Knowledge Management Applications Based on Artificial Intelligence: A Systematic Review

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Abstract

Artificial Intelligence (AI) has received increasing attention from the knowledge management community because AI allows machines to acquire, process, produce and use knowledge to perform tasks. This study addressed the interaction between Knowledge Management (KM) and AI and aimed to shed light on how KM applications based on AI have evolved and to better understand current research trends in KM methodologies through a systematic review of studies. This review included international and Arab studies published between 2000 and 2021 about KM applications based on AI that appeared in the research results in five global databases: Web of Science, IEEE, Springer, Elsevier, and Google scholar. A total of 19 out of (319) research articles published in high-quality journals and conference proceedings were examined. This study has made important contributions. It emphasizes the integrative and strong relationship between AI and KM processes and the importance of KM applications in the context of AI in promoting the organizations' performance in various sectors, including the business sector. Several important and common AI techniques used in the study include Neural Networks, Expert Systems, and Natural Language Processing. This study covers KM gaps in KM applications based on AI research, which may be of value both to academics and to organizations in various sectors.

Disciplinary: Information Science, Knowledge Management, Information Technology.

1 Introduction

K Knowledge has been regarded as a critical component for the survival of organizations in today's competitive era, implying that Knowledge Management (KM) is as important as managing

other assets for the organization to succeed and achieve competitive advantage [47]. The concept of (KM) refers to the process of generating value from an organization's intangible assets, which includes both internal information and external knowledge obtained from customers and other stakeholders. The focus is on the best ways to share knowledge to create values beneficial to the organization [29]. The importance of creating a real value of knowledge lies in the effectiveness of its transfer and sharing throughout the organization. Therefore, studies have emphasized the role and importance of Information and Communication Technology (ICT) in the good and efficient KM in organizations [22]. The enormous technological development and industrial revolution in various fields of the era are due to Artificial Intelligence (AI), which has greatly enriched all aspects of life. ICT nowadays is usually accompanied by AI capabilities. From a KM perspective, AI enables machines to extract and develop knowledge that can be presented to people to enhance decision-making [13].

Despite the growing interest in AI techniques in various fields. According to the literature, studies covering the impact of these technologies on KM and being affected have been modest. This study intends to fill this gap and investigate the growth of KM applications based on AI through a systematic review, to extract lessons learned from this interaction and profit from them in the next years. A systematic review of literature is important and can be used to provide a basis for further research efforts in this area [12]. A systematic review of literature is defined as a "means of identifying, evaluating and interpreting all available research relevant to a particular research question, subject area, or phenomenon of interest" [26]. Therefore, this study aims to: 1- Identify the historical development of the research base and suggest future trends in the field of KM applications based on AI, 2- Assist in understanding AI techniques in the context of KM.

2 Literature Review

This section highlights recent contributions to the current study subject and discusses the evolution of the relationship between KM and AI over the years.

The actual relationship between KM applications and AI began in 1981 when Arthur D. Little opened the Center for Applied Artificial Intelligence to build knowledge-based systems (KBS) for commercial and government clients [46], at that time although "knowledge" was the first word in KBS, it was rarely considered from an epistemological perspective. As a result, it has found in most of the literature a biased view of the organizational value of KBS, looking at them from a technological and engineering perspective and neglecting the epistemological perspective [21]. However, most AI definitions focus on understanding how computer systems can mimic human behavior, produce knowledge, and execute cognitive activities including perception, inference, learning, and decision-making [27,41]. AI focuses on giving devices the knowledge and mental capabilities of humans, so without KM, AI will become a complex process. Both AI and KM are about "knowledge". The methods required for machines to gather and gain knowledge are all provided by AI. Additionally, it aids devices in learning from a variety of sources, processing information in a systematic manner, and then applying this knowledge in the future [1,2].

Studies usually recommend developing an integrated framework for using AI techniques in various KM processes, evaluating their level, and enhancing the processes of knowledge creation, storage, dissemination, and management using AI techniques [14].

Table 1 shows the time tracking of the evolution of the relationship between knowledge management and artificial intelligence for the past ten years. We note from tracking the relationship between KM and AI in the literature that the KM process may contribute to the use of AI methods to help organize knowledge in knowledge management systems, as well as the use of other AI techniques such as intelligent agents to aid in search and retrieval, Agents may be employed to assist in the combination of information, which leads to the creation of new knowledge. From an AI perspective, knowledge representation formalizes and manipulates knowledge within machines so that automated inference techniques allow a computer system to conclude from knowledge represented in an interpretable form. When discussing the role of AI in KM, traditional techniques based on logic as well as machine learning techniques are two indispensable techniques for extracting knowledge and are increasingly used in organizations in KBS, leading to support and enhance KM to improve operational and organizational performance in organizations and thus to gain a competitive advantage for knowledge-based organizations.

Table 1: The time tracking of the evolution of the relationship between KM and AI.

Year	Study	Relationship	AI Methods
2011-2013	[10,15,17]	AI helps knowledge-based organizations gain a competitive advantage by building Expert Systems and other intelligent systems using Decision Trees and Neural Networks.	Intelligent Agent, Expert Systems, Neural Networks
2016	[6,31]	Using AI ensures that the flow of knowledge in KM applications is designed in a way that enables all stakeholders to communicate effectively, and modern AI applications depend on their ability to acquire, represent and process expert knowledge for inference and problem-solving.	(ANN), Genetic Algorithms, Fuzzy Logic in AI
2017	[37,40,43]	AI has made real-time management of big data and integration into KM systems. Therefore, creating new contextual knowledge is made possible through AI.	Ontologies (Artificial Intelligence) Semantic Web, AI-Big Data
2019	[1,34,38]	The inputs, processes, and outputs in KM systems based on AI assist transform data into information and then into different types of knowledge. Managing this knowledge enables people, machines, and organizations to collaborate and exchange knowledge. This ability to collaborate, share, transfer and use knowledge is the main driver of the success of AI as we know it today in the Fourth Industrial Revolution.	Recurrent Neural Network (RNN) methods, (ANN), Data Mining Algorithms
2020	[2,28,42]	KM and AI are complementary. While KM allows knowledge to be understood, AI provides capabilities to extend, use, and create knowledge in unexpected ways.	(ML) Models, Deep Convolutional Neural Networks (CNN) Models
2021	[19,32,45]	Cloud computing, big data, the Internet of Things, and artificial intelligence are among the new digital technologies that are becoming widely used. AI models and Algorithms have become a major contributor to knowledge generation and decision-making accordingly.	Fuzzy K-Nearest neighbor (Fuzzy-KNN), Deep Recurrent Neural Network (Deep RNN), (ML) Models

According to the literature shown in Table 1, the main AI techniques and tools used in the context of KM include a wide range of techniques. Some of the most researched in recent years: Expert Systems, Intelligent Agents, Decision Trees, and has become more focused on Artificial Neural Network (ANN) techniques, Support Vector Machine (SVM), Machine Learning and Deep Learning Models (ML & DL Models).

3 Method

The research followed the methodology suggested by Kitchenham & Charters for conducting systematic reviews of the literature, which is a method that identifies three stages to conduct a systematic review: 1- planning, 2- conducting, 3- summarizing. The first stage specifies the research questions and develops a review protocol containing information important to the review. The second stage identifies and selects the relevant primary studies and extracts data. In the third stage, the results of the review are summarized and disseminated [26] as shown in Figure 1. In addition, the methodology is combined with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) which is a review list containing 27-items as well as a flowchart that shows decisions made by the review authors as they evaluated citations for possible inclusion in the review [36] into the second stage that includes a selection of studies according to PRISMA based on four steps: 1- identification, 2- examination, 3- exclusion, 4- insertion. These stages will be detailed in the subsections.
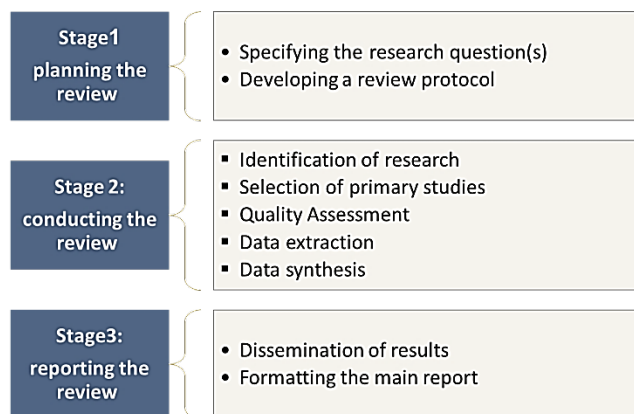

Figure 1: The review process according to Kitchenham and Charters' guideline

3.1 Planning the Review

In this stage, research questions are specified and a review protocol containing the information important to the review is developed.

Figure 2: Research questions.

3.1.1 Specifying the Research Questions

It is the most important part of any systematic review because these questions lead the whole systematic review [26]. Figure 2 shows the questions of this study.

3.1.2 Developing a Review Protocol:

The review protocol details the procedures that will be followed to carry out a given systematic review, this is necessary to decrease the chance of researcher bias[26]. The protocol includes specifying the following:

1-Information Resources:

Five global databases were selected: Web of Science, IEEE, Springer, Elsevier, and Google scholar for research in Arabic. These databases were chosen to use one or more of them by several researchers in the literature, and for its multi-specialty, reliability, and the presence of an entry permit for it, with the possibility of downloading the full text of the studies.

2- Selection Criteria (Inclusion and Exclusion):

The selection criteria help ensure that primary studies related to the scope of the research that provides direct answers to the research questions are selected and analyzed to reduce the possibility of bias and are shown in Table 2.

Table 2: Study Inclusion and Exclusion Criteria

Criteria	Selection	Exclusion
Period	From 2000 to 2021	Before 2000
The Publication Type	Proceedings of conferences - scientific journals	Scientific theses - books - book chapters - editorials
Type	Full text of all types of articles and research	Unavailability of the full text
Information Database	Web of Science, IEEE, Springer, Elsevier, Google Scholar	-
Field	In the title or abstract, it explicitly mentions knowledge management or knowledge management systems in the context of artificial intelligence or vice versa; Artificial intelligence and the application of its techniques in the field of knowledge management.	Knowledge management outside the context of artificial intelligence and its techniques.
Language	Arabic-English	Other languages

3-Quality Assessment Standards:

Next, their quality is assessed based on a list of questions with a measurement scale for each element, which is according to Kitchenham et al. [26] developed by researchers in the context of their study and the selection of the most appropriate quality assessment questions for their specific research questions.

Table 3: Quality Assessment Standards

No.	Question	Standard
1	Are the study objectives evident?	
2	Does the study specify the AI techniques that have been thoroughly investigated?	
3	Does the study clearly link the AI techniques used with knowledge management processes?	Yes "1"; No "0"; Partial "0.5"
4	Are the scales used in the study clearly defined?	
5	Are the data collection methods defined?	
6	Are the results reported?	

Table 3 shows the list consisting of 6 questions on a three-point scale. If the answer is yes, it is 1; if the answer is no, it is 0. If the answer is partial, it is 0.5. Accordingly, each study is rated from 0 to 6, and studies rated below four marks will be excluded.

3.2 Conducting the Review

In this stage, the review is initiated by conducting the protocol developed in Section 3.1, including the following: 1- identification of research 2- selection of relevant primary studies 3- quality assessment of the selected studies 4- data extraction 5- merge extracted data.

3.2.1 Identification of Research

This stage begins with identifying the keywords and search terms. By looking at the relevant studies and books, the keywords and their synonyms have been identified. The main keywords were grouped into two groups and their synonyms were considered to formulate the search strings so that the first group represented knowledge management with its synonyms, and the second group was artificial intelligence with its synonyms. Accordingly, the search strings were identified, taking into account the use of logical operators OR and AND to include synonyms as shown in Table 4.

Table 4: Keywords and search strings

	Group (1)	Group (2)
Keywords	"Knowledge management ", "knowledge discovery ", "knowledge sharing", and "knowledge extraction"	"Artificial Intelligence", "Machine Learning", "Neural Networks" and "Deep Learning".
Search Strings	1-("Document Title": Artificial Intelligence OR "Document Title": Machine Learning OR "Document Title": Deep Learning OR "Document Title": Neural Network) AND ("Document Title": Knowledge management OR "Document Title": Knowledge sharing OR "Document Title": knowledge extraction OR "Document Title": Knowledge discovery) 2- (Content-Type: article) AND (Title: "Knowledge management" OR (Title: "Knowledge discovery") AND (Title: "machine learning") OR (Title: "artificial intelligence") OR (Title: "deep learning"))	

3.2.2 Selection of Primary Studies

Using the search series identified in the selected databases, a primary list of 319 studies was retrieved as shown in Figure 3.
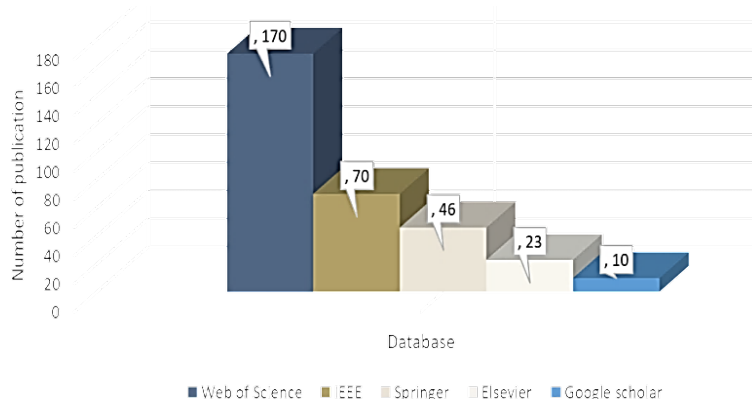

Figure 3: The initial selection of studies by source

The records were first imported into the Mendeley program for the process of sorting and categorizing according to inclusion, exclusion criteria, and deleting duplicates. In this step, 203 studies were deleted and the selected studies were reduced to 116 studies for the next examination.

The next step is to check the full texts to ensure that the selected studies match the criteria. An in-depth examination led to the exclusion of 96 other studies, which resulted in a total of 20 primary studies for the quality assessment stage, as shown in Figure 4.
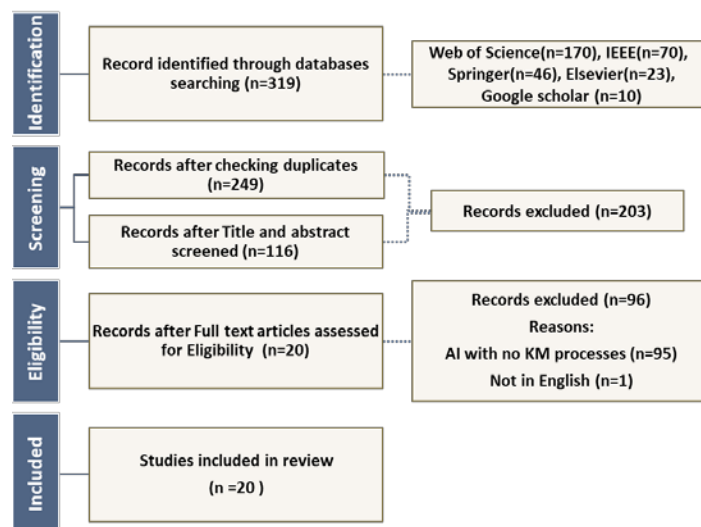

Figure 4: Study Selection Process using PRISMA

3.2.3 Quality Assessment

Based on the quality assessment criteria in Table 3, the selected studies from the previous stage were assessed. Table 5 shows the results of the quality assessment of 20 studies so 19 of which passed the assessment, while one study that did not pass the assessment criteria was excluded and deserved less than 4 marks.

Table 5:. The results of the quality assessment

Q	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
Q1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Q2	0.5	1	0.5	1	1	0	1	1	0.5	0.5	1	1	1	1	1	1	0.5	1	1	1
Q3	0.5	1	1	1	0.5	0.5	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1
Q4	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Q5	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Q6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.5
Total	5	6	4.5	6	5.5	4.5	6	6	5	5.5	6	6	6	6	6	6	5.5	6	6	3.5

3.3 Reporting the Review

The final stage of the systematic review involves writing the results of the review according to the studies selected, answering research questions, and generalizing the results to potentially interested parties. This will be explained in the next section.

4   Result and Discussion

This section presents the results of analyzing 19 studies based on the research questions. The results represent the state of knowledge management research in the context of Artificial Intelligence in terms of 1- scientific additions to studies in the field of study, 2- the most popular years in publication, 3- the most prominent sectors and areas of interest, 4- the most used research methods and data collection methods, 5- the most prominent techniques and applications used, 6-

the most prominent interested countries, 7- the rate of Arab studies to non-Arab studies in the study subject.

4.1 RQ1: How Have the Studies Contributed to Enriching the Knowledge Management Field in the Context of Artificial Intelligence?

This question aims to identify how the contributions that studies have added to enrich Knowledge Management in the context of Artificial Intelligence in terms of what is the contribution, its type, and which knowledge management processes have addressed it, as shown in Table 6. The classification of the type of contribution was based on [39] that classified contributions into six types: model, theory, framework/methods, guidelines, lesson learned, advice/implications, and tool. The contributions were divided in terms of impact into weak contributions (advice and implications, lessons learned, tools and guidelines) and strong contributions (theory, framework/method, and model). As shown in Table 6 and Figure 5, the most common contribution in the field of study is Model, followed by theory.

Table 6: Scientific additions to primary studies

Study	Contribution	Contribution Type	Knowledge Management Process
S1-[8]	There are strong correlations between knowledge acquisition, Artificial Intelligence (AI)	Theory	Acquisition
S2-[35]	Understanding the relationship between AI, customer behavior, and knowledge-sharing may help marketers make better decisions.	Framework/	Sharing
S3-[5]	AI and Knowledge Management are closely linked	Method	Sharing
S4-[18]	Incorporate semantic search, intelligent question and answer, prediction, and knowledge suggestion into a knowledge graph application.	Theory	Extraction / Representation
S5-[6]	Two kinds of knowledge representation may interact dynamically. In this way, the Knowledge Management system's quality improves over time.	Tool	Representation
S6-[44]	Socially-based conceptual Knowledge Management (KM) systems may be extended by Artificial Intelligence (AI).	Model	Sharing
S7-[48]	This paper introduces the ML-AR Data Mining Algorithm and builds a Knowledge Management system for engineering cost consultancies the proposed method is quite effective.	Lesson learned	Acquisition & Sharing
S8-[23]	Filtering tools and pre-analytics may be constructed by combining Knowledge Management with AI.	Tool-	Acquisition/ Storage
S9-[24]	Artificial Intelligence (AI) is on its way to becoming support for Knowledge Management (KM) in a variety of industries.	Model	Capturing / Storage
S10-[33]	A knowledge Warehouse (KW) concept was proposed, it will provide decision-makers with an intelligent analytical platform for knowledge retrieval, sharing, and coding.	Model	Capturing / Sharing
S11-[30]	BPMN and BR are proposed as a framework for Knowledge Management, allowing explicit modeling of knowledge in the form of formal representations.	Theory	Representation
S12-[11]	Natural Language Processing (NLP) improves text analysis fidelity by examining how people reason and create cognition	Model	Extraction
S13-[7]	Artificial Neural Networks are used to evaluate corporate tacit knowledge management performance (ANNs). Using the study's findings will assist advance enterprise knowledge management.	Tool	Tacit Knowledge Management
S14-[16]	Personal knowledge management, intelligent knowledge search, automatic knowledge classification, and tacit knowledge conversion can all benefit from the use of artificial neural networks.	Model	Acquisition, Sharing, and
S15-[9]	To evaluate knowledge management, the integrated theory of	Model	Capturing

Study	Contribution	Contribution Type	Knowledge Management Process
	information entropy and RBF neural network were used. This method overcomes the shortcomings of prior methods		
S16-[44]	The effective evaluation of the army's knowledge management may improve combat effectiveness. In practice, neural networks can evaluate key commanders without thresholds	Theory	Tacit Knowledge Management
S17-[4]	IT has helped information institutions monitor all physical and moral entities in case they are misplaced or removed from their specified locations.	Framework/	Creation, and Sharing
S18-[25]	According to the study, the components of the expert system have a bigger influence on the knowledge management operations of the organization in question, after analyzing data and testing hypotheses.	Method	Creation
S19-[3]	The study aimed to identify artificial intelligence technologies that can retain knowledge and experience, such as "Expert Systems."	Model	Creation, Storage, Sharing, and Application

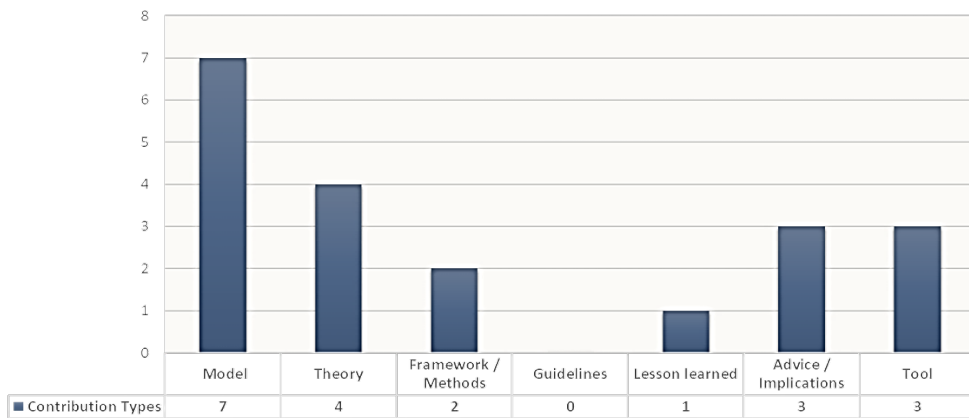|	Model	Theory	Framework / Methods	Guidelines	Lesson learned	Advice / Implications	Tool
Contribution Types	7	4	2	0	1	3	3

Figure 5: the most common contribution

Table 6 emphasizes the strong integrative relationship between Artificial Intelligence and Knowledge Management, as Artificial Intelligence helps to acquire, store and share knowledge. Through the use of Artificial Intelligence techniques, this knowledge can be analyzed to predict the future through smart technologies, which provide decision-makers and experts with insight into timely decision-making and with the appropriate quality in all forms of organizations.
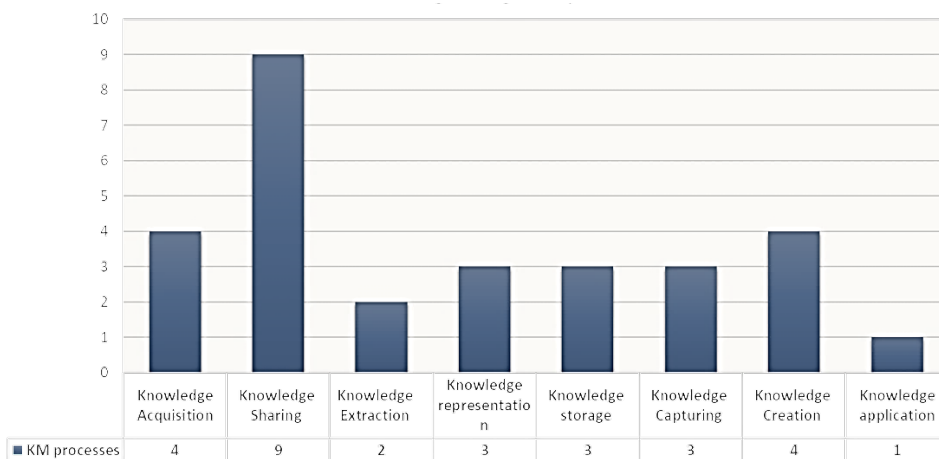

	Knowledge Acquisition	Knowledge Sharing	Knowledge Extraction	Knowledge representation	Knowledge storage	Knowledge Capturing	Knowledge Creation	Knowledge application
KM processes	4	9	2	3	3	3	4	1

Figure. 6: the most common Knowledge Management processes

Figure 6 highlights the positive and strong relationship between Knowledge Management processes and Artificial Intelligence, especially the processes of acquiring, generating, and sharing knowledge. We note the need for more research in the processes of extracting and applying

knowledge. Despite the importance of the knowledge application process, we note the lack of reference to it in studies.

4.2 RQ2: What are the Years Witnessing the Highest Rate of Publication in the Study Subject According to the Source?

The objective of this question is to determine the extent of interest in publishing in the study field over the years and according to the publishing channel, whether scientific journals or conferences. We note from Figure 7 that studies related to the study field remained relatively low for 2000-2008, and then began to increase at a weak pace until it increased dramatically and had an increased interest for 2019-2021. For the publication source, we note that the publication rate in scientific journals is higher than publication in scientific conferences.
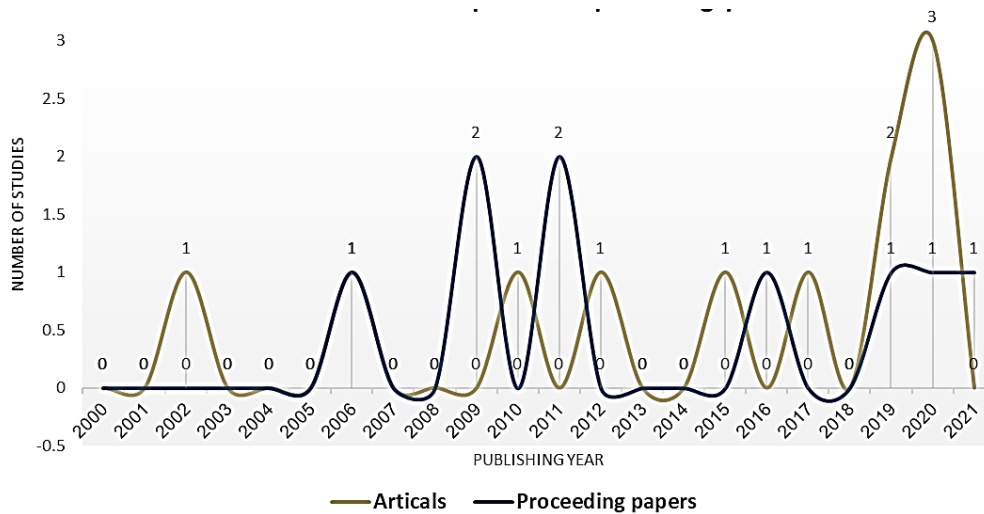
Figure 7: Number of studies per publishing year.

4.3 RQ3: What are the Most Prominent Sectors/Areas of Interest in the Study Subject?

The objective of this question is to identify the most prominent sectors or areas that are concerned with Knowledge Management in the context of artificial intelligence.
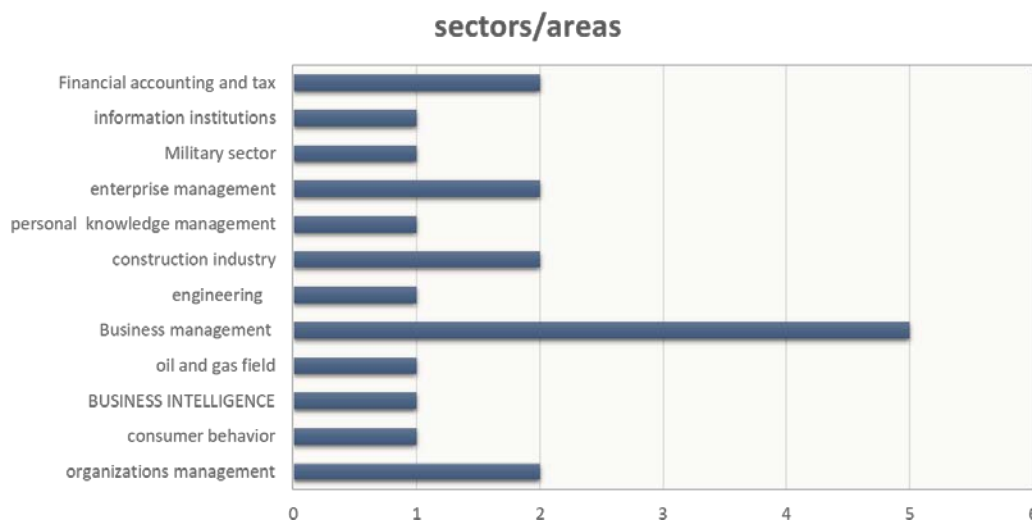
Figure 8: The most prominent sectors/areas of interest in the study subject.

The diversity of fields proves that Knowledge Management is a multidisciplinary field and confirms what studies have proven that it has great importance in enhancing the organizations' performance in various fields and sectors. According to the literature, we note that the business sector is the most benefited from the contributions of the study subject, followed by the rest of the sectors and fields follow in a relatively close manner, and Figure 8 shows these results.

4.4 RQ4: What are the Most Used Research Methods and Data Collection Methods in the Selected Studies?

The objective of this research question is to determine the research methods and data collection techniques used to study Knowledge Management in the context of Artificial Intelligence. The research methods were determined according to Håkansson [20], Figure 9 shows the percentage of each of the research methods used so that we note the superiority of experimental studies of both types (Empirical- Experimental) over theoretical studies that were mostly limited to Arabic studies.
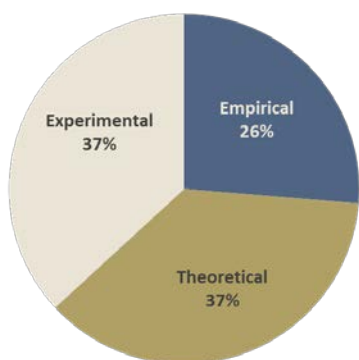

Figure 9: The percentage of each of the research methods
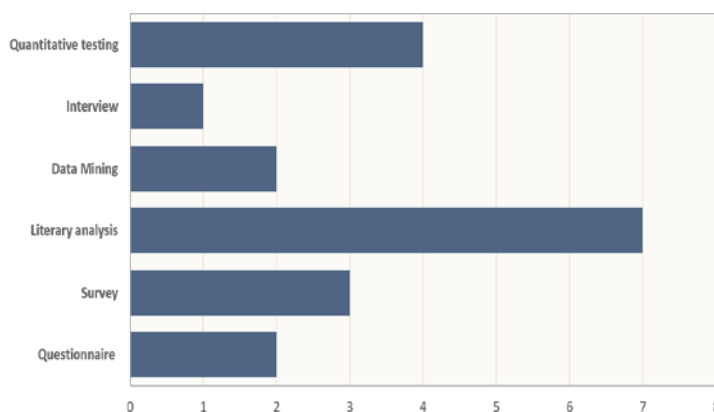

Figure 10: Data collection methods

Regarding data collection methods, Figure 10 shows that the studies used different data collection methods, but the most used method is Literary Analysis followed by Quantitative Testing and the least used is Interviews.

4.5 RQ5: What are the Most Prominent Techniques and Applications Used in the Studies?

The question aims to identify the Artificial Intelligence techniques used in the studies. Some studies have combined more than one type of technique. We note from Figure 11 that Neural Networks are the most used, confirming the literature survey results in the second section because most studies used this technique, followed by Expert Systems. Also, one of the frequently used techniques is Natural Language Processing (NLP), and it is noted the absence of many important and common Artificial Intelligence techniques such as Genetic Algorithms (GA) and Support Vector Machine (SVM).
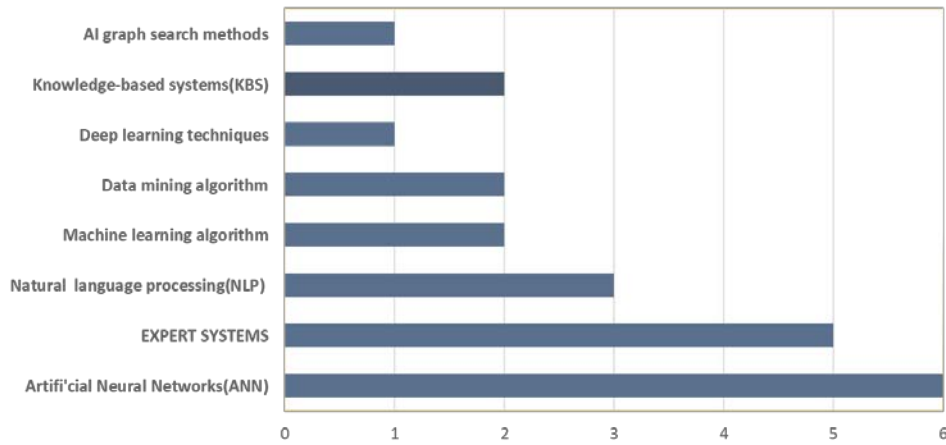
Figure 11: The most prominent techniques and applications used

4.6 RQ6: What are the Most Prominent Countries Interested in the Study Subject?

Many countries have shown interest in searching for different Artificial Intelligence techniques to improve the knowledge management methods in their organizations. Figure 12 shows that China was the country most involved in expanding the scope of knowledge in this field, followed by the United Kingdom and then the rest of the countries in the same proportion
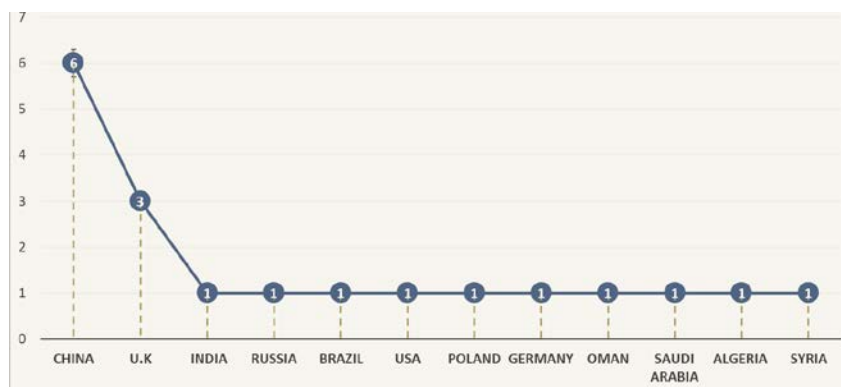

Figure 12: The most prominent countries interested in the study subject.

4.7 RQ7: What is the Rate of Arabic to Non-Arabic Studies in the Study Subject?

This question aims to identify the extent of interest in the study field at the global and Arab levels. It is evident from the results that Arab studies are considered modest compared to global ones. The study encountered while searching several Arab publications in the study field or part of it, but it violates selection and exclusion criteria for that It has been excluded. It is noted that many Arab publications in the field are either in the form of books or scientific theses, and this may be one of the reasons for the lack of publication at the level of Arabic studies 16%, and non-Arabic studies 84%.

5 Conclusion

In this study, a systematic review was conducted to reach a comprehensive analysis of studies interested in the study subject and to discuss the implications of the analysis results. This review resulted in the following main findings: The integrative relationship between Artificial

Intelligence and knowledge management, which provides decision-makers and experts with an insight into decision-making. The positive and strong relationship between Knowledge Management processes and Artificial Intelligence, especially the processes of acquiring, generating, and sharing knowledge. Knowledge Management applications in the context of Artificial Intelligence are of great importance in enhancing the organizations' performance in various fields and sectors because they are widely applied in the business sector, building, and construction, military, gas and petroleum, accounting, and taxation. There are several research ways and methods in the study field, but the most common are the two types of experimental studies as well as the diversity of data collection methods. Neural networks are the most used, confirming the literature survey result in the second section because most studies used this technique, followed by Expert Systems. Also, one of the frequently used techniques is Natural Language Processing (NLP), and it is noted the absence of many important and common Artificial Intelligence techniques such as Genetic Algorithms (GA) and Support Vector Machine (SVM). The modesty of the Arab production in the study field compared to the published English production. In conclusion, this systematic review's results provide a deep insight into the relationship between Knowledge Management and Artificial Intelligence and the role of Knowledge Management Applications based on Artificial Intelligence in improving the organizations' performance in various fields and sectors, which constitutes for those interested in a comprehensive vision of the upcoming Knowledge Management studies, especially those related to Artificial Intelligence. Limitations: This study was limited to specific databases and specific years. Therefore, this study can be expanded to include more studies in different specialized databases and in different years to add different dimensions and thus more valuable to the study results.

6 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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