management [5].
Despite efforts to follow these norms and standards, it is important to recognize that information systems projects are not always successful. There are several factors that can contribute to the failure of these projects, risks being one of the main ones. Risks can arise from different sources, such as lack of adequate planning, poor resource management, lack of experience in the development team, failure to meet customer requirements, among others [6].
According to the CHAOS Report of the Standish Group, the success rate of projects was only 31 %, while challenged projects accounted for 50 % and affected (cancelled) 19 % [7].

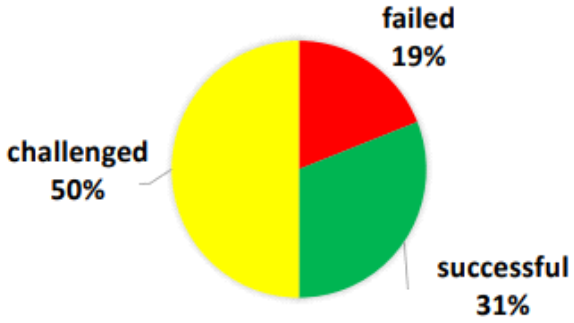


*Figure 1. Project Resolution by Type*

***Succesful, or project success:*** the project is completed on time and within budget, with all the features and functions initially specified.
***Challenged project:*** The project is complete and operational, but over budget, over the estimated time, and offers fewer features and functions than originally specified.
***Failed:*** The project is cancelled at some point during the development cycle.

## 2. Literature review

**Project management**
To understand the general approach of this article, it is first necessary to examine certain fundamental concepts present in the literature, which are essential for a thorough understanding of the central theme being addressed. Among these concepts, project management occupies a primordial place. Project management is defined as a set of processes, techniques, methodologies and tools used to plan, organize, direct and control the resources and activities essential to achieve the objectives outlined in the framework of a project, under specific time and budget constraints [8]. In essence, this discipline involves the coordination and balancing of various elements, such as project scope, human resources, materials, costs, schedule and risks, with the fundamental purpose of achieving the successful accomplishment of a desired result.
Projects represent temporary and singular efforts, characterized by a clearly defined beginning and end, aimed at achieving specific objectives [9]. With this essential understanding in mind, we can enter into a detailed explanation of each of the stages that make up a project [10].

- **Scope Definition:** The initial stage, scope definition, establishes the foundation upon which the entire project will be built. Here, specific project objectives are identified and documented, functional and technical requirements are delineated, and key stakeholders are identified. Clarity at this stage is vital to avoid ambiguity and to ensure that all parties involved are on the same page as to what is expected from the project. A comprehensive scope definition lays the foundation for effective planning and execution of subsequent stages.

- **Planning:** Planning emerges as a central stage that guides the direction of the project as a whole. Here, the objectives and requirements defined in the scoping stage are translated into a concrete plan. This encompasses the allocation of resources, determination of timelines, estimation of costs and identification of potential risks. A solid plan not only acts as a roadmap for the project team, but also provides a framework for measuring progress and making informed decisions throughout the process.

- **Execution:** The execution stage brings the planned project to life. Here, resources are mobilized to develop and build the required information systems solutions. The team works collaboratively to implement and configure the systems, ensuring that the objectives and requirements established in the previous phases are met. This phase is critical to the development of the information system and is characterized by the majority of the hands-on work. During this stage, abstract concepts and detailed designs are transformed into source code with tangible functionality and operational applications.

- **Monitoring:** The monitoring and control stage involves constant supervision of the project's progress. Milestones, performance, costs and schedules are monitored to ensure that the project is progressing as planned. Adjustments are made as necessary to keep the project on track and avoid significant deviations.

- **Closure:** The final stage, closure, involves validation and acceptance of the completed work. Extensive testing is performed and verifies whether the information systems meet the established requirements and expectations.

Together, these stages form a comprehensive information systems project management process. Each stage builds on the previous one, establishing a clear path towards the achievement of project objectives and the successful delivery of advanced technology solutions.


*Figure 2. Project management*

Another concept of vital importance lies in the information systems development process. This process becomes relevant because projects are established as responses to the objectives pursued by the organization. In each project, with precision and specific goals, information systems emerge that are designed with the fundamental purpose of addressing challenges or facilitating the fulfillment of the delineated scopes. These systems act as strategic tools, helping to solve problems and playing an instrumental role in achieving the objectives set for each project.

**System Development Life Cycle or SDLC**

The Software Development Life Cycle (SDLC) is a systematic and structured approach to the planning, design, creation, testing, implementation, and maintenance of software systems [11]. The SDLC guides the software development process from conception to retirement, encompassing all stages involved in the creation and evolution of the system.
The SDLC generally consists of several interconnected phases, each of which has its own activities, objectives, and deliverables. Although the phases may vary depending on the specific methodology used, common major phases in the SDLC include [12]:

- **Concept planning:** This is the first phase in the whole life of a system development. It is here where the people who promote the development of the project, together with the stakeholders, define the systems to be designed and determine the scope of the whole process, allowing the definition of limits for aspects such as material and human resources, budget and time for each task.

- **Define the requirements:** Once the design stakeholders define the scope of work to be performed, the IT experts begin to engage with the end users of the system in order to define the requirements to be met by the completed project. Once all the requirements are gathered, the IT experts meet again with the users to review them in a verification phase. This phase ends when the end users validate the requirements that have been defined, although everything will depend on the methodology used in the development of the system.

- **Design:** This is where IT workers start to convert the defined requirements into a technical reality. At this stage, a technical design is created to visualize the defined requirements for the further development of the new system [13], including the software architecture, user interfaces, database structure and other key components.

- **Development and testing:** In this phase IT specialists begin to create the previously designed system. That is, they create the software and the physical architecture needed to house the system's database. Once the construction of all the system components is completed, testing begins, during which the quality managers ensure that the business requirements are met, using a detailed testing scheme [14].

- **Commissioning:** IT specialists provide end-users with the completed system so that they can start using it and provide them with all the necessary documentation to learn how to use it correctly. They also usually spend a few hours training users in the use of the system.

- **Operations and maintenance:** During a full operation phase, expert developers monitor the system to ensure that it meets the business requirements requested prior to design. Maintenance and user support is provided to ensure that the system continues to function properly [14].

- **Disposal:** This phase comprises the end of the system's life cycle and its decommissioning. Systematic steps must be followed to terminate the system in a secure environment to preserve all useful or sensitive information in order to continue business on a new system.

The Software Development Life Cycle can be adapted to different methodological approaches, such as the waterfall model, the spiral model, the agile approach and others. Each approach has its own advantages and challenges, and the choice depends on the specific requirements of the project and the preferences of the development team.

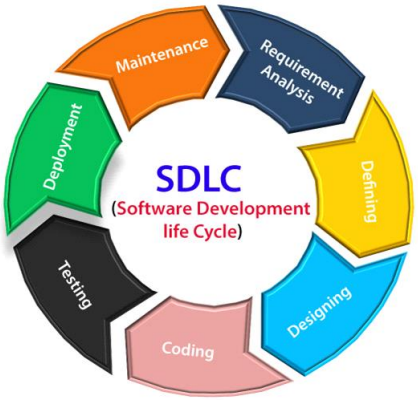


*Figure 3. Phases of Information Systems Development*

After a thorough analysis of the nature of projects and the way in which their execution is managed, as well as a detailed understanding of the information systems development cycle described in the previous section, it is imperative to amalgamate these fundamental concepts. The convergence of these two areas reveals an undeniable truth: the latent presence of risks that could undermine the efforts dedicated to each of these elements. This nuance highlights the crucial importance of risk management in the context of information systems projects. In fact, it is precisely in this conjunction that the central essence of this article is forged, as it reveals the irreplaceable relevance of accurate and effective risk management as a safeguard for information systems projects.
However, the question arises: What does risk management encompass? And furthermore, how can it be implemented within the scope of information systems development projects? It is these questions that we will undertake below, with the purpose of unraveling and clarifying how this vital element can be applied to safeguard and enrich the information systems development process.

**Risk management**

Rapid technological evolution and the inherent complexity of information systems projects have elevated risk management to a preeminent role in achieving successful outcomes. The uncertainty surrounding the implementation of technology systems and the interaction with organizational objectives demands a strategic approach to anticipating and addressing risks [15]. From this fundamental need emanates the imperative demand for effective and accurate risk management. Consequently, it is essential to address a series of essential steps that will enable adequate risk management to be carried out, which will be presented below.

**Risk Identification and Assessment**

The risk identification and assessment stage in information systems project management emerges as a cornerstone in the protection and optimization of the development process. At this crucial point, the foundation is laid for a thorough understanding of potential threats and opportunities that may influence the success of the project [16].

- **Detailed Threat and Opportunity Analysis:** Risk identification is not limited to a superficial enumeration of potential setbacks. Rather, it involves a detailed analysis of every aspect of the project and its interactions. Technical, operational, financial and human resource issues are carefully explored, unraveling connections that could trigger potential problems. Similarly, opportunities are investigated that could be exploited to improve the efficiency or value of the project.

- **Quantitative and Qualitative Assessment Methodologies:** Once identified, these risks are subjected to a rigorous assessment process covering both quantitative and qualitative aspects. The probability of occurrence and potential impact are quantified in numerical terms, allowing a systematic comparison of the relative importance of the identified risks. This assessment provides a sound basis for decision making and resource allocation in line with the magnitude of the risks.

- **Prioritization and Ranking:** Risk identification and assessment entails the need to prioritize and rank these risks according to their impact and likelihood. Through this process, risks are ranked according to their potential to affect the successful completion of the project. This hierarchy provides valuable guidance for focusing risk management efforts on the most significant and critical issues.

- **Stakeholder Involvement:** A crucial component in this phase is the active involvement of stakeholders. The perspective of end users, sponsors, technical experts and other key stakeholders brings a diversity of opinions and knowledge that enriches risk identification and assessment. Collaboration and information sharing contribute to a more complete and accurate picture of potential challenges.

**Mitigation and Contingency Strategies**

The mitigation and contingency strategies stage in risk management for information systems projects stands as an essential bastion for strengthening resilience and ensuring the successful achievement of established objectives. At this critical point, proactive management of identified risks takes the form of concrete actions designed to minimize the negative impact of potential challenges and maximize opportunities for success [17].

- **Mitigation (Acting before adversity):** The mitigation strategy involves the adoption of preventive and corrective measures aimed at reducing the probability of occurrence of risks or mitigating their impact. This may involve modifying processes, improving technological infrastructure, investing in team training or implementing more robust policies and procedures. The key lies in

addressing risks at their root and designing solutions that minimize their likelihood of materialization.

• **Contingency Planning (Preparing for the Unforeseen):** while mitigation focuses on avoiding or reducing risks, contingency planning concentrates on preparing for risks that could materialize despite preventive efforts. In this strategy, detailed plans are developed that outline the actions to be taken in the event that a risk becomes a reality. These plans may include response procedures, assignment of roles and responsibilities, and the preparation of resources needed to effectively address the situation.

• **Cost-Benefit Assessment (Prudent Balancing):** Implementation of mitigation and contingency strategies is not a one-size-fits-all approach. A thorough analysis is required to determine the cost-benefit ratio of each proposed strategy. It is crucial to weigh the cost of implementing these strategies against the potential benefit in terms of risk reduction and improved outcomes. This informed balance ensures that resources are optimally allocated to maximize the effectiveness of risk management [18].

• **Continuous Monitoring and Adaptation (Flexibility to Change):** Implementation of mitigation and contingency strategies does not end with planning and execution. Ongoing monitoring is required to evaluate the effectiveness of these strategies in the evolving context of the project. Strategies should be reviewed and adapted as necessary as circumstances, objectives or identified risks change.

**Integration with the Project Life Cycle**

The integration of risk management with the project lifecycle stands as a meticulously orchestrated symphony, where every note and beat contributes to the achievement of a smooth and successful execution. In this context, risk management becomes a constant companion throughout all stages of the information systems project, intricately woven into each phase to safeguard and enhance outcomes [19].

• **Incorporation from Conception:** the integration of risk management starts from the very conception of the project. At the scope and requirements definition stage, potential risks are identified and potential challenges are anticipated. This proactive mindset lays the groundwork for preventive measures and mitigation strategies from the earliest stages of the project.

• **Resilient Planning:** Risk management is infused into strategic project planning. Identified risks are incorporated into the plan structure, influencing resource allocation, schedules and priorities. This integration ensures that plans are designed with the flexibility to address contingencies and adapt to changing challenges.

• **Informed Execution:** During project execution, risk management acts as a beacon to guide decisions and actions. Continuous risk identification and assessment ensures that potential problems are detected early, allowing for real-time adjustments and adaptations. Integration with execution also includes the implementation of mitigation and contingency strategies in response to emerging risks.

• **Constant Control and Monitoring:** Risk management merges with project control and monitoring, providing a lens through which progress is assessed and deviations are detected. Key risk indicators provide a deep understanding of the health of the project and the effectiveness of the strategies implemented. This integration facilitates informed decision making and making necessary adjustments to stay on track.

• **Lessons Learned and Continuous Improvement:** once the project is completed, risk management remains relevant. The evaluation of lessons learned and lessons learned enriches the organization's knowledge base and fuels future initiatives. The feedback obtained throughout the project life cycle influences the continuous improvement of risk management strategies and the evolution of organizational practices.

**Organizational Culture and Communication**

Organizational culture and communication emerge as crucial pillars of risk management within information systems projects. These elements not only influence the perception and management of risk, but also establish the basis for effective collaboration and informed decision making.

• **Culture of Awareness and Accountability:** A risk-oriented organizational culture creates an environment where awareness of potential challenges and opportunities is intrinsic across all functions and levels of the organization. Teams are not only attentive to risks, but also feel a responsibility to contribute to identifying and addressing them. This team mentality contributes to early detection of risks and the creation of a safer and more adaptive work environment [20, pp. 57].

• **Transparency and Open Communication:** Effective communication is a fundamental component of risk management. Open and transparent communication ensures that risks are shared and understood throughout the organization. Well-established communication channels allow for the rapid dissemination of information on emerging risks, which in turn facilitates the implementation of mitigation and contingency strategies in a timely manner.

• **Active Stakeholder Involvement:** Risk management is not a solitary endeavor, but a collaborative enterprise involving a variety of stakeholders. The inclusion of diverse perspectives, from end users to sponsors to technical experts, enriches risk identification and assessment. This active participation not only improves the quality of risk management, but also fosters commitment and shared ownership in the process [20, pp. 61-62].

• **Training and Awareness:** An effective risk management culture thrives on education and training. Providing team members and stakeholders with appropriate training on risk identification, assessment and management strengthens their ability to contribute to the process. Awareness of the importance of risk management and an understanding of how to apply it brings a sense of empowerment and effectiveness.

• **Continuous Learning and Adaptation:** Organizational culture and communication also facilitate the capacity for continuous learning and adaptation. The willingness to evaluate and analyze responses to risks and strategies implemented fosters continuous improvement. Feedback from past experiences becomes a valuable resource for optimizing future initiatives and strengthening risk management capacity throughout the organization.

Given all the literature previously presented in this article, we can affirm that risk management in information systems projects is a fundamental pillar in the successful achievement of results. The intersection of project management and information systems development reveals the imperative need for accurate and effective risk management to safeguard the efforts dedicated at each stage. Anticipation and mitigation of technological, organizational and security risks are essential to ensure that project objectives are effectively met.

The comprehensive approach presented in this article, which encompasses early identification of risks, implementation of mitigation and contingency strategies, integration with the project life cycle, and promotion of a risk-oriented organizational culture, provides a solid framework for success. Risk management is not only about minimizing threats, but also about taking advantage of opportunities to optimize results.

The dynamic nature of technology and business environments requires constant adaptation of risk management strategies. Stakeholder collaboration, ongoing training and reflection on lessons learned are critical to evolving and improving risk management practices.

Ultimately, effective risk management in information systems projects not only drives the success of individual projects, but also contributes to the continued growth and innovation of organizations in an ever-changing technological world.

## 3. Discussion

The approach presented by various authors shares similarities and differences with the results obtained in the present research on risk management in information systems projects. Both approaches converge in recognizing the critical importance of software development and implementation in today's organizational environment. However, they present slightly different approaches to risk mitigation and the incorporation of standards and practices. [21] [22]

**Similarities:**

***Importance of Risk Management:*** Both approaches coincide in highlighting the fundamental relevance of risk management in the field of information systems projects. Both the articles by other authors and the present article highlight how deficiencies in project execution or software design can generate substantial losses for organizations and society in general.

***Probability of Success:*** Both the articles by other authors and this article mention the statistic that a relatively low percentage of software projects are considered successful. Both approaches recognize that many projects are completed with cost overruns and delays, underscoring the need for effective approaches to improve delivery and minimize associated risks.

***Security and Quality:*** Software security and quality are identified as crucial elements in both approaches. This article highlights how security is a critical factor due to the risk of vulnerabilities and unauthorized access to information. This aligns with the notion that risk management must consider both information protection and product quality.

**Differences:**

***Focus on Standards and Practices:*** The authors emphasize the application of standards such as ISO 27001, COBIT, SSE-CMM, ITIL, and PMBOK as means to mitigate risks and improve software security and quality. In contrast, the focus of our article is more on a comprehensive risk management methodology that is integrated throughout the information systems project lifecycle.

The comparison between the approaches reveals that both address crucial aspects of risk management in information systems projects. The application of specific standards and practices, as highlighted in the articles by various authors, can certainly provide a structured framework for addressing security and quality risks. However, the more comprehensive approach presented in our article also emphasizes the importance of adaptability and consideration of risks at all stages of the project. Risk management is not a static approach, but a dynamic discipline that must evolve along with changing technology

and business environments. The integration of practices and standards can be complementary to a broader risk management methodology, enabling a more agile and flexible response to emerging challenges. Ultimately, the application of standards and the approach to risk management must be tailored to the specific needs and characteristics of each organization and project.

## 3. Conclusions

In the loom of rigorous analysis of project management in the context of information systems, a path has been traced from the conceptualization to the materialization of technological solutions. Each stage, intrinsically linked to the next, has been explored in depth, delineating its influence and contribution to the overall success of the project. Execution, in particular, has been highlighted as a vital phase in which ideas take shape and concrete results emerge. Likewise, risk management has been revealed as an indispensable safeguard in an ever-changing technological environment. Now, in these final conclusions, we will consolidate the lessons learned and distill the key insights that illuminate the path to excellence in information systems project management.

- **Interdependence of Stages:** Smooth and effective project management in information systems depends on synchronization and harmonious interaction between key stages. Synergy between scoping, planning, execution, tracking and closure is essential for optimal performance and effective delivery of solutions.

- **The Powerful Execution:** The execution stage, as the crucible where visions become reality, plays a crucial role. Its dynamic nature, ranging from development to testing and integration, underscores the need for focus, collaboration and adaptability to crystallize functional technology solutions.

- **Mitigation and Contingency:** Risk management emerges as a lighthouse in the storm of technological uncertainty. Systematic risk anticipation and mitigation protects resources and invested effort, ensuring the delivery of solutions in line with organizational objectives.
- **Organizational Culture and Communication:** Creating an organizational culture that embraces risk management and fosters open communication transcends the technical aspects. Collaboration and shared responsibility in identifying and addressing risks nurtures a solid foundation for informed decision making.

- **Lifecycle Perspective:** Integrating risk management throughout the project lifecycle instills resilience and agility. Flexibility to adjust strategies and address changing challenges ensures an effective response in a constantly evolving environment.

**Success Through Uncertainty: Ultimately**, successful information systems project management requires a deep understanding of each component and a masterful ability to weave them into a coherent tapestry. Through skillful execution and thoughtful risk management, project leaders can confidently navigate the waters of technological uncertainty, reaping significant achievements and ensuring innovation and adaptability on the information systems horizon.

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