Knowledge Representation and Technologies in the Latin American Academic Literature

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Abstract

Knowledge management allows managing not only the information possessed by people but also the experiences, judgments, and cognitive beliefs adapted and empowered by an individual's mind. There are five views of knowledge management: people, organizational aspects, process, measurement and knowledge representation, and technologies. This paper proposes a Scoping Study based on the following research questions: how many papers are associated with knowledge representation and technologies? which representation techniques and technologies are presented in the papers? and what categories of them are possibly identified in the papers? In the review, 1107 papers were found, on which exclusion criteria were applied and 61 articles were found for detailed analysis. The analysis allows identifying the following categories for the knowledge representation and technologies view: socialization techniques, techniques or models for knowledge explanation and representation, fields of study, logical and analytical processes, organizational practices, and technological tools.

Keywords

Knowledge Management, Technology, Representation

1. Introduction

An integral knowledge management system requires an approach from different perspectives, known as knowledge management views. One of the views is knowledge representation and technologies. This work proposes a study for search works that deal with the technological and representation view, to identify elements, tools, models, techniques, etc. in these works and propose a categorization of these elements. The Scoping Study is performed for the study's identification and the open coding method is used for the analysis.

This work presents in Section 2 the concepts of Data, Information and Knowledge, Knowledge Management, the views of Knowledge Management, and the Representation and Technological View. Section 3 presents the method. Then, it shows the scoping study in Section 4 and the categories for data analysis in Section 5. Finally, Section 6 presents the results, and Section 7 the conclusions.

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2. Background

This section presents the concepts of Data, Information and Knowledge, Knowledge Management, the views of Knowledge Management, and the Representation and Technological View.

2.1. Data, Information, and Knowledge

Different visions about data and information are presented in [1], which shows that data "has been defined as a symbol that has not yet been interpreted according to Spek and Spijkervet, a simple observation of the state of the world according to Davenport or as a raw, simple and discrete fact as stated by Bhatt, Beveren, Davenport and Prusak, and Herder and others". In the same work, information is understood by Davenport and Prusak and Nonaka and Takeuchi as a set of messages; while for Bollinger and Smith, it is processed data, organized according to Bhatt or with meaning according to Spek and Spijkervet. For Rios Ortega [2], information "means data aggregation, organization, or classification with meaning, (and) implies some kind of processing or understanding." Information can be defined as a function of data [3], to contain both the data and its context, as specified in the following equation:

$$Information = f(Data) = Data + Context \tag{1}$$

Where f (Data) is a function with the input “data”, that gives meaning to these data and returns Information.

The knowledge, from a constructivist approach, is part of a hierarchy, called DIKW proposed by Ackoff [4] constituted by data at the lowest level, information at the next level, and knowledge in the third level of the hierarchy; finally, wisdom constitutes the upper level. For Díaz and Millán [5], knowledge is defined as "the mixture of cognitive and contextualized beliefs, perspectives, judgments, methodologies, information, experiences, and expectations made about an object, which are adapted and potentiated by the mind of an individual (knower)". For Li [3] the knowledge equation is:

$$Knowledge = p(Information) = Information + Context + Insight \tag{2}$$

Where p (Information) denotes the processing function that returns knowledge by making sense of information under its context. The term "insight" represents the tacit implications.

2.2. Knowledge Management

Knowledge management (KM) is a theoretical notion attributed to Etzioni Amitai and defined as "how to create and use knowledge without undermining the organization" [6]. It is an integrated field of multiple disciplines that allow the development of initiatives at different levels of the company [7], with a multidisciplinary approach aimed at a comprehensive and systematic view of information assets [8]. Perez Gonzalez and Darín [9] defines it as "an agglutinating process of information management, technology and human resources whose execution is focused on the improvement of high-impact processes, the optimization of knowledge based on these processes and their dissemination throughout the organization". For Bueno [10], Knowledge Management

is a process through which organizations manage to discover, use and maintain knowledge, with the idea of aligning it with business strategies to obtain competitive advantages.

2.3. Views of Knowledge Management

A view describes the concepts, elements, and characteristics of an integrated knowledge management system from the perspective of a set of related concerns. There are five views: people (role, responsibilities, etc.), organizational aspects (including structure and culture), process (and his activities), measurement and knowledge representation, and technologies [11, 12]. This work is related to the last view. Some authors consider technology and representation as different views, many do not consider the representation, and others use the terms in a similar or indistinct way, therefore the proposal of [12] to consider them as a single view is followed, which will be used throughout this work.

2.4. Representation and Technological View

For [13], the technological view, called "Information and Communication Technologies (ICT)" involves the means to collect, store and distribute data, information, and explicit and tacit knowledge; alignment with the organization's strategy and needs, especially those required when studying the other components.

Servin [14] says, about the technological view, that "a common misconception is that knowledge management is mainly about technology (...) Technology is often a crucial enabler of knowledge management (and) it can help connect people with information, and people with each other, but it is not the solution. And it is vital that any technology used 'fits' the organization's people and processes – otherwise it will simply not be used".

Omran [15] calls "hard aspects" the introduction and use of different key information technologies for knowledge management activities. In particular, he proposes some technologies: data mining, data warehousing, and groupware, among others, and presents the TAM (Technology Acceptance Model) proposed by Davis.

The notion of knowledge representation, in many cases, is associated with Artificial Intelligence and some works of Ronald Brachman. But it is a term used in several fields of knowledge. Several observations on the term can be found in [16] says that the knowledge representation model "is a particular way of representing knowledge by using the knowledge and reasoning mechanism" and [17] which says that the knowledge "must be represented in a way that allows information systems to actively process knowledge, rather than only to represent it, and thus to enable knowledge-based reasoning". For the SUNY Center [18], the knowledge representation is "structures used to store knowledge in a manner that relates items of knowledge to one another, and that permits an inference engine to manipulate the knowledge and its relationships."

3. Method

This article presents a Scoping Study. This section presents the method used and the data analysis.

3.1. Scoping Study

This work proposes a Scoping Study, also known as a Systematic Mapping Study, which is a type of Literature Review. While the Systematic Literature Review makes it possible identity, evaluate and interpret all available research relevant to a particular research question, topic area, or phenomenon of interest, the Systematic Mapping Studies are designed to provide a wide overview of a research area. Their main differences are the depth of the study and the rigorous application of the method and definition of inclusion and exclusion criteria.

Scoping studies "aim to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available and can be undertaken as standalone projects in their own right, especially where an area is complex or has not been reviewed comprehensively before" [19]. It is possible to identify at least four common reasons why a scoping study might be undertaken: to examine the extent, range, and nature of research activity; to determine the value of undertaking a full systematic review; to summarize and disseminate research findings and to identify research gaps in the existing literature [19].

Arksey and O'Malley [20] propose the following method for scoping study: identifying the research question; identifying relevant studies; study selection; charting the data; and collating, summarising, and reporting the results. The phase of study selection is important because the initial outcome examination from the search protocol may pick up several irrelevant studies [20] [21]. This is related to the importance of defining terminology at the beginning of a scoping study, and sometimes reflects some specific difficulties, such as the use of terminology in different countries or different contexts. The phase of charting describes a technique for synthesizing and interpreting qualitative data [21].

3.2. Data Analysis

For the analysis of the results obtained in the review presented in the previous section, an analysis with open coding is carried out, based on the systemic design for the qualitative research [22] and the procedures of Strauss and Corbin [23].

In the open coding, "all the segments of the material obtained for analysis are reviewed and it generates -by constant comparison- initial categories of meaning. It thus eliminates redundancy and develops evidence for the categories (raises the level of abstraction)" [23]. The categories are created from an interpretation of the data [24, 25] .

4. Scoping Study

4.1. Identifying the research question

This paper is based on the following research questions:

- How many papers are associated with knowledge management technologies?
- Which technologies are presented in the papers found?
- What categories of technologies are possibly identified in the papers?

4.2. Identifying relevant studies

For the identification of relevant studies, this study is performed with the criteria presented in Table 1.

Table 1
Search Criteria

Criteria	Details
Source	La Referencia; Redalyc; Scielo
Period Restriction	2019-2021
Keywords	Gestión del conocimiento; Knowledge Management; Gestão do Conhecimento
Inclusion criteria	Publications in Spanish, Portuguese or English
Exclusion criteria	Does not include aspects of technological and representational view

4.3. Review Execution and General Results

The search, whose criteria were defined in 4.2, return 1107 papers (without considering the exclusion criteria). The reading of the works found allows the identification of those that consider aspects of the technological and representational view; there are 61 papers that consider this view.

4.4. Charting the data

For each paper found, the technologies or representations elements are searched and incorporated into a list.

4.5. Collating, summarizing and reporting the results

The data collating, summarizing, and report are presented in Section 5.

5. Categories for Data Analysis

This section considers the papers obtained and presented in section 4.3. and the technologies or representation elements presented in 4.4. For the analysis of the results obtained in the review, an analysis with open coding is presented: by reviewing the data obtained and available and their interpretation, categories of analysis are proposed in this section 5. In section 6 all the elements found are analyzed, using these categories, and identifying each proposed element. Through a review of the data obtained and available and their interpretation, categories of analysis are proposed:

- Socialization techniques: socialization techniques are those that allow the exchange of experiences and the transfer and acquisition of tacit knowledge. For this category, technological tools that could facilitate these techniques are excluded and only techniques and mechanisms are included.

- Techniques or models for knowledge explanation and representation: these are the ways and techniques to make knowledge explicit in some support or model, including those probable models. Each technique or model is likely to be supported by some technological tool, but these tools are not included in this category.
- Field of study: refers to a branch of knowledge or a set of branches of knowledge with interdisciplinary action. Each field encompasses a set of processes, technologies, etc.
- Logical and Analytical Process: corresponds to data and information processing and treatment activities. It may include technological tools but especially involves analysis and exploitation processes.
- Organizational practices: following to [26], this category represents "mechanisms used by an organization to communicate its values, norms, and goals to its employees and is instrumental".
- Technological tools: corresponds to artifacts that are able to be deployed in a technological infrastructure environment, including the software, part of the software, or similar [27, 28, 29]. In general, these tools can model as components in a sequence diagram or deploy a diagram of Unified Modeling Language.

6. Analysis into each category

For each category, a detailed description of the technological and representational elements most frequently found in the works is presented, using references from the articles found in this study.

6.1. Socialization techniques

Socialization techniques are those that allow the exchange of experiences and the transfer and acquisition of tacit knowledge. For this category, technological tools that could facilitate these techniques are excluded and only techniques and mechanisms are included.

The socialization techniques found were Community of practices, Coffee knowledge, Discussion groups, Brainstorming, Mentoring, and Expert assistance. The number of findings is presented in Table 2.

Table 2
Quantity of elements for socialization techniques

Element	Quantity
Community of practice	10
Coffee Knowledge	2
Discussion groups	2
Brainstorming	1
Mentoring	1
Experts Assistance	1

The term most found included in the socialization techniques category has been “community of practice”, which refers to "a group of people united by one or several skills in common,

periodically and stably over time, able to learn and share their experiences in this common practice" [30, 31]. These groups have regular interaction, although he also considers that their formation may be spontaneous (unintentional).

The discussion groups and the coffee knowledge imply less stability and do not require common practices; a coffee knowledge "is a group discussion to reflect and share thoughts and insights in a friendly way (...) It leads to deeper insights and more intense sharing than usual" [32]. Brainstorming can be applied in any of the communities or groups mentioned above.

Wenger [31] also proposes to consider the assistance of colleagues, a technique used by project teams to request assistance from colleagues and specialists on an important situation, whose objective is to obtain knowledge before an activity through a meeting with invited colleagues and specialists; the project team receives insights from its colleagues at meetings. Another proposal for the participation of experts in knowledge management is mentoring through which an expert accompanies a worker, shapes people's competencies, observes and analyzes performance, and provides feedback on the execution of activities.

6.2. Techniques or models for knowledge explanation and representation

In this category are included the ways and techniques to make knowledge explicit in some support or model, including those probable models. Each technique or model is likely to be supported by technological tools, but these tools are not included in this category.

The techniques or models for knowledge explanation and representation found are best practices, case studies, catalogs, directories, frequently asked questions (FAQ), genetic algorithms, knowledge maps, lessons learned, metadata, newsletters, neural networks, ontologies, organizational memory, process map, the quality record for practices, standards and procedures, storytelling, taxonomies, wiki, and yellow pages. The number of findings is presented in Table 3.

The details of the most frequently mentioned techniques, as listed in the table above, are presented below. Since many techniques were found, only the most frequently mentioned are selected for detailed analysis.

The knowledge maps allow the identification of assets and sources of tacit or explicit knowledge but do not contain them. It is useful for the localization, and evaluation of capacities, opportunities, needs, and knowledge restrictions. It is a visual representation of resources and flows of knowledge of the organization.

Good practices are rules or actions that in an organization have given results of improvements in actions or processes and that are conducive to or influence the achievement of objectives, productivity, and competitiveness [33]. Organizational memory is "organizational knowledge that integrates past experiences, archived and lived in the context of the organizations" [34]. For [35] "from the structure of organizational memory is that school organizations understand their internal reality, being able to help in decision making based on good or bad practices." [35] makes a detailed analysis of the concept of organizational memory and its different perspectives.

About the yellow pages, [36] says that "they allow identifying the basic data of an expert, his contact networks, personal interests and the description of his experience in the execution of the projects he has participated in and outside the organization". For [37] provides information on where and how to obtain knowledge within the company. [38] differentiates them from a

Table 3
Quantity of elements for techniques or models for knowledge explanation and representation

Element	Quantity
Knowledge map	10
Organizational memory	8
Yellow pages	8
Best practices	7
Lesson learned	6
Wiki	6
Storytelling	5
Standards and Procedures	3
Ontologies	2
Case Study	1
Catalogs	1
Directory	1
Frequently Asked Questions	1
Genetic Algorithm	1
Metadata	1
Newsletter	1
Neural networks	1
Process Map	1
Quality Record Card for Practices	1
Taxonomies	1

directory where, according to the author, only the expert's Curriculum Vitae is recorded.

Lessons learned to describe experiences and the learning gained from them and should be described by considering "their application (e.g., a task, a decision, or a process) (and) their orientation (i.e., whether they are designed to support an organization or an entire organization)" [39].

A wiki allows share knowledge freely by the workers in an organization, allowing the creation of a knowledge spiral with the accumulation of different contributions over time. Rivero [40] states that wikis "serve for collaboration between workers sporadically and simultaneously, users can update the wiki if they are working collaboratively and have the power to edit a page dynamically".

Several works, among them, [41, 42], propose the use of narratives as another technique that allows describing situations, and experiences, and sharing knowledge.

6.3. Fields of study

A field of the study refers to a branch of knowledge or a set of branches of knowledge with interdisciplinary action. Each field encompasses a set of processes, technologies, etc.

The elements considered "fields of study" and found in the search are Artificial Intelligence, Big Data, Business Intelligence (BI), Cybersecurity, and the Internet of Things (IoT). The number of findings for each element is presented in Table 4.

Table 4
Quantity of elements for fields of study

Element	Quantity
Big Data	5
Business Intelligence	5
Artificial Intelligence	2
Cybersecurity	1
Internet of Things (IoT)	1

Since each element represents a broad concept, some characteristics of each of them are presented below.

Big Data encompasses a set of procedures, methods, and mathematical tools whose origin and development date to several decades of work in statistics. Big Data includes the management of diverse formats (audio, text, video, social networks), modeling through spatial analysis, data analysis, Territorial Intelligence, optimization, simulation, and visualization, and technological services that include analytical frameworks, data warehouses, relational and non-relational databases [43].

Artificial Intelligence is an area of computer science that deals with the design of computer systems that simulate characteristics associated with human intelligence and behavior, is an interdisciplinary area linked to disciplines such as education, neuroscience, biomedicine, robotics, computer science, and psychology, among others [44].

Business Intelligence is "a system comprised of both technical and organizational elements that present historical information to its users for analysis and enables effective decision making and management support, for the overall purpose of increasing organizational performance" [45].

For [46, 47] Internet of Things should be evaluated beyond the technology's platform and consider it as a business ecosystem view, not only as a set of technological tools.

6.4. Logical and analytical process

The logical and analytical process category corresponds to data and information processing and treatment activities. It may include technological tools but especially involves analysis and exploitation processes.

The terms considered logical and analytical processes and found in the Scoping Study are benchmarking, competitive intelligence, content categorization, data analytics, data mining, knowledge summarization, text mining, and workflow. The number of findings is presented in Table 5.

The details of the most frequently mentioned logical and analytical process, as listed in the table above, are presented below.

Data mining consists in "extracting information from a data set and transforming it into an understandable structure for further use" [48]. [45] presents a model of educational data mining. Text mining, on the other hand, is the automatic discovery of information from non-textual textual data. information from unstructured textual data [49]. Text mining encompasses "infor-

Table 5
Quantity of elements for logical and analytical process

Element	Quantity
Data Mining	9
Workflow	5
Text Mining	4
Competitive Intelligence	3
Benchmarking	1
Content Categorization	1
Data Analytics	1
Knowledge Summarization	1

mation extraction, fundamental question-answer systems, and document clustering (discovering relevant categories and properties), among others" [45].

Workflow is a term used to describe the study of the operational activities of an organization, structuring them into different tasks with the objective of automating those tasks if it is possible [32].

6.5. Organizational practices

This category represents a mechanism to communicate its values, norms, and goals to its employees and is instrumental. The organizational practices found are corporate education, virtual learning environment, and virtual reality and simulation. The number of findings is presented in Table 6.

Table 6
Quantity of elements for organizational practices

Element	Quantity
Virtual learning environment	7
Corporate education	2
Virtual reality and simulation	1

Corporate education "is understood as an educational system of an organization that has a multidimensional set of possibilities for human development and provides a continuous process" [32]. The Virtual Learning Environment is a virtual space for training and knowledge transmission [50] that enables the interaction of the organizational community [51, 52] and sharing and generalization of knowledge. [53] understands them as a space for exchange in various directions, breaking with the idea that information centers are single producers of knowledge and is based on [54] stating that it should be "a participatory online space in which everyone (...) can work, create, build, and share as a community". Meanwhile Virtual reality and simulation "provides users with an immersive, 3D experience that can be used to allow surgical trainees to practice skills and operations in a safe yet realistic environment" [55] and "are tools that allow users to be trained in a test environment to avoid errors in production" [56].

6.6. Technological tools

Regarding the artifacts that are able to be deployed in a technological infrastructure environment, including the software, part of the software, or similar. In general, these tools can model as components in a sequence diagram or deploy a diagram of Unified Modeling Language.

6.6.1. Type of systems

Among the technological tools identified, there are some that correspond to different types of systems: Business Expert Systems (BES), Content Manager Systems (CMS), Customer Relationship Management (CRM), Decision Support Systems (DSS), Document Management Systems (DMS), e-Commerce, Enterprise Resource Planning (ERP), Executive Information System (EIS), Group Decision Support Systems (GDSS), Groupware, Information Retrieval System (IRS), Knowledge Management System (KMS), Management Information System (MIS) and Multiagent System. The number of findings is presented in Table 7.

Table 7
Quantity of elements for types of systems

Element	Quantity
Document management system	10
Groupware	8
Content manager system (CMS)	6
Customer Relationship Management (CRM)	6
Enterprise Resource Planning (ERP)	3
Executive Information System (EIS)	3
Group Decision Support Systems (GDSS)	2
Business expert systems	1
Decision Support Systems (DSS)	1
e-Commerce	1
Information Recovery System (IRS)	1
Knowledge Management System (KMS)	1
Management Information Systems (MIS)	1
Multiagent System	1

6.6.2. Repositories and storage media

Other types of tools are the repositories or other data storage media found are academic databases, competency repositories, data repositories, Data Mart, databases, Datawarehouse, documents repositories, ideas repositories, knowledge repositories, models repositories, OLTP databases and virtual libraries. The number of findings is presented in Table 8.

6.6.3. Bidirectional communication tools

Another subcategory found corresponds to bidirectional communication tools: chat and instant messaging, chatbot, e-mail, forum, social media, and video conference. The number of findings

Table 8
Quantity of elements for repositories and data storage media

Element	Quantity
Document management system	10
Groupware	8
Content manager system (CMS)	6
Customer Relationship Management (CRM)	6
Enterprise Resource Planning (ERP)	3
Executive Information System (EIS)	3
Group Decision Support Systems (GDSS)	2
Business expert systems	1
Decision Support Systems (DSS)	1
e-Commerce	1
Information Recovery System (IRS)	1
Knowledge Management System (KMS)	1
Management Information Systems (MIS)	1
Multiagent System	1

is presented in Table 9.

Table 9
Quantity of elements for bidirectional communication tools

Element	Quantity
Social Networks	10
Forum	6
Video conferencing	6
Chat and instant messaging	5
E-mail	3
Chatbot	1

6.6.4. Tools for content presentation

The analyzed works also present tools for content presentation: blog, corporate portal, extranet, and website. The number of findings is presented in Table 10.

6.6.5. Others

Outside of the preceding subcategories, the following technological tools can be found: innovation support tools, intelligence agents, mashups, OLAP tools, search engines, social bookmarking, video and podcasts, and web semantics. The number of findings is presented in Table 11.

Table 10
Quantity of elements for tools for content presentation

Element	Quantity
Intranet / Corporate portal	18
Internet / website	9
Blog	7
Video & Podcast	5
Extranet	5

Table 11
Quantity of elements for other tools

Element	Quantity
Search engine	8
OLAP Tools	5
Intelligence agent	3
Innovation support tools	1
Mashup	1
Social bookmarking	1
Web semantic	1

6.7. Details of technological tools

This section presents details of the technologies most found in the categories presents in the previous sections.

Many works define tools generally mentioned as generic technologies such as intranet or internet (in some cases also called corporate portal and website). [56] include them as a set of company information and services that can be consulted through the Internet or the intranet. Other generic tools such as videos, search tools, and databases are also mentioned. [57] presents in detail the use of storage technologies to select Knowledge Management Tools and Strategies for Medium and Small Enterprises. The use of a data warehouse for education is explained in [45].

Among the most mentioned tools are forums, which are spaces for knowledge sharing. [32] defines them as "defined as spaces to discuss, homogenize and share information, ideas and experiences that will contribute to the development of competencies and to the improvement of processes and activities of the organization".

About social networks, for [58] they are "the set of interpersonal relationships formed spontaneously within an entity (and) represent the relationships between employees, allowing collaborative work where information and knowledge are frequently shared for problem-solving or exchange of knowledge", aimed at sharing knowledge in a common area of interests [32]. [59] mention the application of social networks at the enterprise level in an important international consulting firm. For [32] the main services offered by the networks are: "to find people who have similar interests or needs; to add people in groups or subgroups, to be able to communicate with these groups; and the sharing of content, such as links documents to relevant sites, or even

streaming video".

Among other technologies found in the searches is the Document Management System, which allows managing the flow of documents in the organization, the Groupware, the name given to information technologies to support group work, such as face-to-face or remote meetings [60], and the analytical data processing tools called OLAP Tools [56]; in [45] some ideas of implementation of OLAP tools are presented.

7. Conclusions

This paper presents a Scoping Study based on the following research questions: how many papers are associated with knowledge management technologies? which technologies are presented in the papers? and what categories of technologies are possibly identified in the papers?

The search returned 1107 papers (without considering the exclusion criteria). The reading of the works found allows the identification of those that consider aspects of the technological and representational view; there are 61 papers that consider this view.

Then, analysis and categorization of each of the elements of technology and knowledge representation found are carried out through the open coding technique. The analysis allows identifying the following categories for the knowledge representation and technologies view: socialization techniques, techniques or models for knowledge explanation and representation, fields of study, logical and analytical processes, organizational practices, and technological tools. And finally, the different technological tools are grouped according to the following subcategories: type of systems, repositories and storage media, bidirectional communication tools, tools for content presentation, and others.

The results of this work allow for ordering the different technologies and knowledge representations, categorizing them, and helping to the construction of a technological architecture of an integral knowledge management system.

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