ARTIFICIAL INTELLIGENCE AND ITS ROLE IN MANAGEMENT OF MAIN SYSTEMS OF SMART CITIES

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ABSTRACT

Smart cities aim to be able to develop completely different visions of sustainable and smart development in terms of their reliance on information and communications technology, and by using artificial intelligence techniques, the smart city can adopt creative, effective and economic solutions to the challenges facing cities and achieve the principles of sustainability, and realize the importance of artificial intelligence in managing systems. The main components of smart cities and the obstacles to its activation. The smart city depends on collecting and analyzing data and information in real time to provide various services and activities through the electronic format. Artificial intelligence can intervene at different levels in managing the various systems of smart cities. By studying the general concepts of smart cities, the main hubs and systems of the smart city, the role of artificial intelligence in managing these systems and its impact on the various applications of smart cities, the importance of artificial intelligence in managing smart cities, the obstacles to artificial intelligence management of the city's main systems, and the levels of artificial intelligence intervention in different systems can be understood. For the smart city and its analysis using the S.W.O.T (Strengths, Weaknesses, Opportunities and Threats) system.

Key Words: Smart city, Artificial intelligence, Smart city main systems.

الذكاء الإصطناعى ودوره فى إدارة الأنظمة الرئيسية للمدن الذكية

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الملخص

تهدف المدن الذكية الى القدرة على تطوير رؤى مختلفة كليا للتنمية المستدامة والذكية من حيث اعتمادها على تكنولوجيا المعلومات والاتصالات ، وباستخدام تقنيات الذكاء الاصطناعى يمكن للمدينة الذكية اعتماد حلول خلاقة وفعالة واقتصادية للتحديات التى تمر بها المدن وتحقيق مبادئ الاستدامة ، وإدراك مدى أهمية الذكاء الاصطناعى في إدارة الأنظمة الرئيسية للمدن الذكية ومعوقات تفعيله ، وتعتمد المدينة الذكية على جمع وتحليل البيانات والمعلومات في الوقت الحقيقي لتقديم الخدمات والأنشطة المختلفة من خلال النسق الإلكترونى ، ويمكن للذكاء الاصطناعي التدخل بمستويات مختلفة في إدارة الأنظمة المختلفة للمدن الذكية. ومن خلال دراسة المفاهيم العامة للذكاء الإصطناعى والمدن الذكية والمحاور والأنظمة الرئيسية للمدينة الذكية ، ودور الذكاء الإصطناعى فى إدارة هذه الأنظمة وأثره على التطبيقات المختلفة للمدن الذكية و إدراك أهمية الذكاء الاصطناعي في إدارة المدن الذكية ومعوقات إدارة الذكاء الاصطناعي للأنظمة الرئيسية للمدينة ، ومستويات تدخل الذكاء الاصطناعي في الأنظمة المختلفة للمدينة الذكية وتحليلها باستخدام نظام S.W.O.T (نقاط القوة والضعف والفرص والتهديدات).

الكلمات الدالة : المدينة الذكية ، الذكاء الإصطناعى ، الأنظمة الرئيسية للمدينة الذكية.

Introduction

Smart cities depend on information and communications technology to manage and provide various activities in the city, One of the most important benefits of artificial intelligence is its ability to analyze and interpret data in an amount and speed that would be impossible to analyze at the same speed and quantity using traditional methods, as analytical tools supported by artificial intelligence can process huge amounts of data in real time.

Research Problem

Smart cities aim to be able to develop completely different visions for sustainable and smart development, through their reliance on information and communications technology. The research problem lies in how to use artificial intelligence technologies in the smart city to build creative, effective and economic solutions to meet the needs of society and overcome the challenges facing cities, Achieving sustainability principles, And realizing the importance of artificial intelligence in managing smart city systems and the obstacles to its activation.

Research Hypothesis

The smart city depends on collecting and analyzing data and information in real time to provide various services and activities through the electronic system, and artificial intelligence can intervene at different levels in managing the various systems of smart cities

Research Objectives

Realizing the importance of artificial intelligence in smart city management. Analyzing the obstacles to artificial intelligence management of the city's main systems, and Understanding the levels of artificial intelligence intervention in the various systems of the smart city and analyzing them using a system S.W.O.T (Strengths, Weaknesses, Opportunities & Threats)

Research Methodology

By studying the general idiom of artificial intelligence, smart cities, the main axis and systems of smart cities, and The role of artificial intelligence in managing these systems and its impact on various applications of smart cities.
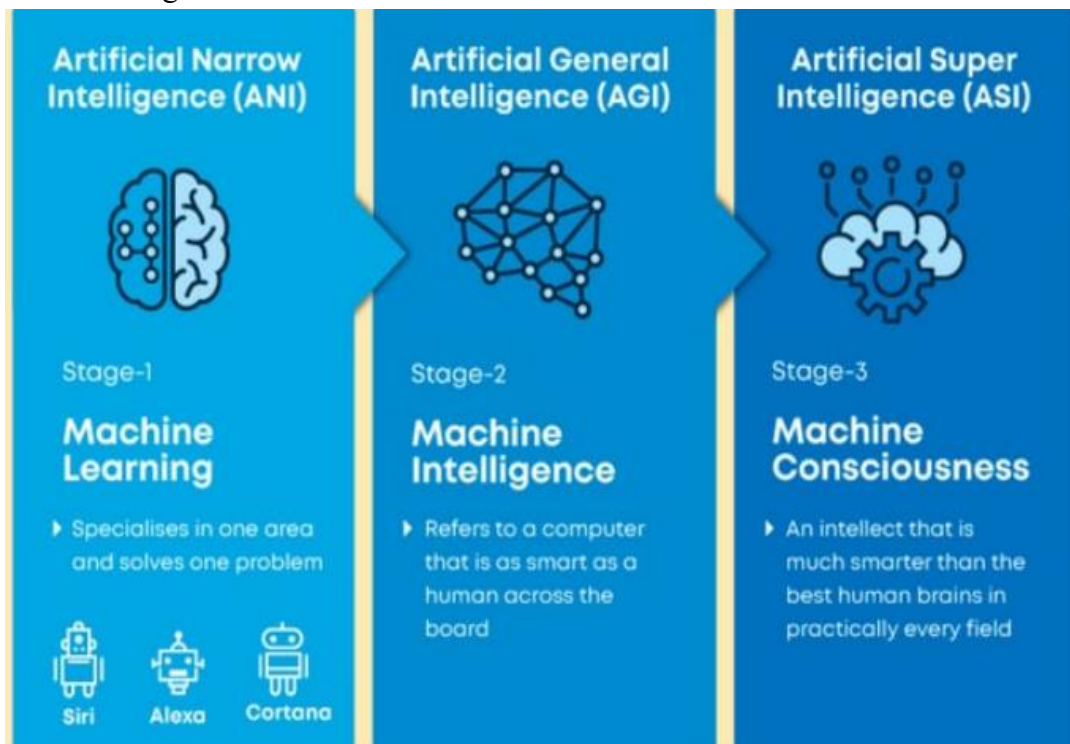
Artificial Intelligence (AI)

The American scientist John McCarthy is considered to be the one who founded the science of artificial intelligence in 1956 AD, and he defined artificial intelligence (AI) as a branch of computer science that aims to create intelligent machines[1].

6.1. Definition of Artificial Intelligence

Artificial intelligence is a branch of computer science. It seeks to accomplish tasks that may require human intelligence using computer programs, This is done through algorithms that address "learning, perception, problem solving, language understanding, and logical thinking." Artificial intelligence is present in our world, from personal assistants to self-driving cars, Artificial intelligence has the ability to develop very quickly [2].

6.2. Types of Artificial Intelligence [3]

There are three types of artificial intelligence as follows and **Fig.1** shows the three types of Artificial intelligence

Fig. 1. Three Types of Artificial Intelligence
Source: Hanif, Khan, **"Types of AI | Different T ypes of Artificial Intelligence Systems"**
University of Science and Technology of Ha Noi, Vietnam,2021.p.2.

- **Type 1:- Artificial Narrow Intelligence (ANI)**

Narrow artificial intelligence is one that specializes in one field or that can only carry out a specific task. For example, there are artificial intelligence systems that can predict a specific disease or several diseases, but they cannot predict the weather. This type is also called weak AI or Specialized AI. All current applications of artificial intelligence in our current era fall into this category, and many of them outperform humans in the tasks assigned to them. Examples of this type include the personal assistant Siri, IBM's supercomputer Watson, self-driving cars, speech recognition, image recognition, text classification, machine translation, etc.

- **Type 2:- Artificial General Intelligence (AGI)**

It is artificial intelligence that can perform any intellectual task as efficiently as a human, as it possesses mental capabilities, thinking processes, and functions equivalent to the human brain, as it seeks to create intelligent machines that are indistinguishable from the human mind.It is also known as (Strong AI, Deep AI, or Full AI).Currently there is no such system.

- **Type 3:- Artificial Super Intelligence (ASI)**

  Artificial Super Intelligence is the third type of artificial intelligence. This term describes a scenario in which artificial intelligence self-improves in an accelerating manner and surpasses human intelligence. In it, machines can outperform human intelligence, and can perform any task better than a human with cognitive characteristics such as true intelligence, thinking, perception, awareness, solving puzzles, making judgments, planning, learning, and communicating. It is a result of the development of General AI, and this type is still a default concept for AI until now.

6.3. Artificial Intelligence Examples [4]

- Discover and monitor code vulnerabilities, detect online fraud, and improve detection models
- Personal assistant and customer service services such as Siri and Alexa
- Treatment recommendations, health care improvement, and disease prediction
- Autonomous driving systems and drones
- Monitor and predict infrastructure problems before they occur.
- Smart systems for stock trading and forecasting changes in the global economy
- Automate, simplify and scale image recognition, video analysis, handwriting analysis, automatic data collection from any document and speech-to-text.
- TV program and social media recommendations

6.4. The Main Elements to Achieve Artificial Intelligence

The Previous examples fall within seven main elements to achieve artificial intelligence: Machine learning(ML), natural language processing(NLP), Expert systems, vision, Speech, planning and Robotics. **Fig.2** shows the seven main elements to achieve Artificial intelligence
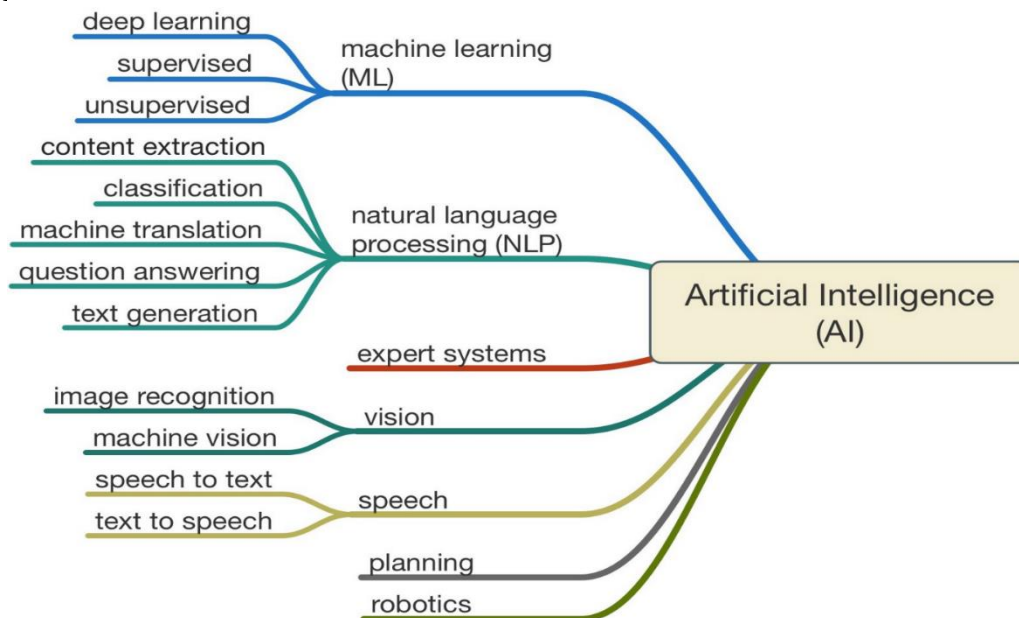
Fig. 2. The seven main elements to achieve Artificial intelligence

Source: C. Kumar, "**Artificial Intelligence: Definition, Types, Examples, Technologies,"** ,2018. http://medium.com/@chethankumargn/artificial-intelligence-definition-types-examples-technologies-962ea75c7b9b.

Smart City

 The term Smart Cities began to appear in the middle of the first era of the twenty-first century, and this term has come to link two basic trends in city development: sustainability, and information and communications technology (ICT). This was in the year 2008 AD by some technology companies, and the beginning of smart cities was through IBM as part of the Smarter Planet initiatives[5].

7.1. Definition of Smart City

There are many definitions of a smart city:
- A smart city is "a city that includes and monitors all infrastructure elements, including roads, railways, contributions, airports, water networks, participation, and buildings, to improve services, install plans for various activities, and rationalize security resources." [6].
- A smart city is "a city that links physical infrastructure, information and communications technology infrastructure, and commercial and social infrastructure with the aim of benefiting from the collective intelligence of the city" [7].
- A smart city is "a city characterized by good performance in its various characteristics, and providing smart activities for its residents who are more independent and aware in making their decisions." This definition is based on highlighting the efficiency of the city's performance in terms of the economy, governance, population, and their life style[8].
- A smart city is "a city that uses information and communications technology techniques to create interactive spaces, integrating the city's electronic space with the physical space" [9].
- A smart city is "a city that has the ability to create through communication technologies to empower the local, which includes a large number of individuals and individuals with the ability to learn, and to integrate digital completeness, enabling creativity and the ability to know" [10].

A smart city can be defined as "the urban environment that integrates the latest contemporary technology systems represented in information and communications technology and relies on it through monitoring and analyzing information within the framework of a basic information infrastructure, managing resources more efficiently, and the ability to innovate, create, and solve problems by investing in the intelligence of individuals." institutions and technologies with the aim of improving the quality of life for citizens, providing and facilitating the practice of various activities, and supporting community participation at the levels of both individuals and the public and private sectors to advance economic growth and enhance economic, environmental and human resources by supporting the possibility of movement through multiple means of travel characterized by a comfortable and safe environment, which achieves A smart lifestyle in which the elements of quality of life and all activities and practices are available using the latest technologies.".

7.2. Main Six Axis of Smart City

The different concepts of the smart city depend on a set of basic points, as explained **Table 1**

Table 1. The basic aspects on which the various concepts of the smart city depend.

ICT	It provides services that support housing, security, health care, transportation, improving the efficiency of industrial energy supplies, the possibility of remote work and e-commerce, and means of entertainment and communication for individuals.
Infrastructure	It means the basic facilities, services, and physical, organizational, and institutional structures necessary for the management of a society or institution or necessary for the growth of the economy.
Sustainable Environment	Satisfying all the needs of the present without compromising the ability of future generations to meet their own needs.
Society	It is a differentiating element between the digital city and the smart city, which is represented in skills, education levels, lifelong learning, community participation, and awareness of the importance of human capital.
Quality of Life	The extent to which individuals realize their role in life in light of the value system in which they live, the culture of society, and its connection to their goals, expectations, and fears.
Governance	These include active political participation, citizenship services, and smart use of e-government.
Economy	The smart economy combines enterprise economics with innovation in economic ideas while promoting a high-quality environment, improving energy security and promoting resource conservation.
Mobility	It is the movement of people and goods while enhancing economic, environmental and human resources by supporting access to multiple means of travel and characterized by a comfortable and safe environment.

The smart city relies on six axes. The six axes depend on economic competitiveness, quality of life, natural resources, human and social capital, mobility, city management and citizen participation in management within the framework of information and communications technology. Under each of these axes there are several factors to achieve it [11]. **Fig.3** shows the six main axes of smart city.
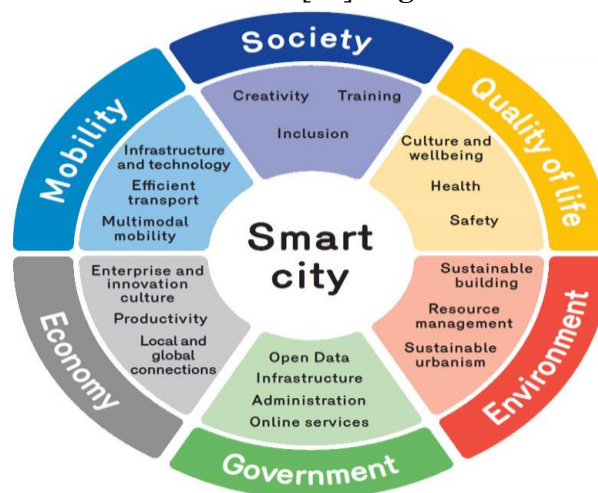
Fig. 3. the six main axes of smart city

Source: Neirotti, Paolo, et al. **"Current trends in Smart City initiatives: Some stylised facts**." 2014. https://arxiv.org/ftp/arxiv/papers/2004/2004.11943.pdf

7.3. Smart City Main Systems [12]

Smart cities depend on a set of main systems(Smart Governance, Smart Healthcare, , Smart Energy, Smart Industry & Production, Smart Mobility & transportation, Smart Living & Infrastructure, Smart Economy and Smart Environment). which a set of applications are available that work to provide services that can be obtained electronically., **Fig.4** shows the smart city main systems.

Fig. 4. the smart city main systems
Source: https://elakademiapost.com/iot

8. Artificial Intelligence Intervention in Smart City Systems and Applications

Smart city systems are managed through an information control center for various systems and applications through sensors and networks, while management can be automated through artificial intelligence, data analysis, and developing accurate solutions in real time.

Table 2. Artificial Intelligence Intervention in Smart City Systems and Applications

Systems	Applications	Artificial Intelligence Intervention
Smart Governance	– Smart governance – Collaborative policies for decision making – Citizen participation	Through algorithms that analyze information about the population's interests and trends, taking into account privacy, linking different systems, analyzing data from these systems, whether motion sensors and monitoring systems, analyzing images, video and other data, and developing solutions in real time.
Smart Healthcare	– Smart hospitals – Electronic health care – Electronic medical records – Health care tracking	Medical teams can obtain information about individuals' medical history, and determine priorities for communicating with patients. This allows for a more general and comprehensive public approach to health care and the determination of operating schedules and drug requirements.
Smart Environment	– Air quality monitoring – Weather monitoring – Smart waste management – Water monitoring	Through monitoring and tracking environmental systems and the changes resulting from them, predicting climate changes, analyzing data and improving sustainability in production processes, managing resources and waste more effectively, as well as developing environmental technologies that can provide the necessary assistance to preserve the environmental environment through monitoring air pollution and emissions. energy, helping develop transportation networks, monitoring deforestation, and forecasting extreme weather conditions.
Smart Energy	– Renewable energy – Smart energy networks – Smart lighting	Through grid management, where AI uses data analytics to estimate the level of energy consumption across homes in any given area. It takes into account a variety of factors such as time of year, peak and off-peak times, and weather conditions. This can help energy companies to be constantly aware of the potential use of electricity in the coming days
Smart Industry & Production	– Smart industry – Smart maintenance – Smart manufacturing – Smart agriculture	In industry, artificial intelligence can analyze production line information, analyze defective items, raw material supply and sales,and In agriculture, it is through crop and soil monitoring, agricultural robots, and predictive analytics. Crop and soil monitoring uses new algorithms and data collected in the field to manage and track crop health.
Smart Economy	– Smart business management – E-Commerce – Smart shopping	Artificial intelligence can speculate through algorithms that analyze information and determine the interests of the user in online shopping.
Smart Mobility & transportation	– Traffic management – Sustainable mobility – Vehicle sharing – Smart parking – Navigation systems GPS	Adopting a system of sensors for vehicle movement, traffic signals, and geographical information systems linked to artificial intelligence, which collects information in real time and sends a report and solution to the control center.

Smart Living & Infrastructure	– Smart buildings – Smart homes – Smart education – Smart infrastructure	Availability of data from various systems sensors, whether from infrastructure networks or smart buildings, managing it, and linking it with various systems. For smart learning, study devices are able to create lessons, problems, and games to suit the student's needs.

9. Analyzing the intervention of artificial intelligence in the systems of the smart city using the S.W.O.T System
(Strengths, Weaknesses, Opportunities and Threats)

Table 3. Analyzing the intervention of artificial intelligence in the systems of the smart city using the S.W.O.T System

Systems	Strengths (S)	Weaknesses (W)	Opportunities (O)	Threats (T)
1- Smart Governance	(S1)Linking, analyzing and exchanging data between government agencies and institutions, as well as with citizens, and providing all documents and data in electronic form.	(W1) Lack of integration of all data, efficiency and accuracy of data to ensure its quality and reliability, and the independence of each party with its own information system.	(O1) Providing data through community participation of individuals, working to increase monitoring devices and sensors in the city, and linking agencies and institutions	(T1) Intensive data monitoring operations represent a threat to individuals' privacy and independence, given that artificial intelligence systems rely on huge amounts of personal data to operate efficiently.
2- Smart Healthcare	(S2)By managing data in real time, special reports and measurements can be generated, which contributes to early diagnosis and detection.	(W2)The lack of availability of all health information for the patient represents a great risk of analyzing the data and giving incorrect results and reports	(O2)Working to increase medical sensors for patients and cloud recording to obtain accurate information at any time	(T2) The large influx of personal information poses a significant risk of violating patients' privacy
3- Smart Environment	(S3)Analyzing climate change data, various energy sources, land uses, and monitoring potential environmental disasters.	(W3) The lack of sensors represents a threat to the quantity and quality of this information, which affects the quality of analysis of this data.	(O3) Working to provide sensors, connect and exchange information between different environmental systems.	(T3) The difficulty of providing sensors in all areas of the city and their confinement to limited areas.

Systems	Strengths (S)	Weaknesses (W)	Opportunities (O)	Threats (T)
4- Smart Energy	(S4) Managing energy networks, understanding the rate of consumption around the clock, and analyzing this data to predict potential consumption.	(W4) Availability of information from environmental monitoring systems, weather conditions, and consumption rates at peak times.	(O4) Work on linking data from environmental monitoring systems to energy network management systems.	(T4) Inaccurate information in environmental monitoring systems leads to the system failing to determine the correct consumption rate.
5- Smart Industry & Production	(S5) Predictive analytics for production line information, item analysis, supplies, product sales, and the use of robots.	(W5) Relying on robots to a large extent increases the unemployment rate.	(O5) Strategies should be developed to support affected workers, such as retraining programs and assistance with career transitions.	(T5) The independence of robots in the system as a whole in the industrial process cannot be achieved without the human factor to approve the solutions proposed by data analysis.
6- Smart Economy	(S6) Optimal exploitation of available human and material energies and resources in a creative manner at the level of various sectors in the city.	(W6) Weak database and information integration between sectors in the city.	(O6) Developing the role of research and development centers and enhancing private sector initiatives to modernize and increase productivity	(T6) Realizing user interest in shopping and electronic commercial practices pose a risk to individuals' privacy and money .
7- Smart Mobility & transportation	(S7) Analyzing transportation and movement system data and traffic flow patterns and making real-time decisions to solve problems.	(W7) The lack of sensors and cameras in the transportation system leads to incomplete data.	(O7) Analyzing data in the city's monitoring and control centers and analyzing real-time images and videos.	(T7) Cyber attacks in an era in which artificial intelligence controls a vital system such as the transportation system.
8- Smart Living & Infrastructure	(S8) Managing data from infrastructure sensors and smart buildings to monitor problems and malfunctions	(W8) Extensive data monitoring poses a threat to individuals' privacy and autonomy.	(O8) Providing monitoring systems at the infrastructure level and raising the level of citizens in protecting information privacy	(T8) The scattering of infrastructure networks throughout the city and the difficulty of providing monitoring and sensing devices.

10.Economic benefits of artificial intelligence in managing main systems of smart cities

- **Improving efficiency:** by analyzing data and making data-based decisions, as artificial intelligence can use data to improve the timing of traffic signals, traffic routing, and energy management.
- **Improving sustainability:** AI helps improve sustainability by reducing resource consumption and improving waste management by using data to improve water and energy efficiency, and waste recycling.
- **Improving citizen safety:** This is through monitoring major city systems and discovering potential problems, such as using data to monitor traffic and emergency situations, and prevent accidents.
- **Save money:** AI can help cities save money by improving efficiency and reducing costs by using data to identify less congested routes for trucks, resulting in fuel savings.
- **Increasing revenues:** by providing new services and improving existing services. For example, AI can use data to create intelligent public transportation systems, leading to increased ridership.
- **Improving the quality of life:** by improving public services and reducing pollution. For example, AI can use data to improve air quality in a city, leading to improved public health.

11.Challenges of applying artificial intelligence in managing the main systems of smart cities

Artificial intelligence has great potential to improve the management of key systems of cities. However, there are some challenges that need to be overcome before AI can be widely adopted in cities

• Cost: The cost of developing and implementing artificial intelligence systems can be high initially.

• Data: AI requires large amounts of high-quality data.

• Regulation: Some AI applications may require special regulation.

Conclusions

– Artificial intelligence paves the way towards the future of smart cities, and employs various technical developments. It provides urban planners with insights based on data analysis by analyzing traffic patterns, proposing changes to road networks to reduce congestion and emissions, and making decisions regarding new infrastructure construction sites or roads. Improving existing infrastructure.

– Artificial intelligence simulation tools may help urban planners develop different scenarios for future development and test their potential impacts on many aspects of city life.

– The ability to involve citizens in the planning process, deductive analysis, and regular linguistic processing techniques to know the residents' opinion about the city's services.

– Artificial intelligence solves problems more efficiently, analyzes more accurate data, mechanizes decision-making, smoothly solves problems, and enhances community participation.

– Integrating AI with urban planning enables planners to make better decisions about resource allocation and project prioritization, which overall leads to more efficient use of time and money.

– The lack of data represents the main obstacle to fully integrating artificial intelligence into the field of urban planning, as accurate and comprehensive data must be available for a number of aspects, such as population density, traffic flow, land use, etc. Among the obstacles are privacy considerations or incompleteness of databases from different sources, and the efficiency and accuracy of data to ensure its validity, quality and reliability.

– Distributing sensors in the city collects real-time data about air quality, noise levels, and other environmental factors that affect the quality of life in the city.

– Artificial intelligence algorithms make decisions based on the data they are fed, which may be biased or inaccurate, and if not monitored and processed, may lead to discriminatory societal outcomes that entrench disparities and inequality.

– Intensive data monitoring operations constitute a threat to the privacy and independence of individuals, given that many artificial intelligence systems rely on huge amounts of personal data to operate efficiently. This results in an escalation of the risk of cyber attacks in an era in which artificial intelligence controls the critical infrastructure of cities (such as the health system and the transportation system).

Recommendations

The focus on sustainability is increasing due to the effects of climate change, which in turn requires a greater focus on reducing carbon emissions and making cities environmentally friendly. This requires the following:

1- Taking measures such as giving priority to public transportation over private transportation or implementing green infrastructure projects.
2- Technology continues to play an increasingly important role in shaping cities
3- Creating initiatives in which smart technologies are implemented in cities around the world using the data and technologies necessary to improve all sectors, from traffic flow to waste management.

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