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Artificial Intelligence as a Catalyst for Management System Adaptability, Agility and Resilience: Mapping the Research Agenda

Ion Popa^{1,2,*}, Simona Cătălina Ștefan¹, Andrei Josan¹, Corina-Elena Mircioiu^{1,*}, and Nicoleta Căruceru¹

- ¹ Management Department, Bucharest University of Economic Studies, 010374 Bucharest, Romania;
- simona.stefan@man.ase.ro (S.C.Ş.); andrei.josan@rei.ase.ro (A.J.); carucerunicoleta18@stud.ase.ro (N.C.)
- ² Academy of Romanian Scientists, 010719 Bucharest, Romania
- * Correspondence: ion.popa@man.ase.ro (I.P.); mircioiucorina19@stud.ase.ro (C.-E.M.)

Abstract: Artificial intelligence (AI) is an increasingly notable presence in society, industries, and organizations, making its necessity felt more in managerial decisions and practices. This paper aims to outline the importance of the topic related to the increase in the adaptability, agility, and resilience of the management system as a result of AI integration, resorting to a bibliometric type of research. A total of 107 papers from the period 2007–2024 exported from the Web of Science Core Collection database were analyzed, with support of Biblioshiny software. This topic is proving to be one of heightened global interest, being comprehensively addressed by world leaders in AI research and technologies such as the United States, China, Great Britain, France, India, and beyond. Collaborative relationships established between geographic regions are captured, noting the power and expansion of the theme on all continents of the globe. Likewise, its thematic and strategic evolution is characterized as a surprising one, managing to incorporate and relate concepts with a strong technical and IT character such as feature extraction, machine learning, reinforcement learning with concepts of a managerial nature as supporting customer-tailored interaction, employee skills development, company productivity, and innovation.



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Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/ licenses/by/4.0/). **Keywords:** artificial intelligence; management; management system; adaptability; agility; resilience; bibliometric analysis

1. Introduction

The continuous evolution of computing capabilities has led to a considerable growth in artificial intelligence (AI) technologies, with the solutions they offer generating interest and thus importance in people's daily lives, emphasizing the omnipresence of AI in contemporary days [1]. With the recent increase in the dynamism and volatility of the business environment [2], digital transformation and the use of AI become mandatory for the organization, to obtain a competitive advantage being a result of the distinct self-development actions that it integrates into its practices [3].

AI technologies are, presently, in the position of laboratories whose tools serve to fulfill a multitude of tasks and functions. However, human beings are the basic pillars that make things happen, as the process of selecting and using the tools appropriate to the organizational circumstances encountered is up to the individual. Therefore, even if AI makes its presence felt in decision-making processes and companies recognize its inevitability, the link with management is made with the strategic approach through AI to respond to environmental challenges [4].

Therefore, there is a gap in the academic literature regarding the relationship between the adaptability, agility, and resilience of management systems and the integration of AI that contribute to the consolidation of these essential features for today's organizations, increasing the understanding of the topic's scientific course, being able to become a support for future analyses that complete the information regarding the role of AI in relation to management systems.

Through this study, we aim to answer the following research questions:

- RQ1. How has scientific production evolved among authors, sources, and related countries in terms of the link between adaptability, agility, and resilience that AI can provide in the management system?
- RQ2. How were collaborative relationships established in order to develop the subject between geographic regions, and what are the countries' preferences in this regard?
- RQ3. What is the thematic and strategic evolution of the subject of management and AI from the perspective of adaptability, agility, and resilience?

As a result of the questions stated, the purpose of this paper is to explore, from a bibliometric perspective, how the use of AI can contribute to increasing the adaptability, agility, and resilience of management systems, outlining the overall image and trends of the topic, which will subsequently allow future studies to focus on its applicability in various industries, sectors, and organizations.

The novelty of this paper comes against the background of the multi-approach of the adaptability, agility, and resilience of management systems on which the characteristics of the integration of AI are manifested, emphasizing the conceptual, thematic, and strategic side of the subject and highlighting the elements that constitute key points for the development of this topic. Therefore, bibliometric analysis was used to outline the answer to the research questions, this being a useful tool to discover a field of research able to avoid subjective perspectives [5]. This paper begins by outlining the managerial perspective of AI and the concepts of adaptability, agility, and resilience, then continuing with a bibliometric-type applicative framework through which it touches on aspects such as scientific production and generated citations, collaborations between authors and between the geographical regions that have participated in the development of the subject, but also the temporal, thematic, and strategic evolution of the theme.

2. Theoretical Background

2.1. Management System and Artificial Intelligence

Organizations of all types, whether from the private or public sector, encounter a difficult set of challenges in their journey toward improving strategic and technological agility in order to reduce the impact of complexity of the environments in which they function [6]. To operate at the appropriate parameters, an organization needs to define its management functions and relationships through the management system which shows in a clear manner how it functions in terms of components, rules, and phases, with the respective applicable managerial processes that lead to the greater effectiveness and efficiency of the organization, as well as the subsystems comprising organizational, informational, decision-making, methodological-managerial, and other management components [7]. The survival of an organization in its operating environment depends on opportunities for renewal to which it is necessary to comply with appropriate capabilities, the reconstruction of the organizational management system being the most relevant part of making progress in a competitive manner. In this sense, the technologization of management processes occurs as a result of the need to streamline administrative and functional activities [8]. Similarly, for businesses to remain relevant in the contemporary landscape, addressing the relationship between management, digital transformation, and cybersecurity is paramount

so that the administration of their digital assets and operations leads to increased competitiveness against the backdrop of a modern strategy [9]. Digital transformation aims to deliver a digitalized customer experience while continuously optimizing the organization's operations and, therefore, responding quickly to market developments. This implies that the requirements of each level should be embraced by the organization's digital assets, its organizational structure, goals, and characteristic values. At the same time, it relies on skills and capabilities associated with digital networks in the presence of organizational agility to an increased degree [10].

Information and communication technologies (ICTs) have become the driving force of globalization and innovation, which has led to a drastic reshaping of the economic landscape. Considering the major impact of technology on global strategies of organizations, ICTs became a source of sustainable competitive advantage, having the power to contribute to the transformation of the value chain of enterprises, especially since every value activity produces and uses information [11]. Therefore, to achieve success, it is necessary for an organization to use the data and information as a vital force, as they are the ones that support managerial decision-making. A crucial part of the management system is the informational one, which converts data into information, subsequently used in decision-making processes, the success of which represents the core of the organization's administrative processes [12]. Meanwhile, information technology helps optimize resources through intelligent information support, contributing to the decision-making area [13].

Nowadays, the use of AI is gaining more and more importance and awareness in all activity fields and industries, as a result of the use of technology innovations and their rapid development with the purpose of solving problems, in some aspects, in a better way than humans [14], and terms such as machine learning (ML), deep learning (DL), and natural language processing (NLP) have become familiar to day-to-day users [15]. Although, initially, the use of AI was mainly related to information technology, given the current impact and development of various AI concepts, more and more activity fields are benefitting from its use in the realm of technology-governed environments, according to research [16,17], as a direct connection to the increase in AI use with the increased efficiency in learning when using ML and DL, which can now support a larger number of tasks compared to ten years ago. However, researchers [18] also consider that it will not be possible for all tasks or activities in a field of activity to be automated, and the presence and human input will still be needed for other or new activities.

Due to increased interest in AI, disadvantages have also been identified [19], such as adversarial machine learning showing a deceptive input, deep fake content in terms of news, videos, images, and content creation, as well as AI ethics. AI systems need to respect the requirements regarding human rights, technical safety and security, privacy and data governance, transparency, non-discrimination and fairness, and societal and environmental wellbeing, which leads to management systems playing a larger role in tackling these challenges and accommodating AI systems within various types of organizations [16].

It is clear that for a progressive and stable integration of AI into the daily practice of companies, it is absolutely necessary for management to direct a significant portion of investments into the training and specialization of people who, through the capabilities they have, help to create a friendly connection between AI applications and the organization's activities [20]. Currently, intelligent systems are already making their presence felt in non-routine decisions, which have effects on strategic directions and are becoming essential for gaining competitive advantages, especially since increasing the level of competitiveness and organizational performance is the meaning of the existence of any company [21]. Some intelligently assisted decision-making systems outperform humans in achieving quantitative objectives and support a reduction in uncertainty in the strategic area. In addition to the potential of AI to support the above, it can also serve to analyze data and generate knowledge [22]. Therefore, we note the immense potential of AI to serve as a support point in all management processes and practices of organizations. Understanding its limitations and using it consciously may lead to achieving higher levels of managerial performance.

2.2. Adaptation, Agility, and Resilience

Given the above considerations, the following attributes are required by management systems to better adjust and incorporate AI into them so that it becomes intertwined: adaptability, agility, and resilience, which congregate to support organizations [23–25]. While agility refers to organizations' or systems' calibration to respond adaptively to external fluctuations, opportunities, and threats [26], which is a cultivated capability of the organization [27], resilience refers to the system's ability to tolerate certain disruptions, manage negative influences, restore performance, and continue to operate in an adaptive way, coping with environmental changes [23]; both complementary attributes contribute to ensuring the adaptability of organizations in the context of the new reality and landscape of AI, with applicability in the respective management systems.

Research carried out by Goldman et al. [28] showed four dimensions for organizations in terms of competitivity and agility: customer enrichment, cooperation, change organization, and people and information impact leverage, while Charbonnier-Voirin [29] considers four practices organizations need to implement into their management systems: change management, value of human resources, cooperation, and value for customers. Furthermore, Winby and Worley [27] identify four routines in agility in an organization: strategy with emphasis on purpose and execution, perception that starts from changes in environment and leads to communication to the decision makers, testing or experimenting as desired by the organization, and implementation of the changes, both incremental and discontinuous.

Taking into consideration that resilience is considered to be one of the three important states in times of changes for an organization as well as its management systems, along with revolution and renewal [30], research [31–33] refers to this as a desirable characteristic for an organization to navigate uncertain times, as well as an emerging field for research and analysis [32–34], leading to two perspectives of organizational resilience [35–38]: as a survival skill, with the organization's ability to adjust, or as a growing skill, with the organization in response to the change [39], ultimately creating superior performance for the organization [38].

In order to measure the resilience of the organization, research refers to the organization system and its management systems, and there are several dimensions used for this, such as robustness, redundancy, resourcefulness and rapidity [40], readiness and preparedness, response and adaptation and recovery/adjustment [41], robustness, agility, and integrity [33], with each dimension leading to potential solutions and conclusions for the organization and its management systems [38]. Organizational adaptability is not a synonym of organizational resilience, as there is a difference in the capacity of the learning and growing of an organization [38,42,43], while organizational agility is not a synonym of organizational resilience, due to a lack of learning and thriving skills in hard and challenging times for an organization, but there is a complementarity between the two [44].

The above concepts cannot exist without human resources, the core of the organization and a mandatory component of each management system, as shown in the studies run by BSI [45] and McKinsey & Company [46,47], with emphasis on the changes following the COVID-19 pandemic in terms of agile leadership, increased use of technology, rapid decision-making, and clear communication within resilient organizations. Gama and Magistretti's [48] research presents their view on AI in management, revealing three possible scenarios: (1) improvement in the existing processes in place, (2) replace human resources with the purpose of cost saving, and (3) expedite analysis, with AI adoption leading to partnering agility and multimodal value co-creation, while Broekhuizen et al. [49] consider the inclusion of AI from the point of view of innovation as a new actor into this process with noted benefits in terms of the identification of opportunities and areas of improvement due to the use of data streams above human perception [50].

3. Methodology

The purpose of this paper is to emphasize the adaptive, agile, and resilient tendencies of AI in the field of management, highlighting the scientific progress made to date, with the help of conceptual and social perspectives. This research was based on bibliometric analysis, a method with notoriety in business research, often based on large volumes of objective data such as the number of publications and citations, which help outline the characteristic evolution of a research area, as well as its emerging trends. At the same time, it offers a broad vision, bringing to light the gaps faced by the studied topic, but also the performance that journals, institutions, and countries achieve, facilitating the emergence of innovative ideas for future research [51,52].

Bibliometric analyses allow us to highlight where academic literature stands in relation to a knowledge field, while also allowing us to observe the interactions of its fundamental concepts with other disciplines. Despite the above, there are some barriers to such a method, an eloquent example being the fact that it does not help to deepen the works studied, relying on their representative keywords. To continue the study process, it is recommended to conduct a combination with another analysis such as systematic reviews [53]. Wanting our study to focus on highlighting the general trends of AI to contribute to the adaptability, agility, and resilience of management systems, bibliometric analysis was selected to help contextualize the topic and serve as a basis for future research considering its high objectivity, transparency, and reliability in noting how the topic in question is positioned at the international literature level [54].

The methodological framework of this research is shown in Table 1. To collect the data used in the analysis, a query was performed in the Web of Science Core Collection database [55] using the following combination of key terms: ("adaptab*" or "resilien*" or "agile*") and ("artificial intelligence" or "AI" or "machine learning" or "natural language processing" or "neural network" or "neural networks") as title and ("management") as topic. Initially, a similar interrogation was performed, but with using "management system" instead of "management". The number of resulting publications was very limited, which could not further support our bibliometric analysis. For this reason, only the term "management" was used in relation to the application field.

Documents written in English, such as articles, review articles, and early access, published between 2007 and 2024, were considered, and for a more rigorous selection of the publications to be analyzed, those indexed in the Social Sciences Citation Index and Science Citation Index Expanded were targeted, thus resulting in 107 documents. All the analyses that will be presented throughout the following sections were designed with the help of the Biblioshiny software program [56].

Scientific Database	Web of Science Core Collection		
		"adaptab*" or "resilien*" or "agil*"	
Keywords	AND	"artificial intelligence" or "AI" or "machine	
		learning" or "natural language processing" or	
		"neural network" or "neural networks"	
		"management"	
Search filters	Title and Topic		
Document types	Article, Review Article, Early Access		
Time interval	2007–2024		
Web of Science Index	Social Sciences Citation	Index (SSCI) and Science Citation Index Expanded	
	(SCI-EXPANDED)		
Language	English		
Number of results		107	

Table 1. Methodological bibliometric framework.

Source: authors with the help of Web of Science Core Collection [55].

4. Results

4.1. Data Description

The main information that characterizes the database used in the analysis is presented in Table 2. The documents' recent period of publication is noteworthy, namely the years 2007–2024, which emphasizes the relevance and actuality of the topic. The 107 documents come from a range of 81 sources such as academic journals, with an annual increase in publications of 25.1%, which shows the growing interest of researchers to study the adaptability, resilience, and agility that AI brings to the field of management. At the same time, the novelty of the scientific papers is highlighted by their average age of 1.27 years.

Table 2. Database main information.

Database Main Information	Results	
Timespan	2007–2024	
Sources	81	
Documents	107	
Annual growth rate	25.1%	
Document average age	1.27	
Average citations per doc	20.2	
References	7921	
Keywords Plus	362	
Author's keywords	465	
Authors	414	
Single-authored docs	9	
Co-authors per doc	4.2	
International co-authorships	56.07%	

Source: authors with the help of Biblioshiny [56].

It is noted that the interest in this topic is not only on the part of the 414 authors who contributed to its elaboration, but also on the part of the other researchers whose works intersected with them, thus generating a citation average per document of 20.2. Furthermore, to describe the publications in a conceptual manner, the authors used a number of 465 keywords, but also 7921 bibliographic references for documentation, in order to be able to properly render the deep specialized nuances of the subject. Regarding collaboration in research, it can be observed that the preference to work in a team prevails (co-authors per doc of 4.2), especially with researchers from other countries due to the rate of international co-authorships of 56.07%.

4.2. Scientific Production, Author Collaborations, and Citation

With the help of the three main categories that constitute it, Table 3 presents, from a numerical point of view, the level of publications produced, the citations generated according to their source, and the authors and countries that participated in the enrichment of the scientific substrate associated with the impact of AI in management. Each category includes the first ten sources, authors, and countries that noted their research presence in this regard. It should be noted that although scientific production is an important indicator considering the effort of researchers to investigate the analyzed domain, citations represent the most relevant factor as they indicate the impact of what is written, the principle being that the authors cite the papers they think are important for their works [57].

The first analyzed category, belonging to academic sources, refers to international journals that include publications related to our topic of interest, more precisely AI and its adaptable, agile, and resilient characteristics in the context of management systems. The *International Journal of Production Research*, belonging to the Taylor & Francis Group [58], ranks first in scientific production and third in citations, standing out through eight such publications with 200 citations granted.

The International Journal of Information Management, an Elsevier-branded journal [59], achieves the highest citations performance, with two of their scientific articles producing 296 citations. Closely, Annals of Operations Research [60] achieves 222 citations for three published papers, followed by the International Journal of Production Economics [61] with two scientific works and 116 associated citations, while another Elsevier [62] journal, Computers & Industrial Engineering, stands with 20 citations. Furthermore, the three IEEE journals [63], Transactions on Engineering Management, Access, and Transactions on Consumer Electronics, score 45, 18, and 10 citations with very few publications. Last, the Sustainability and Applied Sciences—Basel journals, MDPI [64], contribute with 21 and 18 citations, respectively, derived from six and two scientific works.

Regarding the scientific ranking according to the authors, we found that both Gupta Shivam and Modgil Sachin participated in the creation of five papers and scored 246 and 340 citations, respectively, with three of them collaborating. The two authors' works are based on the impact of AI on information systems to support supply chains [65], the implementation of IT in the blockchain framework, and how this influences the financial resilience of supply chains [66], as well as the relationship between AI and supply chains during the pandemic [67].

Likewise, an author with great scientific impact, proven by the second highest number of citations in the ranking (276), deriving from three publications, is Belhadi Amine. Papers to which the author contributed address topics related to AI in the context of supply chain performance and resilience [68], increasing supply chain resilience through AI [69], and proposing no-code AI models to reduce inventory errors for supply chains [70], with the last of these collaborating, in addition to other researchers, with Gupta S. Moreover, Singh Rohit Kumar, Dwivedi Yogesh K., and Wamba Samuel Fosso score 167, 155, and 147 citations, with three scientific papers each, while Kumar Ajay won 110 citations with four works in which he participated, and the rest of the authors in the ranking make their presence felt in the academic research environment with less than 60 citations on the topic of the resilience, agility, and adaptability of AI in management context.

The third category discussed considers the countries that have scientific works associated with our topic. France denotes a remarkable interest in this regard, with 24 scientific papers generating 430 citations, thus taking first place in the ranking. The United Kingdom, India, China, and the United States of America are not far behind, each marking over 200 citations, as well as scientific papers. This aspect is not a surprising one, since, according to Keary [71], all the five states previously mentioned stand out as leaders in the world of AI technologies and research in the current year. The significant investments in AI and the percentage of over 60% of AI researchers working in American companies and universities confirm the country's status, an aspect also valid in the case of China, where by 2027, it will invest 9% in the field of the world total. Also, the United Kingdom is in third place among the world's AI markets, but France holds the position of the most important supplier of AI in European territory, and India delivers more such skills than the G20 states. In addition to these, there are other countries that have contributed to the development of the subject, namely Australia, Italy, Saudi Arabia, Brazil, and Malaysia, even if they have not had much influence among other researchers.

No.	Name	Scientific Production	Citations
	Sources		
1.	International Journal of Production Research	8	200
2.	Sustainability	6	21
3.	Annals of Operations Research	3	222
4.	Computers & Industrial Engineering	3	20
5.	IEEE Transactions on Consumer Electronics	3	10
6.	IEEE Transactions on Engineering Management	3	45
7.	Applied Sciences—Basel	2	18
8.	IEEE Access	2	18
9.	International Journal of Information Management	2	296
10.	International Journal of Production Economics	2	116
	Authors		
1.	Gupta Shivam	5	246
2.	Modgil Sachin	5	340
3.	Kumar Ajay	4	110
4.	Belhadi Amine	3	276
5.	Dwivedi Yogesh K.	3	155
6.	Singh Rohit Kumar	3	167
7.	Wamba Samuel Fosso	3	147
8.	Abadie Amelie	2	26
9.	Chowdhury Soumyadeb	2	26
10.	Dennehy Denis	2	56
	Countries		
1.	China	59	299
2.	United States of America	53	204
3.	United Kingdom	50	388
4.	India	32	304
5.	France	24	430
6.	Australia	11	28
7.	Italy	9	0
8.	Saudi Arabia	9	1
9.	Brazil	8	6
10.	Malaysia	8	2

Table 3. Scientific production and citations level depending on the source, authors, and countries.

Source: authors with the help of Biblioshiny [56].

Figure 1 shows the collaboration rate of the states that stood out as the most productive in the development of the theme related to the agility, adaptability, and resilience of AI in the area of management.

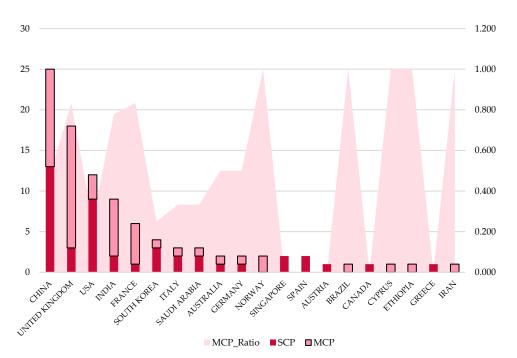


Figure 1. Collaboration of the most productive countries. *SCP* = *single country publications; MCP* = *multiple country publications; MCP_Ratio* = *multiple collaboration rate.* Source: authors based on data from Biblioshiny [56].

It is easily observed that among the first of the most involved states, China, the United Kingdom, the United States, India, and France, as previously described, are also those that have an important connection to the field of AI both as a result of significant investments and training and skills, as expected [72], making the topic easier to approach as a result of the multitude of resources that they own and allocate to this field of technology and AI. Likewise, they have an increased rate of collaboration with other states, with their authors being more open to sharing research experiences with authors from other regions, despite cultural, social, economic, and other differences. The authors of three of them, namely the United Kingdom, India, and France, actually produced more international articles than those developed only on a national level.

International collaborations in research are considered a way to increase the quality of scientific works, with the authors having the opportunity to share knowledge, experiences, and methods of analysis that can lead to the broadening of work perspectives and the generation of innovative ideas. Likewise, this international approach favors developing or newly developed countries in their journey to gain access to valuable information and technologies [73]. As the country with the most international collaborations in the ranking, 15 out of 18, the United Kingdom aims to reach out to researchers from all over the world, establishing long-term partnerships based on research excellence and providing access to infrastructure to facilitate collaborations and respond to challenges that arise in the fields studied. The proof lies in the actions of British researchers, with half of the work that is produced by its affiliated researchers being the result of collaborations with other countries [74].

China ranks second, with 12 documents made in collaboration across the country's border. According to Zhang et al. [75], China is regarded as having the fastest growth from the point of view of scientific research, cooperation at the international level could help to combine global and national features in building top university institutions on this land. In 2022, the United States ranked second in the global production of scientific publications after China, followed by India, whose main area of focus was computer and information

sciences [76]. It ranks third in our list of international collaboration options, with seven documents associated with it.

In the following, we note that Norway has associated two scientific papers made only in cross-border collaboration, and Brazil, Cyprus, Ethiopia, and Iran each produced one work for which they preferred to collaborate with authors outside of their geographical area. On the opposite pole, Singapore and Spain produced two documents in exclusive national collaboration, and Austria, Canada, and Greece both made one document each in the same manner.

However, considering the low number of papers or even unique papers, it cannot be said that these states do not want to collaborate, especially as it is a current topic that has appeared in recent years [77] for which there is still a lot of work to be carried out in order to be completely covered. South Korea, Australia, Germany, Singapore, Spain, and Canada are countries that deserve to complete the ranking considering the private investments allocated to the AI sphere that they conduct, their contribution being a significant one in directing the world towards AI discoveries [72].

In addition to the above, Figure 2 shows the network of collaborations at the worldwide level between states that contributed to the topic we are investigating. As can be observed in the image, countries are grouped into six categories, each representing the cluster of frequent science partners. There are two large clusters, which present themselves as the most complex and in which it seems that some of the leaders of AI research [78] are the ones who unite and coordinate the partners they have, as follows: (1) United Kingdom and India for the purple cluster formed by the Netherlands, Sweden, Denmark, Brazil, Senegal, France, Ireland, Cyprus, Morocco, Hungary, Vietnam, Pakistan, and the United Arab Emirates; (2) China and the United States of America for the green cluster together with Singapore, Bangladesh, Malaysia, Australia, Germany, Norway, South Africa, Estonia, Ethiopia, Iran, Saudi Arabia, Poland, and Portugal.

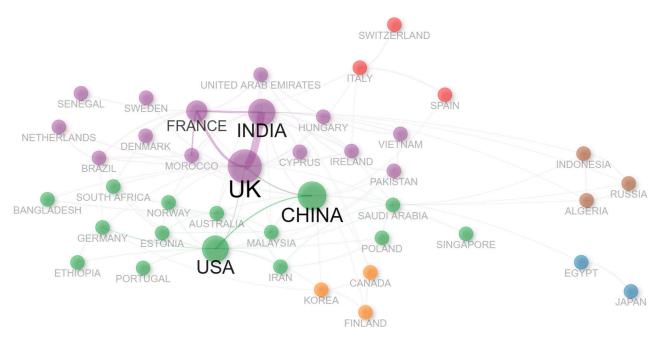
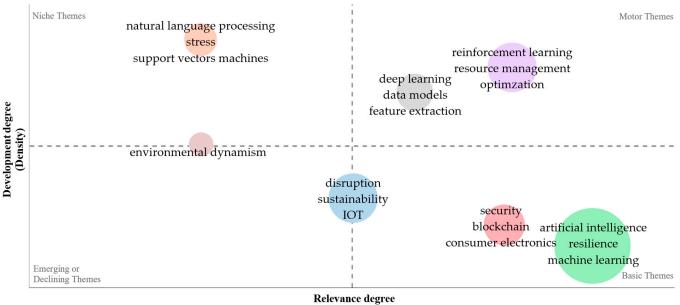


Figure 2. Collaboration network between countries. Source: Biblioshiny [56].

In addition to these, there are four smaller and simpler clusters that include between two and three partner countries and within which no leader stands out where they only seem to work together towards achieving their common goal. These are (1) Spain, Italy, and Switzerland; (2) Russia, Algeria, and Indonesia; (3) Korea, Finland, and Canada; and (4) Japan and Egypt. On a general level, the network does not show collaboration tendencies based on socio-cultural or economic trends, noting that partnerships have been established between European, Asian, and African states with the United States and Australia, evidence of openness towards other cultures and perspectives as well as the appropriate implementation of the principle of equal opportunities [79].

4.3. Temporal and Strategic Topic Evolution

Figure 3 is represented by a strategic map that, based on two coordinates, (1) centrality, which shows the relevance, and (2) density, which shows the development, frames the predominant keywords of the authors in four categories, highlighting the themes that were built with their help. Therefore, centrality helps show the external links on the basis of which a theme interacts with others in the research domain per assemblage, while density shows the intent with which keywords establish links within a topic [80,81].



(Centrality)

Figure 3. Strategic map. Source: authors with the help of Biblioshiny [56].

Basic themes, of general importance in the researched field, are grouped in two clusters. The first cluster, green, is larger and considers "artificial intelligence", "resilience", and "machine learning", defining concepts for our work, while the second cluster considers "security", "blockchain", and "consumer electronics". The motor themes designate the areas that help the development of the domain, and in the present case, they are exposed through two clusters: (1) a purple one represented by "reinforcement learning", "resource management", and "optimization"; (2) a gray one related to "deep learning", "data models", and "feature extraction". Niche themes are less explored, rendered by terms that interact but in a peripheral way and include "natural language processing", "stress", and "support vector machines". At the intersection of these and other emerging themes is "environmental dynamism", and at the intersection of emerging and basic themes "disruption", "sustainability", and "IOT" meet each other [81].

4.4. Thematic Evolution of the Research Topic

The analysis of conceptual structure [82] begins with the evolution of the main keywords used by the authors of scientific papers starting from 2021 and is presented in Figure 4. In the initial period analyzed, it can be observed that the most frequent terms used as basic benchmarks in works are "COVID-19", "resource management", "IOT", and "artificial neural networks" because AI technologies have played a primary role in the administration and control of the challenges generated by the pandemic period, and there was a need to be integrated into management decisions [83], while the Internet of Things leads to increased efficiency in the process of generating and using data, an approach that determines economic advantages [84].

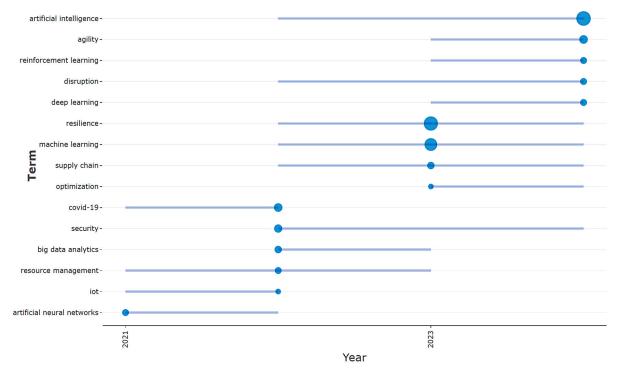


Figure 4. Main keywords evolution. Source: Biblioshiny [56].

The concepts associated with the period 2022–2023 refer to "big data analytics" and "resource management", which has expanded since 2021. In the 2022–2024-time frame, the interest of researchers has focused on concepts such as "artificial intelligence", the fundamental element of our paper, the approach of which seems to have expanded to the present day, alongside other notions such as "disruption", "resilience", "machine learning", "supply chain", and "security". It is noticeable the permanent attention that the mentioned concepts continue to receive, especially since they are characterized by a high novelty and complexity. Considering the fact that our topic falls within the context of management, it is natural that an important part of the analyzed documents refers to the supply chain, being a representative aspect and consisting of the network of organizations involved in various processes that aim to bring value through the products or services offered to the final consumer [85].

Likewise, resilience, another central dimension of our theme, refers to the system's ability to tolerate certain disruptions, manage negative influences, restore performance, and continue to function in an adaptive way, coping with environmental changes [23], and in the present case, the aim is to maintain resilience through AI, which, due to its capacity for deductive reasoning, can easily lead to the right decisions, based on the patterns it encounters [24]. Security comes in addition, especially as a result of cyber-attacks' intensification, meaning that it is absolutely necessary that this be placed in the strategic approaches of organizations in order to increase their resilience [25].

The current year brings to the forefront the notions of "agility", "reinforcement management", "deep learning", and "optimization". Agility refers to organizations or systems' calibration to respond adaptively to external fluctuations, opportunities, and threats [26]. Optimization is a crucial component in neural network research [86], the latter being studied alongside machine learning algorithms by deep learning processes [87], and the "reinforcement" note enables deep learning processes to learn how to interact with the environment based on the rewards received from the actions they generate [88].

Figure 5 completes the conceptual structure, presenting the thematic evolution of the topic of including the adaptability, agility, and resilience of AI in management systems, revealing the existence of two periods that have shaped it, namely 2007–2023 and the period of the current year (2024). It can be easily noticed that there are no major changes between the two periods, with the theme maintaining its fundamental pylons over time. According to Popa, Banciu, and Ștefan [89], for a better understanding of the thematic evolution, Figure 5 will be analyzed in parallel with the mapping of the two conceptual diagrams that describe the periods of the analysis.

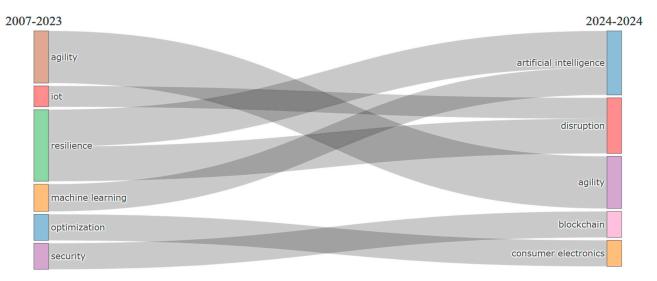


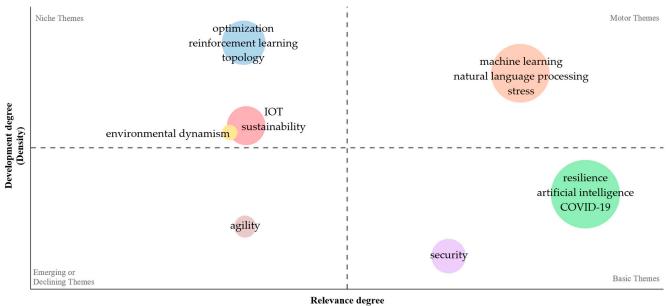
Figure 5. Thematic evolution during the period 2007–2024. Source: authors with the help of Biblioshiny [56].

The 2007–2023 period is highlighted in Figure 6, which is the first conceptual diagram resulting from the analysis process. It is characterized by an important number of scientific publications, 72 to be exact, but also by a remarkable number of citations. The scientific concerns of this period fall into all four types of themes [90], the most significant being that of AI resilience in the context of the COVID-19 pandemic, this being a basic, transversal theme. At the same time, security is a basic element, found in four papers.

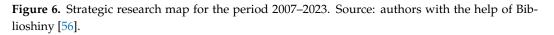
The motor themes, which present high centrality and density, have at their core concepts such as "machine learning", "natural language processing", and "stress", while the niche themes, with marginal importance and development, include topics such as (1) optimization, reinforcement learning, and topology; (2) Internet of Things in the context of sustainability; and (3) environmental dynamism. The emerging themes, poorly developed and marginal, did not expand much in the researched field, with them being strictly related to agility; it is most likely that in the future, this concept will intensify its presence, according to Wang, Lin, and Shao [91], making it a key component through which businesses can put in value resources to respond to environmental changes.

The period of 2024 is presented from a strategic and thematic point of view in Figure 7, which shows some slight changes compared to the previous one, referring to a number of 35 scientific papers designed.





Relevance degree (Centrality)



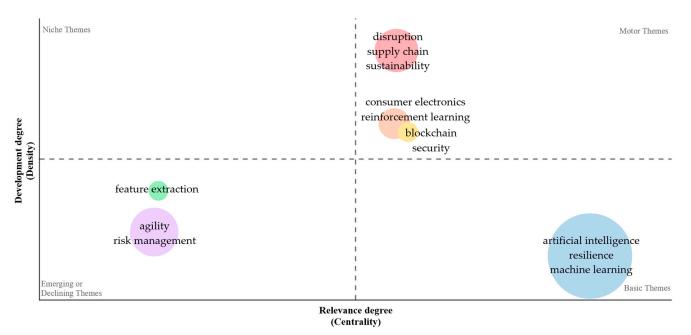


Figure 7. Strategic research map for the period 2024. Source: authors with the help of Biblioshiny [56].

The basic concerns keep their perspective of AI in relation to resilience, but this time the theme is complemented by the concept of "machine learning". In the area of motor themes, there are some interesting changes, with the focus shifting to (1) supply chain disruptions in sustainable frameworks; (2) reinforcement learning for consumer electronics; and (3) blockchain security. During this time, the niche themes have completely disappeared, the emerging themes are starting to gain momentum, with agility being linked to risk management, and in addition to these, feature extraction is also appearing, though it is not yet addressed very much, representing a rather specialized element in the area of data analysis that deals with their classification, grouping, and diagnosis [92].

5. Discussion

This study aims to outline the relationship between AI and the management system from the perspective of three essential dimensions in today's world, namely adaptability, agility, and resilience. To face the volatility and uncertainty of the environment present today in the life of organizations, agility and speed in decision-making processes are primary points to be achieved, and people play the role of their most important asset, as their knowledge and experience contribute to the creation of a suitable organizational design, which embraces the opportunities and uses the threats to their advantage [93]. At the same time, truly resilient economies are those that brilliantly survive crises, where returning to their normal functioning [94] and adaptability, as a key success factor in contemporary business dynamism, can increase the life of an organization [95].

To discuss in depth the significance of the three main dimensions addressed in relation to the management system, Table 4 presents, according to the most current scientific works studied within the bibliometric analysis, the meaning of adaptability, agility, and resilience from several different perspectives. These perspectives are the most common in the publications included in the analysis and manage to comprehensively capture the connection of the studied concepts with the management system.

Table 4. Current conceptual perspectives of adaptability, agility, and resilience according to the publications analyzed.

Concept	Perspective	Authors	Meaning
Adaptability	Supply chain management	Wu, Liu, and Liang [96]	The adaptability of the supply chain increases with the inclusion of AI in its management, being a necessity especially in Industry 5.0 where the chains are of great complexity, interconnected and susceptible to multiple interruptions.
	Energy management system	Elkholy et al. [97]	Adaptability supports the distribution of energy resources according to the availability and charging status of storage systems in order to maintain a continuous and reliable power supply.
	Environmental conservation	Wani, Rahayu, and Ben Amor [98]	AI early warning systems can be used in proactive responses to threats to the environment, which will increase accuracy, adaptability and real-time decision-making for its monitoring and conservation.
	Organizational management	Aljohani [99]	Strategic adaptability to deal with changes is a component of agility in addition to tactical thinking that provides quick responses to them.
	Computing network	Wang et al. [100]	Adaptability is one of the main coordinates of an integrated AI computing network system, along with flexibility and profitability.
	Supply chain management	Yamin et al. [101]	The ability of an organization to maintain the continuity of its logistics operations is called agility.
	Software engineering development	Saklamaeva and Pavlič [102]	In order to implement agile methods, an open attitude of the organization and the staff towards change processes is necessary.
	Organizational management	Khan [103]	Agility is a prerequisite for organizations to survive and gain competitive advantage in order to prosper in the market.

Concept	Perspective	Authors	Meaning
Agility	Organizational and supply chain risks	Aljohani [99]	Proactive risk mitigation is a necessary condition for achieving agility, which supports efficient and rapid responses to unforeseen disruptions.
	Governance	Li, Fan, and Nie [104]	Agile governance is based on the use of adaptability, flexibility, iterativeness and responsiveness to uncertain situations in order to stay away from costly failures.
Resilience	Supply chain management	Yamin et al. [101]	Resilience can be seen as the ability to return to the normal status of operations after disruptions have occurred.
	Urban systems	Lu, Zhai, and Zhai [105]	The process of absorption, adaptation and transformation to the received shocks of urban systems, containing to fulfill their fundamental functions simultaneously, refers to urban resilience.
	Urban heat environment	Liu, Wang, and Bai [106]	Heat resilience considers the ability of cities to withstand and recover from heat waves.
	Energy management system	Habib and Hwang [107]	Resilience refers to the ability to satisfy energy demand despite disruptive events such as fires, disasters, technological problems.
	Entrepreneurship	Shore et al. [108]	Being vital to business success, resilience involves overcoming challenges and adapting to unpredictable situations, preserving fundamental values and harmonizing strategies according to the state of the market.

Table 4. Cont.

Source: authors.

We note that the most common perspective from which the meaning of the concepts is rendered is that of supply chain management [96,101], complemented by energy management systems in the cases of adaptability [97] and resilience [107], but also organizational management in the case of adaptability [99] and agility [103]. Adaptability is also addressed in papers that consider *environmental conservation* [98] and *computing networks* [100]. In general, we note the proactive side of the concept, which supports the correlation of the activity with the environmental conditions, regardless of their changes. Regarding agility, we can say that it was approached from points of view such as software engineering development [102], organizational and supply chain risks [99], and even governance [104], the result being that it complements adaptability, supporting the continuity of actions and the entity optimal functioning. Last but not least, resilience has been linked to topics such as *urban* systems [105], urban heat environment [106], and entrepreneurship [108], with this representing the dimension that makes it possible to return to normal parameters, supporting the absorption of shock-type events in the usual actions of the entity. All of this only serves to highlight the diversity of areas in which the three attributes of management systems are necessary and can be integrated, proving that, regardless of the industry, sector, or field specifics, by focusing on acquiring and growing them, organizations can achieve a favorable, strong, and competitive status.

Furthermore, the integration of AI in economic activities requires an ability to consider the specificities of each field under discussion [109], the management systems, and the architecture of entire enterprises differing according to them. As can be seen from Table 4, it is difficult to highlight a general approach to specific applications of the AI sphere in the context of supporting the adaptability, agility, and resilience of management systems, except in very clearly contextualized situations. As Del Giudice and Della Peruta [110] argue in their study, the integration of modern technologies within businesses requires the continuous and progressive development of knowledge that, together with that already held, ensures a profitable and sustainable evolution. However, an eloquent example of AI applications and their impact on the management system is provided by Kampik et al. [111], with their research proposing a large process model (LPM) that helps merge knowledge with large language models (LLMs), thus allowing for a reduction in the efforts and time periods required for business transformation. AI can also positively impact the adaptability of management systems by supporting organizations' learning to deliver improved customer experiences, facilitating the selection of effective initiatives targeted at each customer category.

ML, in turn, supports predictions that can be used regarding customer interactions and individual sales leads, while NLP automates the sales side by integrating chatbots, which are four times more productive than staff [112]. In addition, the jobs' quality is influenced by AI through the reduction in monotonous tasks and avoiding risky ones, leading to a higher level of employee involvement, but also their safety. Future skills are not to be neglected either. Jobs, although partly replaced by technologies, cannot be covered by them entirely, especially those that involve creativity and soft skills [109]. Likewise, according to Kopka and Fornahl [113] regarding performance in companies, it seems that such technologies support productivity more in small organizations and innovation in large ones.

Paschek et al.'s [114] study of 25 German digital companies demonstrates that process automation and optimization as well as business process management support can be efficiently supported by DL, ML, and AI as a result of algorithms and data analysis use, while the research conducted by Beheshti et al. [115] shows how generative technology can, by training on large datasets and business process models, lead to decisions that are appropriate for contexts and users. Among the benefits generated are conversation understanding, domain-specific knowledge acquisition, decision-making support, collaborative workflows, privacy preservation, and integration with existing systems. Thus, the context of digital transformation has brought about the integration of AI technologies in companies, which has translated into improvements at the organizational level, but also at the process level [116]. Moreover, the study developed by Popa et al. [117] reveals the positive impact that the digitalization process in public organizations has on all the five management functions, namely planning, organizing, coordinating, motivating, and controlling.

6. Conclusions

The topic of this research was noted for a prominent level of novelty, as well as a strong interest from researchers from countries that are leaders in AI technologies and research worldwide, such as China, the United States of America, Great Britain, France, and India [118]. A gratifying aspect is that the trend given by these leaders encourages many other countries around the world to become scientifically involved in topics in the field of AI. International partnerships do not show collaboration tendencies based on socio-cultural or economic specificities, with them being involved in the network states of each continent, which shows openness towards other cultures and a positive impact on the quality of scientific publications by sharing knowledge, experiences, and analysis skills. The thematic and strategic developments highlight the approach of some concepts related to the specifics of management, but also characterized by a strong technical character, highlighting the importance of involving the new technologies of Industry 5.0 in the practices of organizations in order to align with current standards and respond appropriately to the new needs generated by this era.

Theoretical implications. This research highlights the adaptive, agile, and resilient trends of AI in the field of management, highlighting the scientific progress made to date with the help of thematic, strategic, and social perspectives. This paper can provide support for future analyses that complement information on the role of AI in relation to management systems. At the same time, it can be the starting point of some works with a higher technical level, which combines the economic side with engineering, and deals with highly topical concepts that can be integrated into organizational measures such as feature extraction, reinforcement learning, and natural language processing but can also support studies that address the impact of integrating the three main attributes into management processes

Managerial implications. The interest in the present work comes from an organizational background, both from people with management positions and from the executors regarding the understanding of the importance of integrating the latest technologies in the daily activity in order to make the work processes more efficient, support the person in learning some new skills in the relationship with artificial intelligence, and also to respond in a comprehensive, appropriate, and better adapted way to the needs of today's customers.

with the help of AI on the organizations and information systems' architectures.

The limits of this research include the meeting of some concepts with an accentuated technical character, which made it difficult to interpret the results related to them. Simultaneously, given the novelty of the topic, an in-depth perspective cannot yet be described since the works published on this topic contextualize the most common circumstances, with the exceptions to the rule and special particularities being in the process of discovery. Likewise, bibliometric analyses do not necessarily have a high degree of applicability in the professional area, being most often intended exclusively for the academic environment. Regarding the exclusive use of the WoS database, it can be mentioned that this paper does not outline the perspective of all scientific works on this topic, considering also the chronological gap in terms of the publications that appear in the specialized database. Likewise, the use of only the Biblioshiny software program makes it possible to perform standard analyses from the package offered.

Future research directions may consider suitable AI tools that help increase the adaptability, agility, and resilience of management systems, but also how organizations without a basic technical background relate to integrating AI tools into their practices, considering the difficulties seen at first sight. Moreover, given that our study only deals with a part of the management system, focused on the overall picture, for the purpose of in-depth analysis, future research should consider how the architecture of the organization, as well as of the information systems, is impacted by the integration of AI practices. In this way, the changes that occur in the management processes when they are in relation to various AI components can be observed.

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