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GUIDELINES AND STRATEGIES GROUNDED IN KNOWLEDGE MANAGEMENT FOR INNOVATION IN THE PUBLIC SECTOR

DIRETRIZES E ESTRATÉGIAS FUNDAMENTADAS EM GESTÃO DO CONHECIMENTO PARA A INOVAÇÃO NO SETOR PÚBLICO

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ABSTRACT

Objective: This study aims to propose strategic guidelines to foster systematic innovation in public institutions. It seeks to address how public organizations can overcome barriers to continuous innovation and enhance service delivery and societal value. **Design/Methodology/Approach:** The research employs an integrative literature review on Knowledge Management (KM), Organizational Learning (OL), and public sector innovation to identify institutional barriers to innovation and propose guidelines and strategies to mitigate them. Empirical evidence was gathered from institutional surveys and focus groups with employees in a Brazilian forensic institution, enabling a comprehensive understanding of the challenges and opportunities for innovation in this context. **Findings:** The analysis reveals key obstacles to innovation, including administrative constraints and the pressure to process large case volumes. The study proposes strategies centered on strategic leadership, continuous learning, knowledge sharing, external collaboration, and effective information technology (IT) use to foster innovation and ensure organizational adaptability. **Research Limitations:** The findings are based on a single case study, which may limit generalizability to other public institutions. Further research across different contexts is needed to validate and expand the proposed guidelines. **Practical Implications:** The proposed strategies offer actionable pathways for public institutions, particularly in forensic sciences, to enhance innovation capacity, improve operational efficiency, and increase societal value. **Originality/Value:** By integrating theoretical insights on KM and OL with empirical data from a public sector case study, this research provides a comprehensive framework for overcoming innovation barriers in public institutions, contributing both to academic literature and practical policy design.

Keywords: Knowledge management. Innovation. Forensic police. Forensic sciences. Public service.

RESUMO

Objetivo: Este estudo tem como objetivo propor diretrizes estratégicas para promover a inovação sistemática em instituições públicas. Busca abordar como as organizações públicas podem superar barreiras à inovação contínua e aprimorar a prestação de serviços e o valor gerado à sociedade. **Desenho/Metodologia/Abordagem:** A pesquisa utiliza uma revisão integrativa da literatura sobre Gestão do Conhecimento (GC), Aprendizagem Organizacional (AO) e inovação no setor público, a fim de identificar barreiras institucionais à inovação e propor diretrizes e estratégias para mitigá-las. Evidências empíricas foram obtidas por meio de levantamentos institucionais e grupos focais com servidores de uma instituição pericial brasileira, permitindo uma compreensão abrangente dos desafios e oportunidades para a inovação nesse contexto. **Resultados:** A análise revela obstáculos-chave à inovação, incluindo restrições administrativas e a pressão para processar grandes volumes de casos. O estudo propõe estratégias centradas em liderança estratégica, aprendizado contínuo, compartilhamento de conhecimento, colaboração externa e uso eficaz de tecnologias da informação (TI) para fomentar a inovação e garantir a adaptabilidade organizacional. **Limitações da Pesquisa:** As conclusões baseiam-se em um estudo de caso único, o que pode limitar a generalização dos resultados para outras instituições públicas. Pesquisas adicionais em diferentes contextos são necessárias para validar e expandir as diretrizes propostas. **Implicações Práticas:** As estratégias propostas oferecem caminhos práticos para que instituições públicas, especialmente na área de ciências forenses, ampliem sua capacidade de inovação, melhorem a eficiência operacional e aumentem o valor entregue à sociedade. **Originalidade/Valor:** Ao integrar fundamentos teóricos sobre GC e AO com dados empíricos de um estudo de caso no setor público, esta pesquisa fornece um referencial abrangente para superar barreiras à inovação em instituições públicas, contribuindo tanto para a literatura acadêmica quanto para o desenho de políticas práticas.

Palavras-chave: Gestão do Conhecimento. Inovação. Polícia científica. Ciências forenses. Serviço público.

Introduction

Innovation refers to the development and implementation of new ideas, transforming them into new or significantly improved products, processes, or services to enhance performance and value creation (Arundel et al., 2019; OCDE, 2005). In organizations that do not directly produce goods or offer services, innovation focuses on improving internal methods and processes to enhance efficiency, effectiveness, and quality results, aiming to accomplish the institutional mission more effectively (Isik, 2025; Şimşit et al., 2014). Although widely recognized as a crucial driver of organizational performance, effectiveness, and efficiency, public sector innovation often remains reactive or opportunistic, despite the pressing need for a more proactive and strategically planned approach. This reactive posture frequently leads to a misalignment with the pace of changes and innovations adopted by private sector organizations (Alosani et al., 2020).

Consequently, adaptability becomes imperative in a scenario of continuous transformation. Even companies that have been successfully operating for decades must face the challenges that arise from the rapid pace of change. Companies must constantly reassess and update their management approaches to work, innovation, and service provision (Niewöhner et al., 2020). This scenario applies equally to forensics institutions, where a slow adoption of innovations can compromise their efficiency and project a negative image among the public and key stakeholders in the justice system (Bousquet et al., 2023). These institutions play a fundamental role in materializing criminal offenses and providing evidence, thus assisting the justice system to act effectively.

However, many forensics institutions endure heavy workloads, often creating barriers to the development and implementation of new technologies and other innovations. The need to modify routines and invest time in learning new processes and implementing new tools can be a significant challenge (Weyermann et al., 2023). Implementing innovations through the introduction of new technologies and processes can lessen their workload; however, the challenge of integrating innovations into the existing process remains. Furthermore, the pressure to handle a large number of cases and the need for rapid responses often lessen the possibility of researching and adopting innovations in terms of new practices and technologies in forensics institutions (Bousquet et al., 2023; Weyermann et al., 2023).

Bousquet et al. (2023), in their studies at a Brazilian forensics institution, reveal that despite using state-of-the-art techniques and technologies, such as platforms for automated

DNA extraction, automated ballistic identification systems, and mass spectrometers, the institution is often faced with several difficulties in unified and effective implementations of new technologies. These difficulties are boosted by institutional dimensions, administrative deficiencies, and the diversity of areas of activity in the institution (Bousquet et al., 2023a). In this context, Knowledge Management (KM) practices become crucial for promoting and implementing innovations.

KM refers to a series of regular and systematic activities aimed at maximizing the value of available knowledge and ensuring its effective use and transmission (Nazari & Emami, 2012). It is a managerial function responsible for creating or acquiring knowledge, managing its flow, and ensuring its effective and efficient application toward satisfying the long-term interests of organizations (Darroch & McNaughton, 2002). In this context, adopting KM strategies aids in promoting organizational learning (OL), drives the development of innovative practices, and facilitates overcoming challenges related to implementing new technologies and processes (Bartlett, 2003; Rahim et al., 2023).

Nonetheless, the number of specific publications on KM strategies able to promote innovation in the public sector is still relatively negligible, and the peculiarities of forensics institutions highlight the need to address this literature gap (Weyermann et al., 2023). Therefore, this article proposes KM-based strategies and guidelines to overcome barriers to innovation identified in a Brazilian forensics institution. Its objective is to create a model that not only meets its specific demands but also applies to other public sector institutions by aligning KM practices with the institution's operational and strategic needs.

Given that public sector organizations do not withstand the same degree of competitive pressure as private sector organizations, a solid understanding of organizational factors driving knowledge acquisition is essential (Richards & Duxbury, 2015). The role of managers in directing groups' attention to important knowledge and the applicability of knowledge are critical aspects of KM and innovation in the public sector (Richards & Duxbury, 2015).

An effective implementation of KM strategies is expected to promote innovation in a systematic and continuous manner, in addition to resulting in substantial improvements in processes and organizational performance. Such an approach not only benefits the forensics institution targeted herein, but it can also serve as a replicable and efficient model for other public sector institutions. By adopting these strategies, forensics institutions, as well as other public sector institutions, are expected to innovate more easily, improve operational efficiency,

enhance their work environment, and meet current and future demands of society more effectively.

Knowledge management, organizational learning and innovation

Innovation can be defined as the implementation of a product, whether a good or service, that is brand new or significantly improved, as well as encompassing new processes, marketing methods, or organizational methods in business practices, workplace organization, or external relations (OCDE, 2005).

It is observed that innovation tends to focus more on services and improving processes to accomplish the institutional mission of public service institutions (Morales, 2023). Such an effort aims to improve performance and provide benefits to the population, rather than attaining a competitive advantage typical of the private sector. Therefore, it requires a greater need for interaction, negotiation, and conflict resolution with stakeholders (Tate et al., 2018).

Several scholars emphasize the essentiality of knowledge management (KM) to foster innovation and optimize organizational performance (Morales, 2023). KM refers to a continuous and organized set of regular and systematic activities aimed at maximizing the value of available knowledge. It ensures an effective use and impartation of knowledge, assuring its effective dissemination and promoting a culture of innovation and continuous improvement (Nazari & Emami, 2012).

According to Nonaka and Takeuchi (1997), there are two forms of knowledge: tacit and explicit. Tacit knowledge is personal, context-specific, and difficult to express and communicate, while explicit knowledge is documented in formal and systematic language. Nonaka and Takeuchi (1997) argue that knowledge creation arises from an interaction between tacit and explicit knowledge occurring in four distinct processes: a) socialization, which involves tacit knowledge exchange; b) externalization, which transforms tacit knowledge into explicit; c) combination, which integrates explicit knowledge; and d) internalization, which converts explicit knowledge into tacit. There must be an interaction between these forms of conversion for knowledge creation in an organization (Nonaka & Takeuchi, 1997).

In this context, KM adds value by implementing a structured and planned approach to cultivate and share the company's knowledge base composed of lessons learned and best practices (Nonaka & Takeuchi, 1997). The main challenge for organizations is to ensure that

relevant internal and external knowledge is used effectively in innovation processes (Savory, 2009), and thus organizations must become "learning organizations", in addition to having to adapt and thrive in complex and constantly changing environments.

Organizational learning (OL) plays a central role in aiding organizations to achieve continuous innovation development (Savory, 2009). This learning is characterized as a collective capacity based on cognitive and experiential processes encompassing acquisition, sharing, and application of knowledge in the organization (Dibella et al., 1996). Morgan and Ramirez (1983) state that organizational learning occurs when members of an organization use their learning processes to solve a shared problem.

Thus, organizational learning, properly stored and compiled for future use, plays a crucial role in establishing sustainable and innovative practices (Antunes & Pinheiro, 2020).

Research method

An integrative literature review has been conducted to propose strategies and guidelines for innovation in the public sector, but the issue was to verify how to foster and implement continuous and systematic innovations in the public sector based on organizational learning and knowledge management by collecting insights to overcome barriers to innovation identified in the forensics institution. An integrative review represents a comprehensive methodological approach allowing a synthesis of knowledge and application of results of relevant studies in practice (Souza et al., 2010). This method enables the inclusion of both experimental and non-experimental studies, aiming at a comprehensive understanding of the scenario in question (Souza et al., 2010).

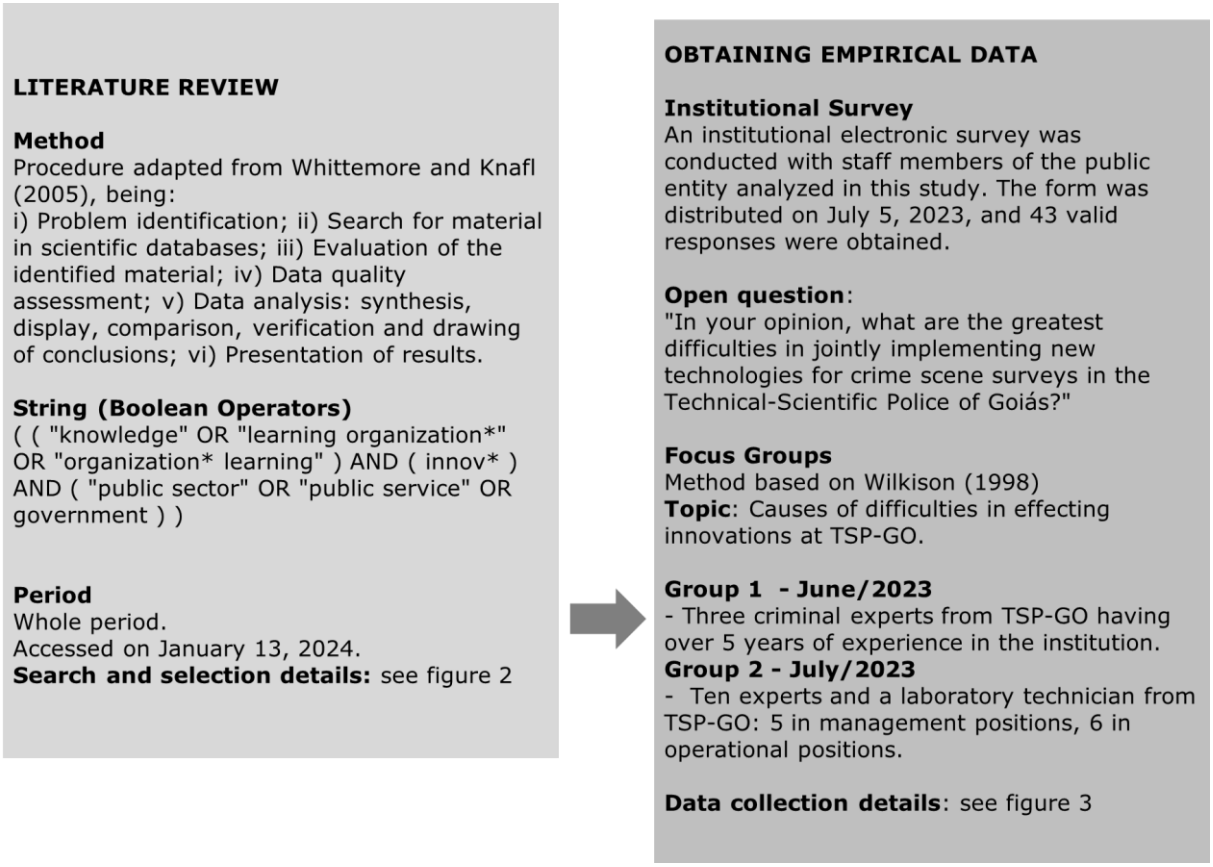
The literature review results were combined with those from empirical data collection. Such data were collected from the employees of the Forensic Science Police Department of the State of Goias (TSP-GO), Brazil, the analyzed public entity. Data collection involved two complementary procedures: an institutional electronic survey sent to staff members of the analyzed institution, and Focus Group sessions conducted with selected employees.

Focus groups are characterized by interviews and group meetings providing participants with the opportunity to explore and express their opinions through reflective discussions on a specific topic (Backes et al., 2011). This interaction is a fundamental feature of the method, as

it enables a depth of reflection on the subject that other data collection techniques often fail to achieve (Backes et al., 2011).

Figure 1

Overview of the methodological process

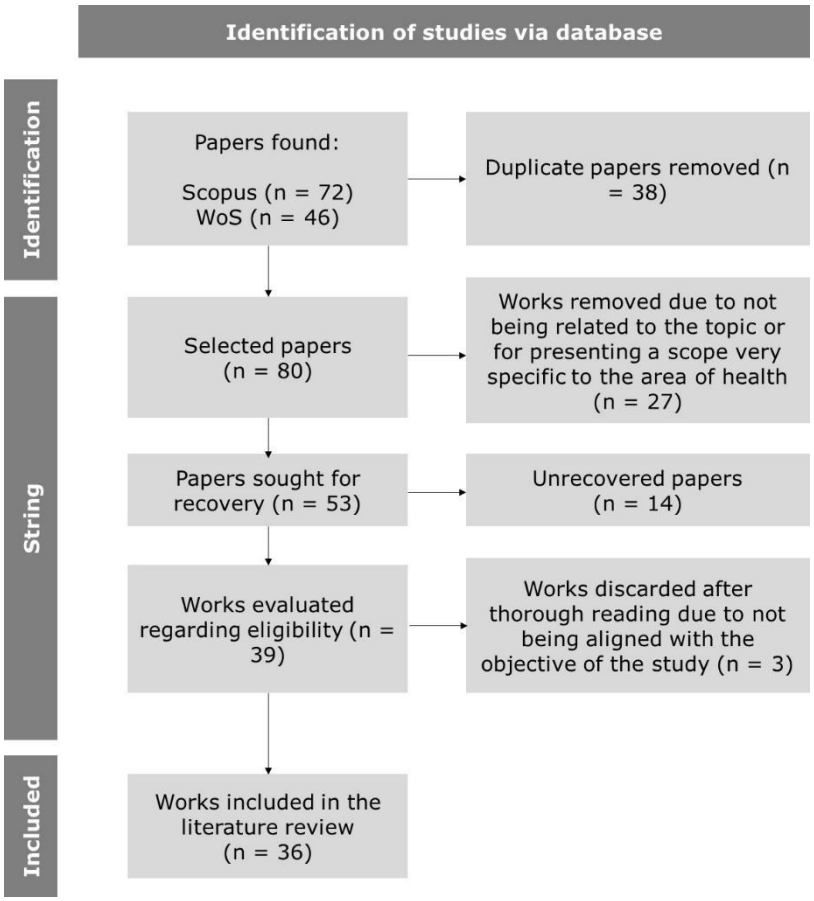


Note. Authors.

The search for articles focused on titles to ensure direct relevance to knowledge management and organizational learning in relation to innovation in the public sector. The choice of the search string was refined after multiple attempts using different keywords, such as “knowledge” and “innov*”, to capture a wider range of relevant studies, thus avoiding unrelated works or works on divergent topics.

Figure 2

Process of searching and filtering papers



Note. Authors based on PAGE et al. (2021).

The institutional survey was conducted from July 5 to 30, 2023, using an electronic form completed by 43 employees of the analyzed public entity. Its purpose was to identify the main difficulties encountered in the joint implementation of new technologies for crime scene investigations in the Forensic Science Police Department.

As for the focus group sessions, the first one (1st Group) was held in June 2023 and the second one (2nd Group) in July 2023, whose steps are detailed in Figure 3.

The 1st Focus Group consisted of 3 employees with over 5 years of experience in the institution, who raised possible causes for difficulties in jointly implementing new technologies in the institution through brainstorming, since it is a useful technique for the collaborative development of ideas in organizations, which assists in solving problems and making decisions (Seeber et al., 2017).

The 2nd Focus Group was composed of 11 employees, including 10 forensic experts and 1 laboratory assistant. The group of participants included individuals working in several departments of the institution: 6 of them held management positions with experience in the operational area, and 5 held operational positions, 4 of whom had previously held management positions. Each participant had worked for at least five years at the institution and was highly educated, including one doctorate, three master's degrees, and seven specialists; three of the latter were currently taking their master's degree courses.

Before the 2nd Focus Group brainstorming session commenced, a brief contextualization was provided about the definition of innovation and its importance for institutions. The difficulties in implementing new technologies identified by the 1st Group were presented, as well as some insights about the institutional survey that was underway. Causes were introduced so that participants could more broadly and easily identify the main obstacles to a unified implementation of new technologies. The participants were then able to write the causes for the difficulties in implementing new technologies in the institution on pieces of paper. Then, with the aid of the entire group, they pasted the pieces of paper containing the identified causes on a board within the category that they deemed to be most appropriate: culture and environment; legislation and standards; management and planning; human resources and labor; training and qualification; infrastructure and equipment. The causes identified by the 1st Group were also categorized at this stage, as well as some insights drawn from the institutional survey presented at the beginning of the 2nd Group session.

Participants were then asked to submit the causes identified via an electronic form. These causes were printed and added to those presented at the beginning of the Group 2 session for the prioritization phase. Participants were divided into two groups, each responsible for half of the causes. They rated the causes using two ordinal scales from 1 to 5, with fixed-choice responses, to measure perceptions of the "importance of resolution" and "ease of resolution" of the listed causes. The ordinal scale with fixed responses was selected owing to its simplicity and clarity, since it allowed participants to prioritize the causes efficiently.

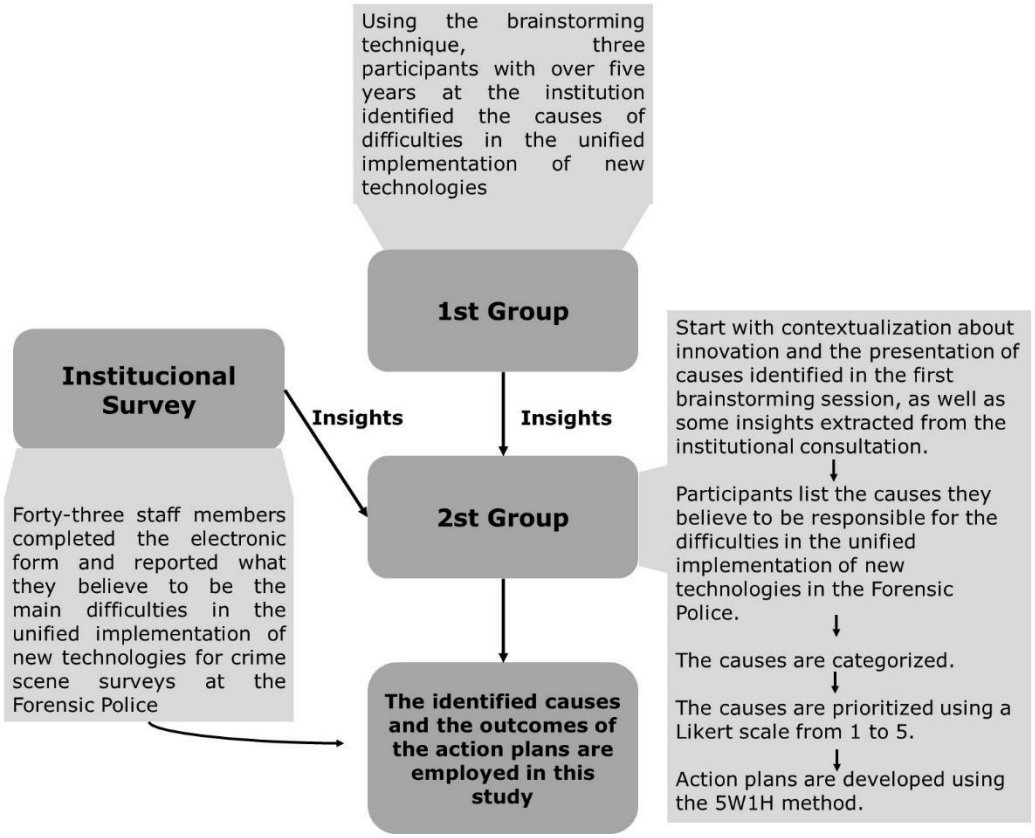
After the groups assigned their scores, the "importance of resolution" score was multiplied by the "ease of resolution" score. Then, the two groups jointly revisited the 25 items with a total score of 10 or more, ensuring consensus and adjusting the listed causes. Subsequently, the four items with the highest scores were selected to develop action plans. The participants, divided into three groups, used the 5W1H methodology to plan the actions (Woo and Jang, 2005). Each group presented their plan and received comments from others. Some

participants had to leave before the end of the sessions, seven of whom participated in the action plans development.

The insights gained from the focus groups, as well as the responses to the institutional consultation, were used to understand the barriers to innovation at the forensics institution where they were conducted.

Figure 3

Institutional survey and step-by-step guide to the Focus Group methodology



Note. Authors.

Thus, the Focus Groups and institutional survey results rendered empirical data that were incorporated into the knowledge of one of the authors who had worked at the institution for 8 years, 3 of which were in the management area, which were added to the results of the literature review to develop KM guidelines and strategies to overcome the barriers to innovation identified in the forensics institution and promote innovation.

Results

This topic presents the results achieved from the integrative literature review, collection, and analysis of data from the institutional survey and focus group sessions. These results were compiled to build a systematized process involving basic strategies and guidelines on KM to overcome barriers to innovation and promote innovation in the forensics institution.

Results from the Integrative Literature Review: Factors Promoting Innovation and the KM-OL — Innovation Model

Results from the integrative literature review through reading, coding, synthesis, and systematization of information regarding the effectiveness in promoting continuous and systematic innovations in the public sector are presented in Table 1 with eight main factors identified as drivers of this process, namely: a) effective strategic leadership for promoting innovation; b) organizational learning culture; c) knowledge sharing; d) innovative employee behavior; e) search for knowledge and collaboration with external sources; f) knowledge management while implementing innovations through the establishment of a solid knowledge base to address the problem by innovation and the innovation process itself; g) use of information and communication technologies (ICTs) facilitating the sharing of knowledge, open communication, and collaboration; h) evaluation of innovations and ambidextrous learning strategy balancing the innovation of "exploration" (search for new opportunities, experimentation and innovation) and "exploitation" (optimization and greatest use of existing opportunities) in a sequential or structural manner (Arundel et al., 2015; Dalkir et al., 2006; Bartlett, 2003; Choi and Chandler, 2015; Choi and Chandler, 2020; Lee and Jin, 2022; Luna-Reyes, 2009; Susanty et al., 2019).

Table 1

Factors related to the promotion of innovations in a continuous and systematic manner

Factor	Description	Authors
A- Leadership	Leadership plays a crucial role in fostering innovation in a continuous and systematic manner, and it is essential to implementing a strategy focused on innovation and knowledge management. This consists of developing an environment prone to learning and innovation; adopting a strategic plan directing innovation efforts; encouraging the sharing of knowledge; encouraging the pursuit of knowledge and collaborating with external collaborators to develop innovations; encouraging individual learning; incorporating the results into the culture and practices of the organization; promoting training and development; encouraging trust in innovation; promoting employee autonomy; investing in ISTs; strengthening employee innovative behavior; assessing the risks and benefits of innovative ideas; and seeking resources to effect innovation efforts.	Luna-Reyes (2009); Savory (2009); Naghavi et al. (2012); Brown and Osborne (2013); Mcnabb (2015); Tang and Yeh (2015); Amusan and Adebola Oyekunle (2016); Bos-Nehles et al. (2017); Nishihara et al. (2018); Martin & Alfaro (2018); Limba et al. (2019); Lee & Jin (2022); Xanthopoulou et al. (2023).
B- Organizational learning culture (OLC)	A learning culture fosters the sharing of data, information, and knowledge, encourages individuals to learn from one another, and incentivizes innovative behavior by each employee, thus aiding in solving problems more quickly and motivating innovation.	Brodtrick (1998); Tahir & Mitomo (2005); Choi and Chandler (2015); Tang and Yeh (2015); Amusan & Adebola Oyekunle (2016); Naghavi et al. (2012); Limba et al. (2019); Susanty et al. (2019); Lee and Jin (2022); Ononye (2022).
C- Knowledge sharing (KS)	Effective knowledge sharing is associated with increased organizational commitment, job satisfaction, and overall performance. KS facilitates the implementation of changes, fosters innovative employee behavior, and contributes to the promotion of an organizational learning culture.	Brodtrick (1998); Bartlett (2003); Dalkir et al. (2006); (Hennala et al. (2012); Naghavi et al. (2012); Kallio & Lappalainen (2015); Susanty et al. (2019); Tajdini and Tajeddini (2018); Ferguson and Blackman (2019); Ononye (2021); Adam (2022); Burgers et al. (2022); Ononye (2022); Zambrano-Gutiérrez and Puppim de Oliveira (2022); Rahim et al. (2023); Xanthopoulou et al. (2023).
D - Employee innovative behavior (EIB)	EIB is a discretionary and active employee behavior able to tackle workplace problems and promote innovation in task performance. EIB positively influences KS and is favored by job autonomy, in addition to assisting the promotion of an organizational learning culture.	Savory (2009); Ferguson et al. (2013); Khilji & Roberts (2013); Adam (2022); Lee & Jin (2022); Ononye (2022); Rahim et al. (2023); Xanthopoulou et al. (2023).
E- Knowledge seeking and collaboration with external sources	Seeking knowledge from external sources (users, other organizations, and universities) can aid organizations in overcoming barriers to innovation, boosting creativity, and increasing understanding of how to solve problems. Collaborative networks can assist organizations in solving problems jointly. By adopting and adapting innovations from other	Arundel et al. (2015); Hartley and Rashman (2018); Savory (2009); Zambrano-Gutiérrez e Puppim de Oliveira (2022).

	organizations, organizational learning related to innovation processes is enhanced and enriched.	
F- Knowledge management while implementing innovations	Motivations for innovation must be clearly identified and analyzed to enable assessment. Collaborative logic models should be created to map connections between activities and outcomes and provide stakeholders with a clear view of the process, highlighting the steps required to achieve end results. For innovation to be successful, it is essential to provide adequate time for its implementation, avoid early assessments, involve stakeholders and employees experienced with current systems, conduct testing, and divide large innovation projects into smaller parts or run them as a series of pilot projects. Involving multidisciplinary teams to ponder innovation can be a success factor. All employees involved in implementing innovation should undergo effective training.	Bartlett (2003); Choi and Chandler (2015); Choi and Chandler (2020); Dalkir et al. (2006); Ferguson et al. (2013); (Khilji and Roberts 2013); Luna-Reyes (2009); Rahim et al. (2023); Savory, (2009); Xanthopoulou et al. (2023); Zambrano-Gutiérrez and Puppim de Oliveira (2022).
G- Information and Communication Technologies (ICTs)	ICTs facilitate KM and support the provision and sharing of knowledge. In addition, they can be used to seek and collect data, information, and knowledge to support decision-making.	Tahir & Mitomo (2005); Dalkir et al. (2006); Luna-Reyes (2009); Brown & Osborne (2013); Khilji & Roberts (2013); (Molete et al. (2015); Mcnabb (2015); Susanty et al. (2019).
H- Evaluation of innovations and balance between exploring opportunities and exploiting existing resources	Innovation must be evaluated so that the organization can learn from its experiences and continually improve. Feedback cycles with subsequent implementation of improvements are crucial to institutionalizing innovation. It is worth avoiding hasty reassessments, since they can result in the premature abandonment of innovative ideas. Implementing ambidextrous learning, which balances the "exploration" of new opportunities and technologies, with their risks and uncertainties, and the "exploitation" of current resources focused on improving and optimizing existing processes and services to increase operational efficiency, mitigates risks in the implementation of innovations, such as unwillingness to change, difficulty in adapting to new practices, and outdated skills.	Alosani et al. (2020); Choi & Chandler (2015); Choi & Chandler, (2020); Limba et al. (2019).

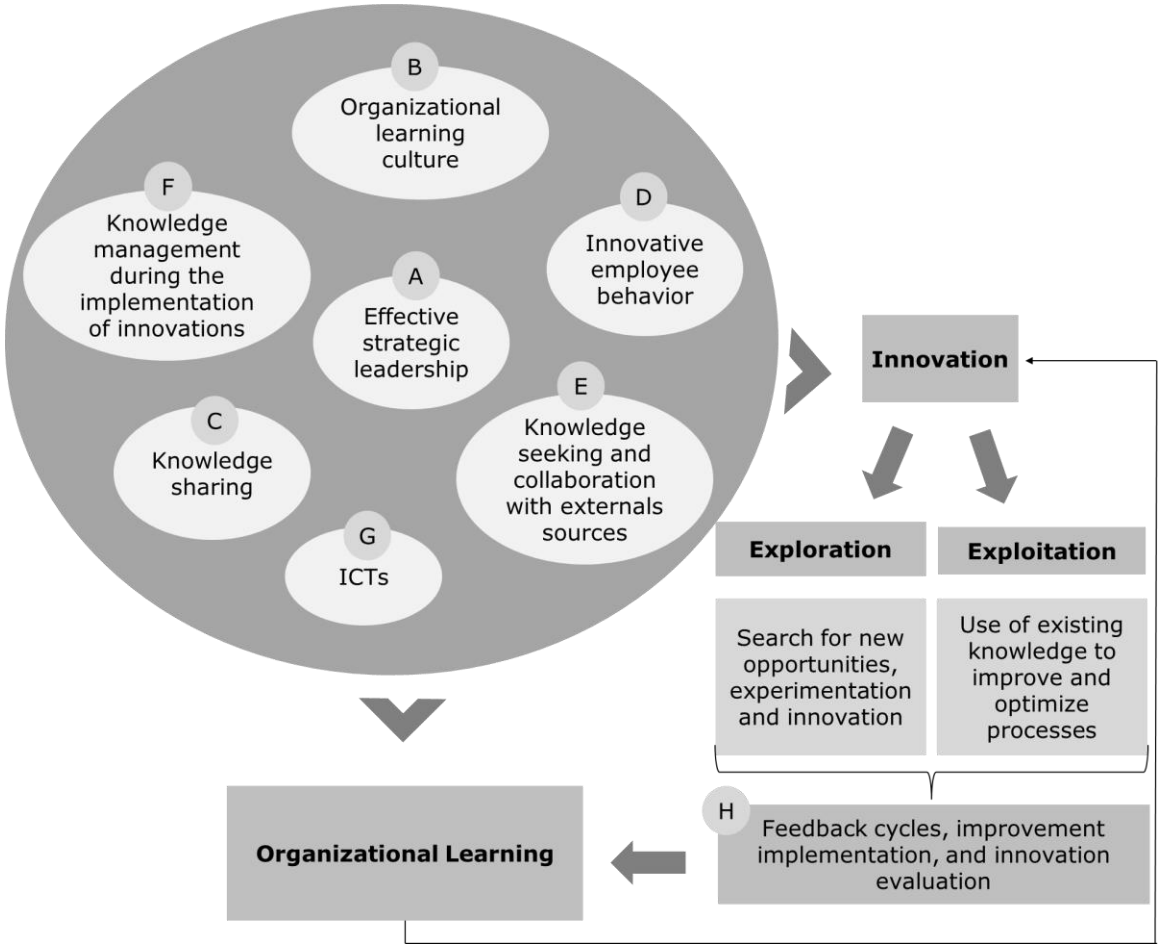
Note. Authors.

It is known that factors related to organizational Knowledge Management eventually assist in promoting organizational learning, and the greater an organization's knowledge about the innovation process is, the more easily it can assimilate new knowledge and innovate (Hartley & Rashman, 2018). An ambidextrous learning strategy, where there is both the implementation of more radical innovations and the improvement of processes through knowledge refinement, can favor continuous and substantial innovation at the institution (Choi & Chandler, 2015).

Thus, Figure 4 shows a framework relating Knowledge Management to organizational learning and innovation based on literature data.

Figure 4

Framework based on literature data showing KM factors required for organizational learning and innovation, as well as the balance between exploiting opportunities and leveraging existing resources



Note. Authors.

It is understood that leadership must implement collaborative strategic planning; therefore, it will serve as an essential roadmap to set institutional objectives and goals. This guide should assist and direct efforts necessary to effectively achieve innovation. Furthermore, it is vital that leaders set challenging goals and foster an environment prone to the generation and safe exchange of ideas, thus boosting creativity and engagement. The adoption of

educational and staff development strategies, together with the collaboration of stakeholders having complementary expertise, enriches learning and innovation processes (Amusan & Oyekunle, 2016; Luna-Reyes, 2009; Tang & Yeh, 2015). Leaders must also encourage and invest in individual learning and integrate such results into the organizational culture (Brodtrick, 1998). In addition, they must use their power and influence to unify teams, focus efforts on strengthening organizational learning, and manage change effectively (Limba et al., 2019).

To effectively promote innovation, it is essential to foster an organizational learning culture, i.e., a favorable environment for knowledge sharing, creativity, and mutual trust (Limba et al., 2019; Dalkir et al., 2006). An organizational learning environment should support both innovation and continuous improvement (Lee & Jin, 2022; Choi & Chandler, 2015). It is essential to encourage teamwork, task interdependence, and interdepartmental communication to facilitate learning and sharing of work experiences (Tang & Yeh, 2015; Ononye, 2022). Providing frequent informal opportunities, such as casual events and workshops, can aid in reducing employees' unwillingness to share knowledge (Lee & Jin, 2022). Furthermore, shared spaces, both physical and virtual, should be created where knowledge can be exchanged so that innovation can thrive; ongoing training of public servants and training programs to develop skills related to innovation and efficient use of knowledge should also be promoted (Amusan & Oyekunle, 2016; Tahir & Mitomo, 2005).

Investing in information and communication technologies (ICTs) is crucial for innovation, as they facilitate both knowledge sharing (KS) and knowledge management (KM) (Dalkir et al., 2006; Molete et al., 2015; Khilji & Roberts, 2013). The use of ICTs in information search, collection, analysis, and knowledge sharing supports decision-making processes and improves innovation performance (Susanty et al., 2019; Tahir & Mitomo, 2005; Luna-Reyes, 2009). Furthermore, building platforms for joint innovation with external sources and communication channels strengthens the capacity for collaboration and integration of new knowledge, in addition to expanding the innovative potential of organizations (Susanty et al., 2019).

Knowledge search and collaboration with external sources are effective in overcoming barriers to innovation (Arundel et al., 2015), and establishing learning partnerships with citizens can produce results valued by society (Brodtrick, 1998). Leadership should use participatory innovation activities, acknowledge customer experience, and stress the role of employees as partners in service development and engagement in learning from external sources (Burgers et

al., 2022; Hennala et al., 2012). Hartley & Rashman (2018) emphasize the relevance of knowledge management (KM) in interorganizational learning and innovation processes by showing that organizations improve their ability to acquire, assimilate, and apply learning over time by integrating external knowledge. Therefore, it is worth realizing that innovations cannot simply be transferred from one reality to another (Ferguson & Blackman, 2019), and that adapting innovations from other institutions can increase the organizational knowledge base, thus favoring innovations (Hartley & Rashman, 2018).

Zambrano-Gutiérrez and Oliveira (2022) report that external learning mechanisms and sectoral diversity promote transformative innovations, while new internal processes and continuous improvements in management procedures result in incremental innovations. Therefore, Kallio and Lappalainen (2015) emphasize that the use of external sources can foster organizational learning through collaborative services in innovation networks, and stakeholders must have a common goal to co-create in a network.

For acceptance and full implementation of innovation, it is essential to manage the implementation process, obtain constant feedback, establish cycles of continuous communication on the progress of projects, as well as perform necessary reassessments and adjustments (Limba et al., 2019; Choi & Chandler, 2020). Assessments linked to specific innovations within an integrated system allow the organization to learn from its experiences, avoiding premature reassessments prone to being affected by the pro-innovation bias of public managers (Choi & Chandler, 2020). Dividing innovation projects into smaller sections or implementing them as a series of pilot projects can improve process management. Furthermore, employing an ambidextrous learning strategy, which balances the search for new opportunities while optimizing existing ones, is fundamental for efficient innovative development, as it prevents knowledge deficits from hindering effective implementation and institutionalization of innovations (Choi & Chandler, 2015).

Moreover, using performance benchmarking to incorporate successful innovation practices can influence good practices within the organization (Choi & Chandler, 2015). Integrating KM projects into daily operations and perceiving failures in innovative projects as learning opportunities rather than just failures assist in setting an environment prone to continuous innovation (Ferguson et al., 2013). Establishing innovation units or teams specifically responsible for KM can assist in better structuring these efforts (Susanty et al., 2019).

Furthermore, integrating KM projects into daily operations is crucial. Viewing failures

in innovative projects as learning opportunities rather than failures assists in setting an environment prone to continuous innovation (Ferguson et al., 2013). Establishing innovation units or teams specifically responsible for KM can better structure these efforts and ensure that the organization is continually learning and adapting (Susanty et al., 2019).

Survey on the Causes of Difficulties for a Joint Implementation of Innovations

An institutional survey was carried out in which 43 employees of the forensics institution targeted by this research completed an electronic form to list the causes of difficulties in introducing innovations through new technologies at the institution. The answers to the question "In your opinion, what are the greatest difficulties in implementing new technologies jointly for investigating crime scenes?" were strategically analyzed to identify specific barriers to the implementation of new technologies, but their understanding can be applied to broader challenges in all types of innovation. The employees' answers were summarized, categorized, and grouped into seven categories: management and planning, financial resources and bureaucracy, organizational culture and adherence, infrastructure and equipment, legislation and standards, human resources and labor, training and qualification (Table 2).

Table 2

Causes of difficulties in implementing new technologies jointly in a Brazilian forensics institution inferred from the institutional survey

Group	Causes of difficulties
Management and Planning	● Implementation of Standard Operating Procedures (SOPs) and mandatory protocols
	● Absence of a standardized institutional method for crime scene investigations
	● Lack of simple and objective standardization to ensure greater efficiency and adherence
Financial resources and bureaucracy	● Lengthy bureaucratic processes for acquiring equipment.
	● Budgetary limitations for purchasing new equipment and technologies.
	● Uneven distribution of financial resources, mainly affecting units outside the capital.
	● Delays in obtaining resources meeting the needs of all expert units.
Organizational culture and adherence	● Organizational culture that may inhibit innovation and adoption of modern technologies.
	● Unwillingness and prejudices of employees regarding the adoption of new technologies
	● Challenges in accepting new technologies by employees
Infrastructure and Equipment	● Lack of computing equipment powerful enough for specific tasks such as 3D modeling.

	● Unavailability of equipment and applications for crime scene investigations and report automation.
	● Challenges in a widespread arrangement of technological equipment, especially in inland areas.
	● Absence of an institutional computerized system for preparing crime scene reports.
Legislation and regulations	● Implementation of SOPs and mandatory protocols (also listed under Management and Planning).
Human resources and workforce	● Large number of calls, which limits the capacity to process crime scenes using new technologies.
	● Lack of a staff responsible for processing and post-process data acquired by new technologies.
	● Lack of qualified personnel in the technology development sector to integrate effective software.
Training and Qualification	● Need for adequate and periodic training of employees.
	● Difficulty in providing advanced and practical training, especially in regions outside the capital.
	● Lack of adequate training for analyzing data collected by new technologies.

The causes listed in the institutional survey reveal some barriers to innovation faced by the Brazilian forensics institution. Data items were also obtained from two focus groups to better understand and detail the causes of difficulties in jointly implementing new technologies at the institution where they were conducted. Furthermore, it was possible to identify greater detail on the causes leading to barriers to a joint implementation of new technologies through data obtained from focus group sessions, in addition to observing that the identified causes could also be barriers to other types of innovations (such as processes, management, and services). The final results of causes identified through the focus group sessions are detailed below and grouped into six categories (previously established for the stage of categorizing the causes in the 2nd focus group session):

- **Management and planning:** delay in providing technology; lack of adequate planning for implementing new technologies; lack of planning for the application of equipment/technology prior to requests; bureaucracy in public service; lack of planning for understanding physical, environmental, and structural needs for implementing technology; inefficient innovation management; lack of financial resources for acquisitions; errors in acquisitions; lack of even distribution of technologies in all regions; lack of prior discussion about what actually matters and makes a difference; lack of communication between sections to make purchases in efficient quantities; lack of transition in management changes; lack of transparency in institutional choices; lack of implementation—through the extensive process of purchasing and allocating technology—when it is to be actually purchased, the employee is no longer interested or the problem has been resolved otherwise; lack of centralization of guidelines and networking into an exclusive team of the Forensic Science Police Department

(e.g., an innovation coordination or management); lack of joint planning involving different areas of the institution (representativeness) so that technology is effective; lack of studies to verify the applicability of new technologies specific to forensics; lack of project prioritization; handling technology as something expensive and delicate, discouraging employees from using it owing to fear.

- **Organizational culture and environment:** common sense of precariousness in public service generating discredit in technology functionality; excessive criticism by civil public servants, even before they are aware of and regularly use the technology; lack of sharing of software/apps developed internally; organizational culture unfavorable to innovation; proactivity for installing new methods and technologies mostly starts from operational activity; civil public servants have difficulty studying new technologies; resistance to change and low acceptance of new technologies by civil public servants; culture punishing those who stand out or seek innovation; adherence to old and established practices; lack of culture and actions promoting adherence to changes in the Forensic Science Police Department analyzed; top-down institutional policies; decisions made by groups selected by affinity instead of technical capacity; micromanagement of units; high demand for productivity, hindering training; pursuit of increased workload through the introduction of technology by civil servants; lack of awareness that innovation is inherent to expert activity and its importance for the public image of the institution; deficiency in communication between sectors of the institution.
- **Infrastructure and equipment:** obsolete equipment; inadequate physical structure; small number of developers available at the Forensic Science Police Department; lack of a technological park so that high-cost equipment can be used for various purposes; high support from other agencies to receive the product of innovation; lack of network presenting technological innovations aimed at expert areas; acquisition unrelated to periodic maintenance of new technologies; concentration/regionalization of new technologies in certain sections and locations.
- **Legislation and standards:** absence of statutory regulations requiring the use of technology within the institution; the fact that technology is optional prevents employees from becoming familiar with it, developing the habit of using it, and consequently leads them to set it aside; excessive workload; and the lack of standard operating procedures (SOPs) or laws informing how and when to use the technology.

- **Human resources and workforce:** lack of employee involvement in the implementation of new technologies; lack of time available for training; perception of increased workload by the employee.
- **Training and qualification:** lack of instructions and training; insufficient financial resources for training; low remuneration and appreciation by instructors.

The ideas listed in the institutional survey at the forensics institution provided a broader view of the institutional deficiencies creating barriers to innovation. Although it focused on understanding the difficulties of implementing innovations using new technologies, the generated ideas also reveal cultural, operational, infrastructure, and procedural deficiencies, assisting in understanding the institutional reality, in addition to allowing the formulation of comprehensive and effective proposals to promote innovation in the institution.

Contextualization of results and innovation model

It is understood that knowledge management strategies, when utilized, favor innovation in the public sector and can assist public institutions in overcoming barriers to innovation. The barriers identified through the surveys carried out are linked to several factors, as shown in Figure 5.

Figure 5

Types of barriers to innovation identified in surveys

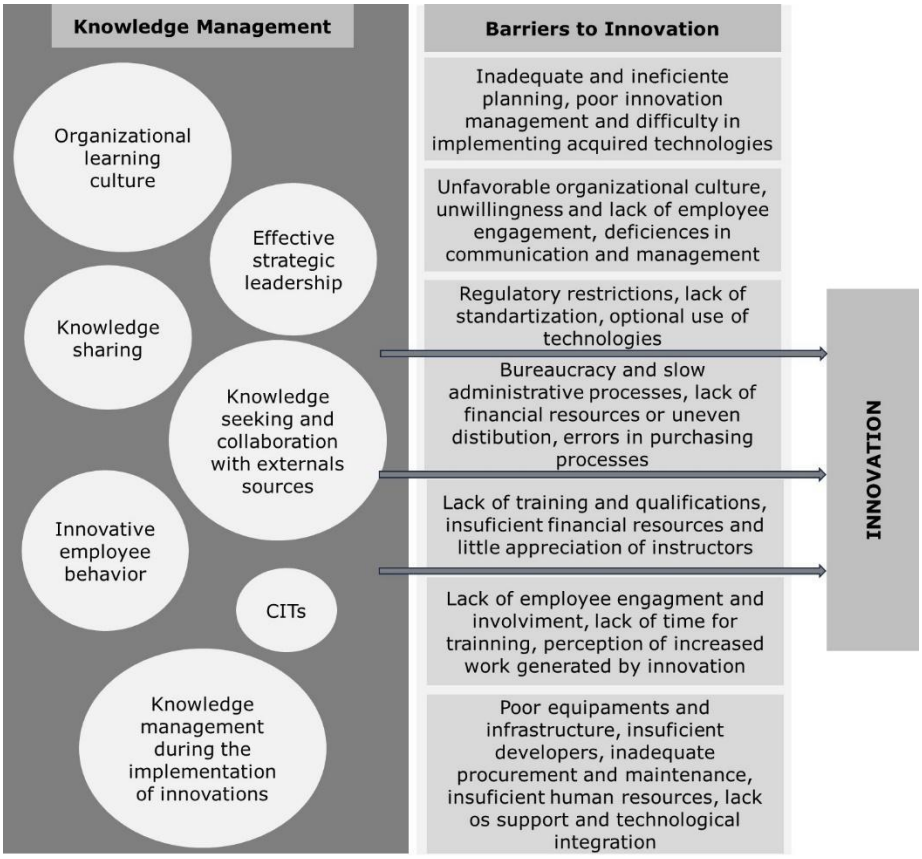
Note. Authors

Based on the literature review results, institutional survey findings, and data obtained from focus group sessions, Figure 6 was compiled to depict strategies able to assist in overcoming barriers to innovation in the forensics institution where the case study was carried out.

Although barriers were identified through issues involving difficulties in jointly implementing new technologies, KM strategies, when applied, contribute to thoroughly fostering innovation. Innovation is understood herein as a means to improve institutional services and enhance the manner in which tasks are performed to achieve the institutional mission (Şimşit et al., 2014).

Figure 6

Strategies for overcoming barriers through Knowledge Management



Note. Authors.

The details of knowledge management guidelines and strategies presented to overcome each of the barriers to innovation identified in the forensics institution, i.e., the target of the case study, are shown in Table 3. It is considered that such guidelines and strategies are fully capable of fostering a continuous and systematic development of innovations in the institution, as well as increasing its organizational performance.

Table 3

Knowledge management guidelines and strategies

Barriers to Innovation	**Guidelines and strategies**		**Factor related to KM**
Management and Planning (I)		● Carrying out strategic planning defining institutional objectives and goals with the collaboration of employees (Mcnnab, 2015). ● Using power and influence strategically to unite people and direct joint efforts towards achieving organizational goals (Nishihara et al., 2018). ● Establishing innovation coordination and its activities to develop and implement innovation strategies, manage innovative projects, and ensure that initiatives are aligned with the institution's objectives (Susanty et al., 2019). ● Supporting employees and encouraging an innovative approach; emphasizing staff learning, sharing of work experience, and communication (Tang & Yeh, 2015).	Effective strategic leadership
		● Creating a database for purchase orders accessible to all units and laboratories of the institution, where everyone can view and request necessary items with established deadlines, allowing sufficient room for justifications. ● Adding a checklist into the project model so that its creator has a roadmap to assess all needs and ensure that nothing is missing when purchasing items, and setting up a project evaluation committee to meet periodically to review and define the priorities of initiatives.	
		● Having transition periods during management changes and encouraging the creation of SOPs for management areas to reduce knowledge gaps in management transitions. ● Ensuring that all affected personnel can participate in the decision-making process regarding the implementation of innovations. ● Testing new technologies through pilot projects before full adoption. ● Establishing clear criteria for prioritizing projects aligned with institutional strategic planning.	
		● Integrating knowledge management projects into daily activities, making them components of work processes, and handling failures in innovative projects as learning opportunities rather than simply failures (Ferguson et al., 2013). ● Using performance benchmarking to incorporate and disseminate successful innovation practices within the organization (Choi & Chandler, 2015). Knowledge sharing.	Knowledge sharing

		• Setting up project development workshops. • Holding purchasing process workshops so that more experienced personnel can teach less experienced employees in practice	
		• Creating study groups involving representatives from different sectors where members assess the best technologies to be acquired, management strategies, bring knowledge and experiences from other institutions to be studied, and deliver results guiding strategic decisions (Bartlett, 2003; Zambrano-Gutiérrez & Puppim de Oliveira, 2022). • Setting up work groups to plan the acquisition of technology items to be acquired and devising detailed plans for implementing new technologies (Bartlett, 2003).	Knowledge management during the implementation of innovations
		• Setting up work groups to propose improvements to institutional processes.	
		• Designing a logical model able to visually represent the connections between an initiative's activities and its outcomes, providing stakeholders with a clear and concise view of the process. This model should highlight the results chain and identify intermediate steps required to achieve end results (Dalkir et al., 2006). • Having a clear understanding of motivations behind innovation, registering and analyzing these motivations to evaluate the progress made (Bartlett, 2003). • Implementing a KM system where knowledge is used for innovation, and the knowledge resulting from innovation is fed back into the system (Xanthopoulou et al., 2023). • Implementing shared problem-solving involving collaboration between staff members to solve challenges; prototyping and experimentation, which allows testing and refining new ideas; implementing and integrating new technologies, ensuring that they are efficiently incorporated into existing processes; and absorbing external knowledge, leveraging insights and information from outside the organization (Savory, 2009).	
		• Seeking knowledge from other organizations about technologies and processes already being used regarding their application and actual effectiveness before acquiring technologies and/or implementing changes (Burgers et al., 2022). • Increasing the prior knowledge base by adapting innovations from other institutions until learning to innovate (Hartley & Rashman, 2018). • Collaborating in a network with other public safety institutions to co-create solutions able to benefit all stakeholders, joining efforts, and promoting joint improvements (Dalkir et al., 2006; Kallio & Lappalainen, 2015; Ferguson & Blackman, 2019)	Knowledge seeking and collaboration with external sources
		• Always seeking continuous feedback on innovations and making the necessary improvements to ensure the full institutionalization of innovation within the organization (Limba et al., 2019). • Conducting specific assessments for each innovation within an integrated system allowing the organization to learn from its experiences and continually improve (Bartlett, 2003; Dalkir et al., 2006). • Avoiding premature reviews of innovations by recognizing potential pro-innovation biases among managers. Dividing heterogeneous innovation projects into smaller parts or	Evaluation of innovations and ambidextrous learning strategy.

		implementing them as a series of pilot projects (Choi & Chandler, 2020). ● Employing an ambidextrous learning strategy able to balance exploration (searching for new opportunities and experimenting with them) and exploitation (optimizing existing opportunities) in a sequential or structural manner (Choi & Chandler, 2015).	
		● Using ICTs to keep all stakeholders involved in the implementation of a given innovation aware of its progress and collect feedback.	Use of ICTs
		● Using ICTs to search, collect, analyze information, and share knowledge aimed at supporting decision-making and improving performance in innovation (Susanty et al., 2019; Tahir & Mitomo, 2005; Luna-Reyes, 2009).	
Financial resources and bureaucracy (II)		● Participating in networking activities and engaging with political and public managers within and outside the organization to ensure adequate attention and financial resource (Bos-Nehles et al., 2017).	Effective strategic leadership
		● Seeking financial resources able to allow more agile and simplified acquisition processes to reduce delays in acquiring and implementing technologies.	
		● Holding events where knowledge and experiences on how to obtain resources can be shared with politicians and other institutions. ● Establishing continuous feedback mechanisms and a policy for implementing new ideas to facilitate process improvement.	Knowledge sharing
Organizational culture and adherence (III)		● Clearly communicating the vision of the places the institution aims to reach and how innovation is vital for such. ● Encouraging the exchange of information, communication, systemic thinking, and use of technology (Tang & Yeh, 2015). ● Developing an environment prone to encourage knowledge exchange, creativity, and mutual trust (Limba et al., 2019; Dalkir et al., 2006) to foster a culture of organizational learning able to support both innovation and continuous improvement (Lee & Jin, 2022; Choi & Chandler, 2015). ● Creating environments where people feel safe enough to express their ideas and share knowledge, transform the essence of ideas into effective accounts, and promote phronesis (practical wisdom) (Nonaka, 2014 as cited in Nishihara et al., 2018). ● Conducting workshops and training on the importance of innovation and how to adopt new technologies, as well as emphasizing learning and sharing work experiences (Tang & Yeh, 2015). ● Clearly publicizing the benefits of knowledge sharing and correct knowledge management for innovation and organizational performance at events and meetings. ● Encouraging collaboration and resource sharing across departments.	Effective Strategic Leadership and Organizational Learning Culture
		● Involving employees in change processes from the very beginning to allow them to give their opinions and make suggestions. ● Demonstrating the benefits of new technologies through practical examples and case studies. ● Fostering a culture of knowledge sharing, mutual assistance, and shared search for solutions and improvements at the time of professional training courses so that new employees are	

		imbued with this collaborative mentality the moment they start working for the institution. ● Involving all sectors in the design of institutional projects, encouraging collaboration, and promoting a sense of belonging.	
		● Supporting employees and encouraging innovative approaches (Tang & Yeh, 2015).	Innovative employee behavior
		● Providing attractive benefits to employees able to create and implement innovations.	
		● Improving the provision of knowledge to employees working in digital areas. ● Promoting reverse mentoring where younger or less experienced employees share new perspectives and skills (such as digital technologies) with more experienced personnel.	Knowledge sharing
Training and qualification (IV)		● Providing mandatory (exempt workload) and effective training in the use of new technologies, routines, and institutional processes, aiming to reduce resistance to change and improve the implementation of new technologies, routines, or processes.	Knowledge sharing
		● Holding meetings, workshops, conferences, and seminars so that employees can exchange knowledge and improve organizational learning (Lee & Jin, 2022; Ononye, 2022).	
		● Adopting an educational and personnel development strategy able to stimulate creativity, ensure innovation, and consolidate knowledge within the organization (Amusan & Oyekunle, 2016).	Organizational learning culture
		● Balancing productivity and training, adjusting workload to allow adequate time for training and development of employees.	
		● Seeking courses in other institutions for employees aiming at improvement by bringing new knowledge to the institution able to generate improvements and innovations. ● Seeking partnerships to promote postgraduate courses to employees. ● Setting up partnerships with officers from other police forces to provide training.	Seek knowledge and collaboration with external sources
		● Taking steps to ensure that there are legal changes to remunerate instructors aiming to raise their remuneration and perception of value. ● Publicly acknowledging the work of instructors. ● Taking steps to build a school for the analyzed public entity with a suitable environment for training officers using simulation and training technologies, resources for research and development, in addition to offering postgraduate courses to employees.	Effective strategic leadership
		● Improving the provision of e-learning training and qualifications and providing relevant courses and instructions for performing official roles capable of being accessed according to their needs.	Use of ICTs
Legislation and		● Developing detailed Standard Operating Procedures (SOPs) informing how and when to use new technologies.	Effective strategic leadership

regulations (V)		● Regularly revising and updating SOPs and standards to reflect technological changes and best practices. ● Collaborating with other institutions facing barriers to developing their own institutional systems to advocate regulatory change. ● Mandating training in the use of new technologies and implementation of new processes and procedures (with workload reduction).	
		● Conducting appropriate training to ensure all employees understand and can follow SOPs.	Knowledge sharing
Human resources (VI)		● Offering mandatory ongoing training (with workload exemption) periodically to officers, so that they know how to perform their functions better, feel more confident in using new technologies, and are more motivated at work. ● Clearly communicating benefits of innovations and how they can make daily work easier to reduce the perception of difficulty in using and increasing workload with technologies.	Knowledge sharing
		● Automating repetitive and administrative processes to free up staff time for innovation and training activities.	Use of ICTs
Infrastructure and equipment (VII)		● Using ICTs to search, collect, analyze information, and share knowledge to support decision-making and innovation performance (Susanty et al., 2019; Tahir & Mitomo, 2005; Luna-Reyes, 2009). ● Setting up a website for joint innovation with external sources and/or communication channels (Susanty et al., 2019). ● Investing in ICTs able to promote Corporate Communication (CC) and KM (Dalkir, 2006; Molete et al., 2015; Khilji & Roberts, 2013).	Effective strategic leadership
		● Developing, evaluating, and improving institutional computerized systems. ● Implementing technologies capable of optimizing processes (such as preparing reports) so that employees have more time to think and develop improvements. ● Investing in the study and implementation of modern technologies, such as artificial intelligence, optimizing routine tasks. ● Seeking partnerships and financing to carry out technology and infrastructure projects. ● Carrying out negotiations with the Public Security Office and investing in its own and/or robust technological development unit integrated with the SSP.	

Captions:

 **Literature proposals**

 **Proposals from participants in the second brainstorming session.**

 **Authors' proposal based on institutional knowledge aligned with literature.**

Conclusion

This study presented guidelines and strategies based on knowledge management to overcome barriers to innovation identified in a case study conducted at a Brazilian forensics institution. Such guidelines and strategies are quite able to promote innovation in a continuous and systematic manner at this institution and in other public sector institutions.

Its methodology consisted of an integrative literature review with empirical data collection through institutional surveys using electronic forms and Focus Group sessions, in addition to knowledge from one of its authors who has worked at the institution for eight years, three of which were in the management area. It was possible to identify key guidelines and strategies for the effective promotion of innovation and for overcoming barriers to innovation. Among the guidelines, the following stand out: the need to exercise effective strategic leadership, promote a culture of organizational learning, encourage knowledge sharing, foster innovative behavior among employees, seek knowledge and collaboration from external sources, effectively manage knowledge during the implementation of innovations, use information and communication technologies, evaluate innovations, and adopt an ambidextrous learning strategy.

Furthermore, the study identified significant barriers able to impede effective innovation, including challenges related to management and planning, financial resource constraints and bureaucracy, training and capacity deficiencies, legislative and regulatory constraints, human resource shortages, and deficiencies in physical and technological infrastructure.

The guidelines and strategies presented herein are quite capable of significantly improving institutional processes, since a practical path for continuous and systematic innovation is provided thereby. This model not only applies to the Forensic Science Police Department but also serves as a guide for other forensics institutions and public agencies facing similar challenges. Furthermore, it aligns with the United Nations Sustainable Development Goal 16, which aims at sustainable development, access to justice for all, and the establishment of effective, accountable, and inclusive institutions at all levels.

This study establishes a solid foundation for future research and practice in the field of forensic sciences, emphasizing the importance of knowledge management as a vital tool for institutional advancement in the contemporary scenario. To further this field of research, it is recommended that future works not only assess and validate the results of the proposed

guidelines and strategies but also evaluate their impact on promoting innovation over time through longitudinal studies. Such continuous evaluation will allow a better understanding of the sustainability and effectiveness of implemented practices. Additionally, it is suggested to explore the adaptability of knowledge management strategies in different institutional scenarios within and outside the area of forensics in the public sector, and examine how variations in organizational contexts can influence the effectiveness of these approaches.

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