INTERNATIONAL SEVEN JOURNAL
OF MULTIDISCIPLINARY
ISSN: 2764-9547

RISK MANAGEMENT IN URBAN INFRASTRUCTURE PROJECTS IN THE PUBLIC SECTOR

GESTÃO DE RISCOS EM PROJETOS DE INFRAESTRUTURA URBANA NO SETOR PÚBLICO

GESTIÓN DE RIESGOS EN PROYECTOS DE INFRAESTRUCTURA URBANA DEL SECTOR PÚBLICO

https://doi.org/ 10.56238/isevmjv2n3-014

Receipt of originals: 05/05/2023 **Acceptance for publication:** 06/05/2023

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ABSTRACT

This article analyzed risk management applied to urban infrastructure projects in the Brazilian public sector, highlighting models, tools and results achieved at different government levels. The research adopted a qualitative approach, with a literature and document review of articles, dissertations and technical guides describing practical experiences in ministries, secretariats and public agencies. The data revealed that the systematic implementation of risk management methodologies promotes higher efficiency, reduces costs and enhances the predictability of schedules and deliveries. Significant advances were identified after the regulation of instruments such as COSO ERM and ISO 31000 adapted to the public sector, enabling the creation of risk matrices, performance indicators and response plans that strengthen governance. Concrete cases were studied, such as the preventive plan of the Civil Defense of Santos, which drastically reduced fatal landslide occurrences, and rail transport projects structured through public private partnerships, in which proper risk allocation increased legal certainty and attractiveness for investors. It was also verified that systems such as ForRisco contributed to institutionalizing risk management in federal institutions by integrating processes and data in digital platforms. Despite the advances, challenges remain related to staff training, resource limitations and the need for an organizational culture focused on prevention. It is concluded that risk management is an essential instrument for sustainable development and the delivery of quality urban infrastructure, promoting greater transparency, efficiency and appreciation of public assets.

Keywords: Risk Management. Urban Infrastructure. Public Sector. Governance. Projects.

RESUMO

Este artigo analisou a gestão de riscos aplicada a projetos de infraestrutura urbana no setor público brasileiro, destacando modelos, ferramentas e resultados obtidos em diferentes níveis de governo. A pesquisa baseou se em abordagem qualitativa, com revisão bibliográfica e documental de artigos, dissertações e guias técnicos que descrevem experiências práticas em ministérios, secretarias e autarquias. Os dados revelaram que a implementação sistemática de metodologias de gerenciamento de riscos promove maior eficiência, reduz custos e amplia a previsibilidade de cronogramas e entregas. Foram identificados avanços significativos após a regulamentação de

instrumentos como o COSO ERM e a ISO 31000 adaptados ao setor público, permitindo a criação de matrizes de risco, indicadores de desempenho e planos de resposta que fortalecem a governança. Estudaram se casos concretos como o plano preventivo da Defesa Civil de Santos, que reduziu drasticamente as ocorrências fatais por escorregamentos, e projetos de transporte sobre trilhos estruturados por meio de parcerias público privadas, nos quais a distribuição adequada de riscos elevou a segurança jurídica e a atratividade para investidores. Também se verificou que sistemas como o ForRisco contribuíram para institucionalizar a gestão de riscos em instituições federais, integrando processos e dados em plataformas digitais. Apesar dos avanços, permanecem desafios ligados à capacitação técnica de servidores, à limitação de recursos e à necessidade de cultura organizacional voltada para prevenção. Conclui se que a gestão de riscos é instrumento indispensável para o desenvolvimento sustentável e a entrega de infraestrutura urbana de qualidade, promovendo maior transparência, eficiência e valorização do patrimônio público.

Palavras-chave: Gestão de Riscos. Infraestrutura Urbana. Setor Público. Governança. Projetos.

RESUMEN

Este artículo analizó la gestión de riesgos aplicada a proyectos de infraestructura urbana en el sector público brasileño, destacando los modelos, herramientas y resultados obtenidos en diferentes niveles de gobierno. La investigación empleó un enfoque cualitativo, con una revisión bibliográfica y documental de artículos, tesis y guías técnicas que describen experiencias prácticas en ministerios, departamentos y agencias. Los datos revelaron que la implementación sistemática de metodologías de gestión de riesgos promueve una mayor eficiencia, reduce costos y aumenta la previsibilidad de plazos y entregas. Se identificaron avances significativos tras la regulación de instrumentos como COSO ERM e ISO 31000, adaptados al sector público, lo que permitió la creación de matrices de riesgo, indicadores de desempeño y planes de respuesta que fortalecen la gobernanza. Se estudiaron casos específicos, como el plan preventivo de Defensa Civil de Santos, que redujo drásticamente las muertes por deslizamientos de tierra, y proyectos de transporte ferroviario estructurados mediante asociaciones público-privadas, en los que una adecuada distribución del riesgo aumentó la seguridad jurídica y el atractivo para los inversores. También se observó que sistemas como ForRisco contribuyeron a la institucionalización de la gestión de riesgos en las instituciones federales, integrando procesos y datos en plataformas digitales. A pesar de estos avances, persisten desafíos relacionados con la capacitación técnica del personal, la limitación de recursos y la necesidad de una cultura organizacional centrada en la prevención. La conclusión es que la gestión de riesgos es una herramienta indispensable para el desarrollo sostenible y la provisión de infraestructura urbana de calidad, promoviendo una mayor transparencia, eficiencia y la valorización de los activos públicos.

Palabras clave: Gestión de Riesgos. Infraestructura Urbana. Sector Público. Gobernanza. Proyectos.

1 INTRODUCTION

Investments in urban infrastructure in the public sector require consistent planning and risk management strategies, since the country's economic and political conditions can alter the execution of works and affect the expected performance, which makes it essential to apply structured methodologies to prevent or mitigate unforeseen events that impact schedules and costs (Girardi et al., 2018).

Risk management has established itself as an indispensable practice for government agencies, being used to guide decisions on public policies, programs, and services in environments permeated by uncertainties, which reinforces the importance of disseminating methodologies and training technical teams to carry out safer projects (Ávila, 2016).

The Brazilian public sector faces additional difficulties due to the size of the projects and the multiplicity of agencies involved, which is why governance, internal control, and risk analysis processes need to be improved, seeking to reconcile legal frameworks and good international management practices (Rocha, 2019).

The implementation of methodologies such as the risk management cycle adopted in ministries and federal institutions makes it possible to organize the stages of identification, evaluation, response, and monitoring, ensuring greater control over events that may compromise the achievement of institutional and sectoral goals (Miranda, 2018).

Studies applied to the reality of Brazilian municipalities reveal that risk management, when well structured, promotes urban resilience and improves the capacity to respond to unexpected events, strengthening the performance of agencies such as Civil Defense and integrating different areas of administration (Ferreira, 2016).

In public-private partnerships, widely used to make infrastructure projects viable, detailed risk analysis is a determining factor to balance public and private interests, as it defines responsibilities and minimizes contractual disputes that can compromise execution (Ferraz & Almeida, 2018).

The literature highlights that risk management in urban projects is not limited to control instruments, but involves an organizational culture focused on prevention, encouraging managers to understand the internal and external factors that influence long-term results (Bermejo et al., 2018).

Reports produced in control and research bodies indicate that ministries responsible for infrastructure works have advanced in the formalization of risk

management processes, but still lack consistent indicators to measure performance and integration between technical and administrative areas (Rocha, 2019).

Metro-rail public transport projects demonstrate that the lack of properly structured risk management generates significant negative impacts, highlighting the need to identify critical factors, assess consequences and propose preventive responses for each phase of the project (Vasconcelos, 2014).

The consolidation of legal frameworks, such as normative instructions and federal decrees, provided the basis for agencies to implement risk policies in line with international best practices, establishing minimum standards for the identification and evaluation of adverse events in the public sector (Ávila, 2016).

Case studies carried out in several regions of the country show that the use of urban risk mapping and monitoring tools contributes to the reduction of material and human losses, highlighting the importance of updating data and integrating information between departments (Ferreira, 2016).

In federal educational institutions and municipalities, methodologies such as ForRisco have been applied with significant results, showing that, when risk management is incorporated into strategic planning, projects become more efficient and transparent (Bermejo et al., 2018).

International experience, reported in comparative studies, indicates that countries that have adopted robust governance and internal control structures have achieved better performance in their projects, reducing waste and increasing the economic and social return of large public works (Ferraz & Almeida, 2018).

The adoption of instruments such as risk matrices, performance indicators, and contingency plans strengthens the decision-making process at different levels of government, allowing managers to prioritize actions and resources in more vulnerable areas (Miranda, 2018).

Therefore, understanding risk management in urban infrastructure projects in the public sector is essential to improve governance policies, methodologies and practices, ensuring that the investments made result in effective and sustainable benefits for the Brazilian population (Girardi et al., 2018).

2 THEORETICAL FRAMEWORK

2.1 EVOLUTION OF RISK MANAGEMENT IN THE PUBLIC SECTOR

Risk management in the Brazilian public sector has been gradually developed, starting from isolated practices to the adoption of structured methodologies that today guide the execution of infrastructure projects and urban services, consolidating itself as an essential element to avoid waste and increase administrative efficiency (Ávila, 2016).

In early efforts, government agencies limited themselves to reactively recording risks, without systematic analysis or contingency plans, which resulted in recurring failures and the difficulty of maintaining consistent execution and governance standards in large-scale projects (Miranda, 2018).

From the 2000s onwards, driven by legal changes and dialogue with international experiences, several ministries and agencies began to adopt integrated risk management models, strengthening coordination between sectors and the definition of clear responsibilities at each stage (Bermejo et al., 2018).

In urban projects financed with federal and state resources, the inclusion of tools such as risk matrices and performance indicators has made it possible to map critical factors from the initial planning, reducing exposure to unexpected events and increasing the predictability of results (Girardi et al., 2018).

Public governance began to incorporate guidelines from control bodies, such as the Federal Court of Accounts, which established benchmarks for risk assessment and internal control, encouraging the creation of internal policies aligned with the best practices of contemporary management (Rocha, 2019).

With the regulation of instruments such as Normative Instruction MP/CGU 01/2016 and Decree No. 9,203/2017, requirements were defined for federal agencies to implement risk management systems that cover strategic processes and activities, increasing the security of administrative decisions (Rocha, 2019).

The evolution of risk management is also notable in the field of public-private partnerships, as in these contractual arrangements the distribution of risks between the public and private sectors needs to be detailed, ensuring financial balance and predictability of revenues and expenses throughout the term of the contracts (Ferraz & Almeida, 2018).

Studies show that the effectiveness of these models depends not only on regulations, but also on the technical training of civil servants, the existence of an organizational culture focused on prevention, and the integration of support technologies, such as computerized monitoring and warning systems (Bermejo et al., 2018).

The specialized literature points out that projects that apply risk management methodologies from conception tend to present superior results in terms of costs, deadlines, and final quality, reinforcing the need to disseminate such practices at different levels of government (Girardi et al., 2018).

Training programs and methodological guides published by government schools, such as ENAP, contribute to standardizing the understanding of concepts and stages of risk management, making teams better able to identify, evaluate, and respond to challenges that arise in complex projects (Miranda, 2018).

In the municipalities, the application of these practices has also brought advances, especially in civil defense and urban planning, in which the analysis of environmental and structural risks helps in the prevention of disasters and in the adoption of policies that ensure greater urban resilience (Ferreira, 2016).

The integration of tools such as susceptibility maps, meteorological monitoring, and municipal risk reduction plans shows that risk management goes beyond the administrative context, and is also a social and technical tool to protect lives and public resources (Ferreira, 2016).

In the international environment, countries that have adopted large-scale PPPs have demonstrated that the proper distribution of risks between the parties and the preparation of mitigation plans are essential to attract investors and ensure the continuity of services provided to the population (Ferraz & Almeida, 2018).

Based on the Brazilian and international experience, it is clear that progress in risk management is associated with more mature governance, capable of aligning diverse interests, managing uncertainties, and promoting a virtuous cycle of continuous improvement in administrative processes (Bermejo et al., 2018).

Therefore, the trajectory of risk management in the public sector reveals a constant movement of improvement, driven by standards, studies and applied practices, which strengthens the execution of urban infrastructure projects and contributes to a more effective and responsible administration (Ávila, 2016).

2.2 PRACTICAL APPLICATIONS OF RISK MANAGEMENT IN URBAN INFRASTRUCTURE PROJECTS

The practical application of risk management in urban infrastructure projects in the Brazilian public sector has gained relevance in the face of recurrent failures in the execution of public works, the limitation of resources and the growing demand for transparency and accountability in public administration, and it is increasingly necessary for managers to identify, assess and respond to potential risks from the initial stages of planning to the monitoring of execution, adopting practices that ensure efficiency, safety, and continuity of essential services to the population, especially in urban contexts marked by complex socio-environmental and budgetary vulnerabilities that require careful decisions based on technical and legal evidence (Miranda, 2018).

Among the mechanisms consolidated in Brazil, the methodology structured in cycles consisting of five stages — environment and objectives, identification of risk events, assessment, response, and monitoring — stands out, a model widely disseminated in manuals of good practices and applied by public agencies such as the Ministry of Planning, whose adoption contributed to the institutional maturation of the risk culture, at the same time that it promoted the alignment between the strategic objectives of public policies and operational activities, offering guidelines to mitigate losses, deviations and losses to the treasury (Miranda, 2018).

This methodological structure allows risk management to be adapted to different project sizes, from small urban interventions to large mobility works, such as rail transport systems, which require not only detailed technical analysis, but also dialogue with civil society and partner companies, especially when they involve public-private partnerships, whose contractual complexity requires clarity in the distribution of responsibilities and effective mechanisms for prevent litigation and ensure the continuity of the service provided, even in the face of unexpected events that may alter the balance of the contract (Ferraz & Almeida, 2018).

The experience of the federal public administration, observed in a case study in the ministries that deal directly with infrastructure, revealed that although there have been advances in the formalization of risk policies and in the creation of governance committees, many of these bodies still face obstacles in the delimitation of risk tolerance guidelines, in the definition of evaluation criteria and in the communication of information.

factors that compromise the effectiveness of the process and hinder the maturation of governance as an instrument to protect the public interest (Rocha, 2019).

In municipal administrations, risk management has proven to be essential, especially in facing natural disasters and structural failures in vulnerable areas, as evidenced in the analysis of the performance of the Civil Defense of Santos (SP), which since the implementation of its annual preventive plan has obtained a significant reduction in fatal occurrences caused by landslides, demonstrating how the integration of technical instruments such as geotechnical maps, meteorological monitoring and contingency plans is capable of promoting greater urban resilience and significantly reducing the population's exposure to geological and hydrological risks (Ferreira, 2016).

The practical applicability is also verified in the analysis of metro-rail projects structured through concessions and public-private partnerships, in which the risk matrix is one of the most relevant documents to ensure the success of the project, as it distributes the obligations of each party and the expected responses to critical events, which allows both the public entity and the private partner to have predictability and legal certainty throughout the execution contractual, as demonstrated in the evaluation of railway projects presented at technical meetings of the sector (Vasconcelos, 2014).

Risk management practices also extend to federal institutions of higher education and other public agencies that have started to adopt computerized systems to map processes, identify threats, establish mitigating measures and continuously monitor organizational units, as in the case of the ForRisco system, whose implementation allowed the development of an institutional policy of integrated management. promoting improvements in organizational culture, management by results, and the prevention of fraud and operational failures (Bermejo et al., 2018).

This type of application makes it possible to connect strategic planning with operational activities, ensuring that institutional objectives are not compromised by foreseeable events that could have been avoided, also strengthening internal audit processes and the performance of control boards, which now have systematized data on the main risks faced by the units and on the effectiveness of the actions taken. creating a logic of accountability and continuous improvement (Bermejo et al., 2018).

In interinstitutional contexts, such as in metropolitan regions that concentrate multiple federative entities and public consortia, risk management requires articulation between different spheres of government and minimum standards of governance, which

reinforces the importance of clear normative instruments, integrated action plans, and effective communication between the actors involved, in order to ensure that investments in urban infrastructure are sustainable and resilient. avoiding duplication of efforts, overlapping of attributions and conflicts of competence (Ávila, 2016).

However, risk management has also been consolidated as a response to the need to prevent losses related to non-compliance with regulatory frameworks, inadequate budget execution and negligence with environmental and social requirements, areas frequently involved in delays, embargoes and judicialization of urban projects, and it is therefore essential that such risks are previously mapped, evaluated as to their probability and impact. and receive response plans that minimize potential damage to the image of the administration and public coffers (Rocha, 2019).

It is important to highlight that even with the established methodologies, the effectiveness of management depends directly on the engagement of senior management, the existence of trained technical teams, the allocation of resources compatible with the identified needs and the construction of an institutional culture oriented to prevention, factors that still encounter resistance in part of the Brazilian public administration, especially in small municipalities with administrative structures and high turnover of strategic positions (Miranda, 2018).

Even so, positive experiences demonstrate that risk management is feasible and beneficial even in restrictive contexts, as long as there is political prioritization of the theme and continuous training, as demonstrated in institutional strengthening projects that involved technical cooperation between universities, schools of government, and international agencies, resulting in the creation of risk centers and the incorporation of participatory diagnostic and planning processes (Bermejo et al., 2018).

The use of the risk matrix as a mandatory tool in concession and PPP bidding processes has also raised the degree of maturity of public management, as it required that the public notices present transparent risk allocation criteria, contractual review clauses and arbitration devices that reduce litigation and promote greater legal certainty for investors. a decisive factor in attracting private capital and expanding the State's investment capacity in urban infrastructure (Ferraz & Almeida, 2018).

In traditional public works, the challenge is similar, because even if they do not involve concessions, the technical, environmental and social risks must be mapped in advance, especially when it comes to works in densely populated areas, subject to

underground interference, expropriation and community resistance, which requires multidisciplinary planning, with the support of engineers, architects, sociologists, jurists and public managers. all aligned with a management methodology that allows for rapid and responsible responses to adverse events (Girardi et al., 2018).

The critical analysis of the practical applications reveals, therefore, that risk management has become not only a normative requirement, but a strategic tool for governance, control and public efficiency, being essential to ensure that investments in urban infrastructure are planned responsibly, executed with predictability and delivered with quality, directly benefiting the population and strengthening the credibility of public institutions with society and to the control bodies (Rocha, 2019).

2.3 EVALUATION MODELS AND TOOLS USED

The assessment models adopted in risk management in urban infrastructure projects in the public sector are fundamental to ensure that risks are not only identified, but also qualified and treated consistently, and in this sense the application of international methodologies adapted to the Brazilian context has proven to be efficient by incorporating structured processes for analysis and categorization of adverse events that impact the life cycle of works and services (Miranda, 2018).

Among the most used benchmarks are COSO ERM and ISO 31000, both integrated into the guidelines of control bodies such as the Federal Court of Auditors, offering the public manager tools to assess the probability of occurrence and the potential impact of risks, allowing prioritizing priorities and defining mitigation plans that are more appropriate to the specificities of the project and the urban environment in which it will be executed (Bermejo et al., 2018).

The use of the risk matrix is an example of a tool that systematizes the assessment, as it allows each risk to be recorded with clear indicators, impact levels, those responsible for the response and associated contingency plans, a resource widely applied in concession contracts and public-private partnerships in Brazil, where the legal and financial complexity requires predictability and strict control of external and internal variables to the project (Ferraz & Almeida, 2018).

In studies carried out within the scope of ministries linked to infrastructure, it was found that the application of governance models associated with risk management allowed the creation of internal monitoring committees, the development of institutional

maturity indicators and the preparation of periodic reports that provide technical support for strategic decisions, reinforcing the importance of aligning evaluation tools with an organizational structure capable of absorbing and using the information generated (Rocha, 2019).

In addition, complementary instruments such as process maps, geotechnical maps, meteorological monitoring systems, and indicator panels have been incorporated into municipal prevention plans, as demonstrated in the case of the Civil Defense of Santos, in which the integration of technical data with risk analysis tools resulted in more effective policies to reduce urban vulnerabilities and mitigate social and economic damage (Ferreira, 2016).

The risk management cycle described in the ENAP manuals also emphasizes the need to combine quantitative and qualitative tools, recommending the use of interviews with specialists, analysis of occurrence history and statistical techniques to assign values to the variables studied, offering the manager a more complete and grounded view of the institution's exposure to different types of risks (Miranda, 2018).

In addition to the identification tools, risk response models involve the development of detailed action plans, schedules for the execution of mitigating measures, creation of financial reserves, and definition of responsibilities, ensuring that, once a risk event is identified, the institution has structured means to respond with agility and minimize negative impacts on the execution of the urban infrastructure project (Girardi et al., 2018).

The methodologies analyzed indicate that risk management should be integrated with strategic planning and governance instruments, so that the results of the evaluation feed decision-making processes and guide the allocation of resources, preventing emergency actions from being taken without a technical basis and that compromise the effectiveness of public policies aimed at urban development (Ávila, 2016).

In the case of public-private partnerships, the risk matrix also assumes the role of a central document in contractual management, because in addition to organizing the risk assessment, it defines who is responsible for each event, specifies rebalancing clauses and guides the application of penalties or financial compensations, being an essential instrument to reduce conflicts and maintain the financial health of contracts over time (Ferraz & Almeida, 2018).

Universities and research centers have also contributed to improving evaluation models by developing specific platforms for public institutions, such as ForRisco, which

incorporates registration, monitoring, analysis, and reporting functionalities, allowing federal, state, and municipal agencies to raise their level of maturity in risk management and strengthen their internal control mechanisms (Bermejo et al., 2018).

The use of digital tools enables even greater integration between technical and administrative areas, offering dashboards and automatic alerts that favor communication between teams and allow managers to make decisions based on up-to-date data, reducing the occurrence of execution failures and expanding the ability to prevent deviations and irregularities in infrastructure contracts (Miranda, 2018).

Evaluation models based on multicriteria analysis have also been used to consider environmental, social, and economic variables, allowing the public manager to prioritize more relevant risks and adopt targeted preventive measures, aligning urban planning with sustainable and socially responsible practices that consider the specificities of each territory and project (Girardi et al., 2018).

The literature points out that the effectiveness of these models depends on the constant updating of tools and the continuous training of public servants, since new demands frequently arise in the urban environment and require innovative solutions, as well as the integration of different databases and complementary methodologies to encompass the complexity of the risks involved in infrastructure works and services (Ávila, 2016).

Technical reports highlight that the application of robust evaluation models and appropriate tools contributes to increasing the confidence of control bodies, society and private partners, generating a more favorable environment for investments and facilitating the obtaining of financing, since financial institutions and development agencies consider the existence of structured risk management processes as an analysis criterion for credit release (Rocha, 2019).

Thus, the use of evaluation models and specific tools for risk management in urban infrastructure projects is a central element to improve public governance, optimize resources, mitigate losses and ensure that projects meet the objectives of sustainable development and improvement of the population's quality of life, consolidating itself as an indispensable practice in modern public administration (Ferreira, 2016).

3 METHODOLOGY

The methodology adopted to understand the risk management practices in urban infrastructure projects in the public sector was based on a qualitative approach, structured as a bibliographic and documentary review, prioritizing the analysis of scientific studies, technical reports and official manuals that describe risk management models and experiences applied to public works and services in complex urban contexts, ensuring a broad perspective based on specialized literature (Miranda, 2018).

National publications available in open databases and in institutional repositories were selected, considering articles from indexed journals, dissertations from graduate programs and technical guides prepared by bodies such as the National School of Public Administration, the Federal Court of Accounts and Brazilian universities, in order to ensure diversity of sources and academic rigor in the composition of the methodological framework (Bermejo et al., 2018).

The time frame covered materials published between 2010 and 2023, a period in which significant normative and institutional evolution is observed in Brazil, especially with the introduction of legal instruments and governance models that require the implementation of risk management systems in strategic urban infrastructure projects, allowing the analysis of paradigm shifts and comparing results obtained in different contexts (Rocha, 2019).

The searches were carried out with descriptors such as "risk management in the public sector", "urban infrastructure", "public-private partnerships" and "governance in public projects", using Boolean operators and filters by language and country, which resulted in an initial set of works that, after exploratory reading, was refined to those that effectively presented applied methodologies and data relevant to the theme under study (Ferraz & Almeida, 2018).

The analysis of the documents was guided by previously defined thematic categories, such as risk identification, assessment instruments, response models, integration with governance and monitoring of results, categories that served as an axis to systematize the data and compare approaches, identifying gaps and points of convergence between national experiences and the recommendations of international good practices (Girardi et al., 2018).

The methodological procedure included the full reading of the selected texts, filing of the central concepts, extraction of representative excerpts and organization in synthesis matrices, enabling the information to be cross-referenced and analyzed from

the perspective of indicators of efficiency, effectiveness and economy, in line with the principles of governance that guide contemporary public administration (Ávila, 2016).

4 RESULTS AND DISCUSSION

The results show that the systematic application of risk management in urban infrastructure projects in the public sector has provided significant improvements in the execution of projects, allowing federal and municipal agencies to reduce delays and waste by adopting methodologies that integrate event identification, impact analysis and structured response, highlighting that the models used converge to international standards adapted to the Brazilian reality (Miranda, 2018).

The analysis of the case studies showed that ministries responsible for large-scale works established internal governance committees and created communication flows to register risks and propose preventive actions, and it was possible to observe an evolution in the organizational culture with greater concern for recording and treating risks in a preventive manner, a fact that was reflected in the reduction of indirect costs and in the increase of transparency before control bodies (Rocha, 2019).

In municipal contexts, such as in the city of Santos, it was observed that preventive plans and geotechnical maps allowed for a reduction in the number of fatal occurrences due to landslides and landslides, a result that demonstrates the relevance of risk management as an instrument of social protection, since it integrates technical data with community education actions, promoting resilience and safety in vulnerable urban areas (Ferreira, 2016).

In the public transport projects on rails evaluated, it was found that the use of risk matrices made it possible for public-private partnership contracts to be structured with greater clarity regarding the distribution of responsibilities, avoiding frequent litigation and ensuring the continuity of the service even in the face of unforeseen events such as exchange rate variations, demand fluctuations and logistical difficulties (Vasconcelos, 2014).

The comparison between models applied in different institutions showed that tools such as ForRisco expanded the capacity for continuous monitoring and predictive analysis, allowing the identification of patterns of events that previously went unnoticed, which strengthened the role of public managers in the planning of new projects and in the

review of internal processes, with positive impacts on operational efficiency (Bermejo et al., 2018).

Results obtained through risk matrices implemented in concession contracts show that the appropriate allocation of risks resulted in greater attractiveness for private investors, a relevant fact in a scenario of budget constraints in the public sector, as it enables the financing of large works with less direct impact on the public coffers and with fair distribution of risks and returns between the parties (Ferraz & Almeida, 2018).

The data extracted from the analyses showed that the adoption of methodologies such as COSO ERM adapted for government agencies allowed risks to be assessed more objectively, defining levels of acceptability and specific response plans, in addition to contributing to the creation of indicators that measure the maturity of the risk management process in each administrative unit evaluated (Miranda, 2018).

In large-scale urban projects, the results showed that the prior identification of environmental and social risks, such as the need for expropriation or the presence of permanent preservation areas, contributed to reducing stoppages and lawsuits, ensuring greater predictability in the execution schedule and strengthening the image of the public administration as a responsible agent committed to sustainability (Girardi et al., 2018).

The discussion about the data also highlights the importance of integrating risk management into internal control and audit policies, since projects evaluated with these tools showed fewer notes of irregularities and misappropriation of resources, revealing that the systematization of information and the elaboration of detailed action plans are factors that reduce exposure to failures and increase the confidence of funders and inspection agencies (Ávila, 2016).

When analyzing the evolution of practices, it was noticed that the agencies that stood out the most were those that created centers specialized in risks, with trained professionals and access to updated information systems, demonstrating that technical qualification is a key element to transform methodologies into concrete results, given that even with good tools available, without adequate training, risks remain underestimated (Bermejo et al., 2018).

Another factor observed was the difficulty faced by some agencies in effectively implementing risk policies due to budget limitations and high turnover of civil servants, factors that impact the continuity of processes and require complementary strategies

such as simplified manuals, periodic courses, and partnerships with universities to maintain knowledge and update internal practices (Rocha, 2019).

The comparative analysis also showed that risk management plays a decisive role in highway and port concession projects, where technical and regulatory complexity requires robust identification and mitigation protocols, and it was reported that projects that adopted structured models had lower contractual accident rates and better financial performance throughout the project life cycle (Ferraz & Almeida, 2018).

Studies indicate that the combination of qualitative and quantitative risk assessment models increases the effectiveness of responses, allowing managers to calibrate preventive measures according to specific probabilities and impacts, a factor observed in projects that implemented multicriteria analysis and scenario simulations, resulting in more realistic plans adjusted to the local reality (Girardi et al., 2018).

The results also show the need for effective communication between different hierarchical levels and sectors involved, as projects in which risk information was shared in a transparent and timely manner showed greater capacity to adapt to changes and better overall performance, highlighting the importance of permanent channels of dialogue and periodic reports for all stakeholders (Miranda, 2018).

Therefore, the discussion of the collected data confirms that risk management, when integrated into the planning and execution of urban infrastructure projects, strengthens governance, increases administrative efficiency and promotes more consistent results, justifying investments in training, technology and institutionalization of robust methodologies as an indispensable condition for the sustainable development of cities and the valorization of public resources (Ferreira, 2016).

5 FINAL CONSIDERATIONS

Risk management in urban infrastructure projects in the public sector has proven to be essential to ensure that planned works and services are delivered with greater efficiency, lower cost and greater predictability, showing that the institutionalization of these practices strengthens governance and expands the State's capacity to respond to complex challenges of planning and executing investments in dynamic and demanding urban environments.

Throughout the study, it was evident that the normative evolution and the introduction of consolidated methodologies contributed significantly to the development

of internal technical competencies by different agencies, creating nuclei and committees dedicated to mapping adverse events, classifying risks, and proposing responses aligned with the strategic objectives of each program or urban project in execution.

The analyses showed that, by adopting tools such as risk matrices, dashboards, and performance indicators, public managers were able to reduce interruptions, control environmental and social impacts, and promote an environment of greater legal and financial security, whether in projects executed directly by the government or in partnerships with private companies.

Practical experiences have revealed that risk management needs to be incorporated from the beginning of the planning of each project, since risks identified early can be treated in a more economical and efficient way, while ignored risks tend to materialize in losses, delays and damage to the institutional image, generating negative effects for the population and the public budget.

It was possible to verify that the construction of an organizational culture oriented towards prevention depends on continuous investments in training of civil servants, updating systems and integration between technical and administrative areas, indispensable elements to transform methodologies into effective results and ensure the continuity of actions even in the face of management changes or budget restrictions.

The results discussed also indicate that the integration between agencies and the standardization of practices is fundamental, especially in metropolitan projects that involve different federative entities, and it is essential that there are stable communication channels and harmonized procedures that avoid duplications of actions and conflicts of competence that may compromise the progress of the works.

The consistent application of risk management has also contributed to increasing administrative transparency, since the systematized documentation of risks, controls, and responses facilitates audits, external reviews, and monitoring by society, strengthening the legitimacy of public investment and creating an environment of greater trust between managers, control bodies, and citizens.

The studies also demonstrated that the adoption of integrated risk models has the potential to stimulate innovation, as the systematic analysis of failures and successes generates learning that feeds back into planning processes, allowing new works to benefit from previous experiences and adopt increasingly efficient and sustainable solutions to urban challenges.

When considering the future scenario, it is observed that the continued improvement of these practices tends to make the public sector more resilient, capable of managing complex projects with less vulnerability to economic crises, political variations or unexpected events, ensuring that cities receive adequate infrastructures for their growth and the needs of the population.

It is concluded that risk management applied to urban infrastructure is a strategic instrument for the sustainable development of cities, strengthening governance, improving the quality of investments and consolidating the commitment of the public sector to the delivery of services and works that promote social well-being, economic efficiency and appreciation of collective heritage.

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