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Review

Leaders' Competencies and Skills in the Era of Artificial Intelligence: A Scoping Review

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Abstract

The era of artificial intelligence (AI) is challenging for company leaders who have to systematically observe the evolving digital environment, as well as to adopt and effectively implement new technologies within their organizations. Effective deployment of AI in a company requires full commitment of the management staff, as it plays a crucial role in shaping employee behavior. As a result, the connection between AI and leadership has increasingly been a subject of academic inquiry, although it has not yet been sufficiently examined. Therefore, the aim of this article is to determine the competencies and skills required for leaders in companies that implement AI. To fulfill this purpose, a scoping review was conducted in accordance with the PRISMA-ScR checklist and diagram flow. The study, conducted in March 2025, involved a review of articles relevant to the research topic that were indexed in the Web of Science, Springer Nature Link, and Scopus databases. The review was limited to open-access articles available in English. Out of the initial 463 articles, 28 studies were qualified for full-text review, of which 17 were selected for detailed assessment. The research led to the identification of a set of 15 competencies and skills considered essential for leaders tasked with AI implementation. The proposed recommendations are meant to improve the development of competencies and skills of leaders involved in decision-making related to AI technology implementation in companies. The findings of the study may enable more effective utilization of AI by prompting changes in leaders' behaviors.

Keywords: leader; competence and skill; artificial intelligence; decision-making; recommendation

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1. Introduction

The use of artificial intelligence (AI) by various business entities in their daily work is becoming a common practice [1]. Therefore, companies that do not start adapting to new trends in digitization today may fall behind the competition in the future, as they could eventually fail to keep up with the market demands. Consequently, leaders who are able to effectively utilize AI technologies can optimize resource allocation and anticipate market trends more accurately [2].

AI can improve workflow within the organization in many ways, including streamlining administrative processes and automating routine tasks [3]. This improvement is essential, especially when managers perform repetitive tasks or need to process large volumes of data. AI can enhance the effectiveness of decision-making by offering various

analytical capabilities and data-driven insights [2]. However, some tasks (especially dealing with interpersonal leadership, such as coaching, mentoring, or motivating) could be more difficult to automate because of their non-routine nature and the personal consideration involved [4]. Furthermore, the use of artificial intelligence potential in organizations also depends on the leadership of senior managers who play a key role in its implementation and use [5]. Therefore, the linking of artificial intelligence with leadership is crucial [6]. Matli [7] pointed out that it is necessary to conduct research focused on leadership characteristics and related implications so that leaders can function in an ever-more digital world.

Schmidt et al. [8] noted that although the competencies and skills of leaders have been the subject of research and analysis, technological developments require a different approach to leadership research. In particular, management is no longer considered a human practice, but a process embedded in technology. Consequently, organizational learning will increasingly be embodied in IT-driven processes [9]. Furthermore, the growing importance of AI is shifting the balance of power away from the managerial hierarchy to a larger group of specialists who have expertise in analytics, programming, and business [10]. This fact was also highlighted by Zaidi et al. [6], who suggested that future research should focus on the development of tech-savvy leadership skills and competencies, as these help to shape an effective AI-driven environment.

According to a report prepared by McKinsey&Company [11], 46% of leaders identified skills gaps in their workforces as a significant barrier to AI adoption. Thus, a research gap has been recognized in the literature, as there is a need to identify the competencies and skills of leaders dealing with AI.

The research question was formulated as follows: What specific competencies and skills are necessary for leaders dealing with AI? Hence, the aim of this article is to determine the competencies and skills required for leaders in organizations that implement AI. The research results contribute to systematizing the knowledge on the most needed leaders' competencies and skills.

This article has a theoretical framework: a scoping review of the literature using the PRISMA flow diagram and PRISMA-ScR checklist [12] was used to conduct the research. The analysis included scientific articles from three databases: Web of Science, Springer Nature Link, and Scopus. Based on the results obtained, it was possible to fill in the identified research gap by identifying a set of 15 competencies and skills, which was followed by proposing recommendations on how to improve them. From a practical point of view, the proposed recommendations can be a valuable guide for managers who want to use and develop the potential of AI in their organizations. In the article, we refer to "organizations"; however, the research results may be applied by representatives of different entities, including small, medium-sized, or large companies/enterprises, as well as government bodies, non-profit organizations, and other institutions.

The leaders' role in the era of AI is discussed in Section 2 of this study. The research method applied is presented in Section 3. The competencies and skills identified during the scoping review and their categorization according to the topics they concern are described in Section 4. The study is summed up with a discussion and synthetic conclusions, which include the limitations and indicate further research directions (Section 5).

2. Literature Review

AI is dealing with the use of technology-aided systems that may have human-like dimensions for problem-solving and decision-making [13]. Nowadays, AI solutions are increasingly being implemented in companies and may include the following [1]: technologies that analyze written language, technologies that convert spoken language into

machine-recognizable form (speech recognition), technologies that generate written or spoken language (natural language generation), technologies that recognize objects or persons from an image (image recognition, image processing), machine learning for data analysis, technologies that automate processes or support decision-making, technologies that enable machines or vehicles to physically move by making autonomous decisions based on observations of the environment. Multi-agent systems (MAS) are also based on AI solutions, allowing them to autonomously solve complicated tasks on behalf of a user.

According to the results of the McKinsey survey (2017), 25% of chief executive officers' workload could potentially be automated, no matter whether it is a high skill or low skill task [14]. In turn, according to the results of the Gartner survey (2019) [15], 37% of the world's companies have implemented AI in one or another form, which represents a 270% increase over the previous four years. Considering that AI is developing very fast [16], appropriate regulations have been introduced [17–20] that should be taken into account by leaders who are planning to implement AI or already apply it.

The role of leadership in the era of AI is undergoing a significant transformation. Companies need leaders who can successfully adopt AI opportunities for their businesses and change them into new business models by utilizing the qualifications of individuals as human resources [21]. Although humans are currently responsible for making final decisions, the direction of AI development indicates that increasingly advanced technologies may radically change this arrangement in the future. The challenges faced by leaders include, among other things, decision-making in distributed systems, ethical oversight of autonomous agents, and work coordination in human-AI teams. In this regard, Matli [7] highlighted the complex nature of leadership as a set of human skills and developing technological capabilities of artificial intelligence that should have the potential to interact and reinforce each other in contexts of modern organizations' operation.

According to van Quaquebeke and Gerpott [22], technology will evolve from a simple tool for human leaders (i.e., the NOW) to the (pro)active advisory/support role for human leaders (i.e., the NEW) to eventually substituting for human leadership (i.e., the NEXT). The authors [22] believe that NEW leadership will become the standard in just a few years. Task-related leadership includes observing employees' work progress, offering task-related advice, helping with problems, or contributing to effectively structuring the work process. A summary of these considerations is presented in Table 1.

Table 1. Stages of leadership development [own elaboration based on [22]].

Leadership Stage	Key Characteristics and Changes
NOW of leadership	Traditional leadership functions transferred to the digital environment (e.g., online meetings, remote management). Humans remain the main decision-makers.
NEW of leadership	Human collaboration with AI. Algorithms support leaders through data analysis, action recommendations, and dashboards. AI assists in decision-making, but humans remain responsible.
NEXT of leadership	AI independently takes over leadership functions. Algorithms respond to the psychological needs of employees: autonomy, competence, and relationships. Employees may prefer AI as a fair, fast, and neutral source of decisions.

Table 1 shows the changes in the roles of leaders over time. These changes will naturally affect the leaders' competencies and skills, which must also undergo transformation. As AI technologies increasingly permeate the workplace, understanding their impact on leaders' attitudes and behaviors becomes crucial to maintaining productivity, efficiency, and workplace stability (combating job security concerns, employee stress, and fear of AI) [15].

Today's leaders can be supported by AI in many ways. For example, in the corporate world, relevant AI-based solutions include MAS or tools such as dashboards for leaders that provide them with frequent updates on the challenges facing their team, and

data-driven recommendations on actions that can be taken to address those challenges (e.g., MONDAY.ROCKS) [22,23].

AI is typically implemented in companies and used together with other advanced digital technologies [24]. However, it was noted that the key challenge remains and deals with the formulation of a coherent vision and roadmap to set the direction of the enterprise's digital transformation [25]. While implementing AI, during the development of complicated projects, an interdisciplinary character of the team involved in this endeavor is required [26]. This, in turn, necessitates the need to develop special competencies and skills of the team leaders dealing with AI. However, Herrmann and Pfeiffer drew attention to the fact that appropriate organizational practices are needed to facilitate the implementation of AI [27]. Moreover, Aldoseri et al. [28] highlighted that an integrated approach to implementing artificial intelligence goes beyond ordinary technological improvements and involves a paradigm shift towards a culture of continuous learning and innovation.

Despite extensive research and rapid progress in the field of AI, some tasks will remain the responsibility of humans. This is emphasized, among others, by van Quaquebeke and Gerpott [22], who pointed out that "true" leadership deals with motivating and enabling people to contribute to the organization's common goals and is still seen mainly as a human prerogative. However, it is becoming inevitable to reorganize certain competencies and skills that play and will continue to play a key role in future leadership. AI-employee coexistence depends on workers' technical, human, and conceptual skills [29]. Babashahi et al. [30] underscored the importance of crucial skill sets, such as technical proficiency and adaptability, to successfully adopt AI.

According to the Cambridge Dictionary [31], "skill" is an ability to do an activity or job well, especially because you have practiced it. In turn, Nijs et al. [32] defined skills as "systematically developed innate abilities that drive excellent performance in one or more domains of human functioning". The term "competence" is broader than "skill". Rodriguez et al. [33] defined competencies as measurable patterns of knowledge, skills, abilities, behaviors, and other characteristics needed to perform a task successfully. According to Vitello et al. [34], competence is the ability to integrate and apply contextually-appropriate knowledge, skills, and psychosocial factors (e.g., beliefs, attitudes, values, and motivations) to consistently perform successfully within a specified domain. Competencies may result in a higher probability of success [35]. Very often in the literature, both competencies and skills are addressed [21].

Abositta et al. [36] highlighted the need for continuous learning and recalibration of leaders' skills, developing advanced technological competencies and adaptive skills that complement AI capabilities, in order to remain competitive in technologically evolving environments. It was also noted that it is crucial to search for ways to coexist with AI while striving for a human-centric future [37]. Despite the concerns about job displacement by AI and changes in required skill sets, organizations and policymakers have to proactively address these challenges by developing reskilling and upskilling programs to raise the level of workers' and managers' competence on AI concepts implementation [21].

Future potential technical/hard skills (including language processing, machine learning, machine vision, Big Data, IoT-related technologies, programming skills, decision-making, etc.) and soft skills (including lifelong learning, adaptability, creativity, communication, emotional intelligence, etc.) that could be needed in the future were considered by Babashahi et al. [30]. Saddam and Anvari [38], in turn, explored the style of leadership adopted within an organization and stated that emotional stability and artificial intelligence training could improve corporate employees' ability to deal with professional challenges. Štrukelj and Dankova [39] drew attention to interdependence between orga-

nizational decision-making levels and styles with an emphasis on the role of AI in this process, considering intuitive, analytical, and routine decision-making types/styles.

The analyzed available literature provides recommendations for leaders to improve decision-making related to AI implementation; however, they were not related to the development of specific competencies. Haq et al. [40] recommended tracking adoption over time, offering insights into technology diffusion, organizational learning, and performance sustainability. Alajrab et al. [41] pointed out the need to facilitate the incorporation of strategic insight and AI-based solutions to improve the performance of services.

Based on the analysis of the available literature, the following was stated:

- The leaders' competencies and skills related to AI evolve and should be analyzed in more detail;
- The recommendations for leaders dealing with AI should be elaborated, considering the development of leaders' specific competencies and skills.

3. Materials and Methods

In order to conduct the research study, a scoping review was carried out to synthesize the evidence and assess the scope of the literature on the topic indexed in three databases containing full-text publications. It was assumed that two core databases should be reviewed (Web of Science Core Collection and Scopus), supplemented by the Springer Nature Link database. These three databases were chosen to ensure access to publications available for international readers on topics related to multidisciplinary research, including engineering, management, and leadership studies.

While reviewing the articles from these databases, three main restrictions (which were also considered as eligibility criteria) were applied:

1. Specific keywords had to be included in the article's title;
2. Only articles written in English were considered;
3. Only open-access articles were analyzed.

These restrictions were selected to ensure transparency, replicability, and accessibility of the review for a broad range of international readers, including both scholars and practitioners without subscription access. It was decided not to limit the study to a specific time period in order to avoid an incomplete understanding of the topic. One of the reasons for refraining from limiting the study to a specific sector was the interdisciplinary nature of AI research and applications that may encourage scholars from diverse academic backgrounds to contribute to the field and publish their research results in various scientific journals [5]. The articles that include characteristics of leaders in terms of their competencies, skills, abilities, capacities, qualities, qualifications, traits, or functions were selected for detailed content analysis.

The study was conducted in March 2025. The articles (obtained from all the analyzed databases and selected on the basis of the predefined eligibility criteria) were exported to a Microsoft Excel file for further processing. Two independent reviewers (the authors of this study) manually screened the titles and abstracts of the selected articles to determine their relevance to the research topic. Duplicated records were removed from the dataset. Any disagreements between the reviewers were resolved through discussion and, where necessary, by jointly re-examining the abstracts to reach consensus on inclusion or exclusion of that article for full-text review. At this stage, mismatched articles were excluded from consideration. No additional literature sources were searched. The individual stages of the research were protocolized in accordance with the PRISMA-ScR checklist. PRISMA flow diagram for the conducted scoping review of selected databases is presented in Figure 1.

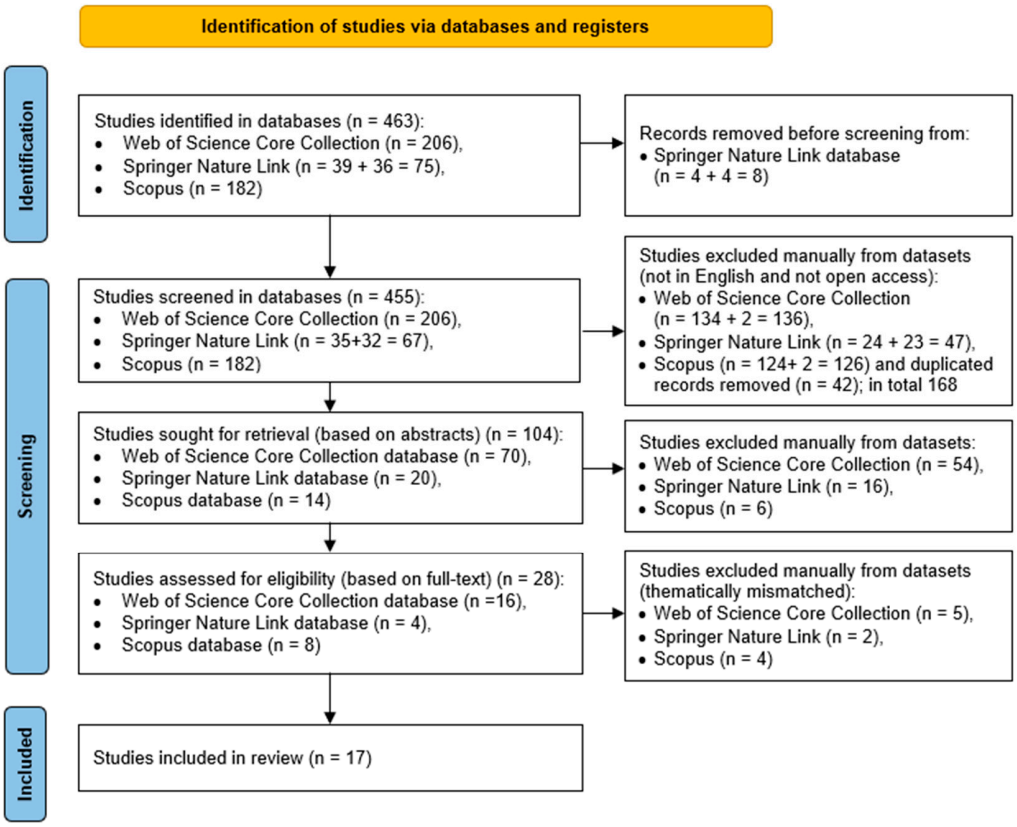

Figure 1. PRISMA flow diagram for scoping review, which included searches of databases [own elaboration based on [12]].

In the Web of Science Core Collection database, the following keywords were used to search for articles' titles: "artificial intelligence" and "leader*" or "AI" and "leader*". By using an asterisk (*), we avoided excluding inflected words (e.g., leadership, etc.). A total of 206 results were yielded. After selecting only open-access articles, 72 publications were obtained. As only articles in English were considered, 70 literature sources from the Web of Science Core Collection database were ultimately selected for abstract analysis.

The same procedure was applied to search for the articles in the Springer Nature Link database, using the keywords "artificial intelligence leader*", which had to be included in the articles' titles, and thus 39 records were retrieved. Four articles were the same as those found in the Web of Science Core Collection database. These articles were removed manually during the data cleaning process to ensure the integrity of the obtained dataset. Out of the 35 publications found, 24 were paywalled (closed-access) articles, so they were eliminated from further consideration. During the next step, the combination of keywords "AI leader*" was used to search for the articles in this database. Thirty-six records were obtained, of which four articles overlapped with those found in the Web of Science Core Collection database. It also turned out that 23 out of 32 articles were fee-based. Finally, 20 articles were selected from the Springer Nature Link database for further analysis of abstracts.

The Scopus database was also checked, and the same procedure as in the two previous cases was applied, i.e., the keywords "artificial AND intelligence AND leader*" or "AI AND leader*" were entered to search for publications. The option to include these words in the articles' titles was applied. A total of 182 records were obtained. In this case, it was decided to change the order of exclusions and, as a first step, limit the search to open-access articles only, which allowed us to narrow the scope down to 58 results. After selecting the articles in English, 56 results were retrieved. After comparing the obtained articles' titles to

those acquired from the Web of Science database, it turned out that 42 articles overlapped. Therefore, they were removed from the dataset, and ultimately, 14 articles were selected for further full-text analysis.

A total of 104 articles from the Web of Science Core Collection, Springer Nature Link, and Scopus databases were qualified for abstract analysis.

After a detailed review of abstracts, 28 articles were selected for further full-text analysis:

- Web of Science Core Collection database—16 articles;
- Springer Nature Link database—4 articles;
- Scopus database—8 articles.

A total of 28 articles were selected for content analysis.

After conducting the full-text screening, it was found that 17 articles met the final criteria for the detailed review. These articles were reviewed to address the issue under investigation. Selected data items characterizing the identified 17 articles are shown in Table 2.

Table 2. Selected data items characterizing identified literature items [own elaboration based on [3,5–7,21,36,37,42–51]].

Authors	Authors' Country	Method/Study Type	Research Theory/Concept/Model	Sector/Study Context
Pang and Zhang (2021) [42]	China	Theoretical reflection	Network game theory	n/a
Peifer et al. (2022) [43]	Germany	Literature study	Not available	Interdisciplinary
Harisanty et al. (2022) [44]	Indonesia, Malaysia	Qualitative study (questionnaires, open-ended questions)	Not available	Library
Anghel (2023) [45]	Romania	Informal discussions	E-recruitment and leadership concepts/Model Honeycomb Complementary Skills Model (HCSM)	Interdisciplinary
Karakose et al. (2023) [46]	Turkey	Qualitative comparative analysis (QCA) based on expert evaluation of AI-generated responses	AI-based large language model (LLM): ChatGPT-3.5 and ChatGPT-4	Education
Abositta et al. (2024) [36]	Turkey	Surveys (electronic and paper)	Transformational Leadership Theory, Adaptive Structuration Theory (AST)/Technology Acceptance Model (TAM)	Engineering firms (manufacturing, construction, and information technology)
Tursunbayeva and Chalutz-Ben Gal (2024) [21]	Italy, Israel	Narrative report	Human-capital approach/Technology, Organization, People (TOP), a framework-based checklist	n/a
Sriharan et al. (2024) [47]	Canada, United States	Systematic literature reviews	Contingency leadership theories, complexity theory, and transformational leadership theory	Health care
Ennis-O'Connor and O'Connor (2024) [48]	Ireland	Narrative report	Not available	Health care
Lee and Cosgrove (2024) [49]	USA	Narrative report	Not available	Health care
Matli (2024) [7]	South Africa	Systematic literature review	Reflexivity concept (social theory)	Interdisciplinary
Ghamrawi et al. (2024) [3]	Qatar, Lebanon	Qualitative study (semi-structured interviews)	Not available	Education
Dai et al. (2024) [37]	Australia	Narrative report	Herbert Simon's administrative decision-making theory and Henry Mintzberg's managerial role theory	Education

Table 2. *Cont.*

Authors	Authors' Country	Method/Study Type	Research Theory/Concept/Model	Sector/Study Context
Madanchian et al. (2024) [50]	Canada	Narrative report	Not available	Interdisciplinary
Hoang (2025) [51]	Vietnam	Mixed methods (semi-structured interviews and survey)	E-Leadership Theory and the Technology Acceptance Model	Education
Bevilacqua et al. (2025) [5]	Italy, Slovakia, Norway, Cyprus, Hungary	Systematic literature reviews	Upper echelons theory (UET), based on the resource-based view (RBV) and new institutional theory (NIT)	Interdisciplinary
Zaidi et al. (2025) [6]	Pakistan	Qualitative study (semi-structured interviews)	Self-determination theory (SDT)	Information technology

To ensure transparency of the results, a basic appraisal of the included studies was conducted, classifying them as high, medium, or low quality according to the clarity of methodology, adequacy of sample, and relevance to the research question (Table 3).

Table 3. Basic appraisal of the finally reviewed articles [own elaboration based on [3,5–7,21,36,37,42–51]].

Authors	Study Type/Method	Clarity of Methodology	Sample Adequacy	Relevance to Topic	Overall Quality *
Pang and Zhang (2021) [42]	Theoretical reflection	Clear	Not applicable	High	Medium
Peifer et al. (2022) [43]	Literature study	Partial	Not applicable	Medium	Medium
Harisanty et al. (2022) [44]	Qualitative (open-ended questionnaire)	Clear	Adequate	High	High
Anghel (2023) [45]	Informal discussions	Limited	Not specified	Medium	Medium
Karakose et al. (2023) [46]	QCA (expert evaluation, AI responses)	Clear	Adequate (expert-based)	High	High
Abositta et al. (2024) [36]	Survey (electronic + paper)	Clear	Adequate	High	High
Tursunbayeva and Chalutz-Ben Gal (2024) [21]	Narrative report	Partial	Not specified	Medium	Medium
Sriharan et al. (2024) [47]	Systematic literature review	Clear	Not applicable	High	High
Ennis-O'Connor and O'Connor (2024) [48]	Narrative report	Partial	Not specified	Medium	Medium
Lee and Cosgrove (2024) [49]	Narrative report	Partial	Not specified	Medium	Medium
Matli (2024) [7]	Systematic literature review	Clear	Not applicable	High	High
Ghamrawi et al. (2024) [3]	Qualitative (semi-structured interviews)	Clear	Adequate	High	High
Dai et al. (2024) [37]	Narrative report	Partial	Not specified	Medium	Medium
Madanchian et al. (2024) [50]	Narrative report	Partial	Not specified	Medium	Medium
Hoang (2025) [51]	Mixed methods (interviews and survey)	Clear	Adequate	High	High
Bevilacqua et al. (2025) [5]	Systematic literature review	Clear	Not applicable	High	High
Zaidi et al. (2025) [6]	Qualitative (semi-structured interviews)	Clear	Adequate	High	High

* Overall quality rating: High—well-described methodology, adequate sample, strong relevance, Medium—partial clarity of methodology or limited sample, but still relevant, Low—weak or informal methodology, limited relevance.

A review of 17 selected articles allowed for the identification of the competencies and skills mentioned in the analyzed studies. On that basis, a set of 15 competencies and skills was identified. The frequency with which the identified competencies and skills were mentioned in the analyzed literature was assessed. This categorization was intended to enhance the systematic approach. Each of the determined competencies and skills corresponds to the individual requirements facing leaders. Recommendations for leaders dealing with the development of specified AI-related competencies and skills were also proposed.

4. Results

4.1. Identification of AI-Related Competencies and Skills Mentioned in the Selected Publications

Based on the detailed review of the 17 selected articles, it was possible to identify the competencies and skills related to AI mentioned in the literature (Table 4). It should be

noted that these articles were published in 2021–2025 and present the current view on the topic under analysis.

Table 4. Competencies and skills related to AI, mentioned in the reviewed articles [own elaboration based on [3,5–7,21,36,37,42–51]].

Authors	Terminology Used by Authors of Reviewed Articles	Mentioned Competencies/Skills
Pang and Zhang (2021) [42]	Functions/qualities	• Ability * • Respect for others • Good judgment * • Open to different views • Consistency • Sincerity and transparency * • Vision • Equality * • Self-awareness • Caring for others • Prudence * • Empathy • Sense of responsibility • Confidence • Intelligence * • Keep the promise • Self-control * • Listening • Organization * • Altruism • Resilience * • Scientific decision-making
Peifer et al. (2022) [43]	Qualifications and competencies	• Professional competencies • Methodological competencies • Personal competencies • Social competencies • Ethical values
Harisanty et al. (2022) [44]	Competencies: professional and soft skills	• Information technology (IT) • Artificial intelligence skills and knowledge • Data analytics • User behavior • System design • Flexibility and adaptability to new situations and technologies • Creativity • Innovation • Critical thinking • Collaboration • Communication
Anghel (2023) [45]	Skills	• Emotional intelligence supported by critical thinking • Regular communicator supported by creativity and improvisation • Wise risk-taking supported by resilience • Lifelong learning supported by observation ability
Karakose et al. (2023) [46]	Skills	• Technological literacy • Strategic thinking • Ethical leadership • Visionary leadership • Change management • Communication • Collaboration • Data-based decision making
Abositta et al. (2024) [36]	Skills and abilities	• Decision-making • Human judgment • Coming up with ideas • Inspiring people and teams • Capacity to mentor and emotionally support staff members

Table 4. *Cont.*

Authors	Terminology Used by Authors of Reviewed Articles	Mentioned Competencies/Skills
Tursunbayeva and Chalutz-Ben Gal (2024) [21]	Skills	• Technical programming skills • Motivation • Talent–fit alignment • Knowledge management • Employee motivation
Sriharan et al. (2024) [47]	Skills/capacity	• Technical capacity: • AI literacy • Subject-matter knowledge • Change leadership skills • Innovation mindset • Interpersonal capacity: • The ability to foster partnerships among diverse stakeholders • The ability to comprehend diverse stakeholder perspectives and deftly influence adoption • The ability to build trust and collaboration • Self-awareness and humility to assemble teams with complementary skills • The integrity and accountability to embody ethical principles • Adaptive capacity: • The foresight and sense-making abilities • The agility to identify and capitalize on transformative opportunities, swiftly adapting and aligning strategies with evolving contexts • Systems thinking
Ennis-O'Connor and O'Connor (2024) [48]	Skills and competencies	• Technological literacy • Long-term strategic vision • Change management • Ethical decision-making
Lee and Cosgrove (2024) [49]	Core competencies	• Basic understanding of AI and familiarity with how commonly used applications work • Integration of AI technologies into the overall organizational strategy • Change management • Understanding regulatory requirements, ethical issues, and other types of risks associated with AI
Matli (2024) [7]	Skills	• Self-awareness • Critical reflection • Ethical judgment • Reflexivity • Decision-making with human oversight • Complex problem-solving • Motivation • Relational capacity • Strategic thinking • Collaborating with AI
Ghamrawi et al. (2024) [3]	Set of competencies	• Technological literacy • Adaptability and continuous learning • Collaborative and coaching skills • Data-informed decision making • Human-centered approaches
Dai et al. (2024) [37]	Capacity/roles	• Emotional intelligence • Creativity • Empathy • Curiosity • Communication • Mutual understanding • Formulating visions • Fostering networks and collaborations • Inspiring people • Motivation • In-depth understanding of AI system performance • Dealing with conflicts • Decision-making

Table 4. *Cont.*

Authors	Terminology Used by Authors of Reviewed Articles	Mentioned Competencies/Skills
Madanchian et al. (2024) [50]	Skills	• Data-driven decision making • Mentoring and coaching • Human intuition • Relationship development • Dispute resolution • Handling complex situations • Emotional intelligence • Critical thinking • Ethical and bias mitigation
Hoang (2025) [51]	Competencies	• Technical proficiency • Pedagogical innovation • Digital collaboration • Change management • Digital communication
Bevilacqua et al. (2025) [5]	Skills/personal traits	• Data-driven decision-making • Agility • Emotional and social intelligence • Technical skills and underlying principles of AI • The ability to analyze data critically and accurately • Openness to innovation • Risk tolerance • Adaptability
Zaidi et al. (2025) [6]	Traits of AI-congruent leaders	• Mobilizer • Humanist
Zaidi et al. (2025) [6]	Traits of AI-congruent leaders	• Innovator • Social builder • Agile mediator • Explorer • Navigator • Emotionally-intelligent • Guardian • Sustainability champion

* Functions/qualities that can be realized by artificial intelligence are mentioned in [42].

Based on the analysis of the 17 selected articles, it could be stated that the authors of those articles often use the terms "competencies" and "skills" interchangeably. For example, Harisanty et al. [44] listed two types of competencies: professional and soft, and also presented definitions of "professional skills and soft skills". Karakose et al. [46] stated that "for the query on digital leadership skills, both versions of ChatGPT gave similar responses, describing these skills as competencies to integrate technology into the teaching and learning process". However, it should be noted that "competencies" is a broader term that also includes "skills".

On the other hand, Sriharan et al. [47] noted that "capacity pertains to the abilities—skills, competencies, or behaviors—that a leader must demonstrate to achieve desired goals". That also shows the variation in terminology related to leaders' characteristics. Considering the differences in the terminology used in the reviewed articles and the fact that the mentioned leaders' characteristics dealt mostly with competencies and skills, we decided to use the term "competencies and skills" for further investigations.

According to Peifer et al. [43], AI will have a significant impact on the work environment, which is why the role and activities of leaders will undergo a transformation. It was stated that the emphasis will shift more towards social skills, while leaders will act as shapers during the interaction between employees and AI. In addition, Tursunbayeva and Chalutz-Ben Gal [21] emphasized the need to assess managers' skills, identify and analyze gaps that may hinder the implementation and use of AI and digital technologies. This proves the necessity to improve the digital skills and competencies of employees. Some

leaders naturally possess different skills that are complementary, while others develop skills in business schools and practice, subsequently combining them randomly [45].

4.2. Categorization of Competencies and Skills Related to AI

Specific competencies and skills mentioned in the reviewed articles (Table 4) were analyzed and synthesized. Based on the review results, 15 AI-related competencies and skills were identified (Table 5) by synthesizing and grouping the recurring or similar items reported in the literature. The categorization was performed manually by the authors of this article. This provided the basis for the extraction and clear definition of a complex set of 15 competencies and skills identified across the 17 articles reviewed.

For example, the identified item "empowering others" encompasses terms such as motivation, employee motivation, coaching skills, mentoring and coaching, capacity to mentor and emotionally support staff members, caring for others, mobilizer, and talent-fit alignment. However, aspects related to empowering employees were mentioned in just over half of the articles reviewed. In turn, competencies such as "creativity" and "human judgement" have been added to the set list, despite their rarer occurrence in the studies analyzed. These competencies are conceptually important for leaders working with AI-based solutions, including MAS.

The 15 identified competencies and skills were cross-referenced with those mentioned in the reviewed articles (Figure 2). The analysis revealed that different authors highlighted different competencies and skills from the identified set, with a maximum of 8 items mentioned in a single article. This reflects the diversity of viewpoints among those authors with regard to competencies and skills required of leaders. For the purposes of this study, it was assumed that competencies and skills that appeared in at least 45% of the analyzed publications were classified as the core ones (marked blue in Figure 3), whereas those occurring less frequently were considered supplementary (marked orange in Figure 3).

Author	Adaptive agility	Change management	Collaboration	Communication	Creativity	Critical thinking	Data-driven decision-making	Emotional intelligence	Empowering others	Ethical leadership	Human judgment	Innovation	Risk awareness and resilience	Strategic thinking and vision	Technological competence and AI literacy	Sum
Pang and Zhang (2021)	0	0	0	0	0	0	1	1	1	1	1	0	1	1	0	7
Peifer et al. (2022)	0	1	0	0	0	0	1	1	0	1	0	0	1	0	1	6
Harisanty et al. (2022)	1	0	1	1	1	1	1	0	0	0	0	1	0	0	1	8
Anghel (2023)	0	0	0	1	1	1	0	1	0	0	0	0	1	0	0	5
Karakose et al. (2023)	0	1	1	1	0	0	1	0	0	1	0	0	0	1	1	7
Abositta et al. (2024)	0	0	0	0	1	0	1	1	1	0	1	0	0	0	0	5
Tursunbayeva and Chalutz-Ben Gal (2024)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
Sriharan et al. (2024)	1	1	1	0	0	0	0	1	0	1	0	1	0	1	1	8
Ennis-O'Connor and O'Connor (2024)	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	4
Lee and Cosgrove (2024)	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	4
Walter (2024)	0	0	0	0	0	1	1	1	1	1	0	0	0	1	1	7
Ghamrawi et al. (2024)	1	0	1	0	0	0	1	0	1	0	0	0	0	0	1	5
Dai et al. (2024)	0	0	1	1	0	0	1	1	1	0	0	0	0	1	1	7
Madanchian et al. (2024)	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	6
Hoang (2025)	0	1	1	1	0	0	0	0	0	0	0	1	0	0	1	5
Bevilacqua et al. (2025)	1	0	0	0	0	1	1	1	0	0	0	1	1	0	1	7
Zaidi et al. (2025)	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	4

Figure 2. Identified 15 competencies and skills mentioned in the reviewed articles [own elaboration based on [3,5–7,21,36,37,42–51]], where 1—competencies and skills mentioned in the publication, 0—competencies and skills not mentioned in the publication.

Table 5. Leaders' competencies and skills identified via analyzing selected articles [own elaboration].

Competencies and Skills	Definition	Specific Competencies and Skills Mentioned in Reviewed Articles *
Data-driven decision-making	It is informed decision-making based on facts rather than intuition and covers analyses and insights derived from complex and massive data generated by AI, while maintaining the crucial role of human judgment, interpretation, and reference to the business context [50].	• Data-driven decision-making • Data-based decision making • Data-informed decision making • Decision-making • Decision-making with human oversight • Scientific decision-making • Data analytics
Technological competence and AI literacy	It encompasses not only the practical knowledge and skills to use AI technologies, but also the ability to understand their risks, challenges, and benefits. Leaders have to be technologically savvy and grasp key AI concepts such as algorithms and deep learning [46,48].	• Technological competence • Technological literacy • Technological capacity • Technical capacity • Technical proficiency • Technical skills and underlying principles of AI • Technical programming skills • Information technology (IT) • Artificial intelligence skills and knowledge • AI literacy • Basic understanding of AI and familiarity with how commonly used applications work • In-depth understanding of AI system performance • Collaborating with AI • System design
Emotional intelligence (EI)	According to Goleman [52], EI may encompass five key components: self-awareness, self-regulation, motivation, empathy, and social skills. It refers to the ability to recognize, manage, and effectively use one's own and others' emotions to foster team cohesion, guide collective efforts, and ensure human-centered responsible leadership [5].	• Emotional intelligence • Emotional and social intelligence • Emotional intelligence supported by critical thinking • Empathy • Self-awareness • Capacity to mentor and emotionally support staff members • Self-control • Self-awareness and humility • Emotionally-intelligent • Social competencies • Social builder
Ethical leadership	It deals with the respect of core values of self-determination, justice, and the protection of privacy and personality. It also impacts the design and operation of AI systems that should ensure individual protection, trustworthiness, and meaningful work-sharing between humans and technology [43].	• Ethical leadership • Ethical decision-making • Ethical and bias mitigation • Ethical judgment • Human-centered approaches • Understanding regulatory requirements, ethical issues, and other types of risks associated with AI • The integrity and accountability to embody ethical principles • Keep the promise • Equality

Table 5. *Cont.*

Competencies and Skills	Definition	Specific Competencies and Skills Mentioned in Reviewed Articles *
Strategic thinking and vision	It deals with the leader's ability to define a clear, future-oriented direction by aligning technology with long-term organizational goals and values. This includes setting strategic priorities, developing a clear vision on how technology can enhance work, and communicating and effectively implementing this vision to ensure that all stakeholders are aligned and engaged [46,48].	• Strategic thinking • Long-term strategic vision • Integration of AI technologies into the overall organizational strategy • Vision • Visionary leadership • Formulating visions • The agility to identify and capitalize on transformative opportunities, swiftly adapting and aligning strategies with evolving contexts
Critical thinking	It refers to the ability to objectively analyze complex information, identify relevant insights, and translate them into well-reasoned actions. It includes self-reflection, awareness of biases, and consideration of broader implications to support adaptive decision-making in dynamic environments [5,7,45].	• Critical thinking • Critical reflection • Reflexivity • The ability to analyze data critically and accurately
Communication	It refers to a leader's ability to create open, honest, and empathetic dialogue that fosters trust, authenticity, and human connection. In today's collaborative environments, it plays an essential role in engaging employees and addressing interpersonal dynamics that remain beyond the capabilities of AI [37,45].	• Communication • Digital communication • Regular communicator
Collaboration	It refers to the leader's ability to build trusting, transparent relationships that actively engage diverse stakeholders in the process of AI transformation within organizations [47].	• Collaboration • Mutual understanding • Collaborative • The ability to build trust and collaboration • Fostering networks and collaborations
Innovation	It refers to fostering a mindset open to change and experimentation, enabling the development, adaptation, and seamless implementation of AI-driven solutions. Leaders with openness to innovation readily embrace emerging technologies, encouraging new ideas and experimentation [5,47].	• Innovation • Innovation mindset • Pedagogical innovation • Openness to innovation • Innovator
Human judgment	It refers to the leader's ability to critically evaluate and balance AI-driven insights with human intuition, ethical awareness, and contextual understanding. It helps leaders to avoid overreliance on technology by ensuring that decisions remain transparent, fair, and aligned with human values [36,50].	• Human judgment • Good judgment • Human intuition
Creativity	It refers to the capacity to generate innovative ideas and apply adaptive thinking to solve complex problems. It supports proactive planning and enables leaders to co-create effective solutions in dynamic environments [45].	• Creativity • Coming up with ideas • Creativity and improvisation

Table 5. *Cont.*

Competencies and Skills	Definition	Specific Competencies and Skills Mentioned in Reviewed Articles *
Change management	It refers to the ability to effectively guide individuals and organizations through technological and cultural transformations by fostering trust, addressing resistance, and promoting continuous learning. It involves creating and communicating a clear vision for change, engaging all levels of staff, and supporting the successful adoption of innovation, including AI-driven solutions [46,48,49].	• Change management • Change leadership skills • Systems thinking • Methodological competencies
Risk awareness and resilience	It refers to a leader's ability to recognize potential threats in uncertain environments and respond with strength, adaptability, and composure. Resilient leaders view setbacks as opportunities for growth, maintaining focus and stability under prolonged pressure [45].	• Risk tolerance • Wise risk-taking supported by resilience • Resilience • Understanding types of risks associated with AI
Adaptive agility	It refers to the ability to remain flexible, open to change, and responsive in the face of technological advancement and evolving work environments. It encompasses foresight, sense-making, and systems thinking, enabling leaders to quickly adapt strategies, embrace emerging technologies, and navigate complex, interconnected systems [44,47].	• Flexibility and adaptability to new situations and technologies • Adaptability and continuous learning • Adaptability • Agility • Adaptive capacity • Agile mediator
Empowering others (motivation, coaching, and mentoring)	It refers to the leader's ability to motivate, coach, and mentor team members to support their growth and align their strengths with organizational goals. By enhancing intrinsic and extrinsic motivation, leaders can drive performance, support AI adoption, and encourage upskilling, creativity, and long-term engagement [21,50].	• Motivation • Employee motivation • Coaching skills • Capacity to mentor and emotionally support staff members • Mentoring and coaching • Caring for others • Mobilizer • Talent–fit alignment

* Statements that appear in the 17 selected articles. In the course of reviewing these articles, it was established that the recurring competencies and skills would be included in the table only once to avoid duplication. In addition, certain competencies that appeared as separate items (e.g., Pang and Zhang [42] self-awareness, empathy, self-control) were consolidated by the authors of this article into a broader category, e.g., emotional intelligence.

Based on the research results presented in Figure 2, it was possible to determine the number of identified competencies and skills mentioned in the analyzed literature (Figure 3). It should be noted that among the 15 identified competencies and skills, the following ones were mentioned more often in the selected articles:

- Technological competence and AI literacy;
- Emotional intelligence;
- Data-driven decision-making.

Technological competence and AI literacy, as well as data-driven decision-making, form the so-called "hard" competencies and skills. This highlights the importance of leaders to have specialized knowledge related to AI and its capabilities. In turn, emotional intelligence is a "soft" competence and skill that organizations' leaders should possess to make decisions related to their organizations' operations.

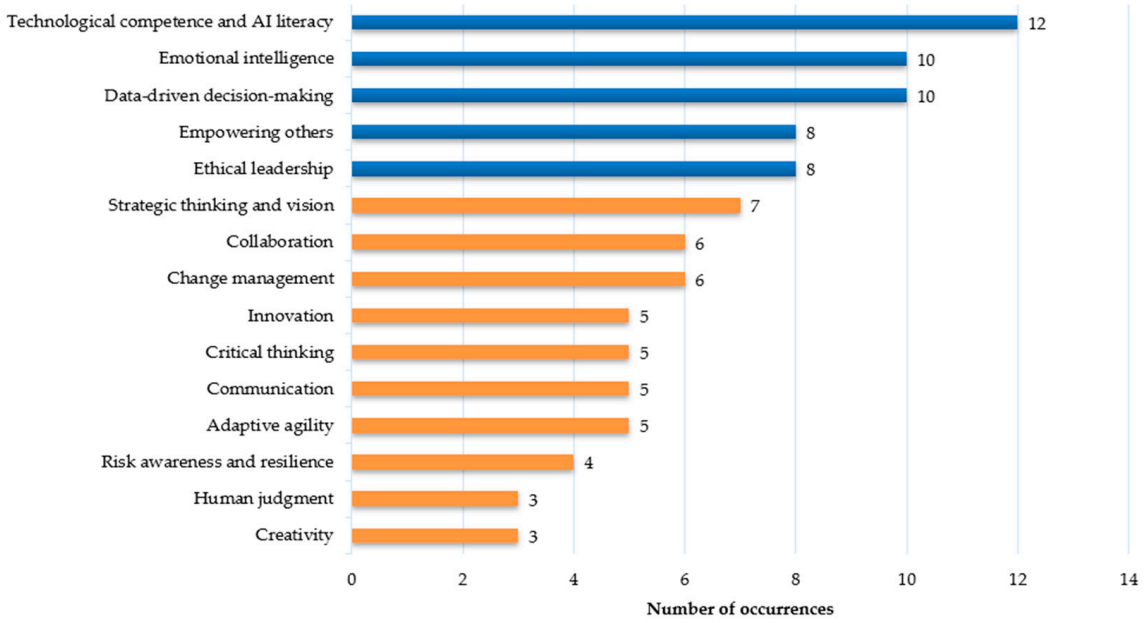

Figure 3. Identified competencies and skills that appeared in selected articles analyzed [own elaboration].

In Table 6, the 15 identified competencies and skills are classified into soft and hard types. It was stated that some competencies and skills can be assigned to both hard and soft groups simultaneously, including the following:

- Critical thinking: requires both data analysis (hard skills) and reflection and cognitive awareness (soft skills);
- Change management: combines process and technology planning (hard) with people and emotion management (soft);
- Ethical leadership: requires knowledge of legal/technological frameworks (hard) and ethical judgement, empathy (soft).

It should be emphasized that, among the 15 identified competencies and skills, the majority (9 items) were classified as soft ones. This finding indicates that leaders should demonstrate the ability to manage teams skillfully when implementing AI solutions, including MAS, within their organizations.

Table 6. Hard and soft competencies and skills [own elaboration].

Competencies and Skills	Examples
Hard (related to professional knowledge and technical skills)	• Data-driven decision-making • Technological competence and AI literacy • Innovation
Soft (related to character traits, interpersonal skills, and social skills)	• Emotional intelligence • Strategic thinking and vision • Communication • Collaboration • Human judgment • Creativity • Risk awareness and resilience • Adaptive agility • Empowering others (motivation, coaching, and mentoring)
Multifaceted (hard and soft)	• Critical thinking • Change management • Ethical leadership

5. Discussion and Conclusions

A scoping review of the available literature was conducted to investigate leaders' competencies and skills related to AI. Based on the review findings, 15 competencies and skills were identified. The frequency of occurrence of these competencies and skills in the analyzed articles was examined, and a classification into soft and hard categories was proposed. The study was intended to reinforce the systematic approach and to delineate the competencies and skills deemed essential for leaders in the AI era.

The conceptual terminology adopted by the authors of the analyzed articles to describe leaders' characteristics related to AI implementation in organizations is open to discussion. It was found that the available literature variably refers to leaders' competencies, skills, abilities, capacities, qualities, qualifications, traits, or functions. Moreover, in some publications, the terms "competencies" and "skills" were often used interchangeably. That impacted the conceptual inconsistency of the presented study, leading to the decision to use the term "competencies and skills" while conducting investigations. Therefore, it is necessary to conduct research aimed at structuring the terminology applied, accompanied by examples of specific competencies, skills, and traits of leaders in relation to AI. Moreover, the study was focused on open-access publications only, which could have eliminated thematically related studies that could also have had an impact on the research outcomes. However, our intention was to ensure accessibility and consistency of the research results, allowing practitioners to have access to the reviewed publications.

The analysis of the identified competencies and skills revealed that the boundaries between them were sometimes blurred; therefore, the classification shown in this article is provisional. Nevertheless, this approach serves to draw leaders' attention to the existence of specific areas for development and allows for reflection on whether certain competencies and skills need to be strengthened. In practice, these competencies and skills are closely interrelated and mutually reinforcing, so it is crucial to develop them in parallel. For example, Madanchian et al. [50] noted that leaders' competencies related to data-driven decision-making have to be supported by emotional intelligence, mentorship capabilities (which we refer to as "empowering others"), and organizational agility (which we refer to as "adaptive agility"). In turn, in a study conducted by Hoang [51], it was noted that digital collaboration acts as a mediator between technical proficiency (here referred to as "technological competence and AI literacy") and change management capabilities, which shows new perspectives on the way e-leadership competencies are developed. Anghel [45] also advocated integration of different competencies, using the metaphor of honeycombs to illustrate combinations such as emotional intelligence with critical thinking, regular communication with creativity and improvisation, and wise risk-taking with resilience. A similar approach can be observed in the article by Ghamrawi et al. [3], where the authors proposed to combine collaboration and coaching skills.

The research study was carried out in March 2025 and was focused only on the analysis of open-access articles written in English, which limited the research results. The attempt to classify skills and competencies was also carried out by Bock and von der Oelsnitz [53], who conducted a systematic literature review and identified 24 leadership competencies, including 12 personality traits and 12 skills. However, those authors [53] used a different protocol to select the literature items, which had an impact on the results. In the above-mentioned study, the need to possess communication skills by leaders was highlighted. Moreover, it was noted that forming high-performance teams working cross-functionally and ensuring a symbiosis of humans and machines is important.

In the presented study, the analysis of the research results revealed that the top competencies and skills, mostly mentioned in the analyzed articles, include technological competence and AI literacy, emotional intelligence, and data-driven decision-making. That

means that the authors of the analyzed articles took these competencies and skills into account to highlight the characteristics required of leaders in the era of AI.

The research was focused on the analysis of articles available in three databases (Web of Science Core Collection, Springer Nature Link, and Scopus) and written in English, which also impacted the research results. The possibility of reviewing other databases (e.g., PubMed, IEEE Xplore, ACM Digital Library, and other management-oriented databases), as well as articles written in other languages, will be considered in our future research.

The limitation of this article also lies in narrowing the analysis exclusively to the individual area, i.e., the leaders' competencies and skills. In future research, it would be beneficial to broaden the perspective and incorporate a more systematic cross-cultural comparison, as well as consider organizational aspects that play an essential role in supporting the implementation and effective use of AI-based solutions, including MAS. Managerial factors such as support from management staff and superior institutions, clearly defined IT development policies [44], the quality of technological infrastructure [44,48], and the availability of financial resources [44,47,48] may be particularly important.

Based on the analysis of the research results, a set of recommendations was derived to support the development of competencies and skills among leaders (practitioners) involved in decision-making related to AI implementation in organizations (Table 7).

Table 7. Recommendations to develop specific leaders' competencies and skills [own elaboration].

Competencies and Skills	Recommendations *
Data-driven decision-making	1. Organization of training on data analysis, statistics, and business intelligence (BI) tools [54]. 2. Expanding knowledge on interpreting reports and dashboards independently and together with the team. 3. Expanding knowledge on data-driven decision-making simulations (e.g., using decision trees). 4. Analysis of cases where an intuitive decision has been verified or overturned based on datasets. 5. Taking part in regular meetings and discussions with analysts, including asking in-depth questions (e.g.,: What does the trend line show? Is the data sufficient? ").
Technological competence and AI literacy	1. Organization of courses on the basics of AI, digital technologies, machine learning, and other relevant topics, including comprehension of fundamental terms and concepts, such as deep learning, algorithms, natural language processing, machine learning, etc. 2. Testing AI tools such as customer relationship management with AI [55]. 3. Experimenting with the implementation of AI technology in routine tasks (e.g., virtual assistants, etc.) [56]. 4. Keeping track of the use of AI in your industry, including subscribing to and reading industry newsletters on AI [57,58]. 5. Participating in training courses and workshops on AI risk assessment tools, including case study analysis of algorithmic errors, data bias, etc.
Emotional intelligence (EI)	1. Use of self-assessment tools [59]. 2. Learning stress management techniques, e.g., breath control, mindfulness, and regeneration breaks 3. Practicing active listening and selecting appropriate techniques for the interlocutor/team. 4. Recognizing the emotions of employees and those prevailing in the team through regular conversations or asking open questions. 5. Participation in the "shadowing" program and communication training.

Table 7. *Cont.*

Competencies and Skills	Recommendations *
Ethical leadership	1. Participation in training courses on the ethical use of AI. 2. Regular monitoring of AI Act [17], OECD [18], ISO [19], and UNESCO guidelines and regulations [20], and following webinars, industry newsletters, and discussion groups. 3. Creation of a space for reporting concerns or unethical activities within the organization. 4. Organizing short training sessions or discussions in teams on ethical dilemmas in ongoing or completed projects. 5. Transparent communication of rules regarding the use and protection of personal data.
Strategic thinking and vision	1. Creating a systematic process for monitoring technological trends (e.g., organizing "Tech Radar" meetings, participating in conferences, seminars, webinars, cooperating with start-ups and experts). 2. Studying market research and strategic foresight–including methods such as PESTLE analysis [60], SWOT, scenario analysis (scenarios: optimistic, pessimistic, surprise, and most likely). 3. Establishing long-term KPI metrics. 4. Engaging all stakeholders in joint planning, consultations, reviews, and adjustments to the strategy by creating an appropriate space for this purpose. 5. Monitoring the achievement of the organization's goals with the help of AI, including the use of analytical dashboards and predictive algorithms.
Critical thinking	1. Analysis of good practices, review and solving various case studies and problems (real and hypothetical); analysis of own successes and failures from the past. 2. Use of cause-and-effect tools (e.g., Ishikawa diagram, 5 whys, reframing, etc.). 3. Team debates, role-playing, brainstorming with the team, reflection after decision-making and projects (what worked, what failed–making a checklist), asking relevant questions, querying assumptions. 4. Working with statistical data, BI tools–comparing results, noticing repeated patterns. 5. Using internal, external, and/or functional benchmarking.
Communication	1. Organization of training on developing communication skills in digital channels. Using remote communication tools within the team (e.g., places for exchanging opinions, e.g., forums, chats, channels, etc.). 2. Using AI to improve written communication [61]. 3. Learning to write clear, specific, and concise messages both for people (to avoid data overload and misunderstandings) and for AI (e.g., learning to write prompts, etc.) [62]. 4. Practicing how to adapt communication style to the audience. 5. Organizing regular meetings (e.g., once a month) combined with a question-and-answer session, without an agenda, for the free exchange of observations, ideas, and concerns.
Collaboration	1. Building a database of employee competencies, enabling the rapid creation of interdisciplinary project teams. Implementing platforms that support team collaboration. 2. Organizing retrospective sessions after each project to discuss insights and provide feedback. 3. Creating and developing team knowledge bases. 4. Implementing Kaizen and ideas boxes, rewarding employee initiatives as a way of engaging the team in joint improvement of processes and collaboration. 5. Creating and developing team knowledge bases that enable the use of experience and lessons learned from previous projects.

Table 7. *Cont.*

Competencies and Skills	Recommendations *
Innovation	1. Organization of themed hackathons or innovation weeks during which teams can test new ideas. 2. Creation of opportunities for experimentation, pilot projects, and prototypes (e.g., introduction of the "10% time for innovation" rule, "Fail small, fail fast, learn faster" [63], etc.). 3. Regularly tracking trends and technologies, e.g., participating in conferences, trade fairs, webinars, and subscribing to industry reports. 4. Participating in training and courses in innovation, design thinking, agile innovation, and using creative thinking techniques [64]. 5. Building a network of contacts with practitioners and academic experts in the field of innovation.
Human judgment	1. Developing an AI policy for the organization that clearly defines when humans make the final decision. 2. Discussing AI suggestions with employees to verify them against the organizational situation and their own intuition and experience. 3. Organization of training and workshops on technology ethics and AI to avoid situations where technology violates human rights (e.g., privacy). 4. Working on reflection after key decisions. 5. Implementing the principle of "decision hygiene", which separates facts from the person presenting them.
Creativity	1. Using creative thinking techniques such as mind mapping, Edvard de Bono's six thinking hats [65], reverse thinking, etc. 2. Organization of creative meetings (e.g., brainstorming, silent brainstorming, rolestorming, What if. . .?, etc.) [66]. 3. Use of idea visualization techniques (e.g., flipcharts, boards, etc.). 4. Changes of meeting location (e.g., creative space or online). 5. Inspiration from others through mentoring, podcasts, and books.
Change management	1. Developing the ability to respond openly to employee concerns by organizing sessions with employees (e.g., on a question-and-answer, AMA (Ask Me Anything) basis, etc.). 2. Involving employees in pilot projects, consultations, and joint testing of new solutions. 3. Using change management models in the workplace [67]. 4. Using change management programs [68]. 5. Participating in real transformation projects by piloting changes and taking action.
Risk awareness and resilience	1. Using basic risk assessment tools (e.g., SWOT analysis, risk matrix, risk checklist, root cause analysis, what-if analysis, etc.). 2. Preparing simulations of crisis situations, alternative scenarios, and contingency plans. 3. Organizing feedback sessions with employees to learn from failures as a knowledge source. 4. Applying methods related to working under pressure (e.g., Eisenhower matrix [69], 80/20 method, "one step at a time", etc.). 5. Creating experience-based knowledge bases (lessons learned, incident logs, retrospectives, post-mortem analysis).
Adaptive agility	1. Exercising perspective change (flexible thinking) (e.g., from the point of view of the customer, team, supplier, etc.). 2. Use of foresight tools (e.g., scenario analysis, trend analysis). 3. Applying iterative methods, such as agile, scrum, lean startup, sprints, and other [70,71]. 4. Trendwatching by subscribing to industry newsletters, reading reports, and using tools such as Google Trends. 5. Participating in projects from other areas of the organization (cross-learning) to broaden the perspective and increase cognitive adaptability.

Table 7. *Cont.*

Competencies and Skills	Recommendations *
Empowering others (motivation, coaching, and mentoring)	1. Regular conversations with employees about their motivations, goals, and needs. 2. Conducting formal and informal mentoring sessions. 3. Strengthening employees' internal motivation through a system of financial and/or material awards, public praise, and bulletin boards, etc. 4. Using diagnostic tests (to match people to tasks appropriately, etc.). 5. Creation of Individual Development Plans.

* References are given only to selected AI tools, methods, and concepts.

The research results may be of interest to decision-makers who are planning to implement AI solutions, including MAS, within their organizations and want to build sufficient competencies and skills to do this. The findings may be applied by leaders (managers) employed in different organizations (enterprises, government bodies, non-profit entities, etc.). The research results may be valuable for leaders who are searching for solutions to better coordinate human–AI teams, oversee ethical use of autonomous agents, and ensure robust decision-making in complex, dynamic systems.

Our future research will focus on the development of separate lists of competencies, skills, traits, and qualities that will be crucial to lead AI implementation in the organizations of various industries (e.g., manufacturing, transport and logistics, agriculture, education, etc.). Conducting the comparative analysis of competencies and skills of leaders representing several industries could be valuable to understand similarities and differences in leaders' characteristics depending on the work conditions. Moreover, investigation of specific competencies needed for leaders working with specific systems only (e.g., MAS) in different countries would be reasonable.

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