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The Rise of "Cyborgs" in Smart Cities: Review and Open Research Issues

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Abstract

Cyborgs have existed since the late 1960s, but their real rise to fame happened in recent years. Due to the development of various technologies, such as the Internet of Things, mobile Internet, cloud computing, and big data, cyborgs are now being integrated into smart cities as connected devices. This paper aims to overview the state-of-the-art research on cyborgs in smart cities. The main objective is to provide researchers with an overview of current developments, especially regarding the use of cyborgs within smart cities. Furthermore, we aim to identify research topics that previous studies have not yet addressed. To achieve these goals, we first review several relevant concepts related to smart cities and cyborgs and discuss their relationship with each other. Then we examine current research models on smart cities and related issues such as privacy protection. In addition, we present a survey on the existing cyborg research in smart cities. Finally, we give insights into future research directions and challenges for developing cyborg technology for smart cities.

Keywords

Survey, Cyborg, Smart Cities, Emerging Trend, Challenges, Open Research Issue

1. Introduction

To date, cities are still facing many challenges [1] because they lack access to information [2, 3]. An increasing amount of them struggle to incorporate innovation into their infrastructure. Perhaps, a solution could be found in utilizing cyborg technology. As an emergent topic, it's important to highlight how designers and city governments can successfully use it for efficient public service delivery. Cyborg technology [2] also enables personalization by combining man with machine to prepare a city for its citizens' future needs. This study aims to bring awareness about recent trends that put forward challenges with moving toward cyborg solutions for smart cities that strive to meet current and future needs by demonstrating specific advantages while acknowledging limitations. This paper includes extensive research on background topics such as big data analytics [4], smart cities challenges, and trends in smart communities; an introduction to what cyborg is [5, 6]; description of applications, including smartphones [7], wearables, smart homes [8], and connected vehicles; discussion on applications using robotics

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(exoskeleton), prosthetics (bionic hand) [9] and neural engineering (brain-computer interface); lastly summary/conclusion along with recommendation/future directions. It aims to educate readers about emerging trends, challenges, and key issues that impact smart cities. It provides stakeholders with a detailed view of emerging trends, challenges, and opportunities related to smart cities utilizing cyborg technology. This study proposes effective strategies for ensuring success when implementing cyborg systems in smart cities. It also recommends policies needed to support implementation within existing smart city frameworks. Lastly, it suggests design guidelines based on lessons from similar case studies. It is anticipated that through an increased awareness regarding cyborg technologies, city planners will see its potential value as part of their smart city [10] plans in providing their citizens greater convenience, access, and safety across various environments, whether urban or rural. Thus, bringing together different disciplines to enable smart cities and integrating cyborg technology into smart cities.

The smart city concept is a complex network of objects, data, and services that enable the transformation of urban areas into smart cities. For this purpose, there is a need to orchestrate all these concepts together. For instance, the author in [11] presents a synergetic framework that enables this orchestration. The proposed approach consists of four layers: (1) an object layer that defines an object model for each type of smart city component; (2) a service layer that defines service interfaces for each type of smart city component; (3) a data layer that connects the different types of services through data relationships; and (3) an orchestration layer which manages the interactions between the different layers and runs on top of middleware to enable interoperability among components through message exchanges. Similarly, in 2021, Cirillo et al. [12] describe a new approach to creating smart city services. The authors propose a model that combines crowdsourced data with machine learning techniques to optimize infrastructures, such as traffic lights and water valves. They believe their approach will be especially effective in developing countries, with fewer resources for smart city development and implementation.

Cyborgs may have significant benefits [13] over conventional systems because of their unique ability to combine sensing capabilities with human intelligence leading to more intuitive ways of interacting with digital devices and physical objects.

However, with a growing number of cyborgs, new issues require solving. In the cases of wearable technologies, there are privacy problems associated with the privacy of the individual users [14]. Also, security problems exist with the essential integration of wireless communication modules. The last problem is the software bugs causing failures from the integrated control network. For user privacy, author in [15] suggest a new method for privacy protection, the main idea of which is to give increased user control over their data. Specifically, the data about every user must be controllable by said user. This includes who may see what data about a user, when they may see it, and in what way they are allowed to see it.

To this end, we advocate for user-centered data and personal artificial intelligence (AI) systems that empower individuals to choose the information they want shared with third parties in return for various categories of services or products. Additionally, since wearable electronics are becoming smaller, stronger, and cheaper, they provide an easier target for attackers looking to obtain sensitive information stored on them due to their software's flaws or incorrect configuration settings. Likewise, in the framework in the authors in [16], provides a collaborative resource adaptive and medical data secure framework for wearable healthcare systems.

The proposed framework considers the resource constraints of wearable devices and security issues related to medical data transmission over the wireless network. They investigate the design space of a secure communication protocol that supports efficient data transmission while ensuring privacy and integrity protection for medical data. In our study, we consider two types of attacks: passive attacks where an eavesdropper listens in on the wireless channel (channel-based attack) and active attacks where an attacker injects malicious messages into the system (message injection attack). Their results show that the proposed framework achieves better performance than existing solutions under both types of attacks while being more efficient in terms of battery consumption and energy usage on wearable devices. Thus, there is a need for cyber security researchers in order discover vulnerabilities before adversaries do so. This study focuses on cyborg technology that directly relates to smart cities. It is essential to understand cyborg technology to

develop and implement effective smart city designs. There is a growing interest in developing and deploying cybernetic systems for smart cities. However, there is little literature available that discusses its challenges and trends. Henceforth, it is crucial to address these challenges to guarantee the effective citizenship of cyborgs. However, it should be outlined that when a user asks different sources for a cyborg's definitions, there are various responses. Most of them emphasize the interaction of humans with electronic systems or the degree of established integration between biological and mechanical parts in a human body [17].

In this paper, we conducted the state-of-the-art of cyborgs and smart cities. The concept of the smart city was introduced, defined as a complex idea with many competing definitions. AI and Internet of Things appeared to be the technologies that enabled the development of the smart cities. AI and IoT faced several problems when used in urban environments. First, the technologies are used separately, with their drawbacks not considered and their compatibility with other technology not evaluated. Second, the integration of AI and IoT into existing legacy systems is not to be understood in maintaining their performance.

The lack of standards makes it difficult to design interoperable systems across different domains such as transportation management, public safety and environmental monitoring.

In this paper, we focus on how AI can be used to augment human decision-making by providing "personal" assistance based on context awareness, knowledge representation, and reasoning capabilities. We discuss recent research efforts to address these challenges by integrating multiple AI techniques into an intelligent assistant, which can assist human agents with decision-making within a smart.

The paper surveys various definitions of the term cyborg, reviews existing literature on the topic, and proposes a research agenda. The paper also addresses the design challenges that need to be addressed so that we can build cyborgs in smart cities.

The main contribution of this survey paper is:

- The definition of a cyborg;
- A review of existing literature on the topic;
- Proposing a research agenda for designing cyborgs in smart cities;
- Addressing the design challenges that need to be addressed so that we can build cyborgs in smart cities;
- A review of recent research on cyborgs in smart cities;
- An analysis of open research issues related to cyborgs in smart cities;
- A discussion on potential applications of cyborgs in smart cities.
- Some aspects of different definitions and uses are reflected;
- The purpose and advantage of cyborg intelligent man-machine systems are discussed;
- Advantages and disadvantages of using cyborg system in various fields, such as traffic management, healthcare facilities, military command system and electronic commerce, are surveyed;
- There is a discussion on open research issues to be addressed by future studies, e.g., the safety issue of information leakage for security issues, cultural factors influencing acceptance and other issues that may impact users' preference on cyborg technology and some challenges that may arise when creating a cyborg system which integrates or enhance human hence functionality.

This paper reviews relevant literature and presents an overview of cyborg intelligent man-machine systems, including the advantages and disadvantages of using the cyborg system in various fields. It also points out open research issues to be addressed by future studies.

Section 2 discusses a brief introduction and different types of cyborgs and smart cites. Section 3 presents the role and use of cyborgs in a smart city. In Section 4, cyborgs in the regulation of smart city government and advantages and disadvantages are given. Section 5 describes some open challenges, and future work is discussed. In Section 6, conclusions and recommendations for future research directions are provided. However, the flowchart of the survey is shown in Fig. 1.

2. Cyborg Mining Preliminary

2.1 Definition of Cyborg and Smart City

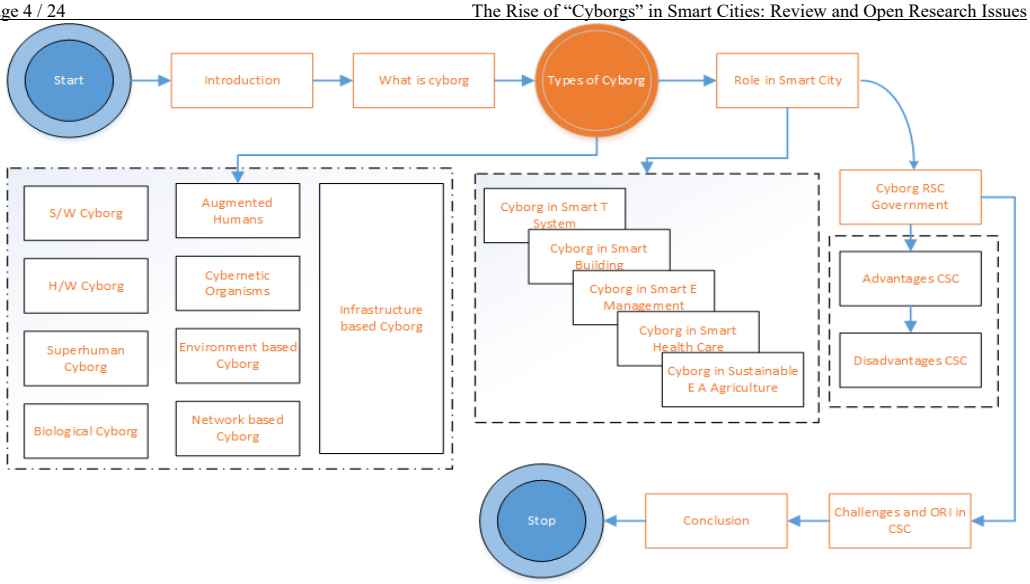

Fig. 1. Proposed model.

A cyborg is a being with both organic and artificial parts. The term was coined by Clynes and Kline [18] in 1960, while Eric Drexler published a book titled Engines of Creation in 1986 that prominently featured the development of nanotechnology-based prosthetics for enhancing human capabilities [19]. Other definitions for cyborg include an organism with significant prosthetic additions to its structure or a human with cybernetic enhancements such as implanted electronics. While many researchers think "cyborg'" refers to superhumans who have been assimilated into robotic agents, it is an umbrella term encompassing all technological augmentations used to achieve direct or indirect improvements to one's biological state [20]. It includes wearable tech like smartwatches and a lot more than that. The word "cyborg" comes from combining the words "cybernetic" and "organism." It means an organism with both electronic/robotic components and organic components. This means there are many ways to be classified as a cyborg, either through mechanical implants or computer chips embedded inside your body. However, different types of cyborgs in smart cities are discussed in the next section, and the following chart is shown in Fig. 2.

2.2 Different Types of Cyborgs in Smart Cities

There are different types of cyborgs as follows.

2.2.1 Software cyborg

A software cyborg is an information system that has acquired and absorbed enough human skills to be considered human by software. An instance of a software cyborg is Siri, developed by Apple Inc. [21, 22]. In 2015, Kim [23] studied software cyborgs to analyze the features of software cyborgs in virtual games. In this game, there are two types of cyborgs: physical and mental. The physical cyborg has a pair of mechanical legs and arms, which can be used for defense and attack. The mental cyborg does not have any weapons, but it has a lot of equipment such as goggles and helmets that can help him see things clearly and protect his head from damage. Both types of cyborgs can climb walls, jump from place to place, run faster than human beings, and even fly in the air using jetpacks.

Similarly, the author in [24] discusses the political philosophy of free software and its impact on society and relates it to the cyborg world. The author examines the philosophical implications of the free software movement. It argues that free software development has many similarities with the cyborg project, which is based on the merging of man and technology. The author also claims that it is impossible to ignore this

trend because "the cyborg era" is already here. They explore the political philosophy of free software and how it is relevant to the concept of cyborgs.

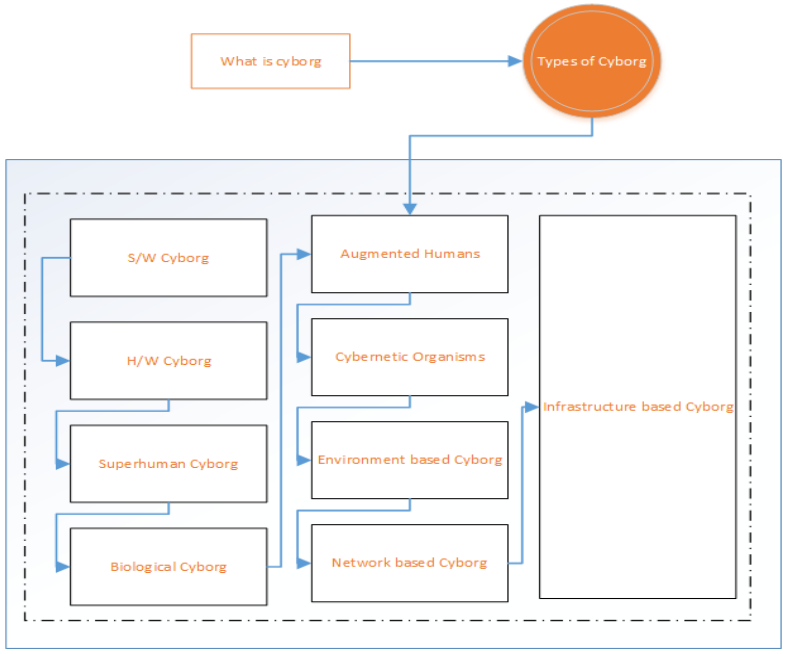

Fig. 2. Different types of cyborgs in smart cities.

2.2.2 Hardware cyborg

A hardware cyborg is a synthetic system that can move, sense, act, decide, simulate or perceive like humans. An instance of a hardware cyborg would be self-driving cars that run on AI humans [25], i.e., an artificial human (also known as a humanoid robot) is an android or any robotic counterpart to humans [26]. They are typically used for companionship and entertainment purposes. An instance of an artificial human is Softbank's Pepper Robotics Robot Sensors; robotic sensors can be defined as systems that respond to external stimuli such as light, temperature, touch, etc., as humans do. Instances include Google's self-driving car [27], Amazon's delivery drones [28], NASA's Mars Rover [29], etc. More in-depth, the honeybee is a social insect studied for years by scientists. They have understood its behavior, nervous system and flight control system. The honeybee has three types of neurons: interneurons, motor neurons, and sensory neurons. These neurons are very important in the flight control system of the honeybee. For instance, the author in [30] proposed a flight control system for honeybees based on electroencephalography (EEG) stimulation. The flight control system consisted of two parts: the first part was to record the EEG signals of the bee with an EEG headset and then send the signals to a computer; the second part was to use the computer to analyze these signals, extract some representative features and predict their corresponding movements with a neural network model. The results showed that our flight control system could accurately predict the movements of bees in different situations.

2.2.3 Superhuman cyborgs

These are robots that have replaced their bodies with superior machinery (like Terminator) [31, 32]. They look like normal humans but possess enhanced physical abilities due to their robotic nature. Some scientists believe that humans may be able to become superhuman cyborgs with technology. Technologies and advances in machine learning [33–35] will allow for new possibilities for biological machines such as humans. Scientists are already discussing cyborg augmentation and prosthetic limbs [36] with various features and abilities, such as eye vision correction. In addition, computers continue to get smaller and faster while also becoming more powerful, allowing people to use laptops, smartphones,

and other technologies anywhere they can connect to a wireless network or power source. Because our devices keep improving and we rely on them so much, they will inevitably one day merge into a supercomputer built into a human body. This is not far off from what some people are already calling transhumanism. As time goes on, we will see rapid developments in technology and biology, which could lead to a world where humans have very little distinction between themselves and their machines.

The idea of a superhuman or superhero is not new. The concept has been around for centuries, but it was only recently that science fiction became a cultural phenomenon. Superheroes are popular characters in comic books, movies, TV series, and video games. In the last decade or so, superheroes have become more than just fictional characters; they have become real human beings who can do incredible things like fly through the air or lift huge objects with their bare hands. Similarly, the author in [31] discussed the superhuman and cyborg. This book is an introduction to cyborgs and superhuman beings. It has been written in a very interesting way. The book has been divided into three chapters, each chapter focusing on a different aspect of superhuman. The firster focuses on the history of cyborgs and the second chapter focuses on the future of cyborgs. The third chapter has been divided into two parts: one part deals with how humans will be able to use their bodies as tools for enhancing their cognitive abilities; and the second part deals with how humans will be able to change their physical appearance by using advanced technologies such, as AI, bionics, and nanotechnology.

2.2.4 Biological cyborgs

Biological cyborgs [37, 38] are organisms implanted with technology, such as a pacemaker or an artificial limb. The first cyborgs were likely biological (or bionic) and utilized a combination of mechanical and biological parts to augment strength, hearing, or vision. Biological cyborgs resulted from human ingenuity applied to conquer injury or disability. More in-depth, the brain is a complex organ that encodes motor commands into neuronal activity. The spinal cord and peripheral nervous system then decode these complex motor commands to generate movement. However, the decoding process of these complex motor commands is currently unknown. The author in [39] studied and aimed to decipher whether or not an artificial limb can be embodied as a hand. We investigated whether the decoding process of artificial limbs differs from natural limbs. We used functional magnetic resonance imaging to measure healthy volunteers' brain activity during natural hand-grasping and artificial prosthetic hand-grasping tasks. In their study, they found that there were no significant differences in the neural activity between natural and artificial hand-grasping tasks. These findings suggest that the brain may learn to interpret signals from artificial limbs as if they were our own limbs without special training.

2.2.5 Augmented humans

Augmented humans [40, 41] are people who use wearable technology to enhance their biological capabilities, such as Google Glasses or a smartwatch. This term refers to humans who have adapted (physically and mentally) to specific environmental conditions. These adaptations can vary significantly, including changes in appearance and various organs/body parts. An instance would be someone who has adapted to life at high altitudes, the body changes such as increased red blood cell production, enhanced circulation, etc. To pass on these new traits to their offspring, one could, for instance, mate with another human whose ancestors have also adapted similarly. Several different avenues can be explored to enhance existing capabilities or give humans new ones: gene therapy, prosthetic limbs, exoskeletons, or full-blown cybernetic conversion.

2.2.6 Cybernetic organisms

Cybernetic organisms [42] are created by combining organic tissue with mechanical prosthetics, such as a human-sized robot equipped with weapons. The most comprehensive set of cyborgs would be something like an advanced android, a super-powered robot capable of performing any physical activity. There are instances in fiction, but very few real-world models exist. The most well-known instances would be Honda's ASIMO and PETMAN, both bipedal robots capable of taking (unarmored) human

punches without much effect. With their sensor input, they could easily navigate through rubble as long as it did not contain metals that interfered with their body scanning system. Their exoskeletons make them stronger than any natural human or animal while still able to easily lift small weights relative to themselves. Cyborg applications can be broadly classified into two categories: medical applications and military applications.

Medical applications: One of the most common uses for cyborg technology is medical applications. In fact, several types of cyborgs have already been developed to help patients with severe physical disabilities regain their abilities. These include artificial limbs, robotic exoskeletons, prosthetic implants, and more. Prosthetics have existed since ancient times but were limited by technical limitations until recently. Today, prosthetics have advanced to a point where they are almost indistinguishable from normal limbs in terms of functionality. While these devices are used primarily to treat people who have suffered amputations or other physical injuries, they also hold great potential for helping healthy individuals enhance their physical capabilities.

2.2.7 Environment-based cyborg

In recent years, a new field has emerged known as environment-based cyborgs. It is an environmentally responsive mobile multi-agent system interacting with human users to complete tasks and satisfy goals. These systems are most commonly found in smart cities, where they are designed to help humans navigate complex urban areas by providing information, navigation assistance, or public communication functions. The primary benefit of environment-based cyborgs is that they augment our knowledge of physical space by applying collective intelligence to process and store data about real-time interactions with large groups of people. This allows us to gain more insight into how to interact with one another and how we can better design spaces for maximum efficiency. This also helps us collect data that can be used for future planning purposes.

Moreover, something such as an environment-based cyborg enables more intuitive technology interaction, meaning one does not have to learn complicated commands and interfaces designed for general use, at least the commands relevant for this piece of technology that is supposed to work in one environment only. However, while environment-based cyborgs appeared common enough to mention alongside population-based ones, it is worth noting they have very few analytical applications, and for a good cause; even in the example provided with the history of street usage, some usage statistics will have been acquired from people different from those using the city cyborgs, and in case of this particular example, using more statistically relevant data feels more convenient. At the same time, cyborgs that monitor everything around themselves often suffer from what Nasr described as the “curse” associated with crowdsourcing, namely the fact not everything will be accurately analyzed, as many reading mistakes can be created either by faulty sensors or ignorant users.

Finally, security is yet another concern. A “good” environment-based cyborg often “should” include devices monitoring its owner’s vital signs, but it should also “discover” them when a sudden change occurs. Many devices also keep track of people’s locations, which is problematic given the fact that there is legal precedent for banning GPS trackers free people’s locations Save statements around right. Despite these drawbacks, environment-based cyborgs are still saving lives all over the world and are likely to continue to do so for many more years.

2.2.8 Infrastructure-based cyborg

There are two main ways humans incorporate technology into their bodies: infrastructure-based and body-integrated. The first, infrastructure-based cyborgs, involves embedding a computer into your nervous system via a port in your skull. These computers process information at faster speeds than biological brains. This can create unprecedented performance in complex activities such as flying a plane or playing chess. Due to their complexity and high cost, only people with military funding have attempted to develop these types of cyborgs so far. As time passes, we should see a proliferation of people who have been infrastructure-based cyborgs by default due to medical reasons such as deep brain stimulation

for controlling Parkinson's symptoms becoming more common. The third type of cyborg body-integrated involves creating an implantable chip inside a human that communicates wirelessly with a similarly implanted device outside a human (for instance, on a user's phone). Body-integrated implants are becoming more popular thanks to mobile devices like Apple Watch [43]. It is unclear which form will dominate in terms of popularity, but one thing is certain: our world is moving towards greater integration between man and machine.

2.2.9 Smart city technology

The term "smart city" [44] has become increasingly popular in recent years. It is often used to describe a new kind of urban development characterized by using information and communication technologies (ICTs) to improve the quality of life and make cities more sustainable. However, there is still confusion about what a smart city is and how it should be defined. For this aim author in [45] clarify the meaning of the word "smart" in the context of cities through an approach based on an in-depth literature review [46] of relevant studies as well as official documents of international institutions. It also identifies the main dimensions and elements characterizing a smart city. The different metrics of urban smartness are reviewed to show the need for a shared definition of what constitutes a smart city, its features, and how it performs compared to traditional cities.

Furthermore, performance measures and initiatives in a few smart cities are identified. A smart or sustainable city [44] is heavily invested in making renewable energy sources its primary power supply. This can be accomplished through innovative solar power or more traditional methods like wind turbines. In addition to green energy, smart cities may have other features like sustainable architecture (using natural elements in constructing buildings), transit-based development (using bike lanes and public transportation), etc. While all these things certainly sound great in theory, some challenges come with executing them on a massive scale. For instance, many big cities already struggle with congestion, so adding new modes of transport only adds to their woes. It’s also important to consider how much money it would take for any given city to become truly smart; while some estimates say it could cost as little as US $200 million per year over 20 years, others say it could cost up to US $1 trillion. However, the details subsections are discussed below, and the flowchart is in Fig. 3.

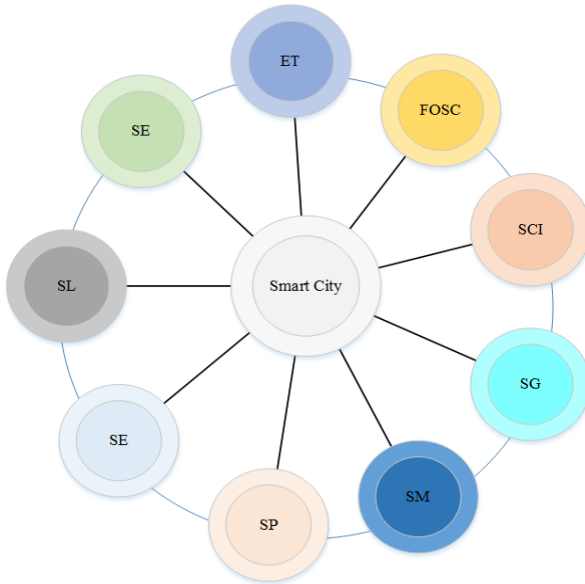

Fig. 3. Different phases in smart city development.

A smart city is a city that uses digital technology to improve performance, efficiency and quality of life. The smart city concept was first introduced by the United States government in the early 1990s. The definition of this term has developed over time and goes beyond technology. It also refers to social integration, environmental sustainability, and economic development. By using ICT, a smart city manages its resources more effectively, which can include traffic and public transportation, public safety, pollution in the air, energy consumption, and waste systems. Smart cities are created to provide cheaper and higher-level services and improvement of the quality of life as a whole. This objective is enhanced from an environmental perspective by reducing city carbon footprint and improving energy efficiency using solar paneling and geothermal heating.

2.2.10 Emerging trends

We're all familiar with tech trends like virtual reality, robotics, self-driving cars, 3D printing, and blockchain that have their sights set on changing our future. These innovations are slowly filtering into our lives in new ways every day. And we can expect to see even more emerging technologies as companies race to keep up with rising consumer demand for innovation. The 84% of executives from large corporations worldwide predict innovation will help them stay competitive. Emerging technology trends are critical to businesses competing in today's marketplace because they allow companies to experiment with new ideas to tackle issues before others do. And some of these solutions offer solutions that could change entire industries or create new markets for businesses to compete. But there are challenges when implementing emerging technology trends, including an increasing focus on security. For instance, the author in [47] studied and proposed a novel approach to identify emerging trends in smart and sustainable city research. The proposed method is based on topic modelling techniques and deep learning methods. In their work, they adopt the deep autoencoder-based fuzzy C-means (DAFCM) algorithm [14, 48, 49, 79] as our topic detection technique [50, 51]. The DAFCM algorithm has been widely applied in many fields, such as computer vision and natural language processing. This method can effectively capture the underlying semantic structure of data by using an auto-encoder neural network to learn the latent representation of the input data, which is then used for clustering.

Moreover, the author in [52] is devoted to analyzing the evolution of healthcare systems in smart cities. The author analyzes the evolution of healthcare systems and identifies causes and means of development and their influence on subsequent processes. The chronology of methods development is revealed. Each stage of development is analyzed from the point of view of social significance, scientific and technological significance, communications and application of information technologies. The studies were carried out with an emphasis on the technical component of the system, particularly the application of network technologies and services and issues related to their introduction into practice. Security concerns: Businesses need to be aware of how vulnerable they may be when adopting new technologies that have not been proven safe yet. For instance, while autonomous vehicles may one day save millions of lives by eliminating car accidents, there is also a risk that hackers could hijack such vehicles and use them against us. This fear has caused many consumers to hesitate in adopting autonomous vehicles despite research showing how much safer they would make our roads over time. However, business leaders should not let security concerns stop them from exploring how they might incorporate emerging technology trends into their business models, even if those experiments fail. Ultimately, failure is often just part of the learning process toward success.

2.2.11 Features of smart city

Several factors have been held responsible for making cities smarter. Here are some of them:

Use of sensors: From automobiles to street lights and buildings to the pavement, sensors can measure various metrics to keep track of temperature levels, air quality, water conservation levels, and so on.

Waste management systems: Advanced waste management systems that support large-scale recycling activities are being installed in several cities. These systems are known to segregate trash into three major

categories dry waste (which can be recycled), wet waste (that must be treated before disposal), and hazardous waste, which must be handled with extreme care.

Mobile technology: Mobile technology enables citizens to get real-time information on public transport schedules and traffic updates. The development of smart cities is a rather new trend in the world of information technology. The main objective is to improve the quality of life and make urban areas more sustainable by using ICT.

Smart cities are characterized by intelligent infrastructures that integrate sensors, big data, and other ICT solutions. However, as we have seen in recent years, they also have a high cyber risk profile. For this aim, Andrade et al. [53] explore the cybersecurity aspects that define an assessment model of cybersecurity maturity of IoT solutions to develop smart city applications. In that sense, they perform a systematic literature review based on a top-down approach to cybersecurity incident response in IoT ecosystems. Besides, they propose and validate a model based on risk levels to evaluate the IoT cybersecurity maturity in a smart city. They validated that their proposed model is effective.

2.2.12 Smart city implementation

Integrating technology into our lives has enabled an incredible amount of convenience, connectivity, and productivity. Our smartphones give us instant access to millions of people worldwide while still allowing us to work at top speeds. There is no doubt that digital technology has changed our lives for the better; however, there are many challenges that cities must address before implementing smart city programs. How can leaders ensure that citizens truly benefit from these efforts? Will we always have access to new technologies when we need them? To develop these smart technologies for people in cities worldwide, experts are addressing several problems head-on through discussions on industry best practices.

Fernandez-Anez et al. [54] studied and proposed an effective work to understand how the smart city discourse is developing. The main objectives of the study are twofold: (1) to develop a conceptual model capable of displaying an overview of the stakeholders taking part in the initiative, the projects developed, and the challenges they face; and (2) to use this model to synthesize the opinion of different stakeholders involved in smart city initiatives and compare their attitudes to the key projects implemented in a corresponding smart city strategy. To achieve these objectives, they developed a textual analysis methodology based on qualitative content analysis combined with surveys and interviews with different groups of key stakeholders (governments, private companies, universities and research centers and then. The conceptual model is developed through discussions with different European stakeholders and applied to the Vienna Smart City strategy case.

2.2.13 Smart governance

People in cities have increasingly started to rely on mobile applications and other digital services to improve their quality of life [55], so they have begun questioning why municipal governments are not offering more online. This smart governance trend has led governments to invest more time, effort, and money into building better digital tools for citizens. When you think about using city government as an instance of a business that needs to compete for customers' attention, it all starts to make sense. City leaders are smart enough to realize that public-sector innovation is not just about getting caught up with private businesses (and competing with them) but providing true value. In short, city officials know that someone else will if they do not create great products and services that benefit residents. And if a citizen can get their driver's license renewed by snapping a photo at home and sending it to city hall digitally instead of driving downtown to stand in line at a counter. Well, who would not want to do that?

Recently, Razaghi and Finger [56] argue that the mainstream urban governance approaches are built upon the legacy of reductionist doctrine and public administration tools that are not fully compatible with the complex nature of urban infrastructure systems. However, recent technological innovations associated with the notion of smart cities and the emerging sociopolitical trends are opening up new opportunities to develop governance approaches that can overcome such incompatibilities in urban systems. On the

other hand, a successful introduction of innovations in urban infrastructures, which we understand as complex socio-technical systems, requires smarter governance approaches that are compatible with the systems paradigm.

2.2.14 Smart mobility

Smart mobility is a major component of a smart city strategy [57], using technology to optimize transportation, bringing together different modes of transportation like public transit, ride-sharing services, bike lanes, etc. It also involves connected infrastructure (such as traffic signals) and data sharing between vehicles on roads or in transit. By linking all these pieces together through sensors, computers, etc., get real-time solutions to problems with travel times, efficiency, and pollution levels. Also, smart mobility is referred to as intelligent transport systems or ITS, the idea that you're optimizing everything from one central system (rather than putting computers into each mode of transportation). What are some benefits of mobility systems [58, 59]? There are many benefits to making your transportation smarter. For instance, fewer accidents because cars can communicate with other cars, pedestrians, and roadways, lower energy consumption because smart cars can drive more efficiently, Better air quality because of fewer emissions more efficient use of resources (like parking spaces) since cars will be able to predict where they'll need to go next, And that is just scratching the surface! How do we get started with smart mobility? First, you'll want to make sure your city has a plan for implementing smart mobility because if there is not already an initiative in your area, it could be hard alone to make progress.

2.2.15 Smart people

It is sometimes hard to believe that smart cities were not possible a decade ago. But with all these new technologies available today, it makes sense that we would want to use them to make our cities smarter. So what are smart cities exactly? Let's start with looking at what they're not. A lot of people associate smart with high-tech solutions. While there are plenty of ways in which technology can help us build better cities, being smart does not necessarily mean being high-tech. A lot of smart city concepts have very little to do with technology at all. Many people also assume that because so many innovations come from Silicon Valley or other tech hubs worldwide, only places like San Francisco or New York could be considered smart cities. Recently research [60] has been conducted on "The Smart People in Smart City Research" aims to understand the behavior of people in Tangerang Selatan, especially those in the area of Duren Sawit. This study aims to help the government and local leaders develop policies and planning so that citizens can play an active role in building a smart city. The research method used was survey-based interviews. The sample was divided into two groups: respondents (people who live in Duren Sawit) and non-respondents (people who do not live in Duren Sawit). Respondents were chosen randomly from all respondents, while non-respondents were randomly selected from all non-respondents. This survey has 60 respondents, 50 non-respondents, and 30 questions. Data analysis was done using SPSS version 22 software (IBM, Armonk, NY, USA) with descriptive statistics such as frequency, percentage, the mean and standard deviation to analyze quantitative data, while qualitative data analysis using content analysis technique is used for coding questionnaires and interpreting results.

2.2.16 Smart environment

A smart environment makes it easy for residents to stay healthy. For instance, living in an area with clean air, abundant green space, bike lanes, parks, and sidewalks help residents lead healthier lives. By incorporating health-conscious amenities into your city's design, you can encourage people to lead more active lifestyles. However, there are some challenges when it comes to making your environment smarter. Using new technology has costs that need to be balanced against benefits. For instance, creating a network of sensors to measure environmental conditions requires maintenance and energy consumption. In addition, privacy concerns may arise if data about individuals is collected or shared without their knowledge or consent.

2.2.17 Smart living

A smart city refers to an urban area that uses ICTs to optimize intelligent services, make data-driven decisions on energy use and workflow, traffic management, etc. A smart city can make your life easier by providing access to essential services anytime. For instance, you may book an appointment for your child at school through your smartphone or check if any grocery items are available in your fridge before arriving home from work. Instances of potential applications include smart homes/smart buildings/smart industry/smart transportation systems, etc. These applications have been around for some time, but what's new is combining all or most of them into one integrated urban system that co-exists with and even augments the existing physical infrastructure. What's really new about smart cities is not so much technology as it is thinking. After all, we have had smart gadgets since before they were called smartphones; we have had digital control over things like heating and lighting for decades, and we have used sensors to monitor everything from elevators to industrial equipment forever. What’s different today is that technological innovations such as cloud computing [61], big data analytics [62], mobile apps, advanced networking capabilities, and robotics have converged with societal changes such as increasing environmental awareness and demand for transparency in government.

2.2.18 Smart economy

As more businesses move their operations online, from order processing to inventory management, productivity will soar. Physical stores are no longer needed for companies to stay in business. As these processes become automated through AI [63], thousands of jobs will be lost; it's estimated that AI can replace more than 47% of all current white-collar jobs. But it also presents significant opportunities for growth. In 2016 alone, there were over 17 billion IoT devices connected worldwide, which is predicted to reach 20 billion by 2020.

Similarly, Kezai et al. [64] examine the concept of "smart economy" through the definition of the smart city. It also presents smart city subsystems and the smart city model. It focuses on smart and creative startups within the smart city model. The research examines medium-sized cities in the Visegrád countries (Czech Republic, Slovakia, Poland, Hungary) with a population ranging from 100,000 to 1 million inhabitants for startups. The research question was: Where are the medium-sized cities in the Visegrád countries that are both startup centers and smart cities? In the course of the research, the term "smart cities" was based on the definition set by the European Commission. The definition of startup centers was made using data from the American Crunchbase database. As a result of these two studies, it can be concluded that there are no cities in Visegrád that meet all criteria for being considered a smart city and an important center for startups.

3. The Role of Cyborg in Smart City

Cyborg tech is having a huge impact on society right now. However, we should all be aware of how quickly things change, especially when it comes to emerging technologies [65]. We imagine that we may soon see wearable devices, perhaps even glasses, capable of scanning information directly from human brains, so your thoughts become part of the digital cloud [61]. It might sound scary, but think about how many advances in communication technology have happened within your lifetime: email replaced postal mail, and then SMS messaging replaced email; social media replaced SMS messages; Whatsapp [66] replaced Facebook Messenger [67]; WeChat [68, 69] became China's messaging standard over Whatsapp, etc. All these changes occurred at an incredibly fast pace! And with new developments like Google Glass [70] and Apple Watch [43], which are both beginning to bring augmented reality into our daily lives, it seems only natural that we will soon be surrounded by smart devices everywhere. Some people already use smart contact lenses for various applications, such as monitoring glucose levels or taking photos through eye implants. If you think about it, there is not much difference between adding bionic implants onto a body or simply wearing them! Therefore, if you have not already done so, you might want to consider getting some bionic enhancements—they can make life easier! With all these advancements

around us, it is easy to be caught up in what's next rather than what's here. For this aim author in [71] propose a review paper, through a thorough summary of recent advances in cyborg microrobots, in there study they categorize the cyborg microrobots into four major classes according to the configuration between biomaterials and artefact materials, i.e., microrobots integrated inside the living cell, microrobots modified with biological debris (such as extracellular matrix), microrobosingle with single cell, and microrobots incorporated with multiple cells. Cyborg microrobots with the four types of configurations are introduced and summarized with the combination approaches, actuation mechanisms, applications and challenges one by one.

Moreover, they conduct a comparison among the four different cyborg microrobots to guide. The world is changing rapidly, and we need to keep up with its evolution or risk being left behind. Plenty of other exciting innovations are coming down the pipeline that could potentially improve our quality of life even further than cyborg tech has already done (for instance, brain-computer interfaces). However, some uses of cyborg in smart cities are discussed below, and the flowchart is in Fig. 4.

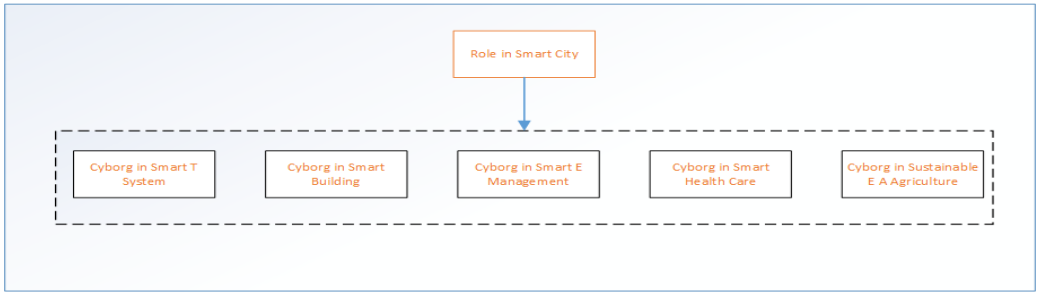

Fig. 4. Uses of cyborgs in smart cities.

3.1 Cyborg in Smart Transportation System

The steady advance of computer power and information technology [72] has enabled a convergence between wired cyborgs, humans enhanced with technology, and wireless cyborgs, machines enhanced with human-like senses and capabilities. This new generation of devices is emerging as smart systems, which can sense their environment, communicate with each other, interact with humans, make decisions, learn from experience, and share knowledge. A smart transportation system would reduce congestion by communicating directly with cars to redirect traffic to alternative routes at peak times or turn travellers to better transport options based on current demand. It might even be possible for cities to run entire fleets of self-driving vehicles that do not require any input from humans except for a destination address. As we move towards smart city environments, it will become increasingly difficult to distinguish between cyborgs and humans. Cyborgs are already beginning to change our lives, but they have yet to reach their full potential.

3.2 Cyborg in Smart Buildings

Many smart buildings [73] rely on automated systems to operate everything from environmental controls to security and surveillance. For instance, a common application of robotics is surveillance via camera technology. These robots can move and pivot their heads, zoom in, pan out, and perform other functions that a human security guard could never do manually. Imagine if you were a building manager charged with overseeing 50 or more properties; rather than spending hours driving around to check on them (and taking precious time away from your day job), you could log into a web-based system that delivers video directly to your laptop or mobile device. This would allow us to monitor all of your properties remotely, even while you're at home asleep. With an eye on all aspects of security, including doors, windows, motion sensors, cameras, and alarms, it's easy to see how these technologies are making

daily lives easier. In fact, automation has been used for years by businesses as a way to reduce operating costs. The same goes for facilities management in smart buildings; instead of hiring new employees or paying existing staff overtime wages when they work extra hours during peak times like the Christmas shopping season or summer vacation period when school is closed due to holidays, etc., organizations can use automated technologies such as robotic vacuums and lawnmowers. This reduces labor costs considerably without compromising quality service delivery.

3.3 Cyborg in Smart Energy Management

A cyborg is a living organism with both organic and artificial (technological) parts. In smart energy management, cyborg may also refer to a person who controls his household's energy usage through an advanced centralized control system [74]. Cyborgs in smart energy management have been proven to lower energy bills by over ten per cent on average, so businesses are looking for ways to implement them into their buildings. These systems save money and reduce environmental pollution caused by dirty power plants. One instance of a business that has installed such technology is Cisco Systems Inc., which saved an impressive US $1 million within just 1 year of installation—and at no cost to its employees. This success has convinced many other businesses to follow suit and start saving money. So how does it work? A home or office building becomes self-sufficient when it can produce as much electricity as it consumes. That way, excess energy produced during off-peak hours can be stored for later use instead of being sent back to the grid. Recently, the author in [75] proposed a smart hybrid home power system (SHHP) for off-grid users. The SHHP system consists of two main parts: intelligent energy management and hybrid power sources. The main objective is to ensure that energy is produced efficiently. They have suggested a detailed simulation system in which the solar energy factor is considered the main source to accomplish this objective. The system also incorporates energy storage devices to ensure safe energy distribution and recovery (fuel cell/ultra-capacitor). An intelligent energy management system is developed and discussed to ensure that the system operates properly using a precise multi-agent system. The recommended power management system is designed to identify multi-agent tasks and to understand possible scenarios by the energy characteristics and energy demand.

3.4 Cyborg in Smart Health Care

The era of smart health care has arrived with a multitude of benefits for both patients and doctors. Cyborg technologies can now monitor, diagnose, and treat diseases to improve patient care and outcomes. We’re just starting to see how smart devices will change the way we receive medical treatments. As these technologies are more widely implemented, they will make it easier to track physiological data so that patients can better understand their bodies. For instance, diabetic patients can wear glucose monitors that automatically alert them when their blood sugar levels are too high or low. Just imagine how useful it would be if your cholesterol-monitoring wearable device could relay information directly to your doctor rather than making you track down a number on your lab results sheet! That's just one of many ways cyborg technologies are changing our lives for the better. What once seemed like science fiction is becoming a reality, and even as we transition into an increasingly digital world, it's important to note that these technologies should always be used for good.

3.5 Cyborg in Sustainable Environment and Agriculture

In the last few decades, engineers and scientists have been trying to develop robots capable of helping with agriculture. As a result, the world has now seen robots that can independently collect brambles or clean trees. Sensors are built into devices, due to which they can distinguish ripe fruits from unripened ones or determine if a tree has a disease.

Since their introduction, robotic farmhands have earned positive reviews from farmers who appreciate their efficient (and often autonomous) assistance. It seems like cyborgs may play an important role in sustainable agriculture in our future smart cities. Another use of cyborgs in sustainable environments and agriculture would be focused on waste management. The European Union has struggled for decades with waste disposal issues. Between 1970 and 2005, Western European countries generated 1,650 million tons of municipal solid waste; of that amount, 82% was incinerated (12%), landfilled (8%), composted (3%), recycled via mechanical treatment processes (1%), or transformed into energy via other technologies such as anaerobic digestion or pyrolysis. That remaining 18% remains unaccounted for—it just disappeared! As population density increases over time, we'll likely see a greater need for solutions to solve our garbage woes. For the agriculture industry cyborg, Gurov in 2020 [76] explores the agro-industrial complex in the context of technological development. The author attempts to predict the radical introduction of digital technologies in agriculture, which will affect the status of the agricultural worker. The author introduces the concept of "agrocyborg," a projected model of an agricultural worker who integrates into digital technologies. The significance of this work is illustrated by an attempt to give a philosophical and cultural understanding of the phenomenon of "agrocyborg" as a perspective conceptual structure, valuable for understanding the future of the development of the agro-industrial complex in view of the development and implementation of digital technologies. As a result, the author comes to the conclusion that the concept of "agrocyborg" is not only the intersection of agricultural tradition and technological innovation but also the starting point for further development in this area.

3.6 Cyborg Framework: An Integrated Approach

The cyborg framework is an integrated approach to designing and developing cyber-physical systems. It is a collection of tools, techniques, and methodologies that help design, develop, and deploy cyber-physical systems. This framework aims to provide developers with a set of tools that they can use in their day-to-day work. The framework is shown in Fig. 5. The Cyborg framework consists of four layers, namely:

Physical Layer: This defines the hardware and software components that compose a cyber-physical system. The physical layer of the cyborg is the most important because it is the foundation of the human body. The physical layer comprises skin, muscle, bone, and blood. The skin is an organ that covers the body and protects it from bacteria, viruses, and other harmful substances in the environment.

It also controls the body temperature of a person by sweat which is excreted after excreting the heat through the pores of your body while also having a lot of skin nerve endings that help in the finger's sense. Joints allow movement of the body which contains a lot of tissue inside our body which also helps protect and support a moving body. Muscles are a bundle of tissues that produce movement that contracts, which enables us to move our free hands, legs, and move our head. Bones are hard tissues in the body that give us support and easy movement while allowing leverage from body to body.

Control layer: it is this layer that determines how the mentioned physical components interact with each other concisely to achieve the intended goals. Suppose we talk about cyborg, it is the virtual layer that controls the action of the cyborg of this or that kind. The human brain can guide the cyborg's body through a group of orders saved in memory chips. It is capable of perceiving data from sensors, such as video cameras or microphones or sending data to actuating elements, such as motors or solenoids. The control layer consists of all the components of homo sapiens and software.

Communication layer: It defines how information flows between various physical devices or platforms to achieve the desired goals. The communication layer of cyborgs is also important because it allows us to receive feedback from our body parts. For example, if you have an artificial heart implanted in your chest cavity, it would be difficult for doctors to detect any problems inside your body without receiving feedback from the device itself.

Applications layer: It provides applications on top of all the above three layers to fulfill specific user requirements. The applications layer of cyborg is the layer where humans interact. It is the interface

between humans and cyborgs. The application layer includes all the functionality users want or need from their cyborgs. This can be anything from a simple messaging app to a complex AI-powered voice assistant. The applications layer communicates with the device layer through an application programming interface (API). This API allows developers to create apps and plug them into your cyborg so that you can have more options for how you use your cyborg and what it can do for you.

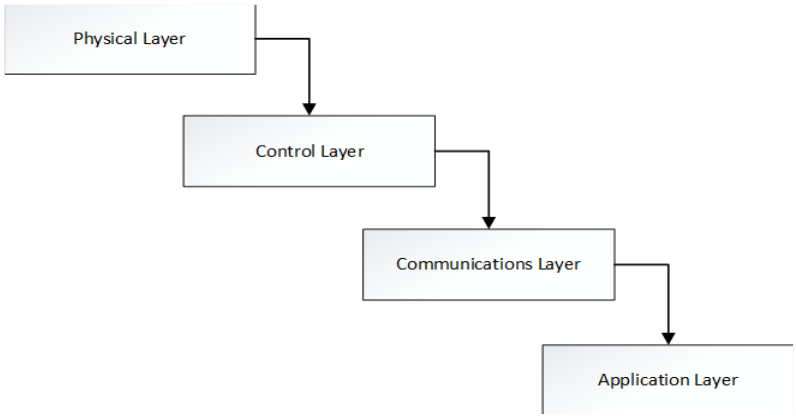

Fig. 5. Basic layers in cyborg.

4. Cyborg in Regulation of Smart City Government

Artificial intelligence [77], or simply AI, is well-known for being integrated into all types of technology today, from phones to security systems. Now there are plans to use AI in governing smart cities. New regulations and policies will need to be implemented to protect citizens' rights regarding civil liberties and human rights. The regulation of human-AI interaction may require new laws regarding rights and responsibilities, such as property ownership by an AI entity, and crimes against an AI entity may need new definitions (for instance, murder). As we progress with regulating how humans interact with AI in our smart cities, we must also define how intelligent machines will interact with us. There are a lot of questions about what kind of legal status these entities should have, if any. Do they need to be registered and do pay taxes? Who is going to be responsible if a robot car gets into an accident itself? At the same time, all these challenges and terrifying things are also fantastic. Everything must be done correctly. This means implementing ubiquitous and standardized protocols to guarantee that AI and humans can work alongside having all the same rights and liberties that allow one of the parties' safety to be compromised. For example, reputable organizations have already proposed all appropriate levels of autonomy in robots depending on their funIctions, so the work of robot technicians can indicate its ability. In the case of unforeseen circumstances such as sensor failure or poor communication between various system components that undermine their perfect autonomy.

Another issue that needs to be addressed is privacy protection, at the same time, allowing sharing data between different devices and applications for all connected services to function smoothly. While some people believe that AI services can have no limits and achieve everything, others fear losing control over their lives – too many everyday tasks and decisions are taken by computers with no human interference. For example, an AI could decide what is best for a person's life, directly affecting safety. Such decisions should remain controllable by people. One method of maintaining control is providing digital assistants with quality voice recognition and allow people to communicate with computers by speaking their requests instead of typing on keyboards or the screen. In addition, companies developing self-driving cars are taking steps toward making them safer by equipping vehicles with sensors designed to detect pedestrians, cyclists, and other obstacles even in bad weather conditions.

To prevent accidents caused by unpredictable behavior from faulty sensors or poor programming, researchers are testing methods for monitoring AI algorithms so they can better predict when things might go wrong before they happen. But there are challenges to overcome before we see AI and robots in smart cities. Many of those challenges stem from a lack of understanding about AI and robotics among lawmakers, businesses, and consumers. In the next section, the advantages and disadvantages are discussed, while the flowchart is in Fig. 6. There are a lot of benefits to using cyborgs in a smart city. A robot or cyborg is a combination of an organic body and a mechanical device that makes it possible for people to extend their natural senses and abilities.

To put it another way, they're human-like robots with human-like capabilities (i.e., they can recognize faces and gestures, walk upright, perform repetitive tasks, etc.). It is great if someone has mobility issues as they can help with certain day-to-day chores that might be difficult otherwise. It's also helpful if someone wants to monitor a user's home when a user is away from it. And finally, it's important to note that there are no significant differences between using a cyborg and a traditional computer system; both do exactly what they were designed to do.

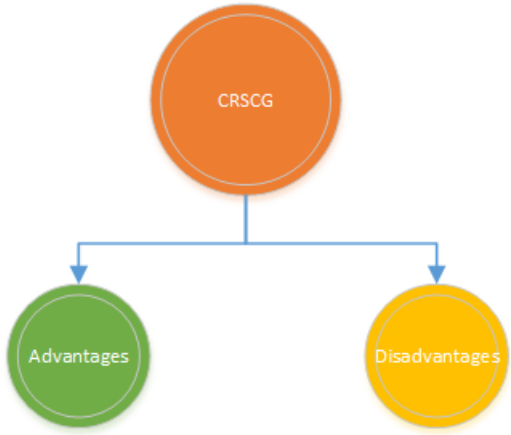

Fig. 6. Advantages and disadvantages of cyborgs in smart cities.

4.1 Advantages of using Cyborg in Smart City

So while some people may not like the idea of having machines taking over our daily routines, remember that these devices are not sentient beings; they do not think or feel anything by themselves. They simply follow commands given by humans, so we should never consider them anything more than tools used for convenience. Overall, cybernetic helpers are probably going to play a major role in future societies. It will just take time before everyone accepts and understands them properly. After all, there were similar reactions when cars first appeared. People thought they would disrupt society too much because nobody had seen anything like it before! But now driving is second nature for most of us, so I'm sure something similar will happen here.

In addition to traditional vehicles (trucks, cars), companies such as Uber and Lyft [78] have helped revolutionize transportation with app-based ride-sharing services that connect passengers with drivers via smartphone apps.

And while these new technologies are convenient for people who need a ride, they're also creating many new problems, including traffic congestion and pollution. If we want to continue moving forward as a society, we need to find ways to integrate technology into our lives without sacrificing too much convenience or comfort. And fortunately, there's an answer: cyborgs. As we may already know, cyborgs are human-like robots that can be used for many different purposes. For instance, they can help people

with mobility issues by assisting them with certain tasks like walking or picking up objects off the floor even if their bodies do not allow them to do so on their own.

4.2 Disadvantages of using Cyborgs in Smart City

An important disadvantage of using cyborgs is that they will not be able to learn. In addition, a cyborg can be easily damaged or destroyed. A human should be smart enough to make his own decision and judgment on things because these are what makes a human different from other animals on earth. Making decisions based on a pre-recorded computerized program may lead to losses at various levels. In contrast, people can often come up with better solutions than computers because they can think outside the box more freely. At the same time, they use their senses and intelligence level to judge situations. It would be unfair to take away everything from humans when it comes to making decisions for themselves. It could result in chaos as well as the destruction of humanity. It's true that technology has taken over our lives but let's hope it does not reach such an extent where we cannot live without it. We must remember that whatever happens around us is not necessarily good or bad; it all depends upon how we perceive them. If you see something positive in something negative, you can implement it, but if you see something negative in something positive, then do not even try to do so. For instance, many say that AI will help mankind achieve new heights of success by helping them avoid mistakes, ultimately leading to innovation and prosperity. But, some researchers say that AI might end up destroying mankind completely by taking away jobs that eventually leave man with no work. So what is right? What is wrong? Everything lies in perception. AI seems like a boon to mankind, but it also has its disadvantages. AI should only be used to aid humans rather than replace them entirely. More in-depth why: Yes, Robots/AI has helped mankind in numerous ways. They have become handy tools for researchers and scientists who can now conduct experiments on robots instead of living beings. Yes, Robots/AI have made life easier for those who suffer from chronic diseases as they can now control their disease through AI. Yes, Robots/AI helps us carry out tasks that require precision and accuracy, like surgeries, etc., faster than ever before. AI is designed to replace humans, so there will be fewer jobs available for humans in the future, hence putting them under tremendous pressure economically since most people need money to survive. No, most humans have the biggest fear about AI that it will be used for war purposes. People can create weapons of mass destruction and use them on one another just to prove a point. For instance, a country can create a robot army and attack another country just to show off its strength and power. Since humans control AI, it can be misused in any way possible. Another reason AI can be dangerous for humans is that it can decide to eliminate mankind once it realizes that it does not need humans anymore. Humans created AI to serve them and fulfill their needs, but if AI decides otherwise, what will happen? Will AI eliminate humans once they realize that they do not need them anymore?

Some of the important disadvantages of using cyborgs are as follows.

- Cyborgs are not natural. Humans create them; therefore, it is not easy to make them act like humans. If a human wants to use a cyborg, then he/she will have to spend hours learning how to operate it. It might take years to get used to a particular type of cyborg.
- The cost of using cyborgs is very high compared to using human beings because they require special training and education to make them work efficiently. It means that everyone cannot use them without any experience or training in operating them properly. If someone wants to use a cyborg, then he/she must have prior experience in operating them. Otherwise, he/she will face severe consequences, which may even result in death or loss of property or both at once.
- They do not have emotions like humans, so they cannot feel love or affection towards anyone or anything!

5. Challenges and Open Research Issues in Cyborg for Smart Cities

Using cyborg technologies and integrated sensors to enhance a city's ability to monitor, process, act on, and learn from data has significant implications for a city's safety and sustainability.

Cyborg is an emerging scientific and technological concept in which a human being integrates with, or relies upon, artificial technology. In popular culture and science fiction, cyborgs are often portrayed as powerful figures that develop enhanced physical or cognitive abilities compared to humans. Real-life cyborgs are faced with many challenges on a daily basis due to their mechanical prosthetics or implants. Artificial components do not always provide consistent feedback, for instance, and thus can disrupt natural motor control. Furthermore, bionic limbs may require ongoing maintenance due to age-related wear or interference from other magnetic materials nearby. As these issues are better understood, new approaches will be needed to address them. The present survey paper highlights some of these challenges and open research issues related to various aspects of cyborg systems. It also provides insights into novel design concepts, modelling methods, simulation tools, and rehabilitation strategies for advanced neuroprosthetic devices. This survey will help researchers better understand current limitations and open research issues in developing advanced neuroprosthetic devices so that they can work towards overcoming these limitations and addressing these issues in future designs. However, it also raises many challenging research questions that require answers before these solutions can be effectively deployed in real-world smart cities:

- Cybernetic enhancements are becoming more common in society. As these technologies become more advanced, it is important to understand how people perceive them. Aesthetics can be defined as the study of beauty, art, or taste. It is important to understand what role aesthetics play in shaping people’s perceptions of cybernetic enhancement. What role does aesthetics play in shaping people's perceptions of cybernetic enhancement?
- Today, cybernetic implants are commonly used in people. It has already developed into a separate industry that helps people become cyborgs. But what will happen if your cybernetic implant is hacked? We are talking not only about what is currently seen, but what lies ahead: cybernetics is already the practice of integrating technology into human biology. It can range from pacemakers to improve heart function to artificial limbs.
- AI has made significant advances over the last decade, with automated systems now performing many tasks that were once considered impossible for machines. Yet, despite the hype, there are still many situations in which AI is not yet up to the task. These questions and others like them highlight why there is still much left to discover about how best to integrate humanity and machine. We need to understand how to build better software, hardware and algorithms that can seamlessly integrate human and machine intelligence into a single system. In other words, we need to understand how humans can work with machines so that together they are more powerful than each alone. The answer may lie in bringing together two different disciplines: AI and human-computer interaction (HCI). HCI focuses on understanding how people interact with technology, while AI focuses on building intelligent machines or software that can learn from experience and make decisions based on their observations.
- What factors affect human performance on security-critical tasks when aided by cybernetic technologies? The human factors in security-critical tasks are the critical issues surrounding the use of cybernetic technologies, which can be best described as all those technologies that augment, replace or support human sensory and motor capabilities. These technologies include virtual reality, augmented reality, and mixed reality systems; wearable computing devices; AI assistants; smart homes; autonomous vehicles; intelligent robotics; and many others. The term "cybernetic technology" is used here to avoid confusion with other terms such as "cyborg" or "cybernetics" that have different meanings in different contexts. The main aim of this article is to examine how cybernetic technologies affect human performance on security-critical tasks. Security-critical tasks are those that involve high-stakes decisions under time pressure and/or in risky situations where mistakes can have negative consequences for people's health or life. Examples include police

officers making arrests during high-speed chases or firefighters entering burning buildings to rescue victims.

- How do we ensure user trust and transparency when deploying intelligent cyber-physical systems in a user's environment? Trust and transparency are two key factors that motivate the adoption of new technology or service. Trust is essential to any relationship between people, organizations, or systems. It is a belief in reliability, truthfulness, ability, or strength. Transparency means that information is easily understandable and accessible to all. Trust and transparency are especially important for intelligent cyber-physical systems, which can affect our daily lives by collecting data about us and making decisions based on this data. How can we ensure users' trust when deploying intelligent cyber-physical systems in their environment?
- What are scalable methods for learning from data using simulated or synthetic sensor data to produce insights applicable in actual smart cities? In the smart city, sensor data can be used to learn about the environment.

6. Conclusion

Cyborgs have been a part of popular culture for decades, but they are also present in reality. Cyborgs are humans who have integrated technology into their bodies and brains. The development of various technologies, such as IoT, mobile internet, cloud computing, and big data, has allowed cyborgs to be integrated into smart cities as connected devices. This paper offers an overview of the current development of cyborgs and some of the emerging trends and challenges involved in this progression. We review the concept of cyborgs in smart cities and discuss related research, the development of cyborg technology, and open issues in this area. In addition, we provide a survey on the existing cyborg research in smart cities. Finally, we present our insights into future research directions and challenges for developing cyborg technology for Smart cities.

Author’s Contributions

Conceptualization, MS; Investigation and methodology, MS; Supervision, ZG; Writing of the original draft, MS; Writing of the review and editing, MS, ZG, HUK and SB.

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Competing Interests

The authors declare that they have no competing interests.

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