



Original Article

# Knowledge Management Maturity Assessment: Evidence from the Literature and a Research Agenda for the Brazilian Public Nuclear Sector

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**Abstract:** Knowledge Management (KM) maturity assessment has been consolidated as a relevant instrument for analyzing an organization's capacity to create, share, and apply knowledge, enabling the identification of developmental stages and gaps in existing practices. In the Brazilian public sector—particularly within the nuclear domain—this approach is especially pertinent, as KM supports high standards of safety, reliability, and sustainability in a context characterized by technological complexity, stringent regulatory requirements, and strong dependence on specialized expertise. In order to map and analyze the international literature on KM maturity assessment, a scoping review was conducted with a focus on applications in the public sector and the nuclear field, aiming to delineate a research agenda for the Brazilian public nuclear sector encompassing processes, people, and technologies. The bibliometric corpus was constructed using the Scopus and Web of Science databases, applying the descriptors “knowledge management maturity,” “maturity model,” and “maturity assessment.” The search strategy resulted in 12 articles indexed in Scopus and 7 in Web of Science, totaling 19 studies. The findings indicate a predominance of KM maturity models applied to the Brazilian public sector, with still limited investigations explicitly addressing the nuclear domain. The most frequently referenced frameworks include the Asian Productivity Organization (APO) model and the model proposed by Batista (2012), which has been widely adopted in Brazilian public administration. An increasing alignment of these models with international normative frameworks, particularly ISO 30401:2018, was also observed. These findings contribute to both the theoretical and applied advancement of KM in Brazilian public nuclear organizations, with implications for safety, governance, and institutional sustainability.

**Keywords:** Knowledge Management, Maturity Model, Scoping Review, Research Agenda



# Avaliação de Maturidade em Gestão do Conhecimento: evidências da literatura e agenda de pesquisa para o setor nuclear público brasileiro

**Resumo:** A avaliação de maturidade em gestão do conhecimento (GC) tem se consolidado como instrumento para analisar a capacidade organizacional de criar, compartilhar e aplicar conhecimento, permitindo identificar estágios de desenvolvimento e lacunas nas práticas adotadas. No setor público brasileiro, especialmente no domínio nuclear, essa abordagem é particularmente relevante, pois a GC contribui para padrões elevados de segurança, confiabilidade e sustentabilidade em um contexto marcado por alta complexidade tecnológica, rigor regulatório e dependência de conhecimentos especializados. Com o objetivo de mapear e analisar a literatura internacional sobre avaliação de maturidade em GC, realizou-se uma revisão de escopo com foco em aplicações no setor público e no campo nuclear, visando delinear uma agenda de pesquisa para o setor nuclear público brasileiro, contemplando processos, pessoas e tecnologias. O corpus bibliométrico foi construído a partir das bases Scopus e Web of Science, utilizando os descritores “knowledge management maturity”, “maturity model” e “maturity assessment”. A estratégia de busca resultou em 12 artigos na Scopus e 7 na Web of Science, totalizando 19 estudos. Os resultados evidenciam a predominância de modelos de maturidade em GC aplicados ao setor público brasileiro, com investigações ainda limitadas no domínio nuclear. Destacam-se como referenciais recorrentes os modelos da Asian Productivity Organization (APO) e o modelo de Batista (2012), amplamente utilizado na administração pública brasileira. Observa-se, ainda, o alinhamento crescente desses modelos a referenciais normativos internacionais, especialmente à ISO 30401:2018. Esses achados poderão contribuir para o avanço teórico e aplicado da GC em organizações nucleares públicas brasileiras, com implicações para segurança, governança e sustentabilidade institucional.

**Palavras-chave:** Gestão do Conhecimento, Modelo de Maturidade, Revisão de Escopo, Agenda de Pesquisa.

## 1. INTRODUCTION

Knowledge Management (KM) enables organizations to structure continuous learning processes through the systematic management of data and strategic information, thereby strengthening intellectual capital and enhancing adaptive capacity, problem-solving capabilities, and responsiveness to environmental changes [1]. To this end, it is essential to employ techniques and methods that transform data into decision-making support, such as strategic analysis, consumer studies, and competitiveness assessment [2]. The implementation of KM requires, as an initial step, a diagnosis of the organization's maturity stage, including the identification of existing practices and institutional conditions [3].

In this context, KM maturity assessment models, such as those developed by the *Asian Productivity Organization* (APO), the Organizational Knowledge Assessment (OKA) of the World Bank, the KM Capability Assessment Tool of APQC, and the General Knowledge Management Maturity Model [4], enable organizations to diagnose gaps, measure outcomes, and guide improvement initiatives. When grounded in a holistic and structured approach, these models support the development, measurement, and continuous improvement of organizational processes, contributing to KM governance and to the planning of short-, medium-, and long-term actions [5].

The relevance of KM is even more pronounced in high-criticality sectors, such as nuclear, healthcare, and defense, where organizational knowledge is essential to safety, operational continuity, and the protection of society and the environment [6,7]. The loss of critical knowledge, generational discontinuity of experts, and the absence of systematic mechanisms for knowledge retention and sharing may result in operational vulnerabilities, repetition of past errors, weakened decision-making processes, and compromised institutional safety, in addition to increased costs and obstacles to long-term strategic projects [8].

From a normative perspective, ISO 30401:2018 establishes requirements for KM systems aligned with organizational context, leadership, planning, operational processes, performance evaluation, and continuous improvement [9]. In Brazil, the Federal Court of Accounts (Tribunal de Contas da União – TCU) emphasizes information and knowledge management as a cornerstone of public governance, risk management, and accountability [10,11]. In the nuclear domain, the *International Atomic Energy Agency* (IAEA) has issued specific guidance documents (e.g., TECDOCs) addressing the preservation of critical competencies, mitigation of knowledge loss, and integration of KM into safety culture [6,7].

Despite the substantial body of scientific literature on KM maturity in the public sector, explicit applications in nuclear organizations remain scarce, and the integration between maturity models and normative frameworks, such as ISO 30401, TCU governance references, and IAEA guidelines, is still limited. In the Brazilian public nuclear sector, characterized by the convergence of public governance requirements and international nuclear safety standards, gaps persist regarding the conceptualization, assessment, and articulation of KM maturity. Accordingly, this study aims to map and analyze the international literature on KM maturity assessment and to articulate it with the aforementioned normative frameworks, in order to support a contextualized research agenda for the Brazilian public nuclear sector, with potential contributions to institutional sustainability, operational safety standards, and the protection of society and the environment.

## 2. MATERIALS AND METHODS

This study adopts a methodological design combining a scoping literature review and a normative alignment analysis, with the aim of mapping the state of the art in Knowledge Management (KM) maturity assessment, deepening the qualitative analysis of recent studies, and identifying convergences and gaps in relation to frameworks applicable to the public

sector and the nuclear field. The methodological flow comprised: definition of the research objective, exploratory search, scoping review, and analysis of findings.

An initial exploratory search was conducted in the Scopus and Web of Science (WoS) databases, covering the period from 2016 to 2025, and carried out on January 24, 2026, thus including studies published up to that date. The descriptors used in the study were “nuclear knowledge management maturity” combined with the terms “knowledge management maturity”, “nuclear sector”, “nuclear field”, “nuclear”, “maturity model”, and “maturity assessment”. The search strategy was developed to ensure comprehensive coverage of the literature, controlled vocabulary terms (e.g., MeSH) and free-text keywords were combined using Boolean operators. The full search string was adapted for each database and limited to Articles and Conference Papers in both databases. The search strategy used in Scopus was as follows: TITLE-ABS-KEY (nuclear knowledge management maturity) OR (TITLE-ABS-KEY (nuclear sector) OR TITLE-ABS-KEY (nuclear field) OR TITLE-ABS-KEY (nuclear)) AND TITLE-ABS-KEY (knowledge management) AND (TITLE-ABS-KEY (maturity model) OR TITLE-ABS-KEY (maturity level) OR TITLE-ABS-KEY (maturity assessment)). In the WoS was TS= (("nuclear knowledge management maturity") or ("nuclear sector" or "nuclear field" or nuclear) AND ("knowledge management") AND (maturity OR "maturity model" or "maturity assessment"))).

The first search identified eight articles in Scopus and none in WoS, with no explicit approaches to KM maturity models. Given this gap, the search strategy was expanded using the broader terms “*knowledge management maturity*”, “*maturity model*”, and “*maturity assessment*”, applied to titles, abstracts, and keywords, in order to map application sectors and examine their relevance to the public and nuclear domains. Consequently, the search strings used in this study, detailed below, were as follows: TITLE-ABS-KEY (“knowledge management maturity”) OR (TITLE-ABS-KEY (“knowledge management”) AND (TITLE-ABS-KEY (“maturity model”) OR TITLE-ABS-KEY (“maturity assessment”))) in the Scopus database,

and (TS= ("knowledge management maturity") OR (TS= ("knowledge management") AND (TS= ("maturity model") OR TS= ("maturity assessment")))) in the WoS database.

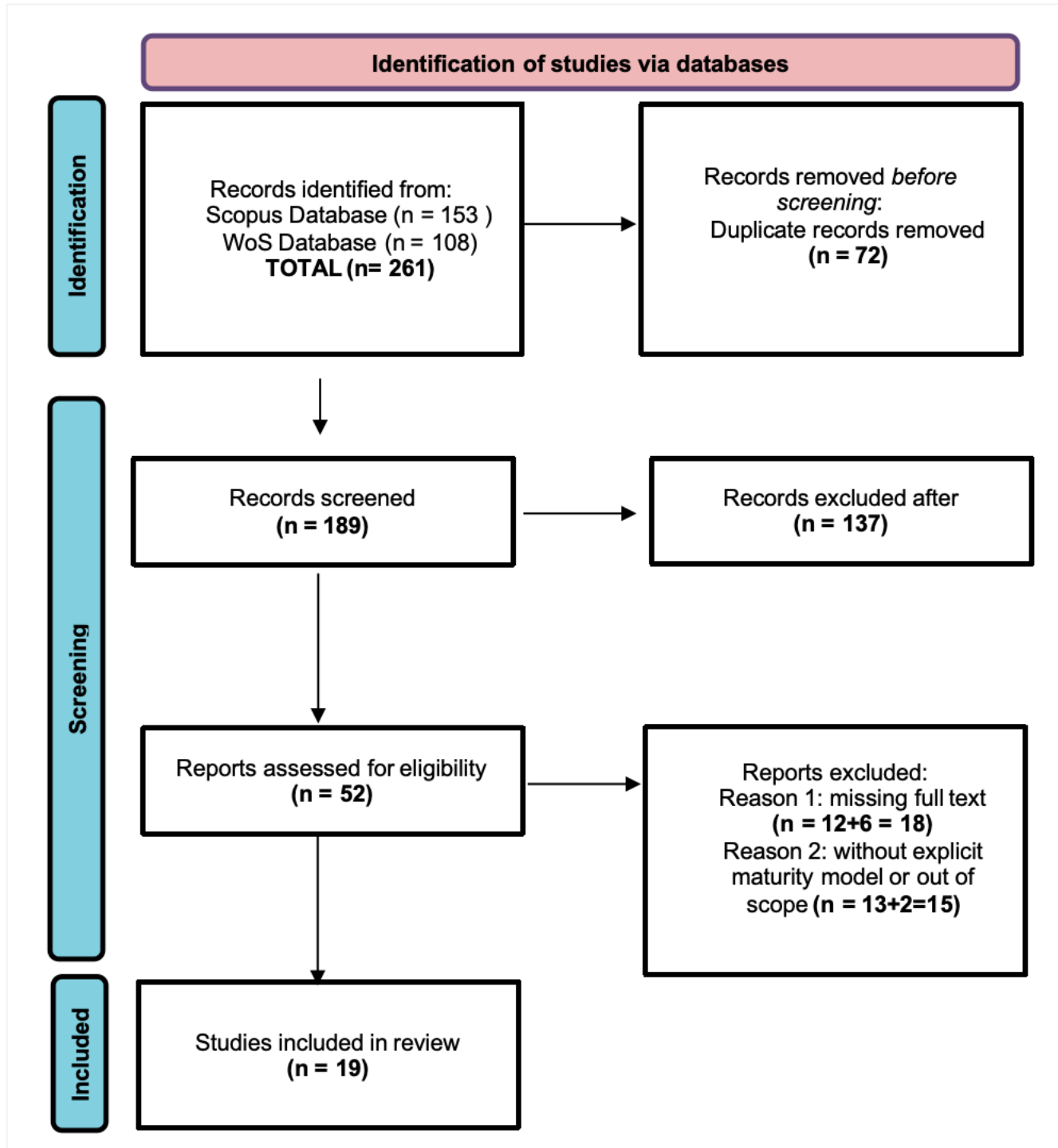
Searches were conducted in English, the predominant language of the international literature, considering the recurrence of these terms in the selected databases. Although both databases were initially searched covering the period from 2016 to 2025, the time frame was subsequently refined to 2020–2025 for the Scopus corpus, in order to enable a more in-depth and up-to-date analysis of full-text studies. In the Web of Science database, however, the broader period (2016–2025) was retained. Given the comparatively smaller volume of results retrieved from WoS, all studies identified in that database were evaluated for thematic eligibility, and those published prior to 2020 were found to be directly relevant to the research questions guiding this review. Their exclusion would have disproportionately reduced the representativeness of the WoS corpus; therefore, they were retained in the final sample. The selection of databases was justified by their broad international coverage and recognized indexing of relevant journals in Information Science and Knowledge Management.

Records were exported in CSV format, screened for duplicates, and subjected to analysis. The scoping review followed the methodological framework proposed by [10], refined by [11], and was reported in accordance with the PRISMA-ScR checklist to ensure transparency, rigor, and reproducibility. Based on this mapping, a scoping review was conducted with the aim of identifying, systematizing, and synthesizing approaches, models, instruments, and empirical applications related to Knowledge Management (KM) maturity assessment. The review was guided by research questions about the main KM maturity assessment models and instruments described in the international literature, the sectors in which these models have been applied, with particular emphasis on the public sector and the nuclear field, and the extent to which these studies align with relevant normative guidelines, when reported. The screening process was conducted in two stages: screening of titles and abstracts, followed by full-text review of eligible articles. The eligibility criteria were defined a priori. Only peer-reviewed journal articles were included, provided that they explicitly

addressed models, frameworks, or instruments for assessing Knowledge Management (KM) maturity in organizational contexts, whether public or private.

The expanded search yielded 108 records in WoS and 153 in Scopus (2016–2025). After applying inclusion criteria, language restrictions (Portuguese and English), time frame (2020–2025), removal of duplicates, and thematic relevance, a corpus of 52 articles (15 from WoS and 37 from Scopus) was selected for full-text review. Of these, 34 provided full-text access (25 from Scopus and 9 from WoS). A total of 18 articles were excluded due to lack of access to the full text, as detailed in the Results section and illustrated in the PRISMA flow diagram (Figure 2). Attempts were made to retrieve these articles through institutional library access and by contacting the authors; however, full access could not be obtained. Studies were excluded if they: purely conceptual in nature, without proposing assessment approaches or defining maturity levels; if they focused exclusively on technological aspects without incorporating a KM perspective; or if they applied the concept of maturity to domains unrelated to Knowledge Management. Thus, the final corpus comprised 19 articles (12 from Scopus and 7 from WoS). The stages of identification, screening, eligibility, and inclusion were systematized in a flowchart in accordance with PRISMA-ScR/JBI recommendations (Figure 2).

**Figure 1.** Flow Diagram of the study search and selection process according to PRISMA 2020. Adapted from the PRISMA Flow Diagram (2020).



Data extraction encompassed both bibliographic and analytical information from the selected studies, including authors, year of publication, country, sector or organizational context, description of the maturity model or framework, number of levels and dimensions

assessed, application methods, and referenced normative frameworks. The data were analyzed using descriptive and thematic approaches and systematized in summary tables, highlighting sectoral distribution and the typology of the identified maturity models.

In addition, a qualitative normative alignment analysis was conducted between the literature findings and the guidelines of ISO 30401:2018, the governance frameworks of the Brazilian Federal Court of Accounts (Tribunal de Contas da União – TCU), and the documents issued by the *International Atomic Energy Agency* (IAEA). This analysis aimed to identify convergences, divergences, and opportunities for articulation between KM maturity models and the normative requirements applicable to the public and nuclear sectors, thereby supporting the development of a future research agenda. Key analytical dimensions were defined based on the normative documents, including, e.g., governance, leadership, processes, knowledge sharing, performance evaluation, organizational culture. Then, the KM maturity models identified in the literature were examined to extract their core components, dimensions, and assessment criteria.

### 3. RESULTS AND DISCUSSIONS

The analysis of the selected studies sought to identify patterns, convergences, and salient elements capable of supporting the conceptual discussion proposed in this article, and the results are presented in Table 1.

**Table 1.** Overview of included studies and their respective Knowledge Management (KM) maturity models.

| Source<br>(Title, Author,<br>Year)                                               | Country | Sector                          | Application<br>Area              | Maturity<br>Model<br>(Author)           | Methods                                                                                     | Dimensions and Levels                                                                                                                                                                        | Standards / ISO<br>/ Quality                      |
|----------------------------------------------------------------------------------|---------|---------------------------------|----------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| <b>Scopus Articles</b>                                                           |         |                                 |                                  |                                         |                                                                                             |                                                                                                                                                                                              |                                                   |
| Análise de nível de maturidade... (Medeiros & Sell, 2024) [12]                   | Brazil  | Public                          | State Court of Accounts (TCE/SC) | MGCPRF (based on APO and MGCAPB)        | Descriptive research; questionnaire (Likert scale 1–5)                                      | 8 dimensions: Strategy, Leadership, Processes, People, Technology, KM Processes, Learning/Innovation, and Results.<br>5 levels: Reaction, Initiation, Introduction, Refinement, and Maturity | Public Adm.; Ipea (Batista, 2012); MGCAPB         |
| KM Implementation in U.S. Army... (Van Laar, 2023) [26]                          | EUA     | Public (Military)               | Army Headquarters                | KM3 (Army KM Maturity Model)            | Qualitative case study; archival data analysis; Knowledge Management Assessment Tool (KMAT) | 4 components: People, Processes, Tools, and Organization.<br>5 levels: Ad Hoc, Repeatable, Defined, Managed, Optimized                                                                       | Army doctrinal frameworks (DOTMLPF-P)             |
| KM maturity assessment frameworks... (Bougoulia & Glykas, 2023) [23]             | Greece  | Theory (Literature-Based Study) | General (Holistic)               | Proposed Holistic Framework             | Systematic Literature Review (SLR)                                                          | Analyzes multiple maturity models (Klimko, Paulzen, etc.) and integrates them with quality management requirements                                                                           | ISO 30401:2018; ISO 9001:2018; Quality Management |
| Proposição de melhoria para elevação da maturidade... (Corrêa et al., 2024) [28] | Brazil  | Private                         | Confessional Education Networks  | KM Holistic Model (Corrêa et al., 2021) | Mixed-methods approach (descriptive statistics and p-value analysis)                        | 13 indicators/domains.<br>5 levels: Incipient, Initial, Established, Managed, and Holistic                                                                                                   | Educational Quality; IPEA (Batista, 2012); APQC   |

| Source<br>(Title, Author,<br>Year)                                                          | Country   | Sector                  | Application<br>Area                        | Maturity<br>Model<br>(Author)                    | Methods                                                                                                  | Dimensions and Levels                                                                                                                                                                                         | Standards / ISO<br>/ Quality                                                       |
|---------------------------------------------------------------------------------------------|-----------|-------------------------|--------------------------------------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Measuring the<br>Maturity of<br>KM... (Kianrad<br>et al., 2024) [17]                        | Iran      | Public                  | Public<br>Libraries<br>Foundation          | APO (Asian<br>Productivity<br>Organization)      | Applied quantitative<br>study; APO structured<br>questionnaire                                           | 7 criteria: Leadership, Processes,<br>People, Technology, Knowledge<br>Management Processes, Learning and<br>Innovation, and Result.<br>5 levels: Reactive, Initiation,<br>Development, Control, and Maturity | Quality<br>Management<br>principles<br>(implicit within<br>the APO<br>framework)   |
| Nível de<br>maturidade em<br>GC de uma<br>clínica escola...<br>(Zilli et al.,<br>2021) [13] | Brazil    | Private<br>(Community)  | University<br>Health<br>Teaching<br>Clinic | KM<br>Measurement<br>Model<br>(Batista,<br>2012) | Qualitative descriptive<br>research; single case<br>study                                                | 7 criteria: Leadership, Processes,<br>People, Technologies, Knowledge<br>Management Processes, Learning and<br>Innovation, and Results.<br>5 levels: Reactive, Initial, Structured,<br>Refined, and Mature    | University<br>Administration;<br>Healthcare<br>Quality Practices                   |
| KM Maturity<br>Level of<br>Indonesian<br>Government...<br>(Tjakraatmadja<br>et al.) [20]    | Indonesia | Public e<br>State-owned | Government<br>Institutions                 | APQC<br>integrated<br>with the APO<br>model      | Qualitative study; case<br>study design;<br>interviews and<br>observation                                | 3 components: People, Processes, and<br>Technology.<br>5 stages: Initiate, Develop,<br>Standardize, Optimize, and Innovate                                                                                    | Bureaucratic<br>Reform Policy;<br>Ministerial<br>Regulation No.<br>14/2011         |
| Evaluation of<br>the maturity<br>level... (Zain &<br>Latief, 2020)<br>[19]                  | Indonesia | Private                 | Construction<br>Company                    | APQC                                             | Statistical analysis<br>(EFA), questionnaire<br>based on IAEA<br>guidelines and<br>Valmohammadi<br>model | 7 organizational criteria<br>5 levels: Initiate, Develop,<br>Standardize, Optimize, and Innovate                                                                                                              | PMBOK 6th<br>Edition;<br>Construction<br>Quality<br>Management;<br>IAEA guidelines |

| Source<br>(Title, Author,<br>Year)                                                             | Country          | Sector                            | Application<br>Area                                                     | Maturity<br>Model<br>(Author)                      | Methods                                                         | Dimensions and Levels                                                                                                                                                                                                                                                 | Standards / ISO<br>/ Quality                                           |
|------------------------------------------------------------------------------------------------|------------------|-----------------------------------|-------------------------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Designing a maturity model for analyzing IKM... (Jääskeläinen et al.) [27]                     | Finland          | Public                            | Public Service Organizations                                            | Model based on Choo (2002)                         | Design Science Research, survey                                 | <b>10</b> domains: Vision/Strategy, Governance, Information Needs, Acquisition, Organization/Storage, Knowledge Products, Knowledge Sharing, Knowledge Use, Measurement, and Results.<br><b>4</b> profiles: Novice, Experimenter, Facilitator, and Advanced Exploiter | Focus on Performance and Public Sector User Satisfaction               |
| KM in two universities before and during COVID-19... (Arias Velásquez & Mejía Lara, 2021) [30] | Peru             | Private                           | Universities (Schools of Engineering)                                   | Intellectus Model and KMCA                         | Case study; Likert-scale questionnaire; social network analysis | <b>3</b> intellectual capital dimensions: Human, Structural, and Relational Capital                                                                                                                                                                                   | Government education and innovation policies (CONCYTEC)                |
| Maturidade da GC: a importância da infraestrutura... (Escrivão & Silva, 2020) [16]             | Brazil           | Public                            | Embrapa (Technology-Based Research Unit)                                | KM Stage Model (based on literature consensus)     | Systematic literature review and empirical research (survey)    | <b>4</b> stages: Functional Initiation, Functional Specialization, Internal Integration, and External Integration                                                                                                                                                     | R&D Management by Batista (2012).                                      |
| Benchmarking KM Practices... (Yan et al., 2024) [29]                                           | Taiwan and Japan | Mixed Sector (Public and Private) | Public Utilities, Manufacturing, Healthcare, and Information Technology | Governance-Based Socio-Technical KM Maturity Model | Multiple case study; semi-structured interviews                 | <b>4</b> Dimensions: Codification, Collaboration/Visibility, Audit, and Leadership                                                                                                                                                                                    | ISO 30401 (hospital certification referenced); auditing and compliance |

| Source<br>(Title, Author,<br>Year)                                               | Country | Sector            | Application<br>Area           | Maturity<br>Model<br>(Author)               | Methods                                                                       | Dimensions and Levels                                                                                                                                                              | Standards / ISO<br>/ Quality                                                      |
|----------------------------------------------------------------------------------|---------|-------------------|-------------------------------|---------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| <b>WoS Articles</b>                                                              |         |                   |                               |                                             |                                                                               |                                                                                                                                                                                    |                                                                                   |
| An investigation on intellectual capital... (Bafti et al., 2019) [25]            | Iran    | Public            | Government Organizations      | G-KMMM (based on Klimko, 2001)              | Mixed-methods correlational study; statistical analysis using SPSS and LISREL | 3 pillars: People, Processes, and Technology.<br>5 levels: Initial, Aware, Defined, Managed, and Optimized                                                                         | Intellectual Capital; Quality Management                                          |
| Modelo de maturidade em GC: uma visão diacrônica (Itaborahy et al., 2021) [14]   | Brazil  | Public            | Public Administration         | MMGC (Itaborahy, 2021)                      | Qualitative exploratory research; literature review                           | 6 dimensions: dimensions: People, Culture, Governance, Processes, Organizational Architecture, and Infrastructure/IT.<br>6 levels: Level 0 (Individual) to Level 5 (Full Maturity) | ISO 30401:2018 (Full alignment)                                                   |
| KM Patterns Model for a Flight Test Environment (Follador & Trabasso, 2016) [24] | Brazil  | Public (Military) | Flight Test Environment (FAB) | Standards-Based Model (System Dynamics)     | System Dynamics (SD); computational simulation; survey                        | 3 domains: Culture/People, Processes, and Technology/Infrastructure. Focus on system adherence within the KM framework                                                             | Brazilian Air Force regulations (DCA 1-1)                                         |
| Gestão do Conhecimento nas Vitivinícolas... (Oliveira et al., 2019) [18]         | Brazil  | Private           | Wine Industry                 | APO Model (Asian Productivity Organization) | Qualitative exploratory-descriptive research; case study                      | 7 criteria: Leadership, Processes, People, Technology, Knowledge Management Processes, Learning, and Results.<br>5 levels: Reactive to Mature                                      | Geographical Indication (IPVUG); National Institute of Industrial Property (INPI) |

| Source<br>(Title, Author,<br>Year)                                                           | Country | Sector               | Application<br>Area                 | Maturity<br>Model<br>(Author)                                | Methods                                                                                                                  | Dimensions and Levels                                                                                                                                                                                                                                    | Standards / ISO<br>/ Quality                                                        |
|----------------------------------------------------------------------------------------------|---------|----------------------|-------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Maturidade da<br>GC na<br>CISCEA...<br>(Teixeira;<br>Frogeri;<br>Piurcosky,<br>2020) [15]    | Brazil  | Public<br>(Military) | Airspace<br>Control<br>System       | IAGCAP<br>(based on<br>Batista, 2012)                        | Quantitative study;<br>hypothetico-deductive<br>approach; structured<br>questionnaire                                    | 6 criteria: Leadership, Organizational<br>Processes, Human Resources,<br>Technology, Knowledge Management<br>Processes, and Learning/Innovation.<br>5 levels: Reactive to Mature                                                                         | MGCAPB<br>(Knowledge<br>Management<br>Manual for Public<br>Administration);<br>Ipea |
| Research on the<br>CMM of Digital<br>Library KM<br>(Yang et al.,<br>2016) [31]               | China   | Public               | Digital<br>Libraries                | CMM-SW<br>(adapted from<br>Carnegie<br>Mellon<br>University) | Key Process Area<br>(KPA) analysis                                                                                       | 18 process areas: (e.g., Marketing,<br>Innovation, among others).<br>5 levels: Initial, Repeatable, Defined,<br>Managed, and Innovative                                                                                                                  | Software<br>Engineering<br>Standards (CMM<br>framework)                             |
| Tradução e<br>validação de<br>conteúdo do<br>instrumento...<br>(Corrêa et al.,<br>2022) [32] | Brazil  | Theory               | Holistic<br>Knowledge<br>Management | Holistic<br>Model<br>(Corrêa et al.,<br>2021)                | Qualitative<br>(translation and<br>adaptation) and<br>quantitative (Content<br>Validity Coefficient –<br>CVC) approaches | 13 dimensions: Strategy, Leadership,<br>KM Team, Resources, Processes,<br>Human Resources, Training,<br>Motivation, Teamwork, Culture,<br>Information Technology,<br>Measurement, and Pilot<br>Implementation.<br>5 levels (From Incipient to Holistic). | Quality<br>Management<br>(Batista, 2012)                                            |

The analyzed studies are predominantly concentrated in the Brazilian context, particularly within public organizations such as courts of accounts, public enterprises, universities, research centers, and military institutions [12,13,14,15,16]. This pattern was identified through the qualitative synthesis of the included studies, considering their application contexts and institutional characteristics, indicates the increasing adoption of Knowledge Management (KM) maturity models as diagnostic and administrative modernization tools, aligned with demands for efficiency, transparency, and institutional continuity in the public sector.

The recurrence of internationally consolidated frameworks is noteworthy, particularly the models developed by the Asian Productivity Organization (APO) and the American Productivity and Quality Center (APQC), which are applied either directly or adapted to the specific organizational contexts under analysis, reflecting both the transferability and contextual flexibility of these frameworks [17,18,19,20]. In Brazil, particular emphasis is placed on the Knowledge Management Model for the Brazilian Public Administration (MGCAPB), proposed by Batista [21], which has been used both as a basis for empirical assessments and for the development of hybrid models [12,13,15]. This convergence reinforces the consolidation of the MGCAPB as a structuring reference for maturity assessments in the national public sector. This finding also suggests a process of methodological standardization within the Brazilian public sector, in which locally developed frameworks gain legitimacy and are progressively institutionalized.

Beyond the adoption of consolidated models, part of the literature advances original conceptual proposals with a holistic or systemic orientation, seeking to integrate Knowledge Management (KM) with strategic, cultural, and governance dimensions [14,22,23]. These initiatives signal a conceptual maturation of the field, shifting KM maturity assessment from a predominantly operational perspective toward a more strategic and integrative approach. Such conceptual broadening is particularly relevant in the public

sector, where KM is strongly associated with institutional continuity, accountability, and the preservation of organizational memory [12,21].

Regarding the dimensions assessed, there is strong convergence around the pillars of people, processes, and technology, which are present in most of the analyzed models [24,25,26]. This convergence was identified through the comparative mapping of model dimensions, as described in the methodological procedures. However, more recent models expand this scope by incorporating dimensions such as leadership, strategy, governance, organizational culture, learning, and innovation [12, 27,29]. This expansion reinforces the ongoing conceptual evolution in the field, recognizing that KM maturity transcends operational and technological aspects and increasingly encompasses strategic and institutional elements, as highlighted by [14] and [23]. From a comparative perspective, models that incorporate a broader set of dimensions tend to offer greater analytical depth, but may also introduce challenges related to operationalization and measurement, particularly in contexts that require standardized and auditable assessment procedures. This perspective is further developed in the holistic model proposed by [22], which extends maturity assessment to 13 critical areas and emphasizes that KM is fundamentally a people-dependent process requiring alignment between organizational practices and strategic objectives [12,14].

Besides that, models vary in their level of methodological formalization, ranging from structured instruments with defined scoring systems to more qualitative and interpretive frameworks. This variation has direct implications for their applicability in highly regulated environments, where traceability, auditability, and alignment with formal standards are critical. In this sense, models with higher levels of standardization and explicit evaluation criteria may be more suitable for sectors such as nuclear energy, where compliance and procedural rigor are essential.

With respect to maturity levels, evolutionary structures composed of four to six stages predominate, typically beginning with ad hoc or reactive levels and culminating in stages of organizational integration and optimization. This evolutionary logic is consistent across both

models inspired by the Carnegie Mellon University's Capability Maturity Model (CMM) and KM-specific frameworks [14,26,31], reflecting a process-oriented understanding of knowledge institutionalization and demonstrating strong convergence with the evolutionary logic proposed by [21].

From a methodological standpoint, the analyzed studies predominantly adopt quantitative approaches based on structured questionnaires using Likert scales, often combined with descriptive statistical analyses and, in some cases, inferential techniques [12,17,19]. Case studies, interviews, and document analyses are also recurrent, particularly in military and high-complexity contexts [24,26]. Systematic literature reviews and design science approaches further complement this panorama, indicating efforts toward conceptual and methodological consolidation aimed at proposing and refining KM maturity models [23,27]. This methodological predominance also indicates a preference for standardized assessment approaches, which facilitate benchmarking across organizations. On the other hand, the predominance of survey-based approaches may limit the depth of contextual understanding, which is particularly relevant in complex and high-risk environments.

A relevant finding concerns the increasing articulation between KM maturity models and normative frameworks, particularly ISO 30401:2018 [14,23,29]. This alignment was identified through the qualitative mapping between the dimensions of the maturity models and the requirements established in the normative documents, as described in the methodological procedures. Although referenced in a limited number of studies, this standard emerges as a structuring element for aligning KM practices with formal management systems, governance mechanisms, and continuous improvement processes. This alignment is particularly significant for highly regulated sectors subject to frequent audits.

Concerning high-criticality organizations, such as military and defense environments, the studies demonstrate that KM maturity is associated with the capacity to capture and reuse lessons learned, support real-time decision-making, and reduce operational vulnerabilities, as evidenced by the KM3 (Army Knowledge Management Maturity Model) applied within the

United States Army [26]. These results support an analytical extension to the nuclear energy sector, characterized by high technical complexity, stringent regulation, and significant socio-environmental responsibility. In this context, KM can be understood as extending beyond the pursuit of operational efficiency and becoming a central element of safety and the prevention of organizational failures. These findings also highlight the need for the development of context-sensitive KM maturity models capable of integrating regulatory compliance, organizational learning, and safety-oriented knowledge practices. However, it is important to note that this interpretation is based on indirect evidence, as most of the analyzed studies do not specifically address nuclear organizations.

Despite the recognized relevance of KM for critical environments, there remains a scarcity of studies that systematically articulate KM maturity models with international frameworks specific to the nuclear sector. Among the works analyzed, only one study [19] explicitly integrates guidelines from the International Atomic Energy Agency (IAEA) into KM maturity assessment, revealing both theoretical and practical gaps. Therefore, the relationship between KM maturity models and nuclear sector requirements should be understood as a potential field of application, rather than an empirically consolidated domain, revealing an important gap in the literature. Overall, the findings indicate that KM maturity models are not homogeneous, differing in structure, purpose, and level of complexity, which directly influences their transferability across sectors.

In light of this scenario, the results suggest that, for Brazilian public organizations operating in the nuclear sector, KM maturity models could be designed to integrate three complementary axes: (i) alignment with international safety and organizational culture guidelines specific to the nuclear sector, according to the IAEA; (ii) compliance with normative KM management systems, such as ISO 30401:2018; and (iii) adaptation to the Brazilian public administration context, particularly the guidelines consolidated by Batista's (2012) model [21]. Such integration may contribute to mitigating the loss of technical

memory, strengthening knowledge governance, and sustaining high standards of safety and operational reliability.

## 4. CONCLUSIONS

The analysis of the 19 studies revealed the predominance of Knowledge Management (KM) maturity models structured around evolutionary stages, typically five, organized according to the pillars of people, processes, and technology, often expanded to include leadership, strategy, and governance. The most recurrent references are the models developed by the Asian Productivity Organization (APO) and the model proposed by [21], widely adopted within Brazilian public administration. An increasing alignment with international normative frameworks was also observed, particularly ISO 30401:2018, indicating stronger integration between KM and formal management systems. In high-critical environments such as military organizations, KM maturity is directly associated with the integration of knowledge into decision-making structures and risk mitigation processes, an aspect especially relevant to the nuclear sector. Nevertheless, a significant gap persists in the systematic articulation between KM maturity models and the regulatory and safety specificities of the nuclear field, as the predominance of generic models limits the incorporation of sector-specific requirements related to operational safety, regulatory compliance, and preservation of technical memory, particularly in light of guidelines established by the International Atomic Energy Agency (IAEA) and the Brazilian National Nuclear Energy Commission. In response, a research agenda is proposed to expand international investigations on KM in the public nuclear sector, develop a maturity model tailored to the Brazilian nuclear context integrating APO, Batista (2012), ISO 30401, and relevant national and international regulations, and further examine the role of KM certification and Artificial Intelligence in organizational maturity assessment. By identifying this gap and outlining structured research directions, the study advances both the theoretical

and applied dimensions of KM in public nuclear organizations, with direct implications for safety, governance, and institutional sustainability.

## CONTRIBUTORSHIP

**Conceptualization:** PPR, BSR, RLAD

**Investigation:** PPR, BSR, RLAD

**Writing – review and editing:** PPR, BSR, RLAD

## CONFLICT OF INTEREST

All authors declare that they have no conflicts of interest.

## DATA AVAILABILITY STATEMENT

The authors declare that the data supporting the results of this study are available within the article. Derived data supporting the findings of this study that are not found in the article may be requested from the corresponding author.

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