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Super AI, Generative AI, Narrow AI and Chatbots: An Assessment of Artificial Intelligence Technologies for The Public Sector and Public Administration

Muhammet Damar[1,2], Ahmet Özen[3], Ülkü Ece Çakmak[4], Eren Özoğuz[5], Fatih Safa Erenay[6]

[1] Dokuz Eylul University, Türkiye **Email**: muhammet.damar@deu.edu.tr **Orcid**: 0000-0002-3985-3073
[2] Upstream Lab, MAP, Li Ka Shing Knowledge Institute, Unity Health Toronto, Ontario, Canada
[3] Faculty of Economics and Administrative Sciences, Dokuz Eylul University, Türkiye. **Email**: ahmet.ozen@deu.edu.tr **Orcid**: 0000-0002-9635-5134
[4] Dokuz Eylul University, Türkiye. **Email**: cakmak.ulkuece@ogr.deu.edu.tr **Orcid**: 0009-0007-5993-8692
[5] Bursa Uludağ University, Türkiye. **Email**: erenozgz@gmail.com **Orcid**: 0000-0002-6878-4628
[6] Management Science and Engineering, Faculty of Engineering, University of Waterloo, Canada. **Email**: ferenay@uwaterloo.ca **Orcid**: 0000-0002-3408-0366

Corresponding author: muhammet.damar@deu.edu.tr

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Review Article

Abstract

Artificial intelligence encompasses a wide range of approaches, methodologies, and techniques aimed at mimicking human intelligence in machines. In recent times, the concepts of Generative Artificial Intelligence (AI), Super AI, and Narrow AI have attracted considerable attention. Undoubtedly, the success of ChatGPT in capturing all attention has played a significant role in this. Artificial intelligence technology has a profound impact on all sectors, and sector representatives are striving to adapt to this technology more quickly. It is projected that artificial intelligence could generate an economic size of 13 trillion American dollars by 2030. Developments in artificial intelligence technologies undoubtedly lead to significant improvements in the functioning of public institutions and access for citizens. Artificial intelligence has the potential to be used in many public services, including security and defense, healthcare services, education, transportation and infrastructure, environmental and natural resource management, law and justice systems, among others. Therefore, evaluating the types of artificial intelligence, Narrow AI applications, and chatbots for public use is seen as highly beneficial from the perspective of public administration and the public sector. In our study, the topics of super artificial intelligence, generative artificial intelligence, narrow artificial intelligence, and chatbots have been extensively evaluated within the context of the public sector and public administration. Utilizing findings from both Turkish and English literature reviews, the importance and potential impacts of artificial intelligence within the public sector, along with current trends, have been comprehensively assessed. This research delves into the concepts of artificial intelligence and its subsets—super AI, generative AI, narrow AI, and chatbots—within the general framework of the public sector. China and the United States are pioneering and leading countries in terms of investment. Although the U.S. stands out in many areas regarding investment, China's integration of artificial intelligence with national strategies and its policies indicate that it may play a more dominant role in the future. There are four main implementation areas of artificial intelligence in the public sector: efficiency and automation, service delivery, data-driven governance, and ethical and regulatory challenges. A review of the literature reveals that the ethical, legal, and social implications of implementing artificial intelligence in the public sector require more careful consideration. The study makes a significant contribution to the field of artificial intelligence discussions in public administration and the public sector, providing a comprehensive assessment of current discussions on artificial intelligence in the literature.

Keywords: *Artificial intelligence, narrow ai, generative ai, chatbots, public administration*

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1. INTRODUCTION

Artificial intelligence is now influencing daily lives, communities, and governmental structures more than ever before (Uzun et al., 2022). It enables groundbreaking developments in fields such as healthcare, agriculture, education, and transportation. Exponential growth is observed globally in consideration of artificial intelligence support. For instance, in the United States, the investment in entrepreneurial companies working in artificial intelligence increased by 20% in 2019, reaching $28.5 billion USD. The European Commission announced an annual investment of €20 billion for artificial intelligence in 2020. Moreover, it is said that artificial intelligence could increase the economic growth rates of the United States, Germany, and Japan by up to 2% in the next decade (Wirtz et al., 2019). Additionally, Bughin et al. (2018) forecasted that artificial intelligence could generate an economic size of $13 trillion by 2030. Developments in artificial intelligence technologies undoubtedly lead to significant improvements in the functioning of public institutions and access for citizens, enabling personnel to focus on more strategic tasks and facilitating faster service delivery (Yalçın, 2024).

Artificial intelligence is an enabling tool with the ability to take action and can be utilized in various fields within the public sector. Indeed, artificial intelligence can analyze large datasets, learn from them, and make decisions. Therefore, artificial intelligence can support many public employees in decision-making processes and even replace them (Maragno et al., 2023). Nowadays, with the adoption of the new doctrine of customer-oriented public administration, public managers aim to increase citizen satisfaction by improving the quality of services they provide (Suebvises, 2018). According to Wirtz et al. (2019), applying and implementing artificial intelligence technology in the public sector offers numerous opportunities to enhance efficiency. It is at this point that current artificial intelligence solutions emerge as strategic tools. Discussions regarding the implementation of artificial intelligence in the public sector are categorized into four main areas: application of artificial intelligence technology, artificial intelligence law and regulation, artificial intelligence ethics, and artificial intelligence society. Therefore, societal readiness in terms of legislation and laws regarding artificial intelligence is crucial.

According to Long & Magerko (2020), artificial intelligence is becoming increasingly integrated into user-oriented technology, yet public perception of these technologies remains limited. While artificial intelligence applications in the public sector are still limited, there are examples of exemplary applications in terms of productivity and efficiency (Maciejewski, 2017). Particularly, artificial intelligence applications supported by big data are noteworthy. In fact, big data has become a game-changer in modern public administration where it is used (Maciejewski, 2017). According to Uzun et al. (2022), governments have a responsibility as decision-makers in technological transformation to integrate artificial intelligence technology into public administration and policies. Busuioc (2021) stated that the low cost and efficiency of big data are decisive factors in public institutions' preference for artificial intelligence solutions in public services. Additionally, artificial intelligence systems have emerged in many applications thanks to big data (Goosen et al., 2018). Nowadays, projects utilizing natural language processing models based on artificial intelligence to improve efficiency and decision-making processes in public administration and to develop positive relationships with citizens are finding widespread application in many countries (Bozdoğanoğlu et al., 2024).

In a future where artificial intelligence transforms the way people interact, work, and live with both humans and machines, it's essential to assess the need for new skills. Particularly, with ChatGPT recently drawing all attention, debates arise regarding whether artificial intelligence technologies can replace human resources in all sectors. Many experts in various fields have become increasingly curious about recent developments within the age-old concept of artificial intelligence. Super artificial intelligence (Super AI), generative artificial intelligence (Generative AI), narrow or weak or applicable artificial intelligence (Narrow AI or Weak AI or Applicable AI), and chatbots are now frequently encountered in the literature. Hence, there arises a necessity

for an in-depth analysis of artificial intelligence in public administration and the public sector. For these reasons, it is deemed necessary to evaluate super artificial intelligence, generative artificial intelligence, and narrow artificial intelligence, focusing on public administration and the public sector. In our planned study, artificial intelligence applications from around the world and in Türkiye will also be examined. It is believed that the study contributes significantly to the field of public administration, providing a comprehensive evaluation of current artificial intelligence discussions in the literature.

2. METHODOLOGY

In our study, the topics of super artificial intelligence, generative artificial intelligence, narrow artificial intelligence, and chatbots have been extensively evaluated within the context of the public sector and public administration. Utilizing findings from both Turkish and English literature reviews, the importance and potential impacts of artificial intelligence within the public sector, along with current trends, have been comprehensively assessed.

This research delves into the concepts of artificial intelligence and its subsets—super AI, generative AI, narrow AI, and chatbots—within the general framework of the public sector. It examines their applications, current debates, and emerging trends in Türkiye and globally, employing literature review and conceptual analysis methodologies. Information gathered from relevant literature serves to establish a conceptual framework and evaluate contemporary policy implementations. Specifically, searches were conducted using key terms such as public sector, public administration, artificial intelligence, productive artificial intelligence, super artificial intelligence, narrow artificial intelligence, and chatbots (e.g., ChatGPT, Google Gemini (Previously Google Bard (Aydin, 2023)), Claude) via Google Scholar and Web of Science.

Articles identified through these keywords were accessed individually to review full texts based on their titles and abstracts. Relevant contributions were integrated into the article's content after thorough reading and discussion of the full texts. Priority was given to highly cited works obtained from the research documents. The gathered articles and other internet sources were then evaluated in the context of their connection to information security and the healthcare sector.

Our research is of a review nature. The findings are organized using the deductive method to fill in the concepts of Super AI, Generative AI, Narrow AI, and Chatbots comprehensively, followed by evaluating the significance of artificial intelligence in the public sector within the literature. Current artificial intelligence applications and chatbot technologies from Türkiye and worldwide are specifically detailed. Insights into public sector applications from Türkiye and other countries were derived from research studies and internet sources, highlighting the advancements made by these nations. The discussion and conclusion sections provide an evaluation of all experiences and insights gained during our research, focusing on critical elements and areas worthy of further investigation.

3. SUPER AI, GENERATIVE AI, NARROW AI, CHATBOTS, PUBLIC ADMINISTRATION AND PUBLIC SECTOR

Miller (2024) defines artificial intelligence as the advancement of computer systems that can execute tasks typically requiring human intelligence. These systems strive to emulate human-like cognitive functions, including learning, problem-solving, decision-making, and language comprehension. Artificial intelligence encompasses intelligent systems focused on acquiring abilities conventionally linked with the human mind, such as language comprehension, learning, logical reasoning, and problem-solving (Saveliev & Zhurenkov, 2021).

Artificial intelligence encompasses a wide range of approaches, methodologies, and techniques aimed at mimicking human intelligence in machines. AI technologies, of course, operate according to specific models.

Significant advancements in language models have been made with the introduction of ChatGPT, developed and publicly released by OpenAI (Bilge, 2023). This language learning algorithm has excelled in understanding, analyzing, and responding to written and spoken communication, thereby attracting significant interest from users (Şentürk, 2023). Naturally, these language models and applications are not exclusive to ChatGPT. Google Gemini (Bard, using Google's LaMDA language family, is currently available in over 200 countries) and many other companies have entered the market and competition. How can these technologies be classified, and are these applications truly superior to the human brain? Furthermore, in what ways might these concepts transform the public sector and public administration? These are valuable questions that many researchers seek to answer.

3.1 Super Artificial Intelligence (Super AI) and Generative Artificial Intelligence (Generative AI)

For many years, mastering the ancient Chinese game of Go was considered extremely difficult, even deemed impossible for artificial intelligence. However, Google DeepMind's AI player AlphaGo has managed to defeat the best human competitors in this game. Initially, AI had to learn the game from humans. But this changed with DeepMind's new version. Now, AlphaGo Zero can learn and improve on its own by playing randomly instead of learning from humans. After three days and 4.9 million games, the world's best Go player became an AI (Revell, 2017). So, what are we experiencing and what kind of development are we witnessing? What kind of intelligence are we facing? For many, this can be frightening. Many average jobs in both the public and private sectors could come to life and confront us through intelligent technology, emerging from software and electronic circuits as robots. These robots could take over many average jobs across different sectors.

Advancements in artificial intelligence technology indicate the development of super intelligent machines that surpass human cognitive abilities (Aithal, 2023). Super intelligent machines refer to highly advanced and autonomous AI systems that possess intellectual capabilities far superior to humans in various domains (Wogu et al., 2018). The possibility that advancements in AI could eventually lead to the development of a super intelligent AI is a cause for concern among humanity. Such an AI could potentially dominate humanity and restrict freedom (Luck, 2024). While super intelligent AI does not yet seem feasible, it is likely that in the future, humans will contend with computers that are more intelligent than themselves. Another point of consideration is whether many problems that are currently unsolvable by the human mind can be resolved by super intelligent AI, which is itself a creation of humans. Dhara et al. (2023) have provided an assessment on this topic through health-related articles. Super intelligent computers could assist in the development of drugs and vaccines for numerous cancer cases and diseases, where the human mind currently falls short.

Artificial intelligence can be divided into three categories: super intelligent AI, general AI, and narrow AI. These categories are sometimes presented as four or nine categories in different sources. However, researchers generally focus on these three critical categories to comprehensively understand AI. Aithal (2023) lists the features of super intelligent machines as follows: enhanced cognitive abilities, self-learning and adaptability, autonomous decision-making, domain expertise and specialization, and ethical considerations. Super intelligent AI is often regarded as a utopian concept in the literature and is more of a goal to be achieved. Frerichs (2019) describes general AI as an AI capable of performing any general task that is asked of it. It is still in the developmental stage. Narrow AI, on the other hand, is designed to handle a specific task or set of tasks pre-defined by the programmer (Frerichs, 2019). Many of today's popular applications fall under this category.

Super intelligent AI surpasses human capabilities, whereas narrow AI is created for specific tasks. Generative AI is designed to match human-level intelligence in terms of breadth and adaptability, though it has not yet surpassed human capabilities. All practical solutions available today can be categorized as narrow AI (Buxmann & Schmidt, 2019; Moser, 2022). Today's AI is directly related to big data and deep learning

technologies, involving extensive training and operation on large data sets. It also encompasses iterative modeling and deployment cycles. However, it appears to be constrained by static contexts and limited to predefined tasks (Moser, 2022).

Numerous nations and corporations have been dedicated to advancing super intelligent AI for an extended period. As an illustration, Lu et al. (2018) highlighted that China, through the development of native supercomputer systems, has formulated a self-governing system software covering fundamental components such as core drivers, operating systems, compilers, communication software, basic libraries, parallel programming environments, parallel file systems, resource management, and scheduling systems. Naturally, overcoming fresh hurdles in architecture, system software, and application technologies is imperative to facilitate the progression of supercomputer systems (Lu et al., 2018). In the literature, many studies involving super intelligent AI focus on ethical issues, the relationship between humans, society, and supercomputers, as well as philosophical evaluations of how the development of super intelligent AI will impact society.

3.2 Narrow (Weak or Applicable) Artificial Intelligence, Public Administration and Public Sector

Researchers have delineated between Narrow AI and artificial generative intelligence (AGI). Narrow AI pertains to systems tailored for particular tasks involving one or more decision-making processes, such as facial recognition in images or autonomous vehicles. On the other hand, AGI, which remains theoretical and unrealized, encompasses the defining characteristics of intelligence across a broad array of cognitive activities (Young et al., 2019). Narrow AI systems undergo training using machine learning algorithms like supervised learning or reinforcement learning to glean insights from extensive datasets, make decisions, or execute tasks based on established patterns and rules. As per Miller (2024), narrow AI, also referred to as weak or specialized AI, represents AI systems meticulously crafted and trained for specific tasks or domains. Unlike generative AI, which aims to emulate human-like intelligence across diverse tasks, narrow AI concentrates on excelling within a defined scope or efficiently carrying out a predetermined set of tasks. Applications of narrow AI encompass image or speech recognition, natural language processing, autonomous vehicles, and recommendation systems. Examples of narrow AI include smart personal assistants like Amazon's Alexa (Goosen et al., 2018) and Apple's Siri, which are tailored for specific functionalities. Machine learning plays a crucial role within narrow AI, enabling systems to learn from and interpret data, make predictions, and generate recommendations. However, models that perform predictive analytics or forecasting have existed prior to the development of narrow AI (Agrawal et al., 2019).

According to Saveliev & Zhurenkov (2021), narrow AI systems can execute complex computations but are limited to tasks constrained by operational environments and specific programming. Most narrow AI applications or machine learning systems are guided by five fundamental components: data input, data processing, predictive models, decision rules, and outputs (Frerichs, 2019). Additionally, there are limiting factors associated with these relevant artificial intelligences. Fischer et al. (2020) have outlined the limiting factors of today's machine learning-based artificial intelligences as follows: theory gap/statistical learning (lack of uniqueness, lack of confidence measure, lack of control of high-dimensional effects), theory-practice gap (narrow AI, data hungry, failure of big data assumption, limited data, bias, limited explainable AI), adoption gap (high adoption efforts, AI expert centric, reuse in its infancy, high initial costs), and social threats (skill gap, acceptance problems).

Applied artificial intelligence (AI) and narrow AI exhibit diverse methodological and application taxonomies, showcasing their extensive contributions across various sectors. Machine learning stands as a foundational technique in both realms, empowering systems to glean insights from data without explicit programming. These methodologies enable applications across sectors such as healthcare, finance, manufacturing, and autonomous systems. In the finance sector, for example, AI applications encompass fraud detection

mechanisms, risk assessment models, algorithmic trading strategies, and customer service chatbots (Miller, 2024). AI has revolutionized business operations in finance, influencing service delivery, fraud detection, risk analysis, and more. Its utilization in financial services within the digital era impacts consumers and markets in numerous ways, including consumer protection, empowerment, financial crime prevention, competition, and market stability (Fernández, 2019; Rawat et al., 2023). Machine learning aids in investment risk assessment by identifying anomalies in financial data and supports automated trading systems. In the manufacturing sector, AI-driven models analyze sensor data to predict machine failures and optimize production processes (Miller, 2024).

Kaplan & Haenlein (2019), artificial intelligence (AI) as the ability of a system to interpret external data accurately, learn from these data, and use these learnings to achieve specific goals and tasks through flexible adaptation. One significant area where AI is relevant in the public sector is decision-making processes. Utilizing AI models allows public organizations to make rational decisions more efficiently in service delivery. An AI-enhanced information gathering model can facilitate access to maximum and accurate information for policy makers (Şahnagil, 2023). When examining the varieties of AI, it is possible to categorize types such as speech recognition, machine learning, natural language processing, and robotics (Önder & Saygılı, 2018).

The public sector can extensively benefit from artificial intelligence, particularly in areas such as firefighting, crime analysis using big data, and efficiently resolving citizen requests in call centers (Serçemeli, 2018; Önder & Saygılı, 2018; Yalçın, 2024; Özdemir, 2022; Bozdoğanoğlu et al., 2024; Ulaşan, 2023; Saveliev & Zhurenkov, 2021). Ingrams et al. (2022) have highlighted two primary ways in which AI can be beneficial to public administration. Firstly, they emphasize the instrumental effects of technological advancements on speed, efficiency, and service quality. Secondly, they suggest that AI contributes to enhancing the quality of government-citizen relationships by influencing public values development.

As per Uzun (2022), public administration holds the potential to foster the advancement of artificial intelligence, which is already undergoing adaptation across multiple sectors within the public domain. Although the integration procedures differ among nations, AI applications are progressively gaining prominence in diverse governmental functions. For example, AI-based automation capabilities simplify complex tasks for government agencies, eliminate redundancies, and enhance productivity for increased outputs.

Artificial intelligence technologies have become an integral part of our daily lives today. They are used in various fields such as voice assistants, translations, e-services, navigation, autonomous vehicles, and smart home devices (Serçemeli, 2018). In addition to these capabilities, it is anticipated that AI will continue to innovate and find applications across many sectors in the coming years. Currently, smart city initiatives are planned with the aim of advancing the information-communication sector globally, enhancing competitiveness in economic sectors, and thereby creating societies with high levels of welfare (Akpınar, 2023). Looking ahead, scenarios where expert and reliable Narrow AI applications manage towns or large cities, potentially overseeing tasks that could prevent unauthorized practices by mayors, could become a reality. Problems that mayors cannot solve alone might be addressed by a consortium of council members. While these scenarios may seem like scenes from a movie, they are not far from becoming reality.

3.3 Public Administration and the Public Sector Perspective on Chatbots: Chat GPT, Google Gemini (Previously Google Bard), Claude, and Others

A chatbot is a computer program utilizing natural language processing technology to interact with users (Shawar & Atwell, 2007). It represents a form of narrow artificial intelligence designed to extract meaningful information from free-text inputs based on user queries, discern the intent behind the user's question, and deliver an appropriate response (Goyal et al., 2018). Unlike generative artificial intelligence, which possesses

capabilities at least comparable to humans, narrow AI is specifically engineered to execute a particular task (Hassabis et al., 2017; Lake et al., 2017; Aoki, 2020).

Chatbots are algorithm-based software designed to parse and interpret human language, aiming to enhance service quality, provide service delivery independent of time and place, and save time (Digital Transformation Office, 2023). One significant feature of chatbots is their incorporation of supervised learning algorithms. These algorithms aid chatbots in continuous learning from interactions with humans and in improving the accuracy of their responses (Androutsopoulou et al., 2019).

Three main combinations are utilized in creating chatbots: user interface, artificial intelligence, and integration (Digital Transformation Office, 2023). When examining types of chatbots, there are rule-based chatbots and AI-powered chatbots. Rule-based chatbot models were initially developed with simplicity in mind, yet they often fail to yield positive results in analyzing questions and providing responses. Therefore, they are typically used for defining simple tasks. However, they do have certain advantages, such as being cost-effective, easy to train, and facilitating human takeover if the chatbot veers off course. On the other hand, AI-powered chatbots are capable of responding to language traffic and answering questions in multiple languages, thereby handling big data. They are more efficient for advanced and nuanced tasks. Advantages of AI-powered chatbots include continually enhancing the information derived from previous interactions, analyzing various behaviors and languages, correcting spelling and grammar errors, generating responses to complex questions independently, and providing natural and more human-like responses compared to rule-based chatbots (Digital Transformation Office, 2023).

Generative AI has revolutionized many fields from text and content development to writing simple program codes, visualization, and video dubbing. Companies like Microsoft, Amazon, and Google are developing their own generative AI models (Livingston, 2023). These companies have integrated text-based Generative AI models into widely used service-oriented applications such as virtual assistants and chatbots (Lambert & Stevens, 2023). One of the most popular applications today is undoubtedly ChatGPT, which is publicly accessible. Productive artificial intelligence has the potential to change how we do things, and chatbots are one of its most popular applications. Despite companies like Google and Meta having their own chatbots, ChatGPT has become popular because it is open to the public (Aydın & Karaarslan, 2022; Aydın & Karaarslan, 2023).

Language models are artificial intelligence models trained on vast text datasets. These models learn the structure of a language, word usage, sentence formation rules, and other linguistic features. A chatbot like ChatGPT operates as a language model, generating meaningful responses based on user inputs. ChatGPT is a generative AI model and is one of the prominent large language models. Generative AI refers to artificial intelligence models that can generate new data or produce realistic content. Models like ChatGPT operate in the field of natural language processing, creating human-like texts.

Large language and multimodal models, sometimes referred to as foundational models, are a type of AI model trained on large amounts of data that can be adapted to various downstream applications, emerging as increasingly popular AI models. Models such as ChatGPT, DALL-E 2, and Make-A-Video have demonstrated impressive capabilities and are widely used in real-world scenarios (Maslej et al., 2023). A model like ChatGPT can be utilized for natural language generation and interacting with users. Figure 1 below illustrates the timeline and national connectivity of selected versions of these large language and multimodal models.

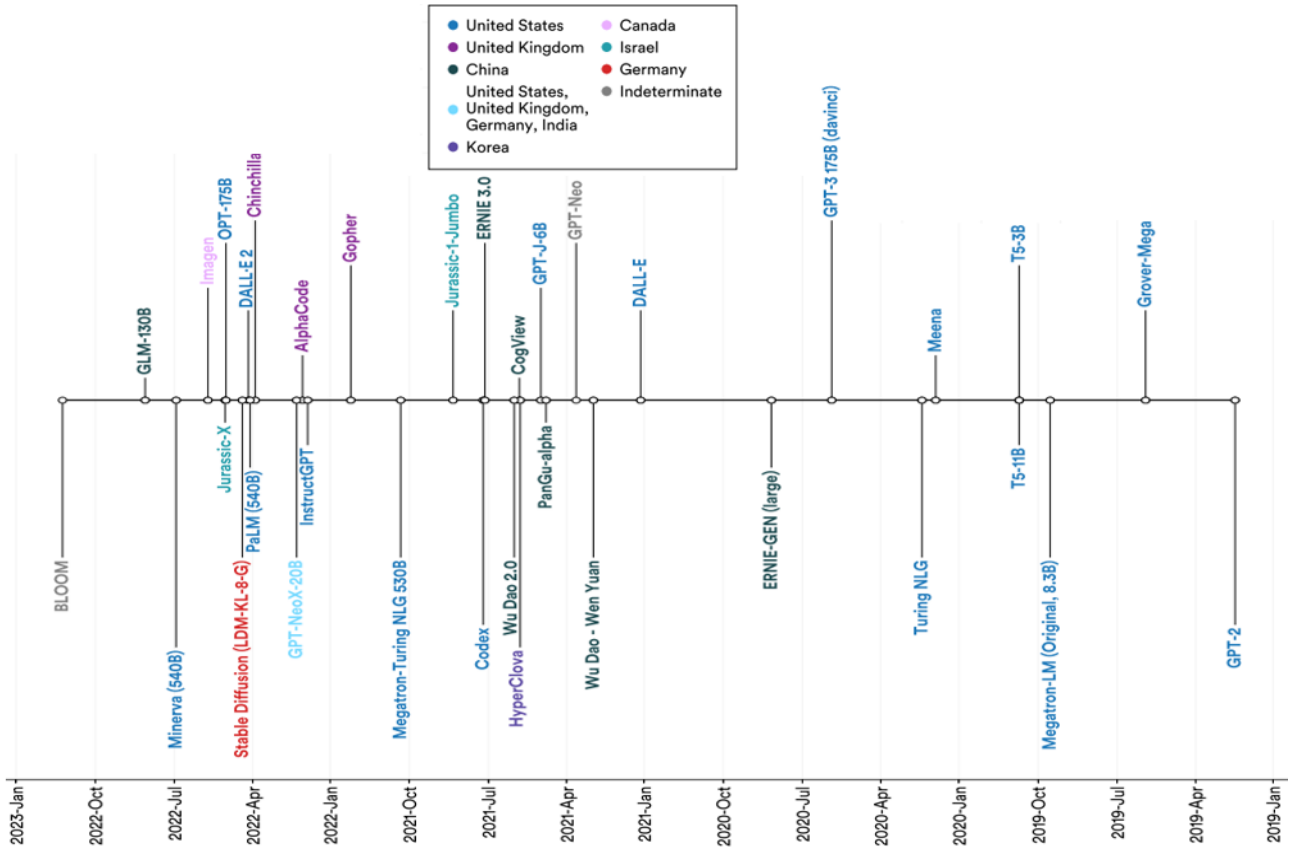

Figure 1. Timeline and National Affiliation of Select Large Language and Multimodal Model Releases (Maslej et al., 2023)

The discourse surrounding large language models and multimodal models often revolves around a specific theme, namely their associated costs. While artificial intelligence companies rarely discuss training costs explicitly, it is widely estimated that training these models can cost millions of dollars and becomes increasingly expensive as they scale (Maslej et al., 2023). Figure 2 below illustrates the selected training costs for prominent large language and multimodal models. For instance, the training cost is approximately 0.05 million dollars for GPT-2, whereas it is noted to be 1.80 million dollars for GPT-3.

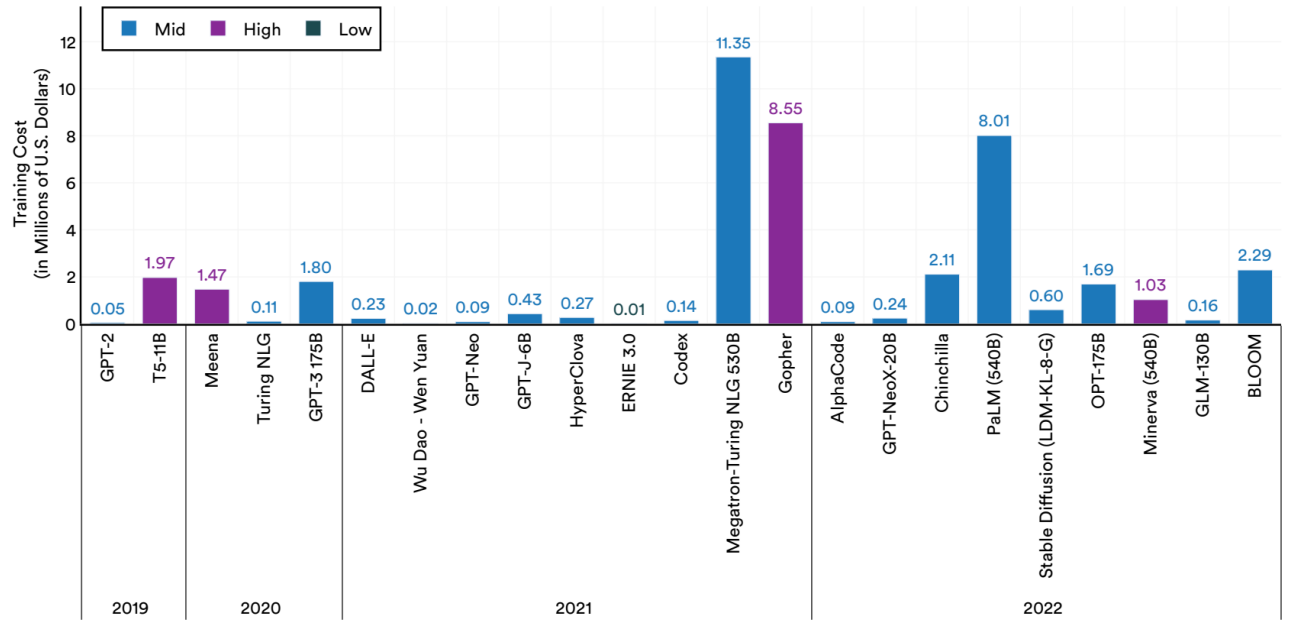

Figure 2. Estimated Training Cost of Select Large Language and Multimodal Models (Maslej et al., 2023)

Examining some features of the ChatGPT application, it can generate answers to questions, examine and debug errors, create text, classify texts, and provide translation, among other capabilities (Koçyiğit, 2023). Examples of applications similar to ChatGPT include MeetClaude developed by Antropic, ErnieBot developed by Baidu, CoPilot developed by Microsoft, Grok developed by XAI, and Google Gemini AI (formerly Google Bard AI) developed by Google, all of which have been launched in the past year by major technology companies developing Generative AI applications.

Artificial intelligence chatbots, leveraging large language models and machine learning, hold the potential to revolutionize our interactions with computers and digital systems. Proponents of these advancements argue that such applications can offer significant benefits to all (Bryant, 2023). Moreover, it is plausible to discuss the integration of chatbots within the public sector. AI applications utilizing public administration and chatbots in public settings have been present for over a decade (De Sousa et al., 2019). According to Misuraca and Van Noordt (2020), chatbots represent one of the most mature and extensively researched artificial intelligence solutions that transcend public boundaries. Indeed, chatbots are intelligent systems capable of handling vast datasets and addressing routine inquiries (Mehr et al., 2017).

Chatbots and other AI tools can assist public institutions in communicating more effectively with the public and delivering services. It is anticipated that they will increase the capacity to provide quick responses to citizens' questions (Yalçın, 2024). Maragno et al. (2023) have demonstrated the feasibility of chatbots for the customer service department of public organizations. Huang & Gan (2023) have stated that chatbots can contribute to service delivery in public institutions by addressing many needs effectively, potentially revolutionizing the public sector. Integration of chatbots into smart city applications such as waste management, transportation, and emergency services can enable citizens to access services efficiently and effectively in real time. Chatbots, widely used in sectors such as education, health care, tourism, banking, and marketing, are also rapidly gaining a foothold in the public sector today (Digital Transformation Office, 2023).

4. THE IMPORTANCE OF ARTIFICIAL INTELLIGENCE IN PUBLIC SECTOR AND SAMPLE APPLICATIONS

Artificial intelligence, with its various components such as machine learning, deep learning, neural networks, cognitive computing, and natural language processing, can be defined not merely as a single technology but as an "enabler." Indeed, it has widespread applications in many different sectors and areas of our daily lives, including health, industry, commerce, education, transportation, and more (Özdemir, 2022). Grace et al. (2018) suggest there is a 50% chance that artificial intelligence will surpass human performance in all tasks within 45 years and fully automate all human jobs within 120 years.

In their study, Wirtz et al. (2019) propose a model that categorizes the challenges of artificial intelligence into four main areas: (1) AI technology implementation, including AI safety, system/data quality and integration, financial feasibility, and the need for specialization and expertise; (2) AI law and regulations, covering the governance of autonomous intelligence systems, issues of responsibility and accountability, and concerns about privacy and safety; (3) AI ethics, addressing rulemaking for human behavior, the alignment of machine versus human value judgments, moral dilemmas, and AI discrimination; and (4) AI society, focusing on workforce substitution and transformation, social acceptance and trust in AI, and the evolution of interactions from human-to-machine and machine-to-machine.

According to Turchin (2018), the problem-solving ability of artificial intelligence stems not from its intelligence per se but from its access to large amounts of data and other resources. The application of big data in the public sector is structured according to the following administrative function systematics (Maciejewski, 2017): public audit (identifying irregularities and taking sensitive actions), public regulation

(shaping social relations through prohibitions or orders), public service delivery (providing specific services or products).

While artificial intelligence varies sectorally in terms of its functions and applications, it offers certain advantages to institutions. Artificial intelligence contributes to organizations by providing recommendations and data for decision-making processes aligned with their goals and strategies, thereby enabling institutions to stay ahead in an increasingly competitive environment. Additionally, the contributions of artificial intelligence to institutions include: (1) automating business processes and enabling automated decision-making, (2) increasing efficiency and reducing costs, (3) boosting sales rates, (4) improving product or service quality, (5) optimizing processes such as supply chain and logistics, (6) enhancing customer satisfaction, loyalty, and experiences, (7) facilitating more efficient and advanced workforce allocation, (8) assisting in the execution of personalized marketing activities (Gtech, 2021). Indeed, the public sector stands among the most critical and important sectors.

Policy makers are defining new strategies to adapt to transformation. Public administration is redefining its duties and responsibilities to integrate into the digital transformation. The public sector is implementing reforms in policy and service delivery to adapt to this change seen in the private sector (Önder & Saygılı, 2018). In recent years, with the influence of the digitalization age, the concept of smart cities has gained significant attention from states. Smart cities use data analytics to enhance living standards, increase sustainability, and improve efficiency in various areas such as transportation, energy, health, and public services (Cuau, 2019). Indeed, such technological developments enhance efficiency, transparency, and accessibility in service delivery within the public sector, making it possible to address current problems and complexities in public administration more effectively (Tanrıverdi, 2021). Furthermore, the use and proliferation of digital service delivery contribute to the growth of public employment volumes (Sarıtürk, 2022).

Various examples of artificial intelligence applications exist in the public sector. For instance, Kouziokas (2016) applied artificial intelligence techniques in public administration to spatially predict crime to promote security management in public transport, and researchers found the developed solution to be highly beneficial. In the United States, the Atlanta Fire Rescue Department's predictive analytics application accurately predicted fires in buildings by 73%. In Canada, the City of Surrey developed an application via chatbot to help citizens find solutions to their municipal infrastructure-related issues (Ulaşan, 2023). Additionally, the Citizen Lab project in Belgium serves as an example of citizen participation in decision-making processes and the use of artificial intelligence technology in the chatbot field. This project automatically classifies and analyzes thousands of evaluations collected on citizen participation platforms using Natural Language Processing (NLP) and Machine Learning techniques. The application allows public officials to better see differences in priorities by separating results according to demographic groups and locations (Cuau, 2019). Of course, in addition to fully and ethically benefiting from natural language processing models based on artificial intelligence in public services, it is necessary to first have access to sufficient, high-quality, and unbiased data (Bozdoğanoğlu et al., 2024).

Another significant outcome of the development of artificial intelligence is unified and citizen-centric governance. In this model, artificial intelligence-based natural language processing models can be used in communication between institutions and citizens. Chatbots developed by public institutions exemplify this process. The progress made by artificial intelligence in natural language processing and deep learning has enabled the implementation of dialogue-based artificial intelligence applications. Communication speeds up with citizens through chatbots in public institutions, reducing the workload of employees (Şahnagil, 2023).

A study conducted by Harvard University identified five different use cases for chatbots in the public sector. These use cases include: answering citizens' questions and complaints through automatic customer support

systems based on artificial intelligence, guiding citizens in document searches and form filling, accepting and directing citizen inputs to relevant institutions, translating information within the public sector, and designing documents for citizens to find answers to their questions (Androutsopoulou et al., 2019).

Bartosz Kopka (2011), who studied the advantages and disadvantages of AI-based chatbots, listed their advantages as: facilitating access to information for citizens, reducing costs in providing services to citizens in the public sector, and making the chatbot system more attractive to users, thereby encouraging more active use. He noted disadvantages such as the time-consuming nature of regularly processing new data and the inability to fully mimic human brains and behaviors in emulation.

5. THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE IN THE PUBLIC SECTOR IN TÜRKİYE AND EXAMPLES OF ARTIFICIAL INTELLIGENCE APPLICATIONS IN TÜRKİYE

Due to the global digital transformation, competition among countries has emerged. To avoid negative impacts on Türkiye from this competitive environment, it is crucial for the country to timely meet the demands of the era (Çarıkçı, 2010). In Türkiye, the integration of artificial intelligence (AI) in the public sector can be traced back to the e-government initiative. The e-government application aimed to leverage information and communication technologies in the public sector (Tamer & Övgün, 2020).

The e-government application was developed with three main objectives: facilitating citizen access to public services and increasing their availability; promoting citizen participation in service production and management processes, efficiently evaluating their preferences and choices; and ensuring rational and effective operation of public institutions. Additionally, transparency in public service delivery, cost savings, reduction of bureaucracy, acceleration of service delivery throughout the year, and increased citizen participation in public services can be listed as other objectives (Akçakaya, 2017).

In Türkiye, the Digital Transformation Office was established under Presidential Decree No. 1 on July 10, 2018, aiming to integrate technology advancements, societal demands, and digital transformation in the public sector. This initiative consolidated efforts previously conducted under different agencies related to digital transformation (e-government), national technologies, big data, cybersecurity, and artificial intelligence (AI) under one roof (Digital Transformation Office, 2024b).

The responsibilities of the Digital Transformation Office regarding artificial intelligence are outlined in Presidential Decree No. 48, which mandates the establishment of the Directorate of Big Data and Artificial Intelligence Applications. The tasks of this Directorate include developing strategies and coordinating efforts for effective use of big data and AI applications in public sectors, and leading AI applications in priority project areas (Akman & Çetin, 2019). Thus, the core task of digital transformation in this process is noted to manage collaboration and coordination among institutions.

Türkiye became one of the first 50 countries to publish its first national AI strategy, providing itself with a roadmap for 2021-2025, in August 2021. The primary goals of these initiatives are to increase societal welfare and strengthen national security (Özdemir, 2022). The policies defined under the 2021-2025 Türkiye Artificial Intelligence Strategy are categorized into six main headings, as outlined by the Digital Transformation Office (2024a): fostering advanced skills in AI, aligning the education system accordingly; increasing R&D activities in AI; enhancing entrepreneurship; ensuring access to high-quality data and technical infrastructure for AI; establishing an ethical and legal framework for AI; developing international collaborations in AI; managing the impact of AI on employment and professions; and transforming institutions and companies with AI applications.

Consequently, Türkiye 's level of AI readiness is progressing alongside these developments. According to the AI Readiness Index 2021, Türkiye improved its position by 14 places to 53rd among 160 countries, with a

score of 55.49 compared to 46 in 2020. This rise can largely be attributed to the optimistic unveiling of its national strategy, which is seen as promising in both the short and long term (Özdemir, 2022).

In Türkiye, public institutions have implemented AI-based digital tools to serve the public. Examples include the Ministry of Foreign Affairs' development of the "Hızır" application under the digital diplomacy initiative, providing a chatbot-based application for citizens abroad to access services around the clock, without the constraints of office hours (Ministry of Foreign Affairs, 2024). Similarly, the Ministry of National Education has developed the MEB Assistant and EBA Assistant applications to provide effective service and assistance to citizens (Ministry of National Education, 2024). Additionally, the Ministry of Treasury and Finance's digital tax assistant "GİBİ" uses AI-based chatbot technology to answer taxpayer queries 24/7, providing updated regulatory information and saving time for citizens (Ministry of Treasury and Finance, 2024). Furthermore, Turkish public institutions have introduced AI-supported tools for smart transportation, energy management, environmental monitoring, education, healthcare, food sector, communication, and social projects, such as ASENA, GAMER, Muhatap, Uyuma, Kades, and NeyimVar (Yalçın, 2024).

To achieve a more effective development trend in AI in Türkiye, the Turkish Informatics Association has emphasized the need to establish a four-legged AI ecosystem. This ecosystem requires coordinated efforts among the supervisory public sector, flexible and dynamic private sector with production capabilities, universities developing creative and innovative technologies, professional chambers safeguarding societal values, and civil society organizations organizing joint activities (TBD, 2020). Overall, Türkiye is taking proactive measures to prepare public institutions for advancements in AI.

6. GLOBAL DEVELOPMENTS IN ARTIFICIAL INTELLIGENCE TECHNOLOGY

In the realm of global technological advancement, artificial intelligence has emerged as a transformative force promising to reshape industries, enhance efficiency, and foster innovation. While advanced countries progress in harnessing the potential of AI, its adoption and effective implementation in developing countries present a distinct set of challenges and opportunities. From infrastructure limitations and skill gaps to ethical considerations, the journey spans numerous opportunities across sectors such as health, education, agriculture, and beyond, uncovering and acknowledging the profound impact AI can have on these nations (Aderibigbe et al., 2023). AI has emerged as a powerful force shaping the global technological landscape, and adoption trends in developing countries are influenced by multiple factors (Pan, 2016). AI models today demonstrate significant potential to benefit humans across various fields, including education, medicine, and scientific research (Anderljung et al., 2023). It is evident that AI will have a direct impact on the international system and power distribution, as a global race spearheaded by the United States and China continues to unfold (Özdemir, 2022).

The United States introduced its national AI strategy, known as the American AI Initiative, via an Executive Order on February 11, 2019. This strategy aims to promote and protect AI technology and innovation in the United States through a collaborative approach. The government identified five key principles to drive AI development: sustaining investment in AI research and development, making federal AI resources available, eliminating obstacles to AI innovation, improving the American workforce through AI-focused education, and creating an international environment that supports American AI innovations and their responsible use. Additionally, the United States employs AI to improve the efficiency of federal government operations and public services (Saveliev & Zhurenkov, 2021). In the digital age, the competencies needed in the IT sector evolve over time in response to changes and transformations within the sector. This evolution also diversifies the characteristics required of human resources in the industry (Damar, 2022a; Damar, 2022b). A similar situation has been observed in the field of artificial intelligence and related sectors. Figure 3 below illustrates this change in the context of the USA.

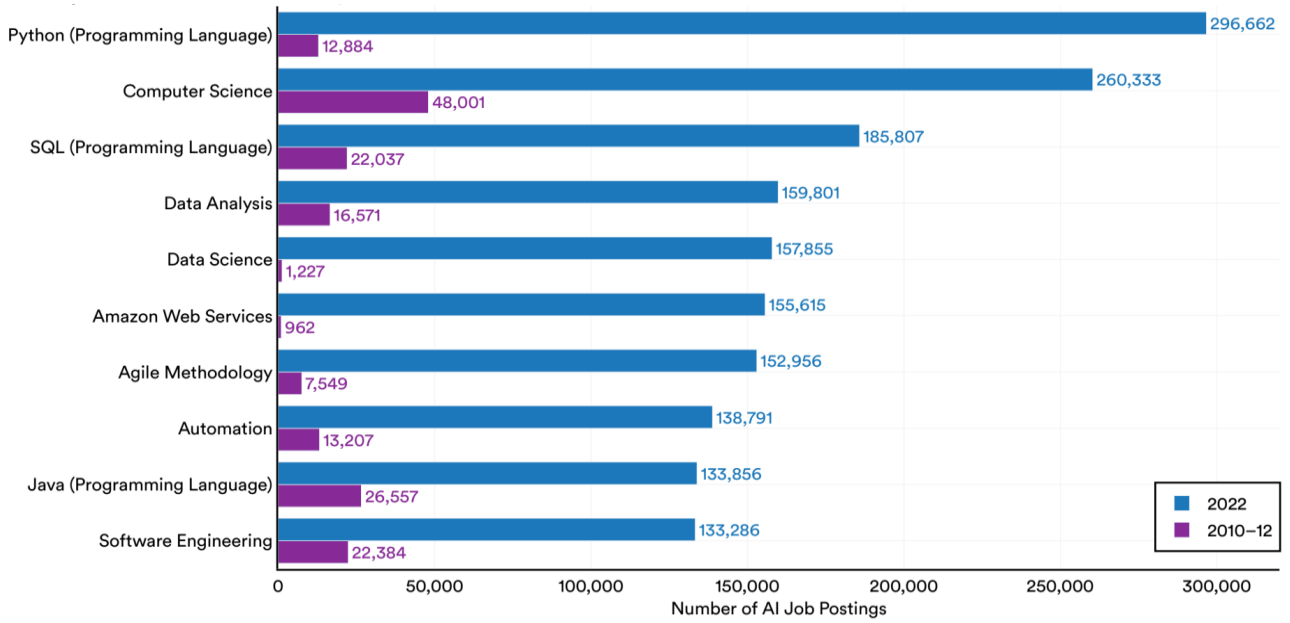

Figure 3. Top Ten Specialized Skills in 2022 AI Job Postings in the United States, 2010-2022

Table 1. Top Five Investment Activities, 2022 (Maslej et al.,2023)

Rank	Company Name	Headquarters Country	Focus Area	FA
AI Merger/Acquisition Investment Activities				
1	Nuance Communications, Inc.	United States	Artificial Intelligence; Enterprise Software; Healthcare; Medicine Learning	19.80
2	Citrix Systems, Inc.	United States	Data Management, Processing, and Cloud; HR Tech	17.18
3	Avast Limited	United States	Data Management, Processing, and Cloud; Fintech; Cybersecurity, Data Protection	8.02
4	AspenTech Corporation	United States	Manufacturing; Software; Supply Chain Management	6.34
5	Vivint Smart Home, Inc.	United States	Cybersecurity, Data Protection; Sales Enablement	5.54
AI Minority Stake Investment Activities				
1	AVEVA Group, PLC	United Kingdom	Chemical; Computer; Data Mining; Electronics; Industrial Manufacturing; Information Technology; Simulation; Software	4.68
2	Grupo de Inversiones Suramericana, SA	Colombia	Financial Services; Impact Investing; Insurance	1.48
3	Fractal Analytics Private Limited	India	Analytics; Artificial Intelligence; Big Data; Business Intelligence; Consulting; Machine Learning	0.35
4	Atrys Health, SA	Spain	Medical and Healthcare	0.28
5	R Systems International, Ltd.	India	Analytics; Information Technology; IT Management; Software	0.17
AI Private Investment Activities				
1	GAC Aion New Energy Automobile Co., Ltd.	China	Automotive; Clean Energy; Electric Vehicle; Manufacturing	2.54
2	Idience Co., Ltd.	South Korea	Emergency Medicine; Healthcare; Pharmaceutical	2.15
3	Uali	Argentina	Drones; Cloud Computing	1.50
4	Anduril Industries, Inc.	United States	Cybersecurity, Data Protection; AR/VR; Drones	1.50
5	Celonis, GmbH	Germany	Retail; Industrial Automation, Network; HR Tech; Insurtech	1.22
AI Public Offering Investment Activities				
1	ASR Microelectronics Co., Ltd.	China	Semiconductor; VC	1.08
2	iSoftStone Information Technology (Group) Co., Ltd.	China	Data Management, Processing, and Cloud; Cybersecurity, Data Protection	0.73
3	Jahez International Company for Information Systems Technology	Saudi Arabia	Artificial Intelligence; E-Commerce; Food and Beverage; Food Delivery; Information Technology; Logistics	0.43
4	Fortior Technology (Shenzhen) Co., Ltd.	China	Electronics; Machine Manufacturing; Semiconductor	0.30
5	Beijing Deep Glint Technology Co., Ltd.	China	Cybersecurity, Data Protection; Music, Video Content	0.29

**FA: Funding Amount (in Billions USD)*

While the United States leads in investments globally, a notable reality in recent years, as in many fields, is China's prominence. Saveliev & Zhurenkov (2021) highlighted Chinese companies as among the most popular among international technology investors, listing leading firms in AI investment such as Sense Time ($1.2 billion in 2018), UBTech Robotics ($820 million), Megvii Technology ($600 million), YITU Technology ($300 million), alongside American companies Dataminer ($391 million), CrowdStrike ($200 million), and Pony.ai ($214 million). China aims to become a global innovation leader in AI by 2030, with ambitious investment plans totaling 1 trillion yuan ($147.8 billion), aiming to establish itself as a "scientific and technical superpower" in AI, leading in all AI domains (English Gov, 2017).

Since 2013, the United States has led in private artificial intelligence investments with $248.9 billion, followed by China with $95.1 billion and the United Kingdom with $18.2 billion. Then, in order, they are Israel ($10.83 billion), Canada ($8.83 billion), India ($7.73 billion), Germany ($6.99 billion), France ($6.59 billion), South Korea ($5.57 billion), Singapore ($4.72 billion), Japan ($3.99 billion), Hong Kong ($3.10 billion), Switzerland ($3.04 billion), Australia ($3.04 billion), and Spain ($1.81 billion) (Maslej et al.,2023). Additionally, Table 1 shows the top five investment activities by country and firm name.

Additionally, another table below illustrates the Top AI Private Investment Activities for the USA, China, European Union, and United Kingdom (Table 2).

Table 2. Top AI Private Investment Events for United States, China, European Union and United Kingdom (Maslej et al.,2023)

United States			
Rank	**Company Name**	**Focus Area**	**FA**
1	Anduril Industries, Inc.	Cybersecurity, Data Protection; AR/VR; Drones	1.50
2	Faire Wholesale, Inc.	Fintech; Retail; Sales Enablement	0.82
3	Anthropic, PBC	Artificial Intelligence; Information Technology; Machine Learning	0.58
4	Arctic Wolf Networks, Inc.	Data Management, Processing, and Cloud; Cybersecurity, Data Protection	0.40
5	Jing Chi, Inc.	Data Management, Processing, and Cloud; AV; AR/VR	0.40
China			
1	GAC Aion New Energy Automobile Co., Ltd.	Automotive; Clean Energy; Electric Vehicle; Manufacturing	2.54
2	GAC Aion New Energy Automobile Co., Ltd.	Automotive; Clean Energy; Electric Vehicle; Manufacturing	1.11
3	Beijing ESWIN Technology Group Co., Ltd	Data Management, Processing, and Cloud; Industrial Automation, Network; Semiconductor; Marketing, Digital Ads; Sales Enablement	0.58
4	Zhejiang Hozon New Energy Automobile Co., Ltd.	Data Management, Processing, and Cloud; Cybersecurity, Data Protection; Sales Enablement	0.44
5	Zhejiang Hozon New Energy Automobile Co., Ltd.	Data Management, Processing, and Cloud; Cybersecurity, Data Protection; Sales Enablement	0.32
European Union and United Kingdom			
1	Celonis, GmbH	Retail; Industrial Automation, Network; HR Tech; Insurtech	1.22
2	Content Square, SAS	Analytics, Artificial Intelligence: CRM: Data Visualization; Digital Marketing; SaaS	0.60
3	Retail Logistics Excellence - RELEX Oy	Retail	0.57
4	Cera Care Limited	Medical and Healthcare	0.32
5	Babylon Holdings Limited	Medical and Healthcare; Music, Video Content	0.30

**FA: Funding Amount (in Billions USD)*

The European Union (EU), not wanting to fall behind in AI technologies led by the U.S. and China, has identified strategic areas to secure a larger share of the market and allocated substantial budgets accordingly. The EU supports early-stage AI research with grants up to €2 million, and provides up to €100 million in support for companies to commercialize positive outcomes after prototype or concept validation (TBD, 2020). Anderljung et al. (2023) emphasized the need for increased regulation and management of AI across various policy domains, prompting the EU to pursue appropriate legal frameworks such as the GDPR, AI Act, Digital Services Act (DSA), Digital Markets Act (DMA), Data Governance Act (DGA), Data Act (DA), and

European Health Data Space (EHDS), positioning itself as a global leader in regulating digital innovation and potential harms (Sharon & Gellert, 2023).

Russia, while taking significant steps in AI, predominantly focuses these efforts within state-controlled frameworks. Over the past decade, Russia has conducted approximately 1,400 AI scientific projects, mostly by non-profit organizations. The country allocated approximately $343 million to AI R&D in the last decade, compared to around $200 million annually from U.S. state budgets for AI research (Saveliev & Zhurenkov, 2021).

In the United Kingdom, a system developed based on AI has proven highly profitable, generating £1.4 billion in additional revenue for the British treasury in its first year, despite its initial cost of £45 million (Caldwell, 2014). The system, Connect, developed by His Majesty's Revenue and Customs, utilizes social network analysis software and data mining techniques to detect fraudulent or undisclosed activities by cross-referencing tax records with other databases (Sanghrajka, 2024). Babuta et al. (2020) suggested that the use of AI within the framework of powers granted to government institutions may raise additional privacy and human rights considerations under existing legal and regulatory frameworks. Currently, however, the concept of responsibility concerning AI remains legally undefined globally (Saveliev & Zhurenkov, 2021). Similar systems have been implemented in different periods in India and Poland (Maciejewski, 2017).

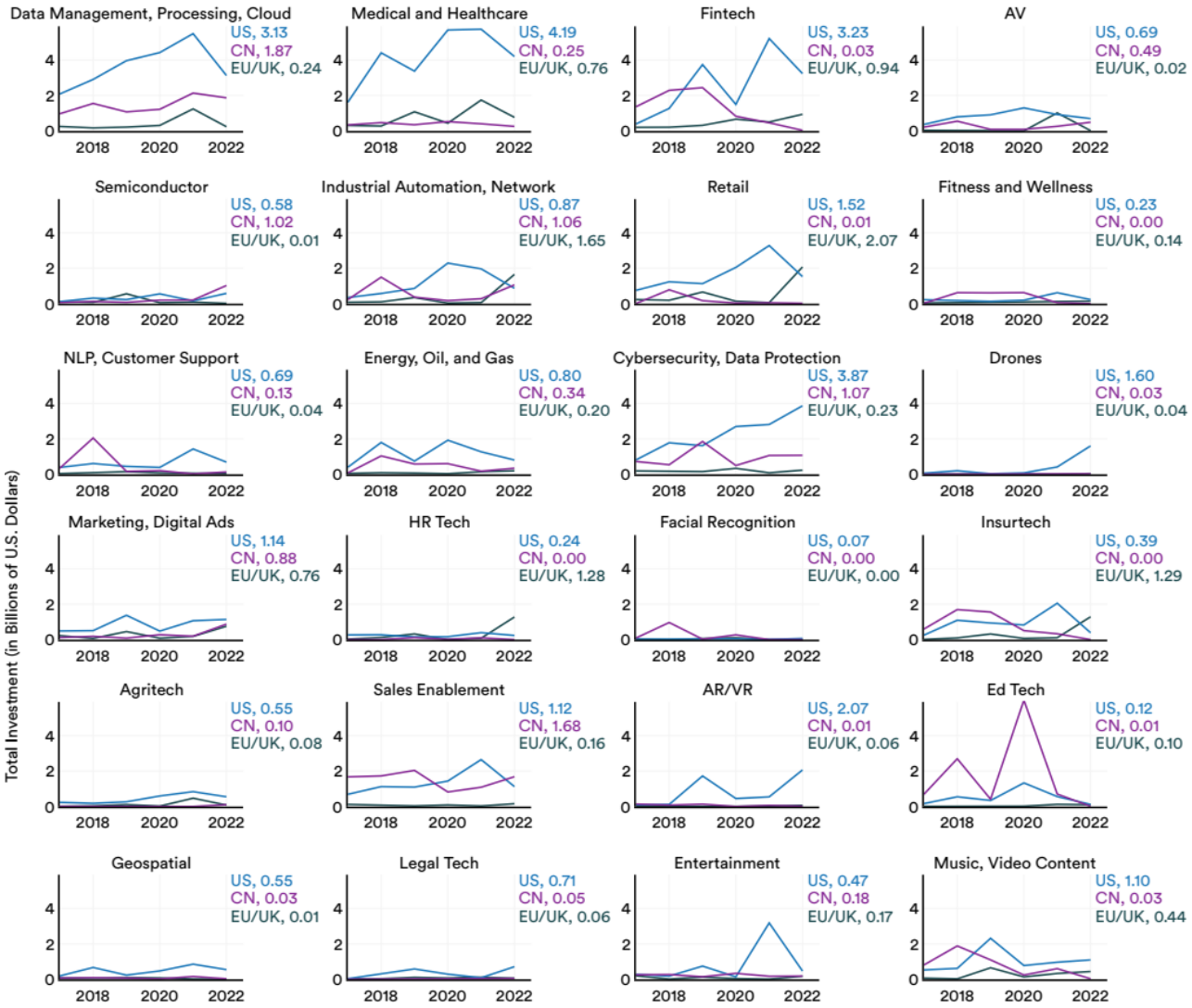

Figure 4. Private Investment in AI by Focus Area and Geographic Area (US: United States, CN: China, EU/UK: European Union/United Kingdom), 2017-22 (Maslej et al., 2023)

Each country invests significantly in artificial intelligence, both through private sector initiatives and government support. The investments made by the United States, European Union, United Kingdom, and China in 24 different areas of artificial intelligence are depicted in Figure 4.

The countries and groups mentioned above can be evaluated as exemplary applications of AI development. Nevertheless, advancements in AI are centered around human welfare. Examples of big data applications have demonstrated exceptional improvements in the effectiveness and efficiency of public administration, suggesting that big data could significantly enhance overall public governance (Maciejewski, 2017). However, the development of AI is progressing towards large-scale, complex distributed systems from relatively limited independent systems. Yet, potential risks such as hardware and software failures, design flaws, malicious attacks, and goal misalignment may arise. Moreover, systems controlled by advanced AI may become unpredictable, leading to ethical risks when making decisions regarding operational matters (Page et al., 2018). In this regard, it is highly valued that policymakers exercise caution in initiatives within public administration concerning artificial intelligence.

In developing countries, the challenges and opportunities of artificial intelligence extend beyond national borders. Global collaboration is essential to share knowledge, best practices, and resources. International organizations, technology companies, and research institutions can play a significant role in supporting developing countries on their AI journeys. Consequently, the integration of artificial intelligence in developing countries is a dynamic journey that requires coordinated efforts, strategic planning, and a commitment to inclusivity (Aderibigbe et al., 2023). The potential benefits of AI technology are substantial not only for the public sector but also for all sectors and countries. Additionally, it serves as a significant and critical catalyst for sustainable development goals globally.

7. DISCUSSION AND CONCLUSION

If we evaluate artificial intelligence technologies for the public sector, they can be applied in various domains such as security and defense for enhancing surveillance capabilities, in healthcare for medical diagnostics and treatment processes, in education for personalized learning materials, in improving public services, in transportation and infrastructure for traffic management and planning, in environmental and natural resource management for assessing environmental risks and natural disaster scenarios, in legal and justice systems for optimizing court decisions and identifying overlooked factors, in conducting financial analyses and economic predictions, among numerous other areas. Therefore, countries worldwide show significant interest in and allocate substantial resources for such a beneficial technology, also outlining national AI strategy action plans.

Artificial intelligence represents a revolutionary technological development with the potential to deeply impact all aspects of our lives. Both private and public sectors have recognized this, resulting in substantial investments in AI in recent years. For instance, according to the International Data Corporation's Worldwide Artificial Intelligence Spending Guide covering 32 countries and 19 industries, global spending on AI was $50.1 billion in 2020 and $85.3 billion in 2021, with projections to exceed $204 billion by 2025. The study highlights that countries like the United States and China are expected to lead in AI spending and reap significant economic gains from AI advancements (Özdemir, 2022).

In Türkiye, efforts are underway to integrate AI into digital transformation and public administration (Avaner & Çelik, 2021). Yalçın (2024) suggests that AI adoption in Turkish public institutions will shape through policies aligned with these institutions' goals and objectives. According to the Turkish Informatics Association's AI report, achieving a competitive global position in AI and swiftly implementing AI solutions in critical sectors require coordinated efforts among supervisory public sector bodies, the dynamic production capacity of the private sector, innovative technology-generating universities, professional chambers safeguarding societal

values, and non-governmental organizations (TBD, 2020). Analyzing the opportunities and threats posed by AI technologies, which bring many innovations to public administration and are expected to continue doing so in the future, is crucial (Gezici, 2023).

The software sector ranks among the leading industries in creating new opportunities and adding value to developing countries. Countries like Türkiye, with a young and dynamic population, have a significant advantage in harnessing this potential (Damar & Özdağoğlu, 2021). In this context, Turkish universities have an important role to play. Their role in supporting scientific advancement is indisputable, and governments should view universities as a strategic tool for capturing current technologies and staying abreast of innovations (Damar & Aydın, 2021; Damar et al., 2020; Damar & Özdağoğlu, 2021). Despite approximately 200 computer science, software engineering, information technology, and AI departments across Turkish universities, many of these departments lack sufficient faculty members (TBD, 2020). Increasing AI-focused departments and integrating AI and machine learning courses into compulsory curricula such as statistics, mathematics, computer science, electrical engineering, electronic engineering, and telecommunications is strongly recommended. It is crucial to appoint academicians to these critical roles based on merit and ensure that appointed individuals are expert researchers in their fields, as they are critical for the country's future.

Furthermore, it is recommended that Türkiye significantly and rapidly enhance its bilateral interaction with China in international cooperation. Suggestions include increasing embassy numbers in G8 countries and countries like China and India, as well as establishing technology intelligence units in these large embassies (TBD, 2020). Additionally, increasing the number of researchers sent to China and India should be encouraged, particularly supporting technology-focused doctoral studies and post-research studies where China and India are pioneers. Civil society organizations such as the Turkish Informatics Association and the Software Industrialists Association are encouraged to engage with China and India, creating special investment and entrepreneurship reports on these countries, which are believed to support cross-border commercial initiatives. Trade and professional chambers should prioritize bilateral cooperation with these countries.

To expedite the integration of AI in the public sector, efforts should focus on accelerating the data cycle, enhancing AI for public policy development, coordinating the workforce with AI, harmonizing public administrations with AI, and prioritizing cybersecurity (Erbaş, 2023). AI investments should be incentivized. Besides resolving operational challenges in AI service delivery and supporting policies, AI is expected to actively create solutions in areas such as risks, crimes, pandemics, natural disasters, etc. (Efe, 2022). To create public value, all levels of government should consciously guide public sector knowledge, skills, and experiences to shape a more diverse and inclusive workforce for current and future capabilities (Lundy et al., 2021). Furthermore, for AI technologies to be developed, effectively used, and thereby ensure comprehensive development, it is imperative to swiftly establish a national AI ecosystem based on transparency (TBD, 2020). Thus, AI can make public services more efficient, use resources more effectively, and provide better services to citizens.

Given that AI technology is rapidly evolving and to plan for the future, it is essential for individuals to not only consider what AI can currently accomplish but also envision its potential future applications. Imagining AI and contemplating the global impacts of such applications are believed to be highly beneficial.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY

All relevant data are within the paper and its Supporting Information.

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