



João Francisco Martins Quinta Gomes

**THE ROLE OF AI IN SMART CITIES: A LEGAL
PERSPECTIVE ON THE FUTURE OF SMART MOBILITY
AND SUSTAINABILITY**

Dissertation to obtain a Master's Degree in Law, in
the speciality of Business Law and Technology

Supervisor:

Dr Tiago de Melo Cartaxo, Senior Lecturer in the University of Exeter

Lisbon, March 2023

Anti-plagiarism statement

I hereby declare that the work I present, is my own work and that all my citations are correctly acknowledged.

I am aware that the use of unacknowledged extraneous materials and sources, constitutes a serious ethical and disciplinary offence.

Lisboa, 15 March 2023

Citation style

This dissertation follows the APA 7 (American Psychological Association 7th edition) citation style. Throughout this work all relevant references are identified in the footnotes, in full when referenced for the first time and in abbreviated form after that, in the following format: Author, Year, Abbreviated title.

Statement regarding the length of the Dissertation

The body of this dissertation, including spaces and notes and excluding the appendixes, occupies a total of 216.414 characters.

*A heartfelt thanks to
my friend Carolina
for her immeasurable support and strength
during this academic phase.*

*To my mother, father and grandmother
for their comfort, love and concern
throughout my journey.*

*To David
for his care and trust.*

*To Francisco for his
friendship and inspiration.*

*To all my remaining friends
for their patience and motivation.*

*To professor Tiago de Melo Cartaxo
for the guidance
in his exemplary orientation.*

ABSTRACT

This dissertation explores the role of artificial intelligence (AI) within innovative technology, providing an overview of the origin, explicability and purpose of AI while addressing technical, ethical and legal arguments to substantiate leadership in the competitive technology market. To better understand this purpose, the dissertation highlights the case of smart cities, as the ideal way for artificial intelligence to maximize its purpose, given its greater ability to contribute to topics such as sustainability and urban mobility, which relate to important areas such as the economy, people and the environment. In this sense, a set of practical AI-based projects is shown to overcome some of the main issues that underline the structural pillars of cities. Moreover, it is also intended to suggest a set of four solutions, as part of the right governance and regulation strategy, to overcome the set of disadvantages and regulatory challenges associated with the very nature of AI, obstacles that simultaneously affect its application in smart cities.

Key words: urban areas - artificial intelligence - smart cities - sustainability - mobility - sustainable development goals - artificial intelligence liability directive - artificial intelligence act

RESUMO

A presente dissertação explora o papel da inteligência artificial (IA) no âmbito das tecnologias inovadoras, fornecendo uma visão geral da origem, explicabilidade e propósito da IA, abordando argumentos técnicos, éticos e jurídicos para substanciar uma liderança no mercado tecnológico competitivo. Para melhor compreender este propósito, nesta dissertação destaca-se o caso das cidades inteligentes, como a forma ideal de a inteligência artificial maximizar o seu propósito, dada a sua maior capacidade de contribuir em matérias como a sustentabilidade e a mobilidade urbana, que se relacionam com tópicos importantes como a economia, as pessoas e o ambiente. Neste sentido, é demonstrado um conjunto de projetos práticos baseados em IA para ultrapassar algumas das principais questões que estão subjacentes nos pilares estruturantes das cidades. Adicionalmente, pretende-se também sugerir um conjunto de quatro soluções, como parte de uma adequada estratégia de governação e regulação, para superar o conjunto de desvantagens e desafios regulatórios associados à própria natureza da IA, questões essas que afetam, simultaneamente, a sua aplicação nas cidades inteligentes.

Palavras-chave: áreas urbanas - inteligência artificial - cidades inteligentes - sustentabilidade - mobilidade - objetivos de desenvolvimento sustentável - diretiva de responsabilidade da IA - regulamento de inteligência artificial

TABLE OF CONTENTS

INTRODUCTION.....	9
1. The impact of innovation in the world:.....	11
2. Operating Artificial Intelligence:.....	13
2.1. Origins, explainability and goals of AI:.....	13
2.2. Why is AI the “revolutionary technology” within emerging tech:.....	17
A. Technical aspects:.....	17
B. Legal Considerations:.....	18
C. Ethical Dimension of Artificial Intelligence:.....	23
3. Smart cities: the path for digital transformation.....	26
3.1. What is a “smart city”?.....	26
3.2. The Sustainability Challenge:.....	28
3.3. Implementing competitive technology for advanced cities:.....	32
4. Shaping smarter cities through Artificial Intelligence:.....	38
4.1. Developing a sustainability strategy:.....	38
i) AI-based remedies to reduce the effects of climate change and for the protection of nature/biodiversity:.....	38
ii) AI-based remedies to stimulate growth and a circular economy:.....	43
iii) AI-based remedies that urge for social aspects:.....	48
4.2. Driving smart mobility:.....	53
i) AI-based remedies to increase road safety:.....	54
ii) AI-based remedies for more accessibility and a dynamic transport mobility network:.....	55
5. Boundaries of implementing AI:.....	58
5.1. General disadvantages and impacts:.....	58
5.2. Regulatory Challenges:.....	61
5.3. Solving AI future governance and regulation: a personal perspective.....	66
6. Conclusion.....	73
BIBLIOGRAPHY.....	75

INTRODUCTION

The primary aim of this research is to examine the role and legal implications associated with the use of artificial intelligence, regarding the reality of smart cities, within a smart mobility and sustainability approach. In the context of innovation, artificial intelligence has been assuming a decisive and distinctive role to combat the challenges that have emerged from the constant technological development, in a world where the concept of innovation is no longer what it used to be. To achieve this, firstly, I will seek to explain the origin and explainability of this concept, from a more restricted perspective and limited purposes to the idea of artificial intelligence as a field of study capable of acting in multiple sectors, depending on the branch in question, namely, machine learning, natural language processing or computer vision. Artificial intelligence will be defined as any system or machine that, for a given set of defined human objectives, is able to make predictions, recommendations, or decisions that influence real or virtual environments.¹

Secondly, I will promote an in-depth analysis of its advantages by providing a solid basis of technical, ethical and legal frameworks which not only substantiate artificial intelligence's prevalence in the face of other competing technologies but also gives us some ideas on their purpose for society. In light of maximizing this purpose, we argue that is necessary to apply them within large urban areas, which have been a major focus of attention in recent years given the daily emerging obstacles that are constantly being brought by the human action, also elucidating an extensive historical basis and detailed description, which lead us on the debate of specific issues: the concept of *smart city*, as a reality that bases the operation of its structural pillars in innovation; the evolution of the notion of sustainable development, as a development focused on the needs of society, without compromising the future; a discussion about technologies in general applicable to build smarter cities; ultimately, the importance of a greater focus of these, especially artificial intelligence, in projects in the area of

¹ OECD (2019), *Recommendation of the Council on Artificial Intelligence* <https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449>

sustainability and urban mobility, since they have in their basis all the structural elements of *smart cities* - circular economy, environmental protection and people;

To better understand its specific role in smart cities, as part of the methodological solution strategy, it is adopted a case study approach by setting up a preferential list of projects based on artificial intelligence and their benefits, basing their choice on reliable European sources, as well as other instruments and international guidelines like the UN Sustainability Goals.

As the final purpose of this research, the last chapter is dedicated to providing an effective governance and regulation strategy by exploring artificial intelligence's decisive issues, specifically those inherent to their very nature, such as the issue of its subjectivity, autonomy and cybersecurity, as well as long-standing regulatory challenges, namely, the problem of legal personhood, liability, data protection law and intellectual property law. Additionally, to address them, four measures are proposed, essentially supported by suggestions recommended in the context of the European perspective, which, according to my view, will contribute to the future of a safer artificial intelligence application, also being essential when AI implementation is made in the scope of smart cities: universal concept on artificial intelligence; the proposal of Artificial Intelligence Act and the Artificial Intelligence Liability Directive as appropriate legislations for a framework on prohibited methods of application and liability and compensation; an adaptive law perspective; finally, the principle of technological neutrality. Any other issues as well as the present ones will be supported by articles, books, reports, recommendations, documents and essentially European legislation.

1. The impact of innovation in the world:

Over the last decades, innovation has been playing a decisive role in the digital transformation process, thus contributing to what we expect to become our society in the contemporary world: a society that promotes the use of new emerging technologies for the more sustainable and efficient development of multiple sectors; for greater economic growth; to solve social disparities; to ensure the necessary responses, in the framework of health, security and climate action; finally, to create new opportunities for the cities of tomorrow.

However, the idea behind innovation comprises much more than the trifling changes made in technologies. It also entails interactions, power influence, inter-company relationships and strategies that could mean an increase compared to the previously followed standards.²

Since the 19th century, the term innovation has been discussed by a wide uncountable variety of authors and has traditionally been understood as the improvement and exploitation of products, patterns, processes, or ideas for the purpose of improving results.

An example of innovation was the creation, in 1817, of the first successful model of bicycles, called *laufmaschine*, by Karl von Drais, which has been perfected over time, by other inventors, until the present-day bicycle models.

Similarly, the so-called incandescent light bulb, created by Thomas Edison in 1879, was the first milestone in the industrialization of electric lighting devices, which have also been continuously improved to this day.

Due to the wide scope that this concept can assume and the continuous development of society, it is worth mentioning that the innovation process from the second half of the 20th century onwards has increasingly assumed new levels.

² Lorenzetti, J., De Lima Trindade, L., Pires De Pires, D., Regina, F., & Ramos, S. (2012). Tecnologia, inovação tecnológica e saúde: uma reflexão necessária. *Texto contexto enfermagem*, 21(2), 432-439. <https://doi.org/10.1590/S0104-07072012000200023>

Consider the first computer prototype, the ENIAC, created in 1946, which originated the well-known modern computing devices we have in circulation nowadays.

Innovation, therefore, has been expanding its horizons, and this is a growing and clear trend. In recent years, this concept has gone further and taken on a different meaning, being seen, in many cases, as a disruptive process, given its dramatic capacity to affect new markets and destabilize the competitive landscape.

Hence, nowadays, compared to past centuries, it is easy to deduce that innovation will no longer require a gradual and exhaustive technical work process, on behalf of the constant technological progress of our world. Whenever the evolution of technology accelerates, as specialists would say “a new family of phenomena are discovered and incorporated into components for further recombination”.³ Furthermore, new legal, social, economic, and environmental challenges continue to arise successively, which, as in other times, ultimately complicate these processes of creation. In this sense, the motto from now on may no longer be to reach the unreachable, but rather to determine the red lines of the innovation process, trying to establish a balance between its potential and obstacles.

In short, as we mentioned initially, innovation represents a more abstract concept that goes beyond technology. However, due to the modern standards currently followed, the use of emerging technologies is often encouraged, making it difficult to interpose a logic that separates the idea of innovation from those. This very innovation, which in the past, assumed other objectives, due to the consolidation of the processes of creation, now assumes another level: measures the effectiveness of pre-existing solutions for concrete problems related to the circumstances of the reality in which we live and resulting from the act of development of these very creations.

The fast emergence of technological means arising from the maximization of this creation process such as Blockchain technologies, and the Big Data phenomenon,

³ Woo, J., Whittington, J., & Arkin, R. (2020). Urban Robotics: Achieving Autonomy in Design and Regulation of Robots and Cities. *Connecticut Law Review*, 52 (1), 319- 410.

the Internet of Things (IoT), the 5G network or even the Metaverse, are representative examples of this incremental innovation, yet disruptive. Employing these in society could simultaneously mean having a radical revolution for the world and social relations or bringing them to their doom.

Because of the numerous challenges and advantages that are in constant collision, with the present work, it is intended to establish some guidelines to achieve a balance between benefits and disadvantages with regard to emerging technologies, emphasizing, among them, the role and contribution of artificial intelligence.

2. Operating Artificial Intelligence:

2.1. Origins, explainability and goals of AI:

The implementation of artificial intelligence systems has been one of the innovative solutions suggested to tackle the many complex challenges we currently are facing. However, to better comprehend its advantages and possible repercussions in this context, we must first assess its meaning and assimilate a little about the technical aspects of its operation.

Since ancient times that homo sapiens species found very tempting the idealization in their mind of the genesis of artificial agents sufficiently capable to transform the physical world.⁴ Against all odds and due to unbridled technological development, today it has become possible to reproduce our humanity⁵ in a machine, and this is seen by many as the achievement of the millennium. These constructions, nothing more, nothing less are associated with the term "artificial intelligence", an expression created in 1955 by John McCarthy, considered and acknowledged for being one of the pioneers of these structures.

Throughout this last century in the scope of its core, through a closer look, we deduce that, even so, there is no consensus about a universal definition of the meaning

⁴ McCorduck, P. (2004). *Machines Who Think A Personal Inquiry into the History and Prospects of Artificial Intelligence* (2nd ed.). A K Peters, Ltd. <https://doi.org/10.1126/science.254.5036.1291.b>

⁵ McCorduck, P. (2004). *Machines Who Think A Personal Inquiry into the History and Prospects of Artificial Intelligence*;

and function of this technological reality, since it has been often contemplated, from different perspectives at different moments in time.

In its early stage, the term artificial intelligence was interpreted in a more restricted perspective and, therefore, as a means to overcome elementary problems of deductive nature and strictly related to the mathematical, logical or linguistic field. According to this model, through intermediary automata with basic programming supported by pre-determined instructions, it becomes possible for them to draw conclusions close to the level of human intelligence. However, the simplicity of these methods had its days counted, since the computational limitation of those times and the excessive accumulation of data did not always allow for providing totally clear results, thus putting the credibility of this technology in question. Consequently, despite its innovative character, led to disappointment⁶ and there was no interest in investment by the major economic agents since the conditions for artificial intelligence to be seen as a real field had not yet been met.⁷

With the subsequent revolutions in the innovation sector, this trend was reversed, and artificial intelligence began to gain notoriety as a whole and assert its presence in the market. Noteworthy is the deployment of new and refined techniques that are now possible to apply to the core of these systems, which are enhanced by the high processing and data storage capacity that, as indicated before, was not feasible.

The influence of these new methods based on inductive or machine learning perspectives, contrary to the previous ones of deductive prediction, quickly came to deserve widespread recognition, given that their reasoning is based on a computational model of self-learning.

With the application of these new models, artificial intelligence finally started to be considered as a real discipline of study, focused on the development of several

⁶ Thorwirth, Z. (2021, January 09). *AI Winter: The Highs and Lows of Artificial Intelligence*. History of Data Science. <https://www.historyofdatascience.com/ai-winter-the-highs-and-lows-of-artificial-intelligence/>

⁷ DiMatteo, L.A. (2022). *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*. Cambridge University Press, pp. 19-21.

subtypes of intelligence artifices which, under the shelter of technological advance, are now capable of accomplishing several competencies: provide a decision-making process; contribute for an efficiency increase in the process of identifying irregularities; demonstrate their exceptional ability to adapt to the environment in which they are being integrated⁸, overcoming, in this way, concrete obstacles.

The introduction and pursuit of these new approaches in the development of the field of artificial intelligence, therefore, represented, before anything else, a real paradigm shift that logically resulted in greater interest from technological giant corporations to seek further investment in these projects.

In a second moment, greater certainty on the definition of the appropriate direction to give to those that could be the guiding machines of our present as we know it and in the times that are still to come. It is thus a definition that follows its historical origin and provides insight into what was initially conceptualized by Alan Turing and John McCarthy⁹ – viewing artificial intelligence as a discipline of study on its role and practical functioning and, on the other hand, a path that, because of its different subfields the term *AI* itself takes on different meanings, depending on the purpose in question. These objectives may be different, due to the possibility that these new methods brought to adjust and learn with the surrounding environment, without having been directly and algorithmically programmed for that effect.¹⁰ Some of these examples are machine learning models which focus on the development and application of self-learning algorithms to provide predictions about data¹¹; speech and natural language processing tools that imply using machines to recognize, interpret, and synthesize human language; computer vision subfield that involves the use of

⁸ Russell, S., & Norvig, P. (2010). *Artificial Intelligence: A modern approach* (3rd ed.). Pearson, p. 234. https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf

⁹ Shubhendu, S., & Vijay, J. (2013). Applicability of Artificial Intelligence in Different Fields of Life. *International Journal of Scientific Engineering and Research (IJSER)*, 1(1), 2347–3878, pp. 28-29. <https://www.ijser.in/archives/v1i1/MDExMzA5MTU=.pdf>

¹⁰ Kaufman, D. (2018). *A inteligência artificial irá suplantará a inteligência humana?* Estação das letras e cores. https://books.google.pt/books?id=Fh-WDwAAQBAJ&printsec=copyright&redir_esc=y#v=onepage&q&f=false

¹¹ Surden, H. (2020). Machine Learning and Law: An Overview. *Research Handbook on Big Data Law*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3686055

deep learning methods to train models to recognize objects, faces, and other visual patterns.¹²

In brief, from early on the conceptualization of the idea of artificial intelligence has represented a goal of human beings. Given its potential and technological development, the difficulty in finding a definition has been notorious, and the idea of artificial intelligence has gone from a perspective in which it is merely a means to solve problems in certain areas, to the understanding that it represents a field of study, with different sub-branches. In accordance with the overview made, it seems to me that is safe to say that today, the focus has been on concluding a more tangible concept of artificial intelligence: a research area of any virtual or physical system that presents an intelligent behaviour or a set of capabilities which allows them to deliver more efficient and similar results to those derived from human conduct; secondly, if enhanced by the use of the most up-to-date methods, they are capable of adjusting their behaviour to the environment in which they are integrated, directing their operation towards the pursuit of specific goals.

The advantages of this perspective allow the viewpoint from which artificial intelligence is approached to go beyond the exploration of its practical applicability – finding its useful purpose. Searching this intent proves to be crucial for us to be able to answer two key questions, which mark the spectrum of this dissertation: "what makes artificial intelligence special compared to other emerging technologies, and in what concrete way can this science impact key sectors within different realities, namely, the case of smart cities?"

¹² Khan, A. I., & Al-Habsi, S. (2020). Machine Learning in Computer Vision. *Procedia Computer Science*, 167, 1444–1451. <https://doi.org/10.1016/j.procs.2020.03.355>

2.2. Why is AI the “revolutionary technology” within emerging tech:

A. Technical aspects:

The interest of the world's major players in artificial intelligence has been growing exponentially in recent times, due to its own characteristics that differentiate it from any other technology in waves of innovation seen to date.

From the *bonus pater familias* point of view, I would hazard to say that one of the great justifying reasons for this great fervor around its implementation is the fact that human beings find it safer and convenient to choose solutions which allow them to have similar results to the ones that would come directly from their own conduct, as oppositely to what other emerging technologies enable. Nevertheless, there is a whole range of factual technical and legal-ethical reasons to overemphasize the role of artificial intelligence in the market.

First, in a technical context, artificial intelligence offers the greatest potential for innovation¹³ compared to other technologies, since it is based on a decentralized model that gives utility and greater security to the amount of data it uses to deliver the desired results. For example, cloud computing technologies, despite being a landmark in innovation, it is noted that they are developed in a centralized way, having the advancement of their process restricted only to the interests of those who hold their control.¹⁴

Secondly, although complex, artificial intelligence is an extremely versatile technology, with scientists having at their disposal the possibility of regularly optimizing these models, which makes them consecutively more sophisticated and intelligent.¹⁵

¹³ Allen, R. (2017, June 12). *Why Artificial Intelligence is Different from Previous Technology Waves*. Medium. <https://medium.com/machine-learning-in-practice/why-artificial-intelligence-is-different-from-previous-technology-waves-764d7710df8b>

¹⁴ Allen, R. (2017, June 12). *Why Artificial Intelligence is Different from Previous Technology Waves*.

¹⁵ Rodriguez, J. (2020, August 5). *Decentralized AI in 5 Minutes*. Medium. <https://medium.com/intotheblock/decentralized-ai-in-5-minutes-2f3769deeff7>

B. Legal Considerations:

Regarding the legal perspective, AI has been one of the points of greatest interest for legal coverage, compared to other emerging technologies. Due to the immense impact that its potentialities may have on the core of society and the connection that these may establish with topics of special legal relevance such as human rights, data protection, cybersecurity or the issue of liability for damages, there is a joint effort by legislators around the globe to establish, in the near future, a legal component on artificial intelligence with a broad scope of application.

Although there are other initiatives being pursued by other countries, I would like to highlight the approaches that have been developed in three jurisdictions on the basis of the following reasons: the United States, due to its importance in the field of scientific research on artificial intelligence. In addition to being a member who helped establish the Global Partnership in Artificial Intelligence (GPAI), they currently have 47 initiatives in collaboration with the AI Policy Observatory of the Organization for Economic Cooperation and Development (OECD)¹⁶; China, which in recent years has asserted its supremacy over the United States in the area of artificial intelligence. In a precautionary logic, given its dimension as a world power and its growing interest in artificial intelligence, considering its history, it is important to continuously pay attention to its legal developments, so that legal frameworks don't enable the implementation of artificial intelligence for purposes that violate fundamental liberties and the rule of law, namely, by stifling freedom of expression and encouraging arbitrary or illegal monitoring programs.¹⁷ This happens because the political motivation in many cases is deeply underlying in the context of projects developed by companies and authorities, a not conforming circumstance with the principle of impartiality and independence. Finally, the European Union because of its more far-reaching perspective¹⁸ focused on the prevention of the risks of AI, and applicable

¹⁶ U.S. Department of State. *Artificial Intelligence (AI)*. <https://www.state.gov/artificial-intelligence/>

¹⁷ Larsen, B. C. (2022, December 8). *The geopolitics of AI and the rise of digital sovereignty*. Brookings. <https://www.brookings.edu/research/the-geopolitics-of-ai-and-the-rise-of-digital-sovereignty/>

¹⁸ Howell, C. T. (2022, August 3). *AI Regulation: Where do China, the EU, and the U.S. Stand Today?* Foley & Lardner LLP. <https://www.foley.com/en/insights/publications/2022/08/ai-regulation-where-china-eu-us-stand-today>

over a large territorial area. Secondly, there are other European regulations that, unlike in other jurisdictions, have implications¹⁹ for these artificial intelligence systems, as would be the case with some of the provisions²⁰ of the General Data Protection Regulation (GDPR)²¹.

Combined, these end up gathering 70% of the global economic impact²² brought about by the potential of artificial intelligence, either because of the high population density that these regions concentrate on or because of the number of activities developed and invested by companies in this sector, which justifies its further analysis.

Regarding the particular case of the United States, it should be noted that the topic of artificial intelligence began to gain relevance with a report²³ drafted in 2016 by the US government, subsequently supplemented with the Executive Order of 11 February 2019, called "Maintaining American Leadership in Artificial Intelligence", which scope aims at promoting research, investment, reducing barriers in the implementation of artificial intelligence, in order to consolidate its world leadership, with regard to this field.²⁴ It is also worth mentioning two moments of strengthening and encouraging its regulation: the 2020 National Artificial Intelligence Initiative Act of 2020 (NAIIA)²⁵, rendered on 1 January 2021, which reveals itself to be part of a

¹⁹ Howell, C. T. (2022, August 3). *AI Regulation: Where do China, the EU, and the U.S. Stand Today?*

²⁰ Article 22 of the European General Data Protection Regulation (GDPR) "data subjects shall have the right not to be subject to a decision based solely on automated processing, including profiling, which produces legal effects concerning him or her similarly significantly affects him or her." Retrieved from Regulation (EU) 2016/679 of the European Parliament and of the Council on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC. Official Journal of the European Union. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679&from=EN>

²¹ Regulation (EU) 2016/679 (GDPR) (2016)

²² European Commission. (2018). *USA-China-EU plans for AI: where do we stand?* <https://ati.ec.europa.eu/sites/default/files/2020-07/USA-ChinaEU%20plans%20for%20AI%20%20where%20do%20we%20stand%20%28v5%29.pdf>

²³ Executive Office of the President National Science and Technology Council Committee on Technology. (2016). *Preparing for the future of artificial intelligence*. National Science and Technology Council. https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf

²⁴ Executive Order 13859. (2019). Federal Register: vol 84, n°31. <https://www.govinfo.gov/content/pkg/FR-2019-02-14/pdf/2019-02544.pdf>

²⁵ Thornberry, W. M. (MAC). (2020). National defense authorization act for fiscal year 2021. *House of representatives*. <https://www.congress.gov/116/crpt/hrpt617/CRPT-116/hrpt617.pdf#page=1210>

national strategy to outline the way forward in the responsible research, development and application of artificial intelligence, as an enabling tool for cooperation, innovation, education and well-being; on the other hand, the publication by the White House Office of Science and Technology Policy (OSTP) of the recent 2022 AI Bill of Rights Blueprint that brings together a set of non-binding guidelines²⁶ to drive the development and implementation of these technologies, with a view to greater security, efficiency, protection of businesses and ensuring the protection of the rights and freedoms of US citizens.²⁷

In the Eastern part of the globe, we may refer to China, which, in the face of the rampant evolution of disruptive technologies, has been focusing on building a governance framework to better harness the possibilities of artificial intelligence systems. Despite such attempts, we believe that the genuine interest in adopting these technologies was solely demonstrated by Chinese government institutions²⁸, following a successful application of artificial intelligence case – *Alpha GO* – a smart computer program developed by Google DeepMind that defeated a professional board player.²⁹ It is noteworthy to emphasize the role of the 2017 *New Generation Artificial Intelligence Development Plan (AIDP)*³⁰ which defines China's AI intelligence strategy through 2030 as a new engine of economic development, a core driving force of a new round of industrial transformation³¹ and a tool for social construction³²; on

²⁶ White House Office of Science and Technology Policy. (2022). *Blueprint for an AI Bill of Rights making automated systems work for the American People*. <https://www.whitehouse.gov/wp-content/uploads/2022/10/Blueprint-for-an-AI-Bill-of-Rights.pdf>

²⁷ Holland, M. (2022, December 6). *Stakeholders want more than AI Bill of Rights guidance*. Tech Target. <https://www.techtarget.com/searchcio/news/252528080/Stakeholders-want-more-than-AI-Bill-of-Rights-guidance>

²⁸ Roberts, H., Cows, J., Morley, J., Taddeo, M., Wang, V., & Floridi, L. (2020). The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation. *AI & SOCIETY*, 36(1), 59–77. <https://doi.org/10.1007/s00146-020-00992-2>

²⁹ Roberts, H., Cows, J., Morley, J., Taddeo, M., Wang, V., & Floridi, L. (2020). The Chinese approach to artificial intelligence.

³⁰ State Council. (2017). A New Generation of Artificial Intelligence Development Plan. *The foundation for Law and International Affairs*, p. 35. <https://flia.org/wp-content/uploads/2017/07/A-New-Generation-of-Artificial-Intelligence-Development-Plan-1.pdf>

³¹ Zhu, X. (2019). Introduction: From the Industrial Economy to the Digital Economy: A Giant Leap—Research on the “1 + 10” Framework of the Digital Economy. In *Management for professionals*. Springer, Singapore. https://doi.org/10.1007/978-981-13-2628-8_1

³² State Council. (2017). A New Generation of Artificial Intelligence Development Plan. *The foundation for Law and International Affairs*, 35, p. 2. <https://flia.org/wp-content/uploads/2017/07/A-New-Generation-of-Artificial-Intelligence-Development-Plan-1.pdf>

other hand, the contribution of several instruments, regarding industry ethics and algorithms. Some representative cases are the *Trustworthy AI White Paper*³³, urging a cautious approach, through the development of legislation and the use of methods promoting the reliability of artificial intelligence systems³⁴; the *Ethical Norms for New Generation Artificial Intelligence*³⁵, which covers areas related to human control, the responsibility of artificial intelligence and protection of personal information³⁶; the *Guiding Opinions on Strengthening Overall Governance of Internet Information Service Algorithms*³⁷ to strengthen the governance of information service algorithms³⁸; the *Provisions on the Management of Algorithmic Recommendations in Internet*³⁹ e as *Guiding Opinions on Strengthening Ethical Governance of Science and Technology*⁴⁰ which, following on from the preceding principles, contribute to the improvement of the ethical system of science and technology, the enhancement of governance efforts, the effective control of ethical hazards, all from a perspective of valorization and promotion of its benefits for society.⁴¹ Finally, it is vital to emphasize the first regional regulation targeted at encouraging the artificial intelligence business in the Shenzhen area.⁴² This document is a crucial step since it enshrines essential concepts and objectives, as well as proposes

³³ JD Explore Academy. (2021). White Paper on Trustworthy Artificial Intelligence. China Academy of Information and Communications Technology. <http://www.caict.ac.cn/english/research/whitepapers/202110/P020211014399666967457.pdf>

³⁴ Wu, Y. (2022, October 14). *AI in China: Regulations, Market Opportunities, Challenges for Investors*. China Briefing News. <https://www.china-briefing.com/news/ai-in-china-regulatory-updates-investment-opportunities-and-challenges/>

³⁵ The National New Generation Artificial Intelligence Governance Specialist Committee. (2021, October 21). *Ethical Norms for New Generation Artificial Intelligence*. <https://cset.georgetown.edu/publication/ethical-norms-for-new-generation-artificial-intelligence-released/>

³⁶ Wu, Y. (2022, October 14). *AI in China: Regulations, Market Opportunities, Challenges for Investors*.

³⁷ Tai, K., Creemers, R., Laskai, L., & Webster, G. (2021, October 18). *Translation: Guiding Opinions on Strengthening Overall Governance of Internet Information Service Algorithms*. DigiChina. <https://digichina.stanford.edu/work/translation-guiding-opinions-on-strengthening-overall-governance-of-internet-information-service-algorithms/>

³⁸ Wu, Y. (2022, October 14). *AI in China: Regulations, Market Opportunities, Challenges for Investors*.

³⁹ Tai, K., Creemers, R., Laskai, L., & Webster, G. (2021, October 18). *Translation: Guiding Opinions on Strengthening Overall Governance of Internet Information Service Algorithms*.

⁴⁰ Xinhua News Agency. (2022, March 20). *The General Office of the Central Committee of the Communist Party of China issued the "Opinions on Strengthening the Ethical Governance of Science and Technology*. <http://english.www.gov.cn/>

⁴¹ Wu, Y. (2022, October 14). *AI in China: Regulations, Market Opportunities, Challenges for Investors*.

⁴² Shenzhen Municipal People's Congress. (2022). *Shenzhen Special Economic Zone Artificial Intelligence Industry Promotion Regulations*. <http://law.pku.edu.cn/chinalaw/eb370a7e0d9edd5e8ca8bb1a5fa6a5e7bdffb.html>

a management and research model to be followed for the implementation of artificial intelligence in various sectors.

Similarly, to the measures given by the aforementioned world powers, the European Union has recognized the significance of taking a position in order to maintain international competitiveness. The first step was done in 2018, with the presentation of a plan that came to outline a long-term strategy based on three goals:⁴³ an endeavor to boost the EU's technological and industrial capabilities⁴⁴, including the use of artificial intelligence for economic purposes when opportunities for various sectors emerge;⁴⁵ a comprehensive examination of the socioeconomic impacts and society's readiness for the changes brought about by its execution;⁴⁶ lastly, establishing a suitable legal and societal framework.⁴⁷

In light of this strategy, we allude to several initiatives developed by the European authorities in a risk-based approach: the presentation of the *White Paper on Artificial Intelligence*⁴⁸, as a guiding document for achieving the objectives and preventing the risks associated with the use of artificial intelligence systems, while respecting European values and rules⁴⁹; the European Parliament's resolution on the importance of developing a unified civil liability scheme for artificial intelligence in Europe, which offers some thoughts and advancements on high-risk AI systems⁵⁰, thus ensuring greater legal clarity certainty for those impacted by their usage; the proposal⁵¹ for an

⁴³ Hovsepayan, E. (2020). Regulating AI: A Success Story for the European Union? *E-International Relations*. <https://www.e-ir.info/pdf/86182>

⁴⁴ Waas, B. (2022) Artificial Intelligence and Labour Law. *Hugo Sinzheimer Institute for Labour and Social Security Law*, p. 48. https://www.hugo-sinzheimer-institut.de/fpdf/HBS-008498/p_hsi_wp_17.pdf

⁴⁵ European Commission. (2018). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. *Artificial Intelligence for Europe*, p. 6. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A237%3AFIN>

⁴⁶ European Commission. (2018). *Artificial Intelligence for Europe*. p. 12

⁴⁷ European Commission. (2018). *Artificial Intelligence for Europe*. p. 16

⁴⁸ European Commission. (2020). White Paper on Artificial Intelligence – *A European approach to excellence and trust*. https://commission.europa.eu/system/files/2020-02/commission-white-paper-artificial-intelligence-feb2020_en.pdf

⁴⁹ Wahl, T. (2020, April 1). *Commission: White Paper on AI*. Eucrim. May 2022 in <https://eucrim.eu/news/commission-white-paper-ai/>

⁵⁰ Schütte, B., & Majewski, L. (2022). Private Liability for AI-Related Harm: Towards More Predictable Rules for the Single Market*. *Market and Competition Law Review*, 6(1), p. 136. <https://doi.org/10.34632/mclawreview.2022.10741>

⁵¹ European Commission. (2021). Proposal for a Regulation on general product safety. COM (2021) 346 final 2021/0170 (COD), amending Regulation (EU) No 1025/2012 of the European Parliament

initiative to replace the current General Product Safety Directive (GSPD), with a view to tackling the challenges created by emerging technologies, including artificial intelligence, in the context of online marketplaces for consumers.⁵²

By harmonizing the previous contributions, it is now possible to achieve a better legal landscape and to pave the way for those that, in my view, if effectively brought into force, may represent the greatest milestones in the European perspective on artificial intelligence - The Artificial Intelligence Act⁵³ - and – the AI Liability Directive⁵⁴ - true regulatory examples for the world regarding the search and creation of a universal law that covers the multiple aspects and forms of implementation of artificial intelligence, its proper application to the various sectors and wide consolidation of compensation and civil responsibility system, as a consequence of any potential damages that the usage of these technologies may originate to those involved.

In short, therefore, together these initiatives represent the first successful attempt to create a governance and regulatory instrument based on fundamental European values which, in line with other measures adopted by other countries, prove and enhance the unparalleled value of artificial intelligence in relation to other technologies which, to date, do not have a sufficiently solid and technically sustained regulatory basis.

C. Ethical Dimension of Artificial Intelligence:

Regarding this third dimension, it is important to mention that artificial intelligence systems are developed for socially intended purposes, so, in this sense, it

and of the Council and repealing Council Directive 87/357/EEC and Directive 2001/95/EC of the European Parliament and of the Council <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0346&qid=1628522210573>

⁵² European Commission. (2021). Proposal for a Regulation on general product safety, p. 1.

⁵³ European Commission. (2021). Proposal for a Regulation of the European Parliament and of the Council. Laying Down Harmonized Rules on Artificial Intelligence (Artificial Intelligence Act). COM (2021) 206 final 2021/0106 (COD). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021PC0206>

⁵⁴ European Commission. (2022). Proposal for a Directive to the European Parliament and to the Council on adapting non-contractual civil liability rules to artificial intelligence. COM (2022) 496 final 2022/0303 (COD). https://commission.europa.eu/system/files/2022-09/1_1_197605_prop_dir_ai_en.pdf

is necessary that regulators adopt a broader perspective and provide the most appropriate response to the problems that these systems bring with them. In these solutions, it is sometimes necessary to establish a connection point with other study realities, namely ethics, which, in the context of regulation and implementation of artificial intelligence, ends up assuming a certain inseparability from the law. Regarding this statement, it is noted that, in practice, in a large part of the initiatives in this field the importance of valuing the moral standards and norms that directly impact one's life is highlighted. An example of this is the resolution adopted by the European Parliament⁵⁵, which seeks to provide a range of recommendations highlighting the importance of ensuring, in the development and implementation of artificial intelligence systems, especially those classified as high-risk, a more human-centric perspective, in compliance with ethical principles.⁵⁶

Following this path of responsible and ethical application of artificial intelligence systems prevents the undermining of those values. Going beyond, I believe that they may even contribute to the maintenance of universal principles/values that are directly related to individual well-being and fundamental rights, which are widely contemplated in instruments like the United Nations Charter or the European Charter of Human Rights.

Among these we highlight the principle of non-discrimination, as long as these systems have in their algorithmic design tools that allow the prevention of prejudice.⁵⁷; the guarantee and continuous recognition of the dignity of the human being, since an artificial agent, due to its efficiency and automation, can more easily supply vital needs that, if not provided by human hands, could lead to the injury of

⁵⁵ European Parliament. (2021). Resolution of 20 October 2020 with recommendations to the Commission on a framework of ethical aspects of artificial intelligence, robotics and related technologies 2021/C 404/04. <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020IP0275>

⁵⁶ European Parliament. (2021). Resolution of 20 October 2020 with recommendations to the Commission on a framework of ethical aspects of artificial intelligence, robotics, and related technologies 2021/C 404/04, Paragraph 2. <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020IP0275>

⁵⁷ Ama. (2020). *Guia para uma inteligência artificial ética, transparente e responsável na administração pública*, p. 6. <https://bo.tic.gov.pt/api/assets/etic/95bcdf56-87ba-446b-9f0b-ab06e1549aa0/>

the individual's own dignity⁵⁸; the principle of transparency, insofar as these systems provide individuals with information whenever they request it; finally, the right to privacy and security of personal data, to the extent that automated processing of data is fair and fit for the projected purposes.⁵⁹

In summary, the competitive innovation market has been bringing us several options regarding the fight against the challenges arising from the application and exploitation of the potential of new emerging technologies. Among these innovations, the special role of artificial intelligence stands out. It has at its core a set of justifying reasons that confirm its disruptive character: firstly, it is a technical versatile technology and, therefore, more prone to innovation; secondly, we find a set of initiatives, at a global level, that may grant these systems, in a near future, a solid legal framework; finally, they may consubstantiate real instruments to promote moral standards and norms. Nevertheless, despite these distinctive factors contributing to placing artificial intelligence at the top of the emerging technologies most likely to succeed, all of this depends on the responsible application. Unwise use of these means could lead likewise to harmful consequences. However, if strict regulatory scrutiny is observed, in the light of its technical aspects and of a society's collective scope, it is possible that artificial intelligence may even exceed expectations and prevent situations that threaten human dignity, which, in turn, encourages respect for universally enshrined ethical principles. For these reasons, artificial intelligence stands apart from other technologies, assuming a revolutionary role in the innovation market and representing a purpose to be followed for the future of sectors. Having answered the first question, we must now understand how its purpose can be maximized, particularly in the field of smart cities.

⁵⁸ For example, using artificial intelligence to fill a possible shortage of workers dedicated to translating documents for blind people. The implementation of such systems in this scenario could avoid a possible situation of discrimination between those who would have access to the content of documents and those who would not, due to their condition, damaging, in turn, that human dignity.

⁵⁹ Souza, J., Maranhão, A., Florêncio, J., & Almada, M. (2021). Artificial intelligence applied to the law and the law of artificial intelligence. *Suprema: revista de estudos constitucionais*, 1(1), 154-180, pp. 160-163.

https://cadmus.eui.eu/bitstream/handle/1814/71840/MARANH%C3%83O_et_al_2021.pdf?sequence=1

3. Smart cities: the path for digital transformation

3.1. What is a “smart city”?

Having discussed the unique singularity of this technology compared to other innovation bets, it is now important to focus our attention on what, in my opinion, may be a key area in the search for the truly useful goal of technology and artificial intelligence - the field of the so-called *smart cities*.

In a first attempt, the notion of a "smart city" can be used to define a conceptual experience of a city that is characterized by its inextricability from technology and the constant pursuit of citizens' well-being.⁶⁰ However, the meaning of this concept proves to be much deeper than one might think, evidencing this complexity and the fact that, so far, there is not an overall and global definition.

To understand more precisely what they are and how they can impact our lives, it is our suggestion to explore four major structuring ideas:

Firstly, smart cities are based on a smart living logic⁶¹, since they seek to improve the quality-of-life indices and continuously study or replicate technological innovations in public facilities and services for their uninterrupted operation and, therefore, providing a comprehensive response to the needs of people (whether residents or visitors). For example, the provision of 5G connectivity in all public infrastructures enables superior performance, readiness, and accessibility for the community.

Secondly, smart cities are based on a smart economy logic, given that they follow globalization patterns and look to improve, through technology, the distribution structure in order to foster productivity and increase the population's consumption levels. Thus, they become, on one hand, an ecosystem of innovation⁶², and thereby

⁶⁰ Ranchordás, S. (2019). Nudging citizens through technology in smart cities. *International Review of Law, Computers & Technology*, 34(3), 254–276. <https://doi.org/10.1080/13600869.2019.1590928>

⁶¹ Winkowska, J., Szpilko, D., & Pejić, S. (2019). Smart city concept in the light of the literature review. *Engineering Management in Production and Services*, 11(2), 70–86, p. 72. <https://doi.org/10.2478/emj-2019-0012>

⁶² Observador Lab. (2020, October 2). *Smart Cities em Portugal? Sim, claro. No Centro de Portugal*. Observador. <https://observador.pt/2020/10/02/smart-cities-em-portugal-sim-claro-no-centro-de-portugal/>

more attractive for investment and hosting of start-ups/companies of international reference⁶³; on other hand, an exemplary model of financial and economic growth.⁶⁴

For example, the use of the Internet of Things (IoT) which has been simplifying distribution/logistics processes and chains, and the encouragement of e-commerce for local businesses⁶⁵, with this latter providing greater value and visibility for their developed activities.

Thirdly, smart cities are based on a logic of smart mobility, seeking to provide effective multimodal transport networks⁶⁶ which are easily accessible to the entire community which, at the same time, constitute truly innovative mobility alternatives to conventional and private means of transport.⁶⁷ Additionally, they also aim to devise strategies and technology-based solutions to combat road challenges. For example, reserving traffic in specific areas of cities only for a fleet of electric and autonomous public transport or the installment of predictive traffic technologies.

Finally, smart cities are also based on a logic of green and ecological development, striving to promote biodiversity in specific spaces and to manage natural resources efficiently⁶⁸ in an attempt to prevent waste and combat climate change. A modern city will be one that will continuously seek to replicate technological solutions to overcome challenges such as the elimination of urban pollution.

⁶³ Bee Smart City GmbH. (2022, January 11). *Smart City Indicators: Six Fields of Action for Success*. Bee Smart City GmbH. <https://www.beesmart.city/en/smart-city-indicators>

⁶⁴ Pajilani, N.D.B., Fahmy-Abdullah, M., Sufahani, S.F., & Ali, M.K.B. (2022). Smart Economy Through Smart Cities. In Kaiser. M.S., Ray, K., Bandyopadhyay, A., Jacob,K., & Long,K.S (Eds.), *Proceedings of the Third International Conference on Trends in Computational and Cognitive Engineering* (pp. 273-283). Springer. <https://doi.org/10.1007/978-981-16-7597-3>

⁶⁵ Pajilani, N.D.B., Fahmy-Abdullah, M., Sufahani, S.F., & Ali, M.K.B. (2022). Smart Economy Through Smart Cities. In Kaiser. M.S., Ray, K., Bandyopadhyay, A., Jacob,K., & Long,K.S (Eds.), *Proceedings of the Third International Conference on Trends in Computational and Cognitive Engineering*, pp. 289. https://www.researchgate.net/publication/358901786_Smart_Economy_Through_Smart_Cities

⁶⁶ Ranchordas, S. (2020). Smart Mobility, Transport Poverty, and the Right to Inclusive Mobility SMART MOBILITY, TRANSPORT POVERTY, AND THE RIGHT INCLUSIVE MOBILITY? *University of Groningen Faculty of Law Research Paper Series*, 13. <https://doi.org/10.1080/10630732.2018.1476794>

⁶⁷ Bee Smart City GmbH. (2022, January 11). *Smart City Indicators*.

⁶⁸ Kobayashi, A. R. K., Kniess, C. T., Serra, F. A. R., Ferraz, R. R. N., & Ruiz, M. S. (2017). Smart sustainable cities: bibliometric study and patent information. *International Journal of Innovation*, 5(1), 77–96. <https://doi.org/10.5585/iji.v5i1.159>

In brief, considering the previous aspects, it should be noted that, regardless of whether they focus on the social area or on the economic and environmental area, all of them converge in their core in the means and objectives. A truly smart city will be one that values and seek to use the power of innovation as a means, in all its basic pillars, to combat its weaknesses and, ultimately, aim for its goal of sustainable development. This concept has always been a big puzzle for specialists, but very meaningful for the present work.

3.2. The Sustainability Challenge:

The growing interest in smart cities inevitably brings the topic of sustainability to the table, as one of the main challenges of what is presumed to be a developed and prosperous city.

Large urban centers are the main economic and strategic points of any country, and for this reason, it is no surprise that more and more initiatives are emerging that encourage the monitoring and implementation of sustainable practices. But what is sustainability and why can this idea contribute to the management of cities and the maintenance of the community?

There have always been those who associate the concept of sustainability, solely and erroneously, with the idea of environmental protection. It is said that the term "sustainable development" was first mentioned by Maurice Strong, in the context of the 1972 United Nations Stockholm International Conference on the Human Environment⁶⁹ as an alternative model⁷⁰ to the development focused on economic growth pursued until then.

This notion was later refined by the 1992 United Nations Conference on Environment and Development in Rio de Janeiro⁷¹, by Ignacy Sachs and the

⁶⁹ UN General Assembly. (1972, December 15). *United Nations Conference on the Human Environment*. Stockholm. <https://www.refworld.org/docid/3b00f1c840.html>

⁷⁰ Félix de Oliveira, D., & de Vasconcelos, L. G. M (2015). ECODEVELOPMENT: AN APPROACH UNDER THE CONTRIBUTION IGNACY SACHS. *Revista de Direito, Economia e Desenvolvimento Sustentável*, 1(2), 29-48. <https://www.indexlaw.org/index.php/revistaddsus/article/view/939/933>

⁷¹ UN. Department of Public Information. (1993). *Agenda 21: programme of action for sustainable development, Rio Declaration on Environment and Development, statement of forest principles: the final text of*

Brundtland Commission's Report of 1987, with the introduction of different ideas about sustainable development. According to it, sustainable development will be characterized as a development that, without endangering current and future generations' capacity to lead sustainable lifestyles, aims to fulfil the needs of developing nations while they strive towards a future characterized by economic growth, social organization and environmental protection.⁷² According to this perspective, we can identify four dimensions: an economic dimension focused on a resource-efficient view to reducing waste⁷³; a social perspective aimed to promote integration, equality and the eradication of poverty⁷⁴; an environmental dimension, regarding the importance of agriculture and environmental degradation issues⁷⁵; finally, a fourth dimension underlying the previous ones, in respect of future generations' health and well-being rights.⁷⁶

Some of these ideals were incorporated into the set of developing objectives that became known as the UN *Millennium Development Goals (MDGs)*⁷⁷, as part of the strategy adopted in 2000, to combat, by the end of 2015, environmental issues, discrimination, hunger, poverty, disease, within other major challenges, which in terms of proportion, would still be very much present in that period all over the world.

agreements negotiated by Governments at the United Nations Conference on Environment and Development (UNCED). United Nations Digital Library System.
<https://digitallibrary.un.org/record/170126?ln=en>

⁷² World Commission on Environment and development. (1987). *Report of the World Commission on Environment and Development: Our Common Future* (Brundtland Report). Paragraph 27 <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>

⁷³ World Commission on Environment and development. (1987). *Report of the World Commission on Environment and Development: Our Common Future* (Brundtland Report), pp. 21-22. Paragraph 66-69.

⁷⁴ World Commission on Environment and development. (1987). *Report of the World Commission on Environment and Development: Our Common Future* (Brundtland Report), p. 7.

⁷⁵ World Commission on Environment and development. (1987). *Report of the World Commission on Environment and Development: Our Common Future* (Brundtland Report), p. 19. Paragraph 48.

⁷⁶ World Commission on Environment and development. (1987). *Report of the World Commission on Environment and Development: Our Common Future* (Brundtland Report), p. 26. Paragraph 97.

⁷⁷ The Millennium Development Goals represent eight goals set by United Nations 189 member states in September 2000, to begin in 1st January 2001, and agreed to be achieved by 2015. The objectives are: first, eliminate extreme poverty and hunger; second, achieve universal primary education; third, promote gender equality and empower women; fourth, reduce child mortality; fifth, improve maternal health; sixth, combat HIV/AIDS, malaria, and other diseases; seventh, ensure environmental sustainability; eighth, develop a global partnership for development. For more information, please check UN General Assembly (2000, September 8). United Nations *Millennium Declaration*. <https://www.ohchr.org/en/instruments-mechanisms/instruments/united-nations-millennium-declaration>

Nowadays, it is unequivocal to state that sustainability took on an even broader importance than in its early days, due to the challenges and adversities brought by human actions. It was in this sense that the previously mentioned MDGs came to be replaced by the *UN 17 Sustainable Development Goals (SDGs)*⁷⁸ in the core of the *2030 Agenda for Sustainable Development*.⁷⁹ These objectives allowed a revolutionary vision⁸⁰ for the world, in seeking to attribute more relevance to sustainable development, an aspect that, in comparison with the previous objectives, was not given as much emphasis.

Sustainable practices have increasingly sought to follow the future perspectives to overcome concrete obstacles of the reality we live in. As examples, we highlight the commitment to take action against climate change⁸¹ and the predisposition to making more smart and inclusive cities.⁸²

Once covered, these ideas demonstrate the versatility of the concept of sustainability, being the first aligned with the position formalized in the *2015 Paris Agreement* adopted under the *United Nations Framework Convention on Climate Change*; the second, in line with the reasoning behind the *2016 New Urban Agenda*.⁸³ The creation of this agenda, while not binding, represents an additional fundamental step in the implementation and politicization of the idea of sustainability, as it arises from a firm

⁷⁸ The UN 17 Sustainable Development Goals serve as a road map for achieving a more equitable and sustainable future for society. For more information about the goals, please check the link United Nations. (n.d.) Take Action for the Sustainable Development Goals. <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

⁷⁹ The *2030 Agenda* for Sustainable Development is a resolution adopted by the General Assembly on 25 September of 2015 and elucidates a plan of action for people, the world and prosperity, until 2030. For more information, please check UN General Assembly. (2015, October 21). *Transforming our world: the 2030 Agenda for Sustainable Development*. <https://sdgs.un.org/2030agenda>

⁸⁰ UN General Assembly. (2015, October 21). *Transforming our world: the 2030 Agenda for Sustainable Development*. Paragraph 7.

⁸¹ UN Sustainable Development Goals. *Goal 13* – “take urgent action to combat climate change and its impacts” <https://www.un.org/sustainabledevelopment/climate-change/>

⁸² UN Sustainable Development Goals. *Goal 11* – “Make cities inclusive, safe, resilient and sustainable” <https://www.un.org/sustainabledevelopment/cities/>

⁸³ “The United Nations New Urban Agenda was adopted at the Quito, Ecuador, at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III), on 20 October 2016, and endorsed on 23 December 2016 by 68 members”. For more information, please check The New Urban Agenda - Habitat III. (2016, December 23). *Habitat III*. <https://habitat3.org/the-new-urban-agenda/>

commitment among the various global actors to achieve a fair urban development within a smart city's approach.⁸⁴

Still, regarding the sustainability concept it is relevant to mention the contribution of the so-called ISO⁸⁵ to the consolidation and awareness of this concept, namely, through the international standards and norms ISO:37120⁸⁶ and ISO:37101⁸⁷, which have established methodologies, indicators, requirements and management systems, in the scope of the development of sustainable cities.⁸⁸

In short, since the last century, we have been seeing big steps regarding the consolidation of the notion of sustainability. Against all possibilities, now, that concept, assumes a very broad meaning, as demonstrated by the existence of 17 SGDs to be reached by 2030, as replacing objectives of the previous MGDs, which did not yet emphasize the necessary importance that this notion today assumes in our everyday. According to these and other milestones throughout the sustainability timeline, the focus is now on developing an urban planning strategy focused on innovative patterns; potentiating economic growth; meeting the challenges of climate urgency and protecting the environment; finally, ensuring an equitable and fair society. Summarized, these topics are harmonized with the four dimensions that are commonly identified in the notion of sustainable development: the idea of concern for future generations, to the extent that they are not compromised by the actions of the current generation⁸⁹; the idea of nature conservation and protection of

⁸⁴ The New Urban Agenda - Habitat III. (2016, December 23). *Habitat III*. Paragraph 66. <https://habitat3.org/the-new-urban-agenda/>

⁸⁵ The ISO (International Organization for Standardization) is a voluntary and independent organization, founded in 1946, which brings together various nationals in commissions and technical working groups, with a view to drawing up the technical formula and agreed international standards, to be followed or considered in the wide variety of realities. For more information, please check International Organization for Standardization. (2023, March 8). <https://www.iso.org/home.html>

⁸⁶ The International Organization for Standardization. (2018). *ISO 37120:2018 Sustainable cities and communities — Indicators for city services and quality of life*. <https://www.iso.org/home.html>

⁸⁷ International Organization for Standardization. (2016). *ISO 37101:2016 Sustainable development in communities — Management system for sustainable development — Requirements with guidance for use*. <https://www.iso.org/standard/61885.html>

⁸⁸ Cartaxo, T.M., Neto, M.C., & Vassalo, C. (2017). Smart Legal Mechanisms for Sustainable Cities. *International Conference on Sustainable Development*. Sarajevo, p. 168. https://research.unl.pt/ws/portalfiles/portal/3487026/TCartaxo_MCNeto_VVassalo_Smart_2017.pdf

⁸⁹ Cartaxo, T. M. (2020). Políticas de mobilidade e transportes: Entre a sustentabilidade e uma transição justa. *e-Pública*, 7(2), 219- 239. pp. 223-224.

biodiversity; the idea of economical and efficient management of natural resources; finally, the idea of social fairness and integration.⁹⁰ According to my view, a city that follows these objectives within its core can be considered a truly smart city. The question now is: how can that transition be reached? In my understanding, emerging technologies can play a key role in making them more intelligent and fulfilling the plan of sustainable development.

3.3. Implementing competitive technology for advanced cities:

Since the periods of industrial revolution, we have been seeing the evolution of large cities up until some of the innovative and practical metropolises that exist already worldwide today.

Furthermore, we have witnessed an exodus of the rural population, in search of better living and working conditions and, all the signs indicate that this might be a trend that will continue during the present century. According to the latest statistics⁹¹, it is expected that between 2019 and 2050 the percentage of the global population living in metropolitan areas will grow from the current 50% to about 68%. It is logical that this overpopulation of cities, derived from their inherent advantages, will contribute to the increase and emergence of new characteristic challenges.

Faced with this unavoidable trend, the search for more efficient solutions, besides those already implemented, becomes paramount to meet the needs of the community and contribute to solving already mentioned long-standing global problems underlying the structure of cities: difficulties in urban management, constraints on public structures and the inability of essential services to respond to the whole community.⁹²

[https://ore.exeter.ac.uk/repository/bitstream/handle/10871/129606/34295-mobility-and-transport-policies-between-sustainability-and-a-just-transition%20\(1\).pdf?sequence=1](https://ore.exeter.ac.uk/repository/bitstream/handle/10871/129606/34295-mobility-and-transport-policies-between-sustainability-and-a-just-transition%20(1).pdf?sequence=1)

⁹⁰ Lumley, S., & Armstrong, P. (2004). Some of the Nineteenth Century Origins of the Sustainability Concept. *Environment, Development and Sustainability*, 6(3), 367–378. <https://doi.org/10.1023/b:envi.0000029901.02470.a7>

⁹¹ Eurostat. (2021, May 20). *Population projections: urban growth, rural decline*. <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210520-1>

⁹² Gomes, J.Q. (2021, November 17). *The paradigm of AI in shaping smarter cities*. WhatNext.Law. <https://whatnext.law/en/2021/11/17/the-paradigm-of-ai-in-shaping-smarter-cities-en/>

Regarding these obstacles, local governments have been urged to change the paradigm and focus, on one hand, on a model adjusted to the SGD's goals; on the other hand, on a model that observes innovative standards and enables the construction of more modern, safe, and efficient cities.

This predisposition for the implementation of a more innovative model that addresses these difficulties leads to the emergence of unique research opportunities for the implementation of new disruptive and revolutionary resources. Within these, we highlight the contributions of Blockchain technologies and augmented reality technologies and the field of artificial intelligence which are currently the most prominent in the competitive technological market.

In relation to Blockchain technologies, it is said that with its application it is possible to improve the public management of cities and promote cybersecurity, due to their capacity of storing records and information in a decentralized and fully transparent network. It should be noted that a distinctive case of success in the application of Blockchain technologies to be noted is Estonia, which currently, by bringing together a large part of its public services and government structures into a more secure protocol⁹³, contributes to greater digital inclusion and simplified public administration.⁹⁴

In fact, the architecture of blockchain technologies seems to bring a range of interesting advantages to smart cities, contributing to greater monitoring, efficiency and streamlining processes, due to the ease of access and communication of information.⁹⁵ The application of these technologies also seems to have a useful

⁹³ Blockchain technologies were presented and implemented as a solution to improve Estonia's cybersecurity, following a political decision that prompted a 2007 wave of cyber attacks on government, banking and communication structures, as well as an unprecedented scenario of protests and devastation in the country. For more information, please check McGuinness, D. (2017, April 27). *How a cyber attack transformed Estonia*. BBC News. <https://www.bbc.com/news/39655415>

⁹⁴ De Santi, R. (2020, October 7). *Blockchain e a Cidade Inteligente*. <https://www.linkedin.com/pulse/blockchain-e-cidade-inteligente-rodolfo-de-santi/?originalSubdomain=pt>

⁹⁵ Almeida, F.G. & Duarte, A.S. (2022, June 1). *Blockchain e Direitos Humanos – a tecnologia ao serviço das empresas (e das pessoas!)*. WhatNext.Law. <https://whatnext.law/en/2022/06/01/blockchain-e-direitos-humanos-a-tecnologia-ao-servico-das-empresas-e-das-pessoas-2/>

purpose at the level of sustainable development, as real-time information can be provided about the process and service of waste collection or air quality in cities.⁹⁶

Even so, despite this being a fruitful instrument, it has some complexities that, in my view, do not attribute the uniqueness necessary to set it apart from other technologies.

First, it is not a standardized technology, and there are some inconsistencies between its nature and the general framework of data protection law.⁹⁷ It is mentioned that blockchain designs were initially architected to enable indefinite and intact storage in this database, however, this assumption goes directly against two fundamental requirements of this branch - limitation in storage and minimization of data.⁹⁸

Secondly, it does not make it possible to ensure that this stored information is truthful. It only prevents manipulation of the recorded information, not verification of the veracity of the data.⁹⁹

Thirdly, although they may have a useful purpose for the sustainability of cities, their maintenance is extremely power-consuming, and thus there is no nexus line between these means and the intended ends, regarding sustainability.

Finally, it is questionable whether the excessive security that the encryption system that Blockchain technology grants to stored data may contribute to the creation of risk situations. It may happen that the inefficiency of the system on which this technology is based may lead to the occurrence of cyber frauds and the destruction of the data itself, due to the theft or loss of the access keys to decrypt this information.

⁹⁶ Iberdrola. (2021, April 22). *Blockchain technology at the service of urban management*. Iberdrola. <https://www.iberdrola.com/innovation/blockchain-for-smart-cities-urban-management>

⁹⁷ EPRS. (2019). Blockchain and the General Data Protection Regulation: Can distributed ledgers be squared with European data protection law? *Scientific Foresight Unit (STOA)*. [https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU\(2019\)634445_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU(2019)634445_EN.pdf)

⁹⁸ EPRS. (2019). Blockchain and the General Data Protection Regulation: Can distributed ledgers be squared with European data protection law? *Scientific Foresight Unit (STOA)*, p. 35. [https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU\(2019\)634445_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU(2019)634445_EN.pdf)

⁹⁹ Almeida, F.G. & Duarte, A.S. (2022, June 1). Blockchain e Direitos Humanos – a tecnologia ao serviço das empresas (e das pessoas!)

About augmented reality technologies, it should be noted that these, in conjunction with 5G network technologies and the Internet of Things (IoT) already implemented, have a very promising potential for the future of large cities. In general, there are already projects that allow the creation of hypothetical scenarios and, consequently, informed decision-making, in order to minimize possible impacts.¹⁰⁰ Consider the project developed by CSD Group Australia Pty Ltd¹⁰¹, which, using augmented reality technologies, by simply scanning a QR Code, it becomes possible to obtain a 3D forecast of the ongoing infrastructure construction process, anticipating possible environmental impacts and enabling more efficient resource management, in line with sustainability objectives.

As we discuss the topic of augmented reality, it is also important to note the contribution that the so-called metaverse may play in the context of smart cities. Through an immersive three-dimensional experience, some believe that soon, cities will have a range of organizational structures and public services purely digital, due to their migration to the world of the metaverse¹⁰², thus helping to overcome the inability of physical services to meet the needs of the population.

Similarly, to Blockchain technologies, despite its advantages, this resource may not be the best answer to meet the challenges, since it still represents a rather recent phenomenon, which explains its dependence on other disruptive resources such as the Internet of Things (IoT).

Secondly, due to the high cost associated with these technologies, they do not imply easy access to all social classes. This circumstance combined with the fact that it is a technology that offers an isolated experience to its user does not contribute to sustainable patterns such as inclusivity.

Thirdly, these are technologies that require a large amount of data, namely, geolocation data¹⁰³ and other information that falls directly under the scope of what

¹⁰⁰ Datta, A. (2022, November 11). *Metaverse for Smart, Sustainable Cities of Tomorrow*. Geospatial World. <https://www.geospatialworld.net/prime/smart-sustainable-cities-metaverse/>

¹⁰¹ *Augmented reality with live BIM onsite*. (2022, September 5). Csd-bim. <https://www.csd-bim.com.au/single-post/augmented-reality-with-live-bim-onsite>

¹⁰² Datta, A. (2022, November 11). *Metaverse for Smart, Sustainable Cities of Tomorrow*.

¹⁰³ Aircada Team. (2022, April 13). *Augmented Reality Disadvantages – Read Before You Adopt*. Aircada Pro. <https://aircada.com/disadvantages-augmented-reality/>

is considered personal data under the General Data Protection Regulation (GDPR). In this sense, the concerns underlying the privacy and security of the personal data of its users are notorious since much of this information embodies sensitive data and is related to the very immanent characteristics of each one.

In view of the above disadvantages, it is my belief that the area of artificial intelligence and automation may play a decisive role in meeting a large part of the challenges that the implementation of the aforementioned disruptive features would not bring: cybersecurity, which continues to represent one of the main problems of Blockchain systems and the structure of a smart city, due to the fact that its sectors are based on applications, networks, sensors, meters that are continuously exposed to unwanted intrusions.

As mentioned, the use of Blockchain technologies is not perceived as the best solution since one of the major disadvantages associated with this resource is the recurring threats related to data security, due to the lack of a mechanism that allows the monitoring and demystification of the stored information.

Artificial intelligence, aided by its ability to correlate and recognize patterns, facilitates the identification of these possible vulnerabilities¹⁰⁴ and, in turn, promotes cybersecurity, preventing possible data theft that Blockchain and other technologies, by their nature, could not prevent; secondly, the issue of exclusion, which augmented reality resources by themselves have an influence and which directly collides with one of the goals of smart cities - integration and participation. Against this, for example, an artificial intelligence project with a robust technical process sufficiently developed to recognize situations of special support and exclusion in a child's activities¹⁰⁵ is likely to provide more beneficial and inclusive results than a solution based singularly on augmented reality.

¹⁰⁴ Olaniyi, O. M., Alfa, A. A., & Umar, B. U. (2022). Artificial Intelligence for Demystifying Blockchain Technology Challenges: A Survey of Recent Advances. *Frontiers in Blockchain*, 5, p.4. <https://doi.org/10.3389/fbloc.2022.927006>

¹⁰⁵ Consider the Autism Glass Project developed by a team at Stanford University. Through the use of special glasses it is possible for autistic children to see and recognize facial expressions, using machine learning and automation, and in turn receive suggestions for social interaction. For more information, please check Stanford University. (n.d.). *Autism Glass Project*. <https://autismglass.stanford.edu/>

Despite this, the role of artificial intelligence does not stop at the advantages of the technical disadvantages of other disruptive resources. In addition to the distinctive factors explored in other chapter 2.2¹⁰⁶, there are also reasons justifying the predominance of AI-based solutions for smart cities: it represents a branch of study, with different subdomains endowed with robust scientific evidence; moreover, it is a reality capable of exceeding human expectations, in light of its potential to disrupt a person's private and individual sphere.¹⁰⁷

Regarding this, we underline its immense contribution to the area of health, in terms of diagnosis and prosthetics; its decisive role in restructuring educational systems and reshaping the thinking of society; and, finally, its contribution to those that are the goals and make a city faithfully smart - the plan for sustainable development and urban mobility - which are absolutely central topics of this work.

In short, more and more reasons have emerged to justify that cities follow smart standards and that urge the implementation of technologies to advance their innovative character.¹⁰⁸ In this sense, technologies like blockchain or even augmented reality technologies stand out, which, despite presenting advantages in the pursuit of specific purposes, underlying the operation of smart cities, still present immense risks for society. It is in this context that artificial intelligence comes to assume a differentiating character since it not only provides answers to the emerging challenges of smart cities, in the wide variety of branches but may also help to overcome the main disadvantages of the other disruptive tools. Among these areas, sustainability and mobility stand out, due to their impact on society, as fields in which artificial intelligence systems may best exploit their intent and provide key solutions to those that remain long-standing urban problems.

¹⁰⁶ For more information, please check Chapter 2.2.

¹⁰⁷ Unesco. (2021). *Recommendation on the ethics of artificial intelligence*. Preamble, p.1. <https://unesdoc.unesco.org/ark:/48223/pf0000380455>

¹⁰⁸ Ranchordás, S. (2019). Nudging citizens through technology in smart cities, p. 14.

4. Shaping smarter cities through Artificial Intelligence:

4.1. Developing a sustainability strategy:

One of the main problems of traditional cities has been the non-existence or the deficient application of sustainable development strategies which, at their core, do not really contribute to overcoming the obstacles underlying the different representative dimensions of this idea of sustainability.

As previously mentioned, this notion has been often perceived only in a single dimension of environmental concerns¹⁰⁹ in the scope of these strategies and solutions, thus leaving out other relevant indicators. This perspective is not defensible, given the times we live in and considering the very nature of smart cities. It is essential to divide and consider several aspects of the idea of sustainability so that it is possible to achieve the goals contemplated by the 2030 Agenda.

With regard to these goals, it should be noted that, nowadays, we are witnessing a multitude of initiatives, solutions and ways of applying artificial intelligence which has been contributing to the strict compliance of this global action plan, thus, enhancing sustainable development. In the context of smart cities, we can divide these solutions under study or implementation into three types: solutions that contribute to reducing the effects of climate change and protection of nature or biodiversity; solutions that enable growth and sustainable circular economy; finally, solutions that urge for social inclusion.

i) AI-based remedies to reduce the effects of climate change and for the protection of nature/biodiversity:

The environmental aspect, within the scope of sustainability, embodies one of the main strategic elements for a successful smart city.¹¹⁰ It is noted that urban centers, by concentrating a large number of economic activities, represent the main points

¹⁰⁹ Bibri cited in Ziosi, M., Hewitt, B., Juneja, P., Taddeo, M., & Floridi, L. (2022). Smart cities: reviewing the debate about their ethical implications. *AI & SOCIETY*. p. 17 <https://doi.org/10.1007/s00146-022-01558-0>

¹¹⁰ Ziosi, M., Hewitt, B., Juneja, P., Taddeo, M., & Floridi, L. (2022). Smart cities: reviewing the debate about their ethical implications, p. 18.

responsible for energy consumption, creation of pollution and spread of greenhouse gas emissions, situations which, consequently, potentiate climate change, contribute to the increase of waste, within the industrial processes, and ultimately lead to the destruction of city green spaces. In view of this, companies and local governments must pay greater attention to the implementation of the necessary measures and the promotion of an adequate response to avoid the risks that these situations may entail. In this sense, there is a whole range of projects that, taking advantage of the potential of artificial intelligence, have been studied and applied, in a logic of preservation and environmental efficiency for the future of cities.

a) *Triple-Network Air Quality Monitoring and Carbon Credit Trading Platform for Sustainable Urban Environments by Satoshi Systems Limited*

Firstly, I highlight the project under study Triple-Network Air Quality Monitoring and Carbon Credit Trading Platform for Sustainable Urban Environments, which, through an intelligent system based on IoT and AI sensors, has been playing an active role in monitoring air quality, particularly in China, and, in turn, contributing to the reduction of pollution levels and greenhouse gases. Pollution has long been one of the major issues of large cities, having been, during the year 2020, responsible for 3.2 million fatalities¹¹¹, according to World Health Organization estimates.¹¹² Given the scale of this issue, it is logical that a proposal that contributes to reducing drastically these rates is well received by economic agents.

In particular, it should be emphasized that this project makes use of a large amount of previous public data on air pollution to do an AI-based forecast and offer real-time information on carbon emissions, which are made available on an online platform.¹¹³ Those that are interested have the option of checking such data and,

¹¹¹ Tumescheit, A.M. (2022, May 17). *How Smart Cities are Driving down Air Pollution with Smart Traffic Flow Optimization*. Fujitsu Blog - Global. <https://corporate-blog.global.fujitsu.com/fgb/2022-05-17/01/>

¹¹² World Health Organization. (2022, November 28). *Household air pollution*. <https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health>

¹¹³ Loughborough University. (2020, March 17). *Computer scientists develop novel artificial intelligence system that predicts air pollution levels*. <https://www.lboro.ac.uk/news-events/news/2020/march/artificial-intelligence-system-air-pollution/>

in response, devising a strategy that will allow them to limit the pollutant emissions associated with their activity.¹¹⁴ As a condition of presenting carbon dioxide levels below the established limit, they are awarded a credit, which may be sold and generate revenue.¹¹⁵ Given this framework, in my vision, the implementation of this project based on artificial intelligence represents added value for cities.

In the first line, it contributes to the maintenance of the right to life and health, as universally recognized rights and representing the top of the pyramid of fundamental rights. By providing this real-time information on existing pollution in a platform, it is possible to measure limits and prevent possible impacts; contribute to an increase in the quality of life of each person and prevent situations of decline in the health of the most vulnerable; finally, contribute for the revitalization of city green spaces. On the other hand, it enables the economic growth of business activities by adopting practices aimed at sustainable development.

In parallel with these advantages, it should be noted that, in the light of the legal landscape, this is a project that meets the objectives that the European Green Deal (EGD)¹¹⁶ and the EU NEC Directive¹¹⁷ have at their core - the commitment to manage air pollution and minimize atmospheric contaminants that have major detrimental consequences on human health and the environment.

b) InFraReD by CIL of the Austrian Institute of Technology:

Regarding the first one, *InFraReD* is a collaboration being developed by the City Intelligence Lab of the Austrian Institute of Technology (AIT) and Bauhaus

¹¹⁴ Loughborough University. (2020, March 17). *Computer scientists develop novel artificial intelligence system that predicts air pollution levels*.

¹¹⁵ Loughborough University. (2020, March 17). *Computer scientists develop novel artificial intelligence system that predicts air pollution levels*.

¹¹⁶ European Commission. (2019). Communication from the Commission to the European Parliament, The Council, the European Economic and Social Committee and the Committee of the Region. The European Green Deal COM/2019/640 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN>

¹¹⁷ Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants. amending Directive 2003/35/EC and repealing Directive 2001/81/EC. <https://eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=CELEX:32016L2284&from=IT>

University, with the aim of providing a new data-analytics¹¹⁸ and deep learning perspective to the urban design by predicting wind flows and mitigating the microclimate effects that certain locations entail.¹¹⁹ According to it, buildings and other cities' structures must be planned considering these wind flows, natural ventilation, and other situations like heatwaves or solar radiation brought by the already existing and occurring urban microclimates, in virtue of climate change¹²⁰, to prevent impacts and improve urban constructions.

A project under this approach could highly contribute to the development of an efficient and climate change preventive urban plan; on the other hand, a plan that underlines the previously mentioned sustainable development goals, namely, by contributing to the improvement of citizens' quality of life. It is notorious that most structures in cities still lack proper insulation and thermal control, which justifies the investigation of projects of this nature seeking to tackle these obstacles.

c) *Climate and Flood Risk Visualization Tool by Mila*

It should be highlighted that the efforts by *Mila*¹²¹ in developing an artificial intelligence visualizing tool, effectively contribute to making the issue of climate change more tangible and apparent for society.¹²² Driven by this process, this project's ultimate goal is to provide the community with a network of AI-generated images and simulations of the impact of possible future catastrophic scenarios arising from climate change, in particular flood situations.¹²³

¹¹⁸ CIL. (2020, April 8). *CIL & Giraffe: AI Wind Comfort on the cloud*. <http://cities.ait.ac.at/site/index.php/2020/04/08/our-ai-models-at-work-introducing-our-partnership-with-giraffe-technologies-2/>

¹¹⁹ CIL. (2020, April 8). *CIL & Giraffe: AI Wind Comfort on the cloud*.

¹²⁰ GPAI. (2021). *Climate change and AI Recommendations for Government Action*. p.81 <https://www.gpai.ai/projects/climate-change-and-ai.pdf>

¹²¹ Based in Quebec, Mila represents an institute that brings together a scientific research community in the field of artificial intelligence, with the goal of studying its advantages and using its potential in societal contexts, notably in the areas of health and climate change. For more information, please check Mila. (2022, November 29). *About Mila*. <https://mila.quebec/en/mila/>

¹²² Luccioni, A., Schmidt, V., Vardanyan, V., & Bengio, Y. (2021). Using Artificial Intelligence to Visualize the Impacts of Climate Change. *IEEE Computer Graphics and Applications*, 41(1), 8–14, p. 9. <https://doi.org/10.1109/mcg.2020.3025425>

¹²³ Luccioni, A., Schmidt, V., Vardanyan, V., & Bengio, Y. (2021). Using Artificial Intelligence to Visualize the Impacts of Climate Change, p. 9.

People's behaviors and attitudes can be influenced by encounters with visuals that clearly depict the future repercussions of choices performed today, according to scientific research.¹²⁴ The images and texts in news reporting the effects of climate change are a great example of how this type of visualization can inevitably affect people's visions of the significance of the problem and their common sense when it comes to taking actions and adopting personal steps to address the issue.¹²⁵ In this sense, considering the capacity that these pictures can have in each individual's perception, and this being an area where artificial intelligence can be greatly expanded and used, these types of initiatives add value to the pursuit of the legally binding international treaty on climate change – *the Paris Agreement*¹²⁶. Firstly, it contributes to building knowledge and strengthening the adaptive ability to climate-related dangers; secondly, it helps promote personal and political awareness, namely, through the implementation of climate-change policies, mechanisms, and frameworks.¹²⁷ In this way, an AI with these characteristics and for legitimate intended purposes could be highly valuable for big cities' upkeep and civil protection, as the impact of natural disasters is greater in these areas, due to the mass population levels and activities.

To sum up, it is my belief that the mentioned AI-based projects are the ones that will bring the most potential for smarter cities, regarding this environment, waste and climate action strand, since they meet the green goals to which worldwide countries have committed to applying through the last years.

¹²⁴ O'Neill & Smith 2016 cited in Hart, P. S., & Feldman, L. (2016). The Impact of Climate Change–Related Imagery and Text on Public Opinion and Behavior Change. *Science Communication*, 38(4), 415–441. <https://doi.org/10.1177/1075547016655357>

¹²⁵ O'Neill & Smith 2016 cited in Hart, P. S., & Feldman, L. (2016). The Impact of Climate Change–Related Imagery and Text on Public Opinion and Behavior Change.

¹²⁶ The Paris Agreement is a legally binding international convention on climate change that includes 194 countries. It was approved at COP 21 on December 12, 2015 and entered into force on November 4, 2016. To see the full-text, please check United Nations. (2015). *Paris Agreement*. https://unfccc.int/sites/default/files/english_paris_agreement.pdf

¹²⁷ United Nation. *13 Climate Action: Take Urgent action to combat climate change and its impacts*. <https://www.globalgoals.org/goals/13-climate-action/>

ii) AI-based remedies to stimulate growth and a circular economy:

A city should be ecologically healthy, with innovative technology and economically productive and efficient industries.¹²⁸ According to European authorities, the adoption of a strategy focused on reducing pressure on natural resources, encouraging sustainable consumptions to avoid waste and empowering consumers, as well as manufacturers¹²⁹, is a necessary step for a more competitive and economically viable Europe.¹³⁰ Projects that meet these objectives should be seen as major contributions to stimulate the growth of a circular economy.

a) *Computer vision and machine learning for manufacturing:*

In the last years, economic growth has increasingly been driven by the implementation of automation and artificial intelligence technologies, within the manufacturing industries, as they are one of the main pillars of smart cities. According to the global tendency, we observe that many manufacturers are already applying machine learning and automation within their industries to reduce costs and environmental impact of production processes¹³¹, as well as to improve productivity and performance. In Europe alone, approximately 51% of the major manufacturers are already seeking AI-based remedies for those purposes.¹³²

Regarding this topic, we highlight some noteworthy examples: the driverless automated forklifts used by the German logistics services company *DHL*, in the

¹²⁸ Yigitcanlar and Lee 2014 cited in Trindade, E. P., Hinnig, M. P. F., da Costa, E. M., Marques, J. S., Bastos, R. C., & Yigitcanlar, T. (2017). Sustainable development of smart cities: a systematic review of the literature. *Journal of Open Innovation: Technology, Market, and Complexity*, 3(1). p.4 <https://doi.org/10.1186/s40852-017-0063-2>

¹²⁹ European Commission. (2020). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *A New Circular Economy Action Plan. For a Cleaner and More Competitive Europe*, COM (2020) 98 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN>

¹³⁰ European Commission. (n.d.). *Circular economy action plan*. Environment. https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

¹³¹ Bellinger, N. (2021, November 2). *The role of AI in sustainable manufacturing*. IT Supply Chain. <https://itsupplychain.com/the-role-of-ai-in-sustainable-manufacturing/>

¹³² Capgemini Research Institute. (2019). Scaling AI in Manufacturing Operations: A practitioners' Perspective. <https://www.capgemini.com/wp-content/uploads/2019/12/AI-in-manufacturing-operations.pdf>

scope of their supply chain optimization strategy, aiming to increase operational efficiency, work safety and flexibility in logistics and their warehouse operations¹³³; solutions regarding predictive maintenance like the one developed by *H2O.ai*, which, through different data, can determine patterns to generate predictions and indicate failures, thus, for example, enabling maintenance costs and environmental impacts to be reduced¹³⁴; the defect detection tool developed by *Vanti Analytics* which, through an end-to-end platform using machine learning and automated sensors for manufacturers¹³⁵, contributes to ensuring quality control, reducing production errors related to aesthetics or product functions¹³⁶; lastly, machine learning platform solutions like the one potentiated by *Aionics* for the optimization and selection of better designs for eco-friendlier batteries.¹³⁷

As companies introduce new features like these projects to the manufacturing sector, we notice substantial growth in the economic dimension of cities. Not only do manufacturers benefit from increased productivity with lower costs¹³⁸, but also consumers are impacted positively, as we can see shifts in their consumption patterns.

By implementing artificial intelligence in the scope of these purposes, we highly contribute to the maintenance of two SDGs: no poverty¹³⁹ and industry, innovation and infrastructure¹⁴⁰. Through the adoption of methods focused on emerging technologies within the manufacturing industries, it is possible to have more efficient, innovative, and sustainable processes, which allow larger productions and higher

¹³³ DHL. (2021, December 14). *DHL Supply Chain Accelerates Roll Out of Autonomous Forklifts With Largest Single Implementation*. <https://www.dhl.com/gb-en/home/press/press-archive/2021/dhl-supply-chain-accelerates-roll-out-of-autonomous-forklifts-with-largest-single-implementation.html>

¹³⁴ H2O.ai. (n.d.). *Predictive Maintenance: Fixing Machinery Before a Breakdown with AI*. <https://h2o.ai/solutions/use-case/predictive-maintenance/>

¹³⁵ Vanti Analytics. (2022, January 27). *Vanti Analytics raises \$16M A round from Insight Partners to unlock AI at scale for manufacturers*. <https://www.prnewswire.com/il/news-releases/vanti-analytics-raises-16m-a-round-from-insight-partners-to-unlock-ai-at-scale-for-manufacturers-301469670.html>

¹³⁶ Vanti. (2022, December 20). *AI-based Defect Detection – A Brief Overview*. Vanti. <https://www.vanti.ai/an-overview-of-ai-based-defect-detection/>

¹³⁷ GPAI, Climate Change and AI: Recommendations for Government Action. p. 77

¹³⁸ Drum Hill Capital. (2016, July 20). *Industry 4.0: A New Era In Manufacturing*. <https://www.drumhill.com/post/industry-4-0-a-new-era-in-manufacturing>

¹³⁹ UN Development Goals. *Goal 1: “No Poverty”*. <https://www.un.org/sustainabledevelopment/poverty/>

¹⁴⁰ UN Development Goals. *Goal 9: “build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”* <https://www.globalgoals.org/goals/9-industry-innovation-and-infrastructure/>

levels of productivity at lower costs for manufacturers. Parallely, a vast quality supply characterized by reduced production costs will bring cheaper prices for consumers and a lower financial strain. This circumstance contributes increase savings and building the resilience of those who would find themselves in more vulnerable situations.

b) AI4Substation by INESC TEC:

It is expected for us to assist in a rise of energy resources waste globally¹⁴¹, being the urban areas alone responsible for 75% of that overconsumption.¹⁴² To face these issues, it is necessary to invest in projects that contribute to mitigating impacts.

Regarding this, it is important to highlight the importance of initiatives like the *AI4Substation* project by INESC TEC, which employs data knowledge extraction and AI to simplify decision-making for grid control center operators facing excessive load due to the vast amount of data from monitoring.¹⁴³ This allows the detection of anomalies in substations for optimizing distribution grid operation and reducing service interruptions during outages.¹⁴⁴

In my view, this can have a significant impact on smart cities since it contributes to improving the efficiency and reliability of the electricity grid. It should be noted that in a smart city, many systems are connected to the electricity grid, namely, transportation, lighting, and heating/cooling systems. A significant volume of data is produced by these, which requires processing, and AI tools can assist and influence their management in a more effective way by quickly identifying the patterns and malfunctions in the scope of the grid's performance, leading to quicker response times and better decision-making in the event of a disruption.

¹⁴¹ According to a report's conclusions, it is expected an increase of at least 1.3% in the energy consumption levels in 2023. For more information, please check Economist Intelligence Unit (EIU). (2022, November 30). *Energy outlook 2023*. <https://www.eiu.com/n/campaigns/energy-in-2023/>

¹⁴² UN-Habitat. (n.d.). *Greener Cities Partnership Blog Series* <https://unhabitat.org/greener-cities-partnership-blog>

¹⁴³ INESC TEC. (n.d.). *AI to reduce the cognitive load and support distribution grid operators*. <https://www.inesctec.pt/en/news/ai-to-reduce-the-cognitive-load-and-support-distribution-grid-operators#about>

¹⁴⁴ INESC TEC. (n.d.). *AI to reduce the cognitive load and support distribution grid operators*.

This optimization brought by innovation prevents financial losses for businesses and helps reduce energy consumption for a lower carbon footprint¹⁴⁵ in smart cities, in line with the UN Sustainable Development Goals, specifically, at the level of energy consumption/production¹⁴⁶ and economic growth.¹⁴⁷

There will be an energy consumption given that we will have a more efficient distribution of electricity, with less environmental impacts. Additionally, there will be economic growth because that non-interrupted distribution will bring lower costs for cities or residents, and it will attract businesses and investment, thus contributing to the creation of more economic opportunities and jobs. It should be noted that, nowadays, infrastructures following sustainability and efficient eco-energy solutions, reveal to be more appealing to businesses, since they lead the way to economic success, given the current challenges of our world.

c) *Trashbot by CleanRobotics*

Due to the concentration of economic activities and high population density, cities continue to represent the main points of plastic waste. According to Eurostat statistics, from 1995 to 2021, there was an average increase in the levels of municipal waste within European countries.¹⁴⁸

In this sense, it is necessary to note projects that invest in smart recycling bins like *Trashbot*, developed by the start-up CleanRobotics, which allows for improving recycling and waste management, in comparison to the capacities of the traditional recycling bins.¹⁴⁹ Through the combination of sensors, automation, machine learning,

¹⁴⁵ Chaurasia, K., & Kamath, H.R. (2021). New Approach using Artificial Intelligence- Machine Learning in Demand Side Management of Renewable Energy integrated Smart Grid for Smart City. *4th International Conference on Innovative Computing and Communication*, p. 1. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3833753

¹⁴⁶ UN Sustainable Development Goals. Goal 12: “ensure sustainable consumption and production patterns” <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>

¹⁴⁷ UN Sustainable Development Goals. Goal 8: “decent work and economic growth” <https://www.un.org/sustainabledevelopment/economic-growth/>

¹⁴⁸ Eurostat. (2023, March 27). *Municipal waste statistics*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics

¹⁴⁹ Clean Robotics. (2022, March 17). *Smart Waste Management: Why Smart Bins are the Future of Recycling*. <https://cleanrobotics.com/why-smart-bins-are-the-future-of-recycling/>

and computer vision, *TrashBot* makes it possible to measure bins saturation and compact it, separate recyclables from landfill items, and monitor diversion rates, contributing all these to improve accuracy, acceleration and organization within waste processes.¹⁵⁰

In my view, making these smart bins a reality in strategic points is a game changer for big cities and a great opportunity to concretize at least five of the SDGs: good health and well-being¹⁵¹; ensuring sustainable consumption and production¹⁵²; providing sustainable cities and communities¹⁵³; taking action to fight climate changes¹⁵⁴; lastly, protecting life on land.¹⁵⁵ Smart bins include special features that improve community protection¹⁵⁶ against circumstances such as overflowing garbage, which poses significant health dangers that potentiate the appearance of problematic diseases.¹⁵⁷ On the other hand, they exacerbate people's well-being in cities, both for habitants and non-residents, given the influence that excess visual and odorous pollution may also have on tourism and, as a result, in local economic activities.¹⁵⁸ Smart bins can also prevent exposure to toxic substances from the accumulation of litter on land and water in cities, which in turn threatens biodiversity and potentiates climate change, by virtue of pollution. Therefore, we see that this project combines dually benefits for economic and environmental dimensions that together make this a true solution for a circular economy.

¹⁵⁰ Clean Robotics. (2022, March 17). *Smart Waste Management*.

¹⁵¹ UN Sustainable Development Goals. Goal 3: “ensure healthy lives and promote well-being for all at all ages” <https://www.un.org/sustainabledevelopment/health/>

¹⁵² UN Sustainable Development Goals. Goal 11: “make cities inclusive, safe, resilient and sustainable” <https://www.un.org/sustainabledevelopment/cities/>

¹⁵³ UN Sustainable Development Goals. Goal 12: “ensure sustainable consumption and production patterns” <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>

¹⁵⁴ UN Sustainable Development Goals. Goal 13: “take urgent action to combat climate change and its impacts” <https://www.un.org/sustainabledevelopment/climate-change/>

¹⁵⁵ UN Sustainable Development Goals. Goal 15: “sustainability manages forests, combat desertification, halt and reverse land degradation, halt biodiversity loss” <https://www.un.org/sustainabledevelopment/biodiversity/>

¹⁵⁶ Smart City NZ. (2021, November 17). *The Benefits of a Smart Waste Management System | Smart City*. https://www.linkedin.com/pulse/benefits-smart-waste-management-system-city-smart-city-nz/?trk=organization-update-content_share-article

¹⁵⁷ Smart City NZ. (2021, November 17). *The Benefits of a Smart Waste Management System*.

¹⁵⁸ Ecube Labs. (2016, July 8). *Overflowing garbage bins: 5 impacts on health and environment, and how to prevent*. <https://www.ecubelabs.com/overflowing-garbage-bins-5-impacts-on-health-and-environment-and-how-to-prevent/>

iii) **AI-based remedies that urge for social aspects:**

Smart cities aspire to produce more sustainable and livable urban environments via the use of emerging technologies and data-driven solutions. To achieve these objectives, local authorities must focus their attention on long-standing issues regarding the social dimension of smart cities, namely, inclusivity and equity. As part of the strategy for a well-succeeded city and increase in social justice, it is necessary to increase participation of all community members in the scope of the planning and development of cities initiatives, by promoting measures for equal opportunities, regarding accessibility to structures and rights; secondly, involving marginalized communities and local organizations, which, in many cases, are left out of decision-making processes.

There are some artificial intelligence projects which can be explored for these purposes.

a) Chatbots for social inclusivity:

Applying artificial intelligence in the scope of smart city solutions implies great changes for city administration and its operational structures. Natural language processing, machine learning and speech recognition-based technologies reveal to be some of the many examples of how this field has been contributing to reducing the administrative workload and improving communication with citizens, thus providing a more accessible and socially sustainable city.¹⁵⁹

A practical demonstration of this is the AI-powered chatbot - *Korana*¹⁶⁰ - developed by a Croatian start-up to support local institutions in personalizing recommendations and improving service delivery¹⁶¹ for inhabitants or the citizens

¹⁵⁹ Bonsai.tech. (n.d.). *The first Smart City Chatbot in Croatia*. <https://bonsai.tech/success-stories/smart-city-chatbot>

¹⁶⁰ Hippold, S. (2018, July 25). *Use AI To Make Cities Smarter*. Gartner. <https://www.gartner.com/smarterwithgartner/use-ai-to-make-cities-smarter>

¹⁶¹ Jones, A. (2021, August 10). *How Smart Cities are Benefiting From Conversational AI*. Dasha. <https://dasha.ai/en-us/blog/smart-cities-conversational-ai>

they serve.¹⁶² This smart city pilot project emerged following the Smart City Strategy for the city of Karlovac in Croatia, allowing to provide accurate and faster information in relation to contacts, financial support, utilities, and construction tips, as well as answering business or investment-related questions.¹⁶³ *Wienbot* is another big, noteworthy example regarding the application of natural language processing and speech recognition technologies, as artificial intelligence branches, in the scope of cities, which had particular importance during the period of the COVID-19 epidemical crisis.¹⁶⁴ As a free interactive messaging or voice chatbot for the city of Vienna¹⁶⁵, it allows bigger citizen engagement by providing answers to frequently asked questions¹⁶⁶ relating to individual situations (e.g., find a parking space or route description¹⁶⁷). All these and other virtual assistants have in their core, a training data solution so that they can establish patterns about it on their own and generate new outputs.¹⁶⁸ This circumstance allows automated communication similar to human interactions and can bring a set of benefits for the societal dimension.

From a legal perspective, the implementation of these projects, in the scope of the European Union, could contribute to the accomplishment, at least, of five principles of the *European Pillar of Social Rights (EPSR)*¹⁶⁹: the right to access essential

¹⁶² Bonsai.tech. (n.d.). *The first Smart City Chatbot in Croatia*. <https://bonsai.tech/success-stories/smart-city-chatbot>

¹⁶³ Pauković, D. (2020, December 10). *Virtual Assistant Korana: Link Between Administration and Citizens of Karlovac*. Total Croatia News. <https://www.total-croatia-news.com/lifestyle/48823-virtual-assistant-korana>

¹⁶⁴ During the pandemic situation, statistics showed that every month was sent around 300,000 inquiries to WienBot. On the other side, coronavirus was implicated for 50% of the replies. For more information, please check DigitalesWien. (2022). *AI against Covid-19 disinformation*. <https://digitales.wien.gv.at/en/ai-against-covid-19-disinformation/>

¹⁶⁵ Intelligent Cities Challenge. (n.d.). *WienBot (interactive messaging service)* <https://www.intelligentcitieschallenge.eu/wienbot-interactive-messaging-service>

¹⁶⁶ WSA. (2017). *WienBot – a chatbot for the city of Vienna*. <https://wsa-global.org/winner/wienbot-a-chatbot-for-the-city-of-vienna/>

¹⁶⁷ Austrian Business Agency. (2023). *Forbes praises the WienBot as exemplary*. <https://investinaustria.at/en/news-events-press/forbes-praises-the-wienbot-as-exemplary>

¹⁶⁸ Hacker, P., Engel, A., & List, T. (2023, January 20). *Understanding and Regulating ChatGPT, and Other Large Generative AI Models: With input from ChatGPT*. Verfassungsblog. <https://doi.org/10.17176/20230120-220055-0>

¹⁶⁹ The European Pillar of Social Rights (EPSR) is an initiative by the European Commission which consists in a list of 20 principles to reaffirm social rights and labour rights, within an inclusive European community. For more information, please check European Commission. (2017, November 16). *The European Pillar of Social Rights in 20 principles*. <https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/economy-works->

services; the right to the right to social protection; inclusion to the homeless; the right to equal opportunities; the right to education, training and life-long learning.¹⁷⁰ It should be noted that the marginalization of communities has been one of the big challenges of urban centers, as today there are still difficulties in their access to structures and services. By implementing chatbots in the scope of cities we could surpass service inefficiencies and guarantee equal opportunities, as well as attend to other situations of vulnerabilities, which often involve discriminatory factors. For example, employing messaging chatbots to easily provide the necessary assistance to immigrants by communicating with them in their native languages, thus, contributing for equal opportunities, which is commonly a right underlined by national legislations worldwide; secondly, implementing chatbots in public streets could help remove homeless people from their precarious situations and combat social exclusion¹⁷¹, in line with the logic of Article 3 of the Treaty on European Union (TEU) ¹⁷², thus contributing for their reintegration in society and right to assistance; thirdly, implementing an educational chatbot in cities' schools could assist children, regarding sexual education and health issues¹⁷³ or even helping those with disabilities, thus contributing for the right to an inclusive and a quality education, in alignment with the objectives of long standing UN Universal Declaration of Human Rights

[people/jobs-growth-and-investment/european-pillar-social-rights/european-pillar-social-rights-20-principles_en](https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/economy-works-people/jobs-growth-and-investment/european-pillar-social-rights/european-pillar-social-rights-20-principles_en)

¹⁷⁰ European Commission. (2017, November 16). *The European Pillar of Social Rights in 20 principles*. Principles 1, 3, 12, 19, 20. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/economy-works-people/jobs-growth-and-investment/european-pillar-social-rights/european-pillar-social-rights-20-principles_en

¹⁷¹ European Commission. (2021, June 21). European platform to combat homelessness is launched. https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3044

¹⁷² “The Union’s aim is to promote peace, its values and the well-being”, “it shall combat social exclusion and discrimination, and shall promote social justice and protection...”. Retrieved from the European Union. (2007). Consolidated version of the *Treaty on European Union*, 13 December 2007, 2008/C 115/01. OJ C115/13. art. 3, paragraphs 1 and 3, https://eur-lex.europa.eu/resource.html?uri=cellar:2bf140bf-a3f8-4ab2-b506-fd71826e6da6.0023.02/DOC_1&format=PDF

¹⁷³ UNICEF. Safeguarding girls and boys: When Chatbots answer their private questions, p.1-2. <https://www.unicef.org/eap/media/5376/file/Chatbots%20and%20safeguarding.pdf>

(UDHR)¹⁷⁴ and the purpose of Article 24 of the Convention on the Rights of Persons with Disabilities (CRPD).¹⁷⁵

That said, we can see that chatbots represent an added value for the social dimension of sustainability. They can be implemented to overcome concrete societal hurdles directly related to the aims of the previously mentioned international and European legal instruments. Furthermore, solutions like these, are aligned with the sustainability standards like the SDGs: “ending poverty in all its forms everywhere”¹⁷⁶; “ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all”¹⁷⁷; “making cities and human settlements inclusive, safe, resilient and sustainable”.¹⁷⁸

b) AI-based tools for gender equality:

Gender inequality, within the social dimension, has been something that has persisted since ancient times¹⁷⁹, but with technological innovation and the development of increasingly structured artificial intelligence systems, this topic has been becoming more and more visible, due to the risks that these systems might bring for gender inequality.¹⁸⁰ Notwithstanding these drawbacks and the consideration they must deserve, it is also critical to emphasize their positive side and investigate the possibilities that these systems bring for the detection of gender prejudice situations.

In light of this, we refer to two projects that can contribute to this dimension: firstly, the AI-based tool by *Textio*, a company that has been recognized recently by

¹⁷⁴ United Nations. (1948). *Universal Declaration of Human Rights*. https://www.un.org/en/udhrbook/pdf/udhr_booklet_en_web.pdf

¹⁷⁵ United Nations. (2006). *Convention on the Rights of Persons with Disabilities*. Treaty Series 2515. art. 24 <https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities/article-24-education.html>

¹⁷⁶ UN Development Goals. Goal 1: “End poverty in all its forms everywhere”. <https://www.un.org/sustainabledevelopment/poverty/>

¹⁷⁷ UN Development Goals. Goal 4: “Quality Education”. <https://www.un.org/sustainabledevelopment/education/>

¹⁷⁸ UN Development Goals. Goal 11: “Make cities inclusive, safe, resilient and sustainable” <https://www.un.org/sustainabledevelopment/cities/>

¹⁷⁹ Agarwal, S., & Yemul, R. (n.d.). *AI and Gender Equality: Unlocking Gender Bias in Artificial Intelligence*. AI Policy Labs. <https://aipolicylabs.org/ai-and-gender-equality-unlocking-gender-bias-in-artificial-intelligence/>

¹⁸⁰ Agarwal, S., & Yemul, R. (n.d.). *AI and Gender Equality: Unlocking Gender Bias in Artificial Intelligence*.

Forbes as one of the most promising companies in the area of artificial intelligence.¹⁸¹ This tool is capable of providing to cities recruiters with a more inclusive talent approach via optimization of e-mails or job posts, with machine learning-powered suggestions aimed at different candidates and eliminating gender biases.¹⁸² Secondly, we refer to the initiative by *Syndio* that, through an AI-analyzing data platform, turns possible to measure pay and ensure equitable and fair salaries between men and women¹⁸³; thirdly, we highlight the AI-powered app *Laadli* which was developed to ensure more safety and prevent sexual harassment for women in the streets.¹⁸⁴ This app uses machine learning to create the ideal and safest route for women by collecting patterns and evaluating routes through specific criteria, namely, if the surroundings are a crime-prone area or if it is very crowded.¹⁸⁵

Gender equality represents a fundamental human value¹⁸⁶ according to the Universal Declaration of Human Rights (UDHR) and the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW). Under the first one's provisions, everyone is entitled to all the rights and freedoms without distinction of any kind, such as race, color, religion, sex, gender or another status.¹⁸⁷ Therefore, every person benefits from equal protection before the law and is entitled without any discrimination¹⁸⁸, being states obligated to take measures to that effect.¹⁸⁹ Despite the idea underlining these rights being consecrated, according to the 2022

¹⁸¹ Violante, A. (2020, July 8). *Textio was named to Forbes AI 50: America's most promising Artificial Intelligence Companies*. Textio. <https://textio.com/blog/textio-named-to-forbes-ai-50-americas-most-promising-artificial-intelligence-companies/32076783824>

¹⁸² Textio. (n.d.). *Inclusive Talent Attraction*. <https://textio.com/products/recruiting>

¹⁸³ Syndio. (2023). *Build an equitable workplace*. <https://synd.io/>

¹⁸⁴ Laadli. (n.d.). *My Site*. <https://www.inaequalis.org/general-8>

¹⁸⁵ Ritesh, E.S. (2021, January 28). *Women Safety through the Lens of Artificial Intelligence*. LinkedIn. https://www.linkedin.com/pulse/women-safety-through-lens-artificial-intelligence-snigdhaa-ritesh/?trk=public_profile_article_view accessed in 21 February 2023

¹⁸⁶ United Nations. (n.d.). *OHCHR and women's human rights and gender equality*. <https://www.ohchr.org/en/women>

¹⁸⁷ United Nations General Assembly. (1948). The Universal Declaration of Human Rights (UDHR). New York: United Nations General Assembly, art. 2. <https://www.un.org/sites/un2.un.org/files/2021/03/udhr.pdf>

¹⁸⁸ United Nations General Assembly. (1948). The Universal Declaration of Human Rights (UDHR), art. 7

¹⁸⁹ United Nations General Assembly. (1979). Convention on the Elimination of All Forms of Discrimination against women, art. 2, 5, 10, 11, 12, 16. <https://www.ohchr.org/sites/default/files/cedaw.pdf>

World Economic Forum's report on Global Gender Gap, we will still need 132 years to reach full gender parity¹⁹⁰, revealing these results that there is still much to be done.

In my view, these artificial intelligence projects could influence and counteract this trend, since they address these topics' main issues and imbalances, specifically, those related to the workspace, women's rights, and their safety, thus underlining the pursued purposes of the previously mentioned instruments. In addition, they contribute to the achievement of one of the sustainable development goals that, according to voluntary reviews in several countries¹⁹¹, has been receiving particular attention: empowering all women and girls and achieving gender equality.¹⁹²

4.2. Driving smart mobility:

Following the discussion of sustainability, it is now necessary to highlight the context of urban mobility. Urban mobility in smart cities has been gaining significant relevance in recent years. Not only we have been witnessing a growing tendency for the city urbanization phenomenon¹⁹³ but also in terms of the existing number of vehicles in circulation and owned by each person.¹⁹⁴ This leads to an increase in traffic congestion¹⁹⁵ and saturation of public services, two of the main challenges of urban centers. As cities continue to develop their structural pillars and become more complex, we also see a growing need for initiatives to foster a safe mobility network and universal accessibility to avoid risks for citizens. In this regard, it is my

¹⁹⁰ World Economic Forum. (2022). *Global Gender Gap Report 2022*, Insight Report, p. 5. https://www3.weforum.org/docs/WEF_GGGR_2022.pdf

¹⁹¹ UN Secretariat of the Committee for Development Policy. (2019). *Are some SDGs more important than others? Revealed country priorities from four years of VNRs*. <https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/Note-SDGs-VNRs.pdf>

¹⁹² UN Sustainable Development Goals. *Goal 5 - "empowering all women and girls and achieving gender equality"*. <https://www.un.org/sustainabledevelopment/gender-equality/>

¹⁹³ McKinsey Global Institute. (2011). *Urban world: mapping the economic power of cities*, p. 18. https://www.mckinsey.com/~media/mckinsey/featured%20insights/urbanization/urban%20world/mgi_urban_world_mapping_economic_power_of_cities_full_report.ashx

¹⁹⁴ Eurostat. (2022, July 19). *Stock of vehicles by category and NUTS 2 regions*. https://ec.europa.eu/eurostat/databrowser/view/TRAN_R_VEHST__custom_3007143/bookmark/map?lang=en&bookmarkId=08217f89-b2c2-4a34-897a-78ad4064f730

¹⁹⁵ Boix-Palop, A. (2019). *The challenges of urban mobility regulation and the New Urban Agenda*, University of València, p.1. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3414970

understanding that artificial intelligence can play a transformative role, under the holistic approach mentioned by international entities¹⁹⁶, together with national strategies on the matter for, ultimately, to promote a more inclusive and safe future for everyone.

In the scope of these purposes, we highlight some projects focused on improving road safety, transport mobility networks, and better accessibility.

i) AI-based remedies to increase road safety:

It should be noted the flexibility of the road solutions from Redflex, which are now powered with computer vision and artificial intelligence software.¹⁹⁷ Through a platform, it is possible to analyze data and contribute to increasing traffic flows¹⁹⁸ within rush hour congestions, as well as improving safety for pedestrians and other public road users, by acting directly in traffic lights management.¹⁹⁹ Furthermore, through its *Halo* system, this company aims to ensure more effectiveness for law enforcement and predicting infractions²⁰⁰, given its functionality of detecting when drivers exceed the maximum speed allowed or pass red lights.²⁰¹

Another noteworthy example is the advanced driving assistance solutions (ADAS) offered by Mobileye from Intel, which is already being applied to many vehicles worldwide.²⁰² Artificial intelligence, in its branches of computer vision and machine learning, is very present at the core of these ADAS features. Through these, it is possible for a vehicle to monitor its route and detect other road or walk-side

¹⁹⁶ Diran, D., Van Veenstra, A., Timan, T., Tiesta, P., & Kirova, M. (2021). *Artificial Intelligence in smart cities and urban mobility, How can Artificial Intelligence applications be used in urban mobility and smart cities and how can their deployment be facilitated*, Policy Department for Economic, Scientific and Quality of Life Policies. Directorate-General for Internal Policies of the European Parliament, p. 6. [https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/662937/IPOL_BRI\(2021\)662937_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/662937/IPOL_BRI(2021)662937_EN.pdf)

¹⁹⁷ Hutton, P. (2020, November 25). *Redflex buys machine vision and AI company*. Highway News. <https://highways-news.com/redflex-buys-machine-vision-and-ai-company/>

¹⁹⁸ Redflex (n.d). *Our Solutions*. <https://redflex.com/solutions/>

¹⁹⁹ Redflex, (n.d). *Hold the Red*. <https://redflex.com/solutions/hold-the-red/>

²⁰⁰ Redflex (n.d). *Halo*. <https://redflex.com/solution/halo/>

²⁰¹ Redflex. (n.d). *Red lights*. <https://redflex.com/solutions/red-light/>

²⁰² Mobileye. (n.d.). *Leading the evolution from assisted to autonomous driving*. <https://www.mobileye.com/solutions/>

users, given its blind spot functionality.²⁰³ Facing risks, it can send visual and audible alerts whenever there are land change situations or the minimum distance between vehicles is breached, thus preventing collision and avoiding unnecessary dangers for pedestrians or cyclists²⁰⁴ who are often the most affected in city road traffic.²⁰⁵

Using innovative and smart solutions like these represents the future of cities and is an added value to overcome some of their most defying obstacles, within urban mobility. From a legal perspective, they meet the standards advocated by numerous guidelines and instruments worldwide, namely, the already mentioned *New Urban Agenda*, which highlights in its provisions the importance of smart mobility solutions to improve road safety and integrate sustainability of cities²⁰⁶; the UN's plan *Decade of Action for Road Safety*, following its resolution²⁰⁷, which aims to achieve less traffic and road fatalities until 2030²⁰⁸; the UN's *Vienna Convention on Road Traffic*, in the sense, that drivers need to exercise precautionary behaviour under the risk of being held liable, under their national frameworks.²⁰⁹

ii) AI-based remedies for more accessibility and a dynamic transport mobility network:

The existence of deficient urban mobility plans is still a well-known reality in the structure of many cities around the globe. Due to the constant human-driven phenomena²¹⁰ that have been emerging daily, there is a growing need to provide more efficient and intelligent mobility solutions to meet the needs of citizens.

²⁰³ Mobileye. (n.d.). *AI-based Collision Avoidance Technology*, <https://ims.mobileye.com/fleets/us/technology/>

²⁰⁴ Mobileye. (n.d.). *AI-based Collision Avoidance Technology*

²⁰⁵ SafetyNet. (2009). *Pedestrians & Cyclists*, p. 3 <https://road-safety.transport.ec.europa.eu/system/files/2021-07/pedestrians.pdf>,

²⁰⁶ United Nations. (2017). *The New Urban Agenda*, Paragraph 113 and 115 <https://habitat3.org/wp-content/uploads/NUA-English.pdf>

²⁰⁷ UN General Assembly. (2020). *Resolution A/RES/74/299*, <https://documents-dds-ny.un.org/doc/UNDOC/GEN/N20/226/30/PDF/N2022630.pdf?OpenElement>

²⁰⁸ World Health Organization. (2021, October 28). *WHO kicks off a Decade of Action for Road Safety*. <https://www.who.int/news/item/28-10-2021-who-kicks-off-a-decade-of-action-for-road-safety>

²⁰⁹ United Nations. (1968). *Vienna Convention on Road Traffic*, Treaty Series 1719, art. 15,16, 17, 18 and 19 https://treaties.un.org/doc/Treaties/1977/05/19770524%2000-13%20AM/Ch_XI_B_19.pdf

²¹⁰ Renda, L. (2021, February 3). *Advancing Development by improving human mobility*, UNDP Blog. <https://www.undp.org/blog/advancing-development-improving-human-mobility>

In this sense, we highlight the implementation of projects such as the company EasyMile's *EZ10* solution, which emphasizes the automation features of artificial intelligence, by creating an electric, public and autonomous inclusive transport network for everyone, to overcome operational failures in important areas of cities, such as universities, parks or hospitals.²¹¹ Furthermore, through data analysis, it is able to adapt driving characteristics according to the road or weather conditions.²¹² People with disabilities are one of the most benefited from this project, as every vehicle has ramps to make access more convenient and comfortable. Secondly, we highlight the AI-powered e-scooter and bike-sharing services by LIME²¹³, which represent a shared movement solution between private and public transport models for citizens living in big cities. In the scope of this fleet, artificial intelligence has been used for predictive maintenance²¹⁴, preventing crashing, and pavement riding²¹⁵, and, ultimately, contributes to stimulating alternative sustainable mobility options and reducing car-owning tendencies.²¹⁶

These two projects represent two exemplary solutions of a modernization strategy for the urban mobility sector, in line with the plan drawn by the New European Urban Mobility Framework²¹⁷, the 2030 Agenda and the UN SDGs, as sustainability is indissociable from smart mobility. They can contribute to the well-

²¹¹ EasyMile. *EZ10 Passenger Shuttle* <https://easymile.com/vehicle-solutions/ez10-passenger-shuttle>

²¹² EasyMile. *EZ10 Passenger Shuttle*.

²¹³ Geraint, E. (2021, January 14). *How Lime Is Supporting Sustainable, Smart Mobility That Will Continue To Transform Our Lives In 2021 And Beyond*. Forbes <https://www.forbes.com/sites/drgeraintevans/2021/01/14/how-lime-is-supporting-sustainable-smart-mobility-that-will-continue-to-transform-our-lives-in-2021-and-beyond/>

²¹⁴ Sanakkayala, D.C., Vijayakumar, V., Kumar, N., Karan., Soni, G., Kamat, P., Kumar, S., Patil, S., & Kotecha, K. (2022). *Explainable AI for Bearing Fault Prognosis Using Deep Learning Techniques*. *Micromachine*, 13(9), 1-24. <https://www.mdpi.com/2072-666X/13/9/1471>

²¹⁵ Intelligent Transport. (2022, July 14). *Lime unveils latest e-scooter technology to combat pavement riding* <https://www.intelligenttransport.com/transport-news/137745/lime-ai-computer-vision-e-scooter-safety/>

²¹⁶ Invers. (2021, January 7). *Shared Mobility 2021: 5 Trends You Should Keep an Eye On* <https://inversmobility.medium.com/shared-mobility-2021-5-trends-you-should-keep-an-eye-on-e60a150aff01>

²¹⁷ Communication from the Commission to the European Parliament, The Council, the European Economic and Social Committee and the Committee of the Region. (2021). *The New EU Urban Mobility Framework* https://transport.ec.europa.eu/system/files/2021-12/com_2021_811_the-new-eu-urban-mobility.pdf

being²¹⁸ and universal access to education²¹⁹, as they can consubstantiate additional mobility solutions for school transport, for those who do not have access, due to the inexistence of routes, or for children with disabilities who, to this day, still suffer from the non-existence of mobility structures and necessary for their city movement²²⁰; they are projects indissociable from sustainability patterns, given their commitment in adopting clean energy mobility solutions²²¹, such as electrical or other safer and affordable²²² eco-friendlier alternatives under the EU Renewable Energy Directive²²³, that contribute to lower levels of pollution, within the limits proposed by political authorities²²⁴, energy consumption efficiency, thus combating climate change.²²⁵

Summing up, artificial intelligence presents various advantages for numerous sectors. However, its potential could be especially decisive in the context of large cities. Due to the growing wave of challenges, many of them resulting from human action, the areas of sustainability and urban mobility end up being the two main topics in which projects based on artificial intelligence could mark the difference and improve the building and consolidation of smarter cities, in line with the targets defined by several international and European instruments. Regarding sustainability, we have identified computer vision and machine-learning projects that have direct impacts on climate prevention and protection of the environment and biodiversity; automation and predictive maintenance projects that stimulate the circular economy

²¹⁸ UN Sustainable Development Goals. *Goal 3* <https://www.un.org/sustainabledevelopment/health/>

²¹⁹ UN Sustainable Development Goals. *Goal 4* <https://www.un.org/sustainabledevelopment/education/>

²²⁰ Santos, I. (2018). Urban Mobility and the Sustainable Development Objectives. *Confederação Municipal de Municípios*, p. 7 <https://www.local2030.org/library/491/Mobilidade-Urbana-e-os-Objetivos-de-Desenvolvimento-Sustentvel.pdf>

²²¹ UN Sustainable Development Goals. *Goal 7* - “ensure access to clean and affordable energy”. <https://sdgs.un.org/goals/goal7>

²²² UN Sustainable Development Goals. *Goal 11* - “make cities inclusive, safe, resilient and sustainable”. <https://www.un.org/sustainabledevelopment/cities/>

²²³ Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast). (2018) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02018L2001-20220607&from=EN>

²²⁴ European Commission. (2023, February 14). *European Green Deal: Commission proposes 2030 zero-emissions target for new city buses and 90% emissions reductions for new trucks by 2040*. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_762

²²⁵ UN Sustainable Development Goals. *Goal 13* - “take urgent action to combat climate change and its impacts”. <https://www.un.org/sustainabledevelopment/climate-change/>

and promote a low waste policy; finally, machine-learning and speech and natural language processing projects, aiming at inclusiveness and equal rights. On the other hand, in the scope of mobility, we identify automation and computer vision projects, which increase safety on roads and surrounding areas; second and lastly, projects related to machine learning and autonomous transport, which promote a sustainable and universally accessible urban mobility network. However, it should be noted that along with advantages, we often have drawbacks and artificial intelligence is one of the most controversial fields, on accounts for the various barriers it presents at the regulatory, technical, and ethical levels. This will be explored in the following chapter.

5. Boundaries of implementing AI:

5.1. General disadvantages and impacts:

The field of artificial intelligence has been causing substantial disruptions and changing the core of many sectors. Such disruption is expected to continue in the years to come.²²⁶ Given its many advantages, specialists are already predicting the benefits these systems might have for the future of our society²²⁷ since they make a change in the way smart cities are conceptualized.

From improving companies' operations and combating climate change to reducing traffic congestion and improving safety in the streets of the cities, AI shows signs of being the revolutionary technology of the century. However, to fully comprehend its value for smarter cities, we need to approach its implementation carefully and responsibly, guaranteeing that it serves the public interest and promotes the overall general welfare. It is recognized that the disruption we initially addressed is powerful enough to have significant dire effects in different contexts.

²²⁶ Dimatteo, L. Poncibò, C., & Cannarsa, M. (2022) *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*. Cambridge, p. 3

²²⁷ McKnight, W. (2022, September 2). *Life in 2050: How Will AI Shape the Future?* <https://www.informationweek.com/ai-or-machine-learning/life-in-2050-how-will-ai-shape-the-future->

It should be noted that AI systems, in general, lack the creativity and emotions to see beyond conventional human thinking²²⁸, in the sense that, they only provide results regarding the data they process, having for that a large dependence on it.²²⁹ It is true that these systems have the ability to discover unique solutions that humans might not have perceived, or they might have analyzed but abandoned them in favour of more human-comprehensive alternatives.²³⁰ Yet, in frontier scenarios, artificial intelligence will lack an emotional component that, due to their lack of feelings, would be unable to provide the best solution. Assume an artificial intelligence system is used to detect suspected illegal conduct. This system will analyze data from different sources, including social media posts and CCTV footage, using machine-learning skills to identify those persons who are at a higher likelihood of engaging in crime. In this situation, if data is not strictly used, artificial intelligence will only consider the input and any learning based on that data, and, in consequence, may perpetuate discrimination against particular population segments, such as marginalized communities or persons with specific physical or mental characteristics, regardless of whether they've committed crimes. This circumstance will lead to another problematic issue around the application of artificial intelligence - the perpetuation of biases that go against the root of society - which brings ethical and legal concerns.

Secondly, we mention the safety risks brought by the excessive autonomy of artificial intelligence systems.²³¹ It is known that artificial intelligence has the autonomy to process and provide results. In the case of machine learning solutions, as we had already the opportunity to mention, it is shown an unequalled self-learning capacity without having been directly programmed for that purpose. This circumstance represents one of the main fears of its application. In case of a malfunction, faulty programming, corrupted data, or physical damage to the

²²⁸ Scherer, M. (2016). *Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies and Strategies*. *Harvard Journal of Law & Technology*, 29(2), 363-365. Spring. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2609777

²²⁹ Ismail, N. (2018, April, 23). *The success of artificial intelligence depends on data*. Information Age. <https://www.information-age.com/success-artificial-intelligence-data-10142/>

²³⁰ Scherer, M. (2016). *Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies and Strategies*, p. 364

²³¹ Scherer, M. (2016). *Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies and Strategies*, p. 366

equipment, these systems could bring safety consequences and harm to individuals.²³² Moreover, it could allow more security breaches resulting from cyber-attacks.

Thirdly, we mention cybersecurity which is another obstacle to their implementation. Across the globe, we note a huge effort by national governments in trying to implement a cybersecurity strategy to combat the challenges brought by artificial intelligence, especially when they are leveraged by malicious people.²³³ Since recently, outlaws have been using AI to improve and perpetrate their crimes, namely, by applying it for purposes of detecting flaws in software or security programs, to send phishing emails or even creating continuously evolved advanced malware to prevent detection by defensive technologies.²³⁴ Employing artificial intelligence by these illegal means is very risky for individuals' privacy but especially harmful for smart cities' pillars since they are relying on "smart" infrastructure to maintain visibility, collect data and more.²³⁵

Summing up, artificial intelligence is made up of a range of benefits that are countered by technical drawbacks. From a technical point of view, we highlight the lack of creativity and limitation of action by its dependence on data, to cybersecurity risks which are sometimes leveraged by the excessive autonomy of these systems. Together, these technical constraints of AI emphasize the importance of carefully considering rigorous strategies when it comes to their building or implementation, namely, through the expansion of computational power and making bigger volumes

²³² Scherer, M. (2016). *Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies and Strategies*, p. 366

²³³ The European Coordinated Plan on Artificial Intelligence's strategy acknowledges AI's potential to improve cybersecurity while simultaneously emphasizing the hazards presented by AI-based cyber attacks and the need to address them. Retrieved from Communication From The Commission To The European Parliament, The European Council, The Council, The European Economic And Social Committee And The Committee Of The Regions. (2018). *Coordinated Plan on Artificial Intelligence*. COM(2018) 795 final Chapter 2.7 <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52018DC0795&rid=3>

²³⁴ Violino, B. (2022, September, 13). *Artificial intelligence is playing a bigger role in cybersecurity, but the bad guys may benefit the most*. CNBC <https://www.cnbc.com/2022/09/13/ai-has-bigger-role-in-cybersecurity-but-hackers-may-benefit-the-most.html>

²³⁵ Momenta Partners. (2019). *White Paper: Introduction to IoT in Smart Cities*. <https://www.momenta.one/hubfs/Resources/Whitepapers/Downloads/WP-IoT-Smart-Cities-PDF-LIVE.pdf>

of machine-readable data available.²³⁶ This is especially important considering that many AI applications nowadays employ inductive rather than deductive methodologies²³⁷, as we had the opportunity to point out.²³⁸ However, to achieve a better evaluation, in my view, it is also necessary to address artificial intelligence from a regulatory point of view, since many of these general technical disadvantages raise legal and ethical challenges, which we will now explore more deeply.

5.2. Regulatory Challenges:

The relationship between law and artificial intelligence is becoming increasingly close. This circumstance has been influenced, in recent years, by the growing trend of regulatory challenges, due to the implementation and application of its advantages, in general, for society and smart cities. For both cases, we identify a common set of arguments and regulatory challenges in their use.

Firstly, it is important to mention the issues regarding artificial intelligence's legal personhood and liability. Due to technological advances and the production of results similar to those arising from human action, it has been increasingly questioned whether it is necessary or not to attribute legal personality to artificial intelligence systems, as beings endowed with rights, duties and responsibilities.²³⁹ According to this idea, it is important to point out the following: artificial intelligence systems do not represent entities because they are not organisations, nor natural persons since they do not possess characteristics inherent to a human being, such as subjectivity or consciousness.²⁴⁰ In the context of a task, a machine will provide a more objective result, free of any emotion, which totally differs from a task effectively performed by a human being. Furthermore, although the last few years have been especially

²³⁶ Dimatteo, L., Poncibò, C., & Cannarsa, M. (2022). *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*, p. 21

²³⁷ Dimatteo, L., Poncibò, C., & Cannarsa, M. (2022). *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*, p. 21

²³⁸ For more information, please go to Chapter 2.2;

²³⁹ Chesterman, S. (2020). *Artificial Intelligence and the Limits of Legal Personality*. *International & Comparative Law Quarterly*, 69(4), p. 819-844. doi:10.1017/S0020589320000366

²⁴⁰ Gunkel, D., & Wales, J. (2021). *Debate: what is personhood in the age of AI?*. *AI & SOCIETY*, 36, pp. 478–479 <https://doi.org/10.1007/s00146-020-01129-1>

promising for artificial intelligence, we find that we do not yet have enough technological development to overcome all barriers.²⁴¹ Based on these arguments, we are in a position to affirm that the legal personality of artificial intelligence systems will hardly have in a near future the same legal framework as the legal persons or natural persons that worldwide legal systems envisage in their legislations.

The fact that the issue of legal personality surrounding artificial intelligence is difficult to ascertain also leads to difficulties in addressing another of the main long-standing problems of artificial intelligence implementation and its relationship with individuals: the determination of liability whenever artificial intelligence is involved. Regarding liability concerns, this question has been emerging more often since many businesses have begun to include artificial intelligence in their operations, which, owing to its capabilities, makes them more efficient. Still, because specific artificial intelligence branches have some autonomy and learning potential, they may occasionally bring consequences and harm people's rights, being vital for this to determine who is held responsible for these damages and compensations. Let's take one of the examples mentioned earlier - implementing AI-powered autonomous passenger transport systems for structural pillars of cities²⁴² - into consideration. If by chance the artificial intelligence system makes a wrong decision that results in physical harm to its users, they are within its rights to seek to hold the responsible accountable. This raises two problems: on one side, the problem of uncertainty around the determination of the person accountable for the damage. It can be the manufacturer, the distributor or the third party, all this depending on different circumstances and the nature of the liability involved. We can identify four types of liability associated with AI systems usages: non-compliance liability, when individuals fail to take adequate precautions to maintain regulatory compliance, being an example of this, the liability coming from the lack of measures adopted by businesses, in preventing discriminatory bias by AI regarding categories of candidates in a specific

²⁴¹ Toews, R. (2021, June, 1). *What can Artificial Intelligence still can't do?* Forbes. <https://www.forbes.com/sites/robtoews/2021/06/01/what-artificial-intelligence-still-cant-do/?sh=6a5b0b4666f6>

²⁴² For more information, please go to Chapter 4.2 ii);

recruitment process²⁴³; fault liability, which, is based in intent or negligence of the faulty party, being commonly related with extra-contractual situations of violation of legally protected interests or fundamental rights²⁴⁴; defect and mal-performance liability of manufacturers, independently from their intent or carelessness, for manufacturing defects or weaknesses detected which blocks total effectiveness when consumers use the products²⁴⁵; finally, strict liability, whenever it's not one of the previous ones and assents in a causal link.²⁴⁶ On the other side, a problem of adequacy, since there are a lot of liability regimes enshrined in various worldwide regulations and laws. Because these rules are based on concepts formulated in the past, they sometimes reveal to be inadequate²⁴⁷ to meet the challenges that emerging technologies and artificial intelligence pose for individuals. It can even happen that, sometimes, this inadequacy does not allow compensation for those who have their rights harmed, so it might be necessary to create new regimes.

Thirdly, we note the challenges that employing artificial intelligence might comprehend for data protection or intellectual property law. This issue can be raised, for example, whenever there is a computer vision system involved. Let us take for discussion the AI-based visualizing tools examples²⁴⁸ given before:

Like other artificial intelligence systems, these build results based on patterns and data. In fact, these systems are generative models, so they will require even more additional information to cover all extreme climate scenarios, under various contexts, locations, and conditions. Initially, this leads to scenarios where particular information is taken into consideration when it should not be, resulting in clear data

²⁴³ Wendehorst, C. (2022). *Liability for Artificial Intelligence: The Need to Address Both Safety Risks and Fundamental Rights Risks*. In Voeneky, S., Kellmeyer, P., Mueller, O., & Burgard, W. (Eds.), *The Cambridge Handbook of Responsible Artificial Intelligence: Interdisciplinary Perspectives* (Cambridge Law Handbooks, pp. 187-209). 192, Cambridge: Cambridge University Press. doi:10.1017/9781009207898.016

²⁴⁴ Wendehorst, C. (2022), p. 192

²⁴⁵ Wendehorst, C. (2022), p. 193

²⁴⁶ Wendehorst, C. (2022), p. 194

²⁴⁷ European Commission. (2019). *Liability for artificial intelligence and other emerging technologies*. Expert Group on Liability and New Technologies - New Technologies Formation, p. 19 https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/JURI/DV/2020/01-09/AI-report_EN.pdf

²⁴⁸ For more information, please go to Chapter 4.1 i) c) and 4.1 ii) a);

breaches or even invasions of privacy if the data concerns an individual's personal information, under the scope of the GDPR. This data protection legislative framework includes no reference concerning AI. Yet, artificial intelligence systems end up falling within its scope²⁴⁹, as the GDPR regulation applies wherever personal data is being processed.²⁵⁰ This will mean that, those who apply artificial intelligence systems within the scope of their activities and if these involve handling information likely to represent personal data, will be subject to comply with the data processing principles. I highlight some of the most relevant for this purpose: the principle of lawfulness, fairness and transparency that, according to its Art. 5(1) (a), controllers will have to adapt AI systems in order to enable a legitimate use and demonstrate to data subjects clarity in their processing; the purpose limitation principle that, according to its Art. 5(1) (b), their processing must be fit for the purposes originally determined; the principle of data minimization which, according to art. 5(1) (c), requires the use of data to the extent necessary; finally, the principle of accountability which, according to art. 5(2) and 24 GDPR, requires controllers to establish suitable mechanisms to fulfil reporting and accountability obligations. The big problem around the relationship between data protection law and artificial intelligence is that on a significant number of occasions, this data is used disregarding these binding principles. For instance, AI-powered visualization systems create the possibility of capturing a huge amount of personal data, more than supposed, for purposes other than those stipulated, not fulfilling the necessary transparency and legitimacy.

Despite this, if we go deeper, we verify that some situations might even involve issues regarding copyright law. Considering that artificial intelligence systems of data visualization work according to specific techniques and operate with a massive volume of content, it can happen that occasionally some copyright or patent rights are infringed, as they are used without any permission from their owners.²⁵¹ It is

²⁴⁹ Spiecker, I. D. (2022) *AI and Data Protection*. in Dimatteo, L.a., Poncibò, C., & Cannarsa, M. (2022). *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*. Cambridge, p. 132

²⁵⁰ Regulation (EU) 2016/679 (GDPR), art. 2°

²⁵¹ Butterick, M. (2023). *We've filed a lawsuit challenging Stable Diffusion, a 21st-century collage tool that violates the rights of artists. Because AI needs to be fair & ethical for everyone*. Stable Diffusion Litigation. <https://stablediffusionlitigation.com/>

difficult to predict if the images considered by AI and used to provide results in the scope of the prevention of flood risks in cities have a copyright ownership. Using them as means might lead to violating creators' rights and could result in more lawsuits, namely, under the logic of the provisions of the historic Berne Convention²⁵², the complementing WIPO Copyright Treaty²⁵³, the TRIPS Agreement²⁵⁴, or the new European Copyright Directive for the Digital Single Market.²⁵⁵ Furthermore, under these, applying artificial intelligence to generate visual works, is still something that is not direct and currently stipulated, within intellectual property law.²⁵⁶ Regarding AI inventorship, we verify some contributions like the case law judgment *Thaler v. Vidal*²⁵⁷, in which, was ruled that only natural persons could have the status of inventorship. Nevertheless this circumstance, until machines can legally create their own works, it is my understanding that this question will be at the center of attention in the years to come.

Fourth and finally, it is important to discuss the key issue of ethics, which is at the heart of all regulatory challenges, given its inseparability from the law as we have already mentioned. Ethical concerns around artificial intelligence arise, as there is a justified fear that a negligent development and application of these technologies will contribute to supplanting the human race. As we mentioned, these technologies are

²⁵² World Intellectual Property Organization. (1884). *Berne Convention for the Protection of Literary and Artistic Works*. <https://www.wipo.int/wipolex/en/text/283693>

²⁵³ World Intellectual Property Organization. (1996). *Copyright Treaty*, S. Treaty Doc., <https://www.wipo.int/wipolex/en/text/295157>

²⁵⁴ TRIPS: Agreement on Trade-Related Aspects of Intellectual Property Rights. (1994). Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 [hereinafter TRIPS Agreement]

²⁵⁵ Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on *copyright and related rights in the Digital Single Market* and amending Directives 96/9/EC and 2001/29/EC <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0790&from=EN>

²⁵⁶ Brooke, T., Garno, D., & Velasco, R. (2022). *Image-Generating AI: Trends and Legal Challenges | Insights* | Holland & Knight. <https://www.hklaw.com/en/insights/publications/2022/12/imagegenerating-ai-trends-and-legal-challenges>

²⁵⁷ In this case, the plaintiff created and managed artificial intelligence systems that yielded patented innovations. Plaintiff's patent application was refused by the United States Patent and Trademark Office (PTO), and the Federal Circuit upheld that judgment, ruling that the machine could not be qualified as an inventor, according to The Patent Act which recognizes only natural persons to be named as inventors. *In Thaler v. Vidal*. No. 21-2347 (Fed. Cir. 2022) <https://law.justia.com/cases/federal/appellate-courts/cafc/21-2347/21-2347-2022-08-05.html>

endowed with autonomy and the ability to provide results in a much more efficient and faster way than any human being could. Considering these advantages, we are not surprised that nowadays companies aim to implement more and more machines to carry out certain activities, thus extinguishing work positions that would usually be occupied by humans. To what extent is this morally permissible for human beings? Is it acceptable to let artificial intelligence change our behaviors? Doesn't this undermine the dignity of human beings and all the efforts that they have made to assert themselves throughout history? Artificial intelligence has a non-existent subjectivity, so if this is not considered in its practical applications and when building regulatory solutions, this circumstance leads to the creation of ethically unacceptable situations that harm fundamental rights like equality, a decent job, or even privacy.

Summing up, artificial intelligence promises a world of potential, as we can draw real benefits from many projects currently being developed. Although, there are some issues regarding legal personhood, liability, data protection or intellectual property law. Hence, it is necessary for legal authorities to focus on finding solutions for a trustworthy implementation of artificial intelligence, within ethical and morally acceptable limits, to overcome its immanent disadvantages and regulatory obstacles.

5.3. Solving AI future governance and regulation: a personal perspective

Artificial intelligence has been assuming itself as one of the most successful realities in the innovation and technological market. Due to the numerous projects representing its application and investments that we see in the market, we realize that today, this is a unique technology that presents new possibilities and new challenges to address in a variety of sectors. In my view, it is critical for the responsible authorities, specifically, to pay closer attention to the fundamental boundaries that underlie the technical aspects and nature of artificial intelligence. This is especially important given the development of increasingly intelligent AI systems, which require effective governance and regulation strategies to ensure their resilience and strength. As we will see, such strategies are essential to building smarter cities, which represent an ideal field for their application, as demonstrated by the benefits of the AI-based projects mentioned above.

First of all, I underline the importance of clarifying the concept of artificial intelligence to face its challenges. Before we legislate on something, it is relevant that we know exactly what it is about as well as identify its obstacles. The drafting of the AI Act attempted to design a concept of these systems in the scope of its provisions.²⁵⁸ However, as we have explained in the work, historically, this has been a difficult notion to define and even today we can see an open debate on the subject around the globe, with various definition initiatives, some more restrictive, others broader, being, therefore, different.²⁵⁹ Regarding this, it is commendable the move of the European institutions to reach a consensual agreement on one what is one of the most controversial issues, regarding the adoption of the AI definition²⁶⁰ used by the OECD, as well as addressing notions related to their risk-categorization.²⁶¹ This contributes to a better harmonization on the topic, as well to avoid that specific AI generative models like ChatGPT, which are currently in the spotlight, are not left outside the reach of legislation.²⁶²

Secondly, I underline the importance of promoting the consolidation of a universal legal framework about the implementation of artificial intelligence and also the determination of liability for damages and the resulting compensations to be granted whenever artificial intelligence is implicated. These are key topics for us to achieve the right regulation and governance strategy. The AI Act presented by European Commission, the adapting digital age proposal²⁶³ for the Product Liability

²⁵⁸ Proposal for Artificial Intelligence Act, Title I art. 3, and Title II art. 5.

²⁵⁹ For more information, please check chapter 2.2.

²⁶⁰ OECD conceptualises artificial intelligence as the following: "machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments." definition retrieved from OECD (2019), *Recommendation of the Council on Artificial Intelligence* <https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449>

²⁶¹ Bertuzzi, L. (2023). *EU lawmakers set to settle on OECD definition for Artificial Intelligence*. [www.euractiv.com. https://www.euractiv.com/section/artificial-intelligence/news/eu-lawmakers-set-to-settle-on-oecd-definition-for-artificial-intelligence/](https://www.euractiv.com/section/artificial-intelligence/news/eu-lawmakers-set-to-settle-on-oecd-definition-for-artificial-intelligence/)

²⁶² Bertuzzi, L. (2023). *EU lawmakers set to settle on OECD definition for Artificial Intelligence*.

²⁶³ Proposal for a Directive of the European Parliament and of the Council on liability for defective products. COM(2022) 495 final 2022/0302 (COD) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022PC0495&from=EN>

Directive²⁶⁴ as well as the new initiative for an AI Liability Directive²⁶⁵, are excellent examples of contributions to follow up on this path.

With regards to AI Act, it has a firm foundation in Article 114 TFEU, intending to offer greater protection for individuals and respect for the fundamental rights articulated by the EU Charter of Fundamental Rights. To this end, it harmonizes a set of coherent rules, which are complemented by other instruments with which artificial intelligence may have an influence.²⁶⁶ These objectives are achieved by the imposition of requirements applicable in the context of their conception and in a posthumous moment of application of artificial intelligence in the market. Regarding these requirements, I would highlight the inclusion in the regulation of a list of prohibited and unacceptable artificial intelligence practices under the Union's values, either because of the different categorizations of different types of artificial intelligence or because of the increased transparency obligations that, depending on the situation and risk, these may entail²⁶⁷; finally, the designation of supervisory and compliance authorities and the establishment of codes of conduct for suppliers.²⁶⁸

The AI Liability Directive comes to be the follow-up positive legislative act to implement the provisions and ideas advocated in the context of the AI Act. First because reinforces transparency and accountability principles by ensuring that victims of AI-caused damages are protected in the same way as victims of damages caused by general products. In cases where a potential claimant suspects that a high-risk AI system has caused damage, the national courts can order the disclosure of relevant evidence, once the claimant has produced evidence to support the admissibility of his claim and sought to get from the accused proof.²⁶⁹ If the defendant fails to comply

²⁶⁴ Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products [1985] OJ L 210/29 <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31985L0374&from=EN>

²⁶⁵ Proposal for a Directive of the European Parliament and of the Council on adapting non-contractual civil liability rules to artificial intelligence COM(2022) 496 final 2022/0303 (COD) https://commission.europa.eu/system/files/2022-09/1_1_197605_prop_dir_ai_en.pdf

²⁶⁶ Proposal for Artificial Intelligence Act, pp. 6-7;

²⁶⁷ Proposal for Artificial Intelligence Act, pp.13-16

²⁶⁸ Proposal for Artificial Intelligence Act, p.17

²⁶⁹ Proposal for AI Liability Directive, art. 3 (1) (2) and (3)

with the order to provide the necessary information and material, it is presumed that he or she is incurring a breach of his duty of care.²⁷⁰ The proposal sets forth three requirements that must be met to establish a causal relationship²⁷¹: it must be proven the defendant's culpability or the individual whose conduct the defendant is liable; that culpability is the result of the AI response or its absence; finally, if the claimant demonstrates the causality between the harm and that AI action or inaction.²⁷² Accomplished these conditions, the causal link between the defendant's fault and the AI system's output or failure to produce an output is presumed. This means that the defendant will be liable for the damages caused by the AI system unless they can prove that they took all necessary precautions to prevent such damages from occurring.²⁷³ Secondly, the fact that it is a legislative act that gives the possibility to member states to shape its content, thus contributing to the respect of long-standing national legal norms. General regulations generally tend to clash with rules that member states have already incorporated into their legislation, and a topic such as liability represents an area with structural divergences depending on the legal system in concern. A directive makes it possible to reduce the risk of excessive internal interference.²⁷⁴

All these instruments, alongside other recommendations imposed by European Commission, allow us to provide a richer framework for the regulation and governance of artificial intelligence and its liability issues. Furthermore, not only do these initiatives emphasize the importance of considering an ethical dimension, within the maintenance of the impacts brought by the usage of these systems, but it also helps to overcome some obstacles that artificial intelligence has brought in the context of data protection law. By considering legitimate privacy-related concerns, we are now

²⁷⁰ Proposal for AI Liability Directive, art. 3 (5)

²⁷¹ Proposal for AI Liability Directive, art. 4

²⁷² Coco, Magda. Barros, Inês Antas. Kindylidi, Iakovina. (2022) Proposal for a Directive on AI Liability - Insights & Media - VdA - Vieira de Almeida, Sociedade de Advogados. <https://www.vda.pt/pt/publicacoes/insights/proposal-for-a-directive-on-ai-liability/25251/>

²⁷³ EU proposes new approach to liability for artificial intelligence systems | Osborne Clarke. (n.d.). <https://www.osborneclarke.com/insights/eu-proposes-new-approach-liability-artificial-intelligence-systems>

²⁷⁴ Wendehorst, C. (2022). *AI liability in Europe: anticipating the AI Liability Directive*. Ada Lovelace Institute. <https://www.adalovelaceinstitute.org/wp-content/uploads/2022/09/Ada-Lovelace-Institute-Expert-Explainer-AI-liability-in-Europe.pdf>

closer to concretizing some of the AI-related provisions of the GDPR which was not made and thought strictly for that matter. Nevertheless, it should be noted that the aforementioned instruments are still under analysis, so we will continue to assist emerging loopholes in situations, in which people are unable to truly exercise their fundamental rights. Therefore, is necessary to reinforce the effort and press institutions for them to enter quickly and effectively into force.

Thirdly, artificial intelligence legislation should be studied with an adaptive law perspective, especially, when they are applied in cities, in the sense that these are constantly changing technologies with the potential to revolutionize the market. Hence, it is necessary to consider the numerous impacts that their application can have, effects that can sometimes be most detrimental to marginalized communities.²⁷⁵

Fourthly, I think it is important to take into consideration in this strategy a kind of principle of technological neutrality, in the sense that any legislative measure created by the main authorities should not favour the use of one technology to the detriment of another.²⁷⁶ It is true that artificial intelligence, in the sum of its potentialities, presents added advantages in relation to the use of other technologies, as we have been proving throughout this work. Still, we do not believe that it is possible to take full advantage of its capabilities if it is not articulated with the features provided by other major technological innovations such as Blockchain or Augmented Reality. As we have indicated, some of these technologies end up filling the gaps of others²⁷⁷, so it becomes important to interconnect them in their use for better results. Within the European Ecological Pact, reference is made to this concept regarding the energy sector and combating climate change.²⁷⁸ However, the pact is omissive regarding its elaboration, and there is no other express reference to this idea.

²⁷⁵ Craig, A., Cartaxo, T., (2022), *Resilience Justice and Adaptive Law in European cities*, pp. 146-150 in *Urban Climate Resilience: The Role of Law*. Elgar Studies in Climate Law <https://doi.org/10.4337/9781803922508>

²⁷⁶ Apetro. A que chamamos neutralidade tecnológica? <https://www.apetro.pt/folder/newsletter/previous/Newsletter070421163212.aspx>

²⁷⁷ For more information, please go to chapter 3.3

²⁷⁸ European Commission. (2019). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, *The European Green Deal*. (COM/2019/640 final). chapter 2.1.2, p. 6 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN>

Therefore, there must be a greater willingness on the part of institutional authorities to clearly stipulate this aspect in the text of any legislative instruments related to the application of emerging technologies.

By completing the governance and regulation approach with these proposals, we are on the right track to resolving barriers and deploying emerging technologies not just globally, but particularly in smart cities. Why this?

Smart cities rely on data, thus managing how sensitive information about citizens is processed and defining standards for the processing of that data by businesses that operate with AI systems in compliance with the GDPR is a formula of safeguarding the basic right to privacy; secondly, an effective liability regime is critical to the success of smart cities. One of the main areas where artificial intelligence systems are used in smart cities is in the mobility sector, particularly in traffic management projects. As such, clear rules and directives, like the previous ones, regarding accountability measures of the ones involved in the deployment and operation of these systems, whether we are talking about the manufacturers of the AI technology, the operators of the system, or the city itself, prove to be mandatory for cities good functioning and execution of the sustainability standards they seek to follow. In the concrete case of cities, special attention should be even given to the liability regime for autonomous vehicles, given that this represents one of the main sustainable mobility solutions for the future; finally, smart cities depend on ethical considerations. Employing unregulated AI systems can create unpleasant situations: not worrying about future generations or increasing discriminatory bias behaviour rather than promoting inclusiveness. Solutions like those mentioned, contribute to recognizing the commitment made by many instruments and guidelines, regarding sustainability patterns, that we have come to refer to throughout our work. They lead to efficient results and reduced adverse effects for society or the world. Focusing on this, means being ethically structured.

To sum up, artificial intelligence has a lot of boundaries, but it is my opinion that the future of governance and regulation of artificial intelligence, oriented toward smarter cities, should be an AI nature-based measures approach. Firstly, the need to clarify doubts around its concept and make it more universal; second, the importance

of consolidating a legal framework for its implementation and liability for damages; third, the need for an adaptive law perspective regarding their application; fourthly, observing a principle of technological neutrality, in the sense, that AI can major its capacities through complementary technology. European Union in this regard has been taking several initiatives with several potential benefits. Therefore, I believe they must continue on the right path to becoming a reference in the context of global governance and regulation, not only in the area of artificial intelligence but also others that today affect so many individuals' lives.

6. Conclusion

In the last century, emerging technologies have completely revolutionized the world, with the innovation concept reaching another level, since its conception.

Within these technological novelties, artificial intelligence, in its different ramifications, has been proving to assume a bigger and special role in the competitive market²⁷⁹, for technical, ethical and, most importantly, legal reasons. Artificial intelligence can contribute to overcoming challenges that, if posed before technologies like Blockchain or Augmented Reality, could not provide an adequate response. Furthermore, through comparison, we see that, around the world, many jurisdictions have sought to establish a legally consolidated basis, through initiatives and recommendations, in an attempt to assert themselves in the area of artificial intelligence, which, despite being an area full of positive aspects, if not used for the intended purposes, can bring harmful consequences to society and fundamental rights²⁸⁰, in virtue of their subjectivity, autonomy and cybersecurity risks.

Therefore, it is absolutely necessary to find a good broad strategy of governance and regulation. Firstly, this is achieved by focusing on long-standing technical aspects and regulatory challenges: the adoption of a uniform harmonized concept of artificial intelligence; the creation of a universal liability regime for the use of artificial intelligence; finally, the incorporation of an adaptive law perspective in the legislator's thinking and a principle of technological neutrality, in the sense that there is an interdependence between technologies. In this context, the European Union has been adopting some decisive contributions which I believe will mark the future of this sector, such as the AI Act, the AI Liability Directive and the new Product Liability Directive. Secondly, through the exploration of specific projects in the scope of large cities, namely, those that contribute to social participation, the fight against climate change, safer urban mobility, greater accessibility and for the stimulation of the

²⁷⁹ Fowler, G. (2020, February, 5). *AI For A Competitive Advantage*. Forbes. <https://www.forbes.com/sites/forbesbusinessdevelopmentcouncil/2020/02/05/ai-for-a-competitive-advantage/?sh=74a52c9402b5>

²⁸⁰ European Union Agency for Fundamental Rights. (2020). *Getting the future right – Artificial intelligence and fundamental rights* <https://fra.europa.eu/en/publication/2020/artificial-intelligence-and-fundamental-rights>

circular economy. In my opinion, these will represent the best way for artificial intelligence to maximize its potential and pursue the sustainable development standards which institutional authorities have been adapting and underlining, in the scope of many international conferences and guidelines, and also mark the core of what those cities are intended to be - *smart cities* - concept of heated debate through the last decades.

Globally, but especially in the European context, together these represent consolidating means that can enhance the future and mark future generations.²⁸¹ Without this, artificial intelligence, has the capabilities to supplant humankind. Therefore, we must focus on continuing to do our work and take the best of results of what the innovation market has to offer, measuring them with the limits of what is or not unethically acceptable in the eyes of the race that still will live for a long time in our world.

²⁸¹ Van Rijmenam, M. (2022, November, 24). *The Need for Longtermism to Ensure a Thriving Digital Future*. The Digital Speaker | Strategic Futurist. <https://www.thedigitalspeaker.com/need-longtermism-long-term-approach-thriving-digital-future/>

BIBLIOGRAPHY

Agarwal, S., & Yemul, R. (n.d.). *AI and Gender Equality: Unlocking Gender Bias in Artificial Intelligence*. AI Policy Labs. <https://aipolicylabs.org/ai-and-gender-equality-unclocking-gender-bias-in-artificial-intelligence/>

Aircada Team. (2022, April 13). *Augmented Reality Disadvantages – Read Before You Adopt*. Aircada Pro. <https://aircada.com/disadvantages-augmented-reality/>

Allen, R. (2017, June 12). *Why Artificial Intelligence is Different from Previous Technology Waves*. Medium. <https://medium.com/machine-learning-in-practice/why-artificial-intelligence-is-different-from-previous-technology-waves-764d7710df8b>

Almeida, F.G. & Duarte, A.S. (2022, June 1). *Blockchain e Direitos Humanos – a tecnologia ao serviço das empresas (e das pessoas!)*. WhatNext.Law. <https://whatnext.law/en/2022/06/01/blockchain-e-direitos-humanos-a-tecnologia-ao-servico-das-empresas-e-das-pessoas-2/>

Ama. (2020). *Guia para uma inteligência artificial ética, transparente e responsável na administração pública*. <https://bo.tic.gov.pt/api/assets/etic/95bcaf56-87ba-446b-9f0b-ab06e1549aa0/>

Apetro. A que chamamos neutralidade tecnológica? <https://www.apetro.pt/folder/newsletter/previous/Newsletter070421163212.aspx>

Augmented reality with live BIM onsite. (2022, September 5). Csd-bim. <https://www.csd-bim.com.au/single-post/augmented-reality-with-live-bim-onsite>

Austrian Business Agency. (2023). *Forbes praises the WienBot as exemplary*. <https://investinaustria.at/en/news-events-press/forbes-praises-the-wienbot-as-exemplary>

Bee Smart City GmbH. (2022, January 11). *Smart City Indicators: Six Fields of Action for Success*. Bee Smart City GmbH. <https://www.beesmart.city/en/smart-city-indicators>

Bellinger, N. (2021, November 2). *The role of AI in sustainable manufacturing*. IT Supply Chain. <https://itsupplychain.com/the-role-of-ai-in-sustainable-manufacturing/>

Bertuzzi, L. (2023). *EU lawmakers set to settle on OECD definition for Artificial Intelligence*. [www.euractiv.com. https://www.euractiv.com/section/artificial-intelligence/news/eu-lawmakers-set-to-settle-on-oecd-definition-for-artificial-intelligence/](https://www.euractiv.com/section/artificial-intelligence/news/eu-lawmakers-set-to-settle-on-oecd-definition-for-artificial-intelligence/)

Boix-Palop, A. (2019). *The challenges of urban mobility regulation and the New Urban Agenda*, University of Valencia, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3414970

Bonsai.tech. (n.d.). *The first Smart City Chatbot in Croatia*. <https://bonsai.tech/success-stories/smart-city-chatbot>

Brooke, T., Garno, D., & Velasco, R. (2022). *Image-Generating AI: Trends and Legal Challenges | Insights | Holland & Knight*. <https://www.hklaw.com/en/insights/publications/2022/12/imagegenerating-ai-trends-and-legal-challenges>

Butterick, M. (2023). *We've filed a lawsuit challenging Stable Diffusion, a 21st-century collage tool that violates the rights of artists. Because AI needs to be fair & ethical for everyone*. Stable Diffusion Litigation. <https://stablediffusionlitigation.com/>

Capgemini Research Institute. (2019). *Scaling AI in Manufacturing Operations: A practitioners' Perspective*. <https://www.capgemini.com/wp-content/uploads/2019/12/AI-in-manufacturing-operations.pdf>

Cartaxo, T. M. (2020). Políticas de mobilidade e transportes: Entre a sustentabilidade e uma transição justa. *e-Pública*, 7(2), 219- 239. [https://ore.exeter.ac.uk/repository/bitstream/handle/10871/129606/34295-mobility-and-transport-policies-between-sustainability-and-a-just-transition%20\(1\).pdf?sequence=1](https://ore.exeter.ac.uk/repository/bitstream/handle/10871/129606/34295-mobility-and-transport-policies-between-sustainability-and-a-just-transition%20(1).pdf?sequence=1)

Cartaxo, T.M., Neto, M.C., & Vassalo, C. (2017). *Smart Legal Mechanisms for Sustainable Cities. International Conference on Sustainable Development*. Sarajevo. https://research.unl.pt/ws/portalfiles/portal/3487026/TCartaxo_MCNeto_VVassalo_Smart_2017.pdf

Chaurasia, K., & Kamath, H.R. (2021). *New Approach using Artificial Intelligence- Machine Learning in Demand Side Management of Renewable Energy*

integrated Smart Grid for Smart City. *4th International Conference on Innovative Computing and Communication*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3833753

Chesterman, S. (2020). Artificial Intelligence and the Limits of Legal Personality. *International & Comparative Law Quarterly*, 69(4), 819-844. doi:10.1017/S0020589320000366

CIL. (2019, May 29). Wind Flow Prediction through Machine Learning. <https://cities.ait.ac.at/site/index.php/2019/05/29/wind-flow-prediction-through-machine-learning/>

CIL. (2020, April 8). *CIL & Giraffe: AI Wind Comfort on the cloud*. <http://cities.ait.ac.at/site/index.php/2020/04/08/our-ai-models-at-work-introducing-our-partnership-with-giraffe-technologies-2/>

Clean Robotics. (2022, March 17). *Smart Waste Management: Why Smart Bins are the Future of Recycling*. <https://cleanrobotics.com/why-smart-bins-are-the-future-of-recycling/>

Coco, Magda. Barros, Inês Antas. Kindylidi, Iakovina. (2022) Proposal for a Directive on AI Liability - Insights & Media - VdA - Vieira de Almeida, Sociedade de Advogados. <https://www.vda.pt/pt/publicacoes/insights/proposal-for-a-directive-on-ai-liability/25251/>

Communication from the Commission to the European Parliament, The Council, the European Economic and Social Committee and the Committee of the Region. (2021). *The New EU Urban Mobility Framework* https://transport.ec.europa.eu/system/files/2021-12/com_2021_811_the-new-eu-urban-mobility.

Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products [1985] OJ L 210/29 <https://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:31985L0374&from=EN>

Craig, A., & Cartaxo, T. (2022), *Resilience Justice and Adaptive Law in European cities*, pp. 146-150 in *Urban Climate Resilience: The Role of Law*. Elgar Studies in Climate Law <https://doi.org/10.4337/9781803922508>

Datta, A. (2022, November 11). *Metaverse for Smart, Sustainable Cities of Tomorrow*. Geospatial World. <https://www.geospatialworld.net/prime/smart-sustainable-cities-metaverse/>

De Santi, R. (2020, October 7). *Blockchain e a Cidade Inteligente*. <https://www.linkedin.com/pulse/blockchain-e-cidade-inteligente-rodolfo-de-santi/?originalSubdomain=pt>

DHL. (2021, December 14). *DHL Supply Chain Accelerates Roll Out of Autonomous Forklifts With Largest Single Implementation*. <https://www.dhl.com/gb-en/home/press/press-archive/2021/dhl-supply-chain-accelerates-roll-out-of-autonomous-forklifts-with-largest-single-implementation.html>

DigitalesWien. (2022). *AI against Covid-19 disinformation*. <https://digitales.wien.gv.at/en/ai-against-covid-19-disinformation/>

Dimatteo, L., Poncibò, C., & Cannarsa, M. (2022). *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*. Cambridge.

DiMatteo, L.A. (2022). *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*. Cambridge University Press.

Diran, D., Van Veenstra, A., Timan, T., Tiesta, P., & Kirova, M. (2021). Artificial Intelligence in smart cities and urban mobility, How can Artificial Intelligence applications be used in urban mobility and smart cities and how can their deployment be facilitated, *Policy Department for Economic, Scientific and Quality of Life Policies*. Directorate-General for Internal Policies of the European Parliament, [https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/662937/IPOL_BRI\(2021\)662937_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/662937/IPOL_BRI(2021)662937_EN.pdf)

Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants. amending Directive 2003/35/EC and repealing Directive 2001/81/EC. <https://eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=CELEX:32016L2284&from=IT>

Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources

(recast). (2018). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02018L2001-20220607&from=EN>

Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on *copyright and related rights in the Digital Single Market* and amending Directives 96/9/EC and 2001/29/EC <https://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:32019L0790&from=EN>

Drum Hill Capital. (2016, July 20). *Industry 4.0: A New Era In Manufacturing*. <https://www.drumhill.com/post/industry-4-0-a-new-era-in-manufacturing>

EasyMile, EZ10 Passenger Shuttle <https://easymile.com/vehicle-solutions/ez10-passenger-shuttle>

Economist Intelligence Unit (EIU). (2022, November 30). *Energy outlook 2023*. <https://www.eiu.com/n/campaigns/energy-in-2023/>

Ecube Labs. (2016, July 8). *Overflowing garbage bins: 5 impacts on health and environment, and how to prevent*. <https://www.ecubelabs.com/overflowing-garbage-bins-5-impacts-on-health-and-environment-and-how-to-prevent/>

EPRS. (2019). Blockchain and the General Data Protection Regulation: Can distributed ledgers be squared with European data protection law? *Scientific Foresight Unit* (STOA). [https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU\(2019\)634445_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU(2019)634445_EN.pdf)

EU proposes a new approach to liability for artificial intelligence systems | Osborne Clarke. (n.d.). <https://www.osborneclarke.com/insights/eu-proposes-new-approach-liability-artificial-intelligence-systems>

European Commission. (2018). *USA-China-EU plans for AI: where do we stand?* <https://ati.ec.europa.eu/sites/default/files/2020-07/USA-ChinaEU%20plans%20for%20AI%20%20where%20do%20we%20stand%20%28v5%29.pdf>

European Commission. (2019). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, *The European Green Deal*.

(COM/2019/640 final). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN>

European Commission. (2019). *Liability for artificial intelligence and other emerging technologies*. Expert Group on Liability and New Technologies - New Technologies Formation. p. 19
https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/JURI/DV/2020/01-09/AI-report_EN.pdf

European Commission. (2020). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *A New Circular Economy Action Plan. For a Cleaner and More Competitive Europe*, COM (2020) 98 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN>

European Commission. (2020). WHITE PAPER: On Artificial Intelligence – A European approach to excellence and trust. https://commission.europa.eu/system/files/2020-02/commission-white-paper-artificial-intelligence-feb2020_en.pdf

European Commission. (2021). Proposal for a Regulation of the European Parliament and of the Council. Laying Down Harmonized Rules on Artificial Intelligence (Artificial Intelligence Act). COM (2021) 206 final 2021/0106 (COD). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52021PC0206>

European Commission. (2021). Proposal for a Regulation on general product safety. COM (2021) 346 final 2021/0170 (COD), amending Regulation (EU) No 1025/2012 of the European Parliament and of the Council, and repealing Council Directive 87/357/EEC and Directive 2001/95/EC of the European Parliament and of the Council <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0346&qid=1628522210573>

European Commission. (2021, June 21). European platform to combat homelessness is launched. https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3044

European Commission. (2022). Proposal for a Directive to the European Parliament and to the Council on adapting non-contractual civil liability rules to artificial intelligence. COM (2022) 496 final 2022/0303 (COD).

https://commission.europa.eu/system/files/2022-09/1_1_197605_prop_dir_ai_en.pdf

European Commission. (n.d.). *Circular economy action plan*. Environment. https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

European Commission. (2023, February 14). *European Green Deal: Commission proposes 2030 zero-emissions target for new city buses and 90% emissions reductions for new trucks by 2040*. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_762

European Parliament. (2021). Resolution of 20 October 2020 with recommendations to the Commission on a framework of ethical aspects of artificial intelligence, robotics and related technologies 201/C 404/04, <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020IP0275>

European Union Agency for Fundamental Rights. (2020). *Getting the future right – Artificial intelligence and fundamental rights* <https://fra.europa.eu/en/publication/2020/artificial-intelligence-and-fundamental-rights>

Eurostat. (2021, May 20). *Population projections: urban growth, rural decline*. <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210520-1>

Eurostat. (2022, July 19). *Stock of vehicles by category and NUTS 2 regions*. https://ec.europa.eu/eurostat/databrowser/view/TRAN_R_VEHST_custom_3007143/bookmark/map?lang=en&bookmarkId=08217f89-b2c2-4a34-897a-78ad4064f730

Eurostat. (2023, March 27). *Municipal waste statistics*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics

Executive Office of the President National Science and Technology Council Committee on Technology. (2016). *Preparing for the future of artificial intelligence*. National Science and Technology Council. https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf

Executive Order 13859. (2019). Federal Register: vol 84, nº31.
<https://www.govinfo.gov/content/pkg/FR-2019-02-14/pdf/2019-02544.pdf>

Félix de Oliveira, D., & de Vasconcelos, L. G. M (2015). ECODEVELOPMENT: AN APPROACH UNDER THE CONTRIBUTION IGNACY SACHS. *Revista de Direito, Economia e Desenvolvimento Sustentável*, 1(2), 29-48.
<https://www.indexlaw.org/index.php/revistaddsus/article/view/939/933>

Fowler, G. (2020, February, 5). *AI For A Competitive Advantage*. Forbes.
<https://www.forbes.com/sites/forbesbusinessdevelopmentcouncil/2020/02/05/ai-for-a-competitive-advantage/?sh=74a52c9402b5>

Geraint, E. (2021, January 14). *How Lime Is Supporting Sustainable, Smart Mobility That Will Continue To Transform Our Lives In 2021 And Beyond*. Forbes
<https://www.forbes.com/sites/drgeraintevans/2021/01/14/how-lime-is-supporting-sustainable-smart-mobility-that-will-continue-to-transform-our-lives-in-2021-and-beyond/>

Gomes, J.Q. (2021, November 17). *The paradigm of AI in shaping smarter cities*. WhatNext.Law.
<https://whatnext.law/en/2021/11/17/the-paradigm-of-ai-in-shaping-smarter-cities-en/>

GPAI. (2021). *Climate change and AI Recommendations for Government Action*.
<https://www.gpai.ai/projects/climate-change-and-ai.pdf>

Gunkel, D., & Wales, J. (2021). Debate: what is personhood in the age of AI?. *AI & SOCIETY*, 36, 473-486. <https://doi.org/10.1007/s00146-020-01129-1>

H2O.ai. (n.d.). *Predictive Maintenance: Fixing Machinery Before a Breakdown with AI*.
<https://h2o.ai/solutions/use-case/predictive-maintenance/>

Hacker, P., Engel, A., & List, T. (2023, January 20). *Understanding and Regulating ChatGPT, and Other Large Generative AI Models: With input from ChatGPT*. Verfassungsblog. <https://doi.org/10.17176/20230120-220055-0>

Hippold, S. (2018, July 25). *Use AI To Make Cities Smarter*. Gartner.
<https://www.gartner.com/smarterwithgartner/use-ai-to-make-cities-smarter>

Holland, M. (2022, December 6). *Stakeholders want more than AI Bill of Rights guidance*.
Tech Target.

<https://www.techtarget.com/searchcio/news/252528080/Stakeholders-want-more-than-AI-Bill-of-Rights-guidance>

Hovsepayan, E. (2020). Regulating AI: A Success Story for the European Union? *E-International Relations*. <https://www.e-ir.info/pdf/86182>

Howell, C. T. (2022, August 3). *AI Regulation: Where do China, the EU, and the U.S. Stand Today?* Foley & Lardner LLP. <https://www.foley.com/en/insights/publications/2022/08/ai-regulation-where-china-eu-us-stand-today>

Hutton, P. (2020, November 25). *Redflex buys machine vision and AI company*. Highway News. <https://highways-news.com/redflex-buys-machine-vision-and-ai-company/>

Iberdrola. (2021, April 22). *Blockchain technology at the service of urban management*. Iberdrola. <https://www.iberdrola.com/innovation/blockchain-for-smart-cities-urban-management>

INESC TEC. (n.d.). *AI to reduce the cognitive load and support distribution grid operators*. <https://www.inesctec.pt/en/news/ai-to-reduce-the-cognitive-load-and-support-distribution-grid-operators#about>

Intelligent Cities Challenge. (n.d.). *WienBot (interactive messaging service)* <https://www.intelligentcitieschallenge.eu/wienbot-interactive-messaging-service>

Intelligent Transport. (2022, July 14). *Lime unveils latest e-scooter technology to combat pavement riding* <https://www.intelligenttransport.com/transport-news/137745/lime-ai-computer-vision-e-scooter-safety/>

International Organization for Standardization. (2016). *ISO 37101:2016 Sustainable development in communities — Management system for sustainable development — Requirements with guidance for use*. <https://www.iso.org/standard/61885.html>

International Organization for Standardization. (2018). *ISO 37120:2018 Sustainable cities and communities — Indicators for city services and quality of life*. <https://www.iso.org/home.html>

International Organization for Standardization. (2023, March 8). <https://www.iso.org/home.html>

Invers. (2021, January 7). *Shared Mobility 2021: 5 Trends You Should Keep an Eye On* <https://inversmobility.medium.com/shared-mobility-2021-5-trends-you-should-keep-an-eye-on-e60a150aff01>

Ismail. N. (2018, April, 23). *The success of artificial intelligence depends on data.* Information Age. <https://www.information-age.com/success-artificial-intelligence-data-10142/>

JD Explore Academy. (2021). White Paper on Trustworthy Artificial Intelligence. China Academy of Information and Communications Technology. <http://www.caict.ac.cn/english/research/whitepapers/202110/P020211014399666967457.pdf>

Jones, A. (2021, August 10). *How Smart Cities are Benefiting From Conversational AI.* Dasha. <https://dasha.ai/en-us/blog/smart-cities-conversational-ai>

Kaufman, D. (2018). *A inteligência artificial irá suplantará a inteligência humana?* Estação das letras e cores. https://books.google.pt/books?id=FhWDwAAQBAJ&printsec=copyright&redir_esc=y#v=onepage&q&f=false

Khan, A. I., & Al-Habsi, S. (2020). Machine Learning in Computer Vision. *Procedia Computer Science*, 167, 1444–1451. <https://doi.org/10.1016/j.procs.2020.03.355>

Kobayashi, A. R. K., Kniess, C. T., Serra, F. A. R., Ferraz, R. R. N., & Ruiz, M. S. (2017). Smart sustainable cities: bibliometric study and patent information. *International Journal of Innovation*, 5(1), 77–96. <https://doi.org/10.5585/iji.v5i1.159>

Laadli | My Site. (n.d.). My Site. <https://www.inaequalis.org/general-8>

Larsen, B. C. (2022, December 8). *The geopolitics of AI and the rise of digital sovereignty.* Brookings. <https://www.brookings.edu/research/the-geopolitics-of-ai-and-the-rise-of-digital-sovereignty/>

Lorenzetti, J., De Lima Trindade, L., Pires De Pires, D., Regina, F., & Ramos, S. (2012). Tecnologia, inovação tecnológica e saúde: uma reflexão necessária. *Texto contexto enfermagem*, 21(2), 432-439. <https://doi.org/10.1590/S0104-07072012000200023>

Loughborough University. (2020, March 17). *Computer scientists develop novel artificial intelligence system that predicts air pollution levels*.<https://www.lboro.ac.uk/news-events/news/2020/march/artificial-intelligence-system-air-pollution/>

Luccioni, A., Schmidt, V., Vardanyan, V., & Bengio, Y. (2021). Using Artificial Intelligence to Visualize the Impacts of Climate Change. *IEEE Computer Graphics and Applications*, 41(1), 8–14. <https://doi.org/10.1109/mcg.2020.3025425>

Lumley, S., & Armstrong, P. (2004). Some of the Nineteenth Century Origins of the Sustainability Concept. *Environment, Development and Sustainability*, 6(3), 367–378. <https://doi.org/10.1023/b:envi.0000029901.02470.a7>

McCorduck, P. (2004). *Machines Who Think A Personal Inquiry into the History and Prospects of Artificial Intelligence* (2nd ed.). A K Peters, Ltd. <https://doi.org/10.1126/science.254.5036.1291.b>

McGuinness, D. (2017, April 27). *How a cyber attack transformed Estonia*. BBC News. <https://www.bbc.com/news/39655415>

McKinsey Global Institute. (2011). *Urban world: mapping the economic power of cities*. https://www.mckinsey.com/~media/mckinsey/featured%20insights/urbanization/urban%20world/mgi_urban_world_mapping_economic_power_of_cities_full_report.ashx

McKnight, W. (2022, September 2). *Life in 2050: How Will AI Shape the Future?* <https://www.informationweek.com/ai-or-machine-learning/life-in-2050-how-will-ai-shape-the-future->

Mila. (2022, November 29). *About Mila*. <https://mila.quebec/en/mila/>

Mobileye, (n.d.). *Leading the evolution from assisted to autonomous driving*. <https://www.mobileye.com/solutions/>

Mobileye. (n.d.). *AI-based Collision Avoidance Technology*, <https://ims.mobileye.com/fleets/us/technology/>

Momenta Partners. (2019). *White Paper: Introduction to IoT in Smart Cities*. <https://www.momenta.one/hubfs/Resources/Whitepapers/Downloads/WP-IoT-Smart-Cities-PDF-LIVE.pdf>

Observador Lab. (2020, October 2). *Smart Cities em Portugal? Sim, claro. No Centro de Portugal*. Observador. <https://observador.pt/2020/10/02/smart-cities-em-portugal-sim-claro-no-centro-de-portugal/>

OECD (2019), *Recommendation of the Council on Artificial Intelligence* <https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449>

Olaniyi, O. M., Alfa, A. A., & Umar, B. U. (2022). Artificial Intelligence for Demystifying Blockchain Technology Challenges: A Survey of Recent Advances. *Frontiers in Blockchain*, 5. <https://doi.org/10.3389/fbloc.2022.927006>

O'Neill & Smith 2016 cited in Hart, P. S., & Feldman, L. (2016). The Impact of Climate Change–Related Imagery and Text on Public Opinion and Behavior Change. *Science Communication*, 38(4), 415–441. <https://doi.org/10.1177/1075547016655357>

Pajilani, N.D.B., Fahmy-Abdullah, M., Sufahani, S.F., & Ali, M.K.B. (2022). Smart Economy Through Smart Cities. In Kaiser. M.S., Ray, K., Bandyopadhyay, A., Jacob, K., & Long, K.S (Eds.), *Proceedings of the Third International Conference on Trends in Computational and Cognitive Engineering* (pp. 273- 283). Springer. <https://doi.org/10.1007/978-981-16-7597-3>

Pauković, D. (2020, December 10). *Virtual Assistant Korana: Link Between Administration and Citizens of Karlovac*. Total Croatia News. <https://www.total-croatia-news.com/lifestyle/48823-virtual-assistant-korana>

Proposal for a Directive of the European Parliament and of the Council on liability for defective products. COM(2022) 495 final 2022/0302 (COD) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022PC0495&from=EN>

Proposal for a Directive of the European Parliament and of the Council on adapting non-contractual civil liability rules to artificial intelligence COM(2022) 496 final 2022/0303 (COD) https://commission.europa.eu/system/files/202209/1_1_197605_prop_dir_ai_en.pdf

Ranchordás, S. (2019). Nudging citizens through technology in smart cities. *International Review of Law, Computers & Technology*, 34(3), 254–276. <https://doi.org/10.1080/13600869.2019.1590928>

Ranchordás, S. (2020). Smart Mobility, Transport Poverty, and the Right to Inclusive Mobility SMART MOBILITY, TRANSPORT POVERTY, AND THE RIGHT INCLUSIVE MOBILITY? *University of Groningen Faculty of Law Research Paper Series*, 13. <https://doi.org/10.1080/10630732.2018.1476794>

Redflex (n.d). *Halo*. <https://redflex.com/solution/halo/>

Redflex (n.d). *Our Solutions*. <https://redflex.com/solutions/>

Redflex, (n.d). *Hold the Red*. <https://redflex.com/solutions/hold-the-red/>

Redflex. (n.d). *Red lights*. <https://redflex.com/solutions/red-light/>

Regulation (EU) 2016/679 (GDPR)

Regulation (EU) 2016/679 of the European Parliament and of the council. (2016). Official Journal of the European Union. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679&from=EN>

Renda, L. (2021, February 3). *Advancing Development by improving human mobility*, UNDP Blog. <https://www.undp.org/blog/advancing-development-improving-human-mobility>

Ritesh, E. S. (2021, January 28). *Women Safety through the Lens of Artificial Intelligence!* https://www.linkedin.com/pulse/women-safety-through-lens-artificial-intelligence-snigdhaa-ritesh/?trk=public_profile_article_view

Roberts, H., Cowls, J., Morley, J., Taddeo, M., Wang, V., & Floridi, L. (2020). The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation. *AI & SOCIETY*, 36(1), 59–77. <https://doi.org/10.1007/s00146-020-00992-2>

Rodriguez, J. (2020, August 5). *Decentralized AI in 5 Minutes*. Medium. <https://medium.com/intotheblock/decentralized-ai-in-5-minutes-2f3769deeff7>

Russell, S., & Norvig, P. (2010). *Artificial Intelligence: A modern approach* (3rd ed.). Pearson. https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf

SafetyNet. (2009). *Pedestrians & Cyclists*. p. 3 <https://road-safety.transport.ec.europa.eu/system/files/2021-07/pedestrians.pdf>

Sanakkayala, D.C., Vijayakumar, V., Kumar, N., Karan., Soni, G., Kamat, P., Kumar, S., Patil, S., & Kotecha, K. (2022). *Explainable AI for Bearing Fault Prognosis Using Deep Learning Techniques. Micromachine*, 13(9), 1-24. <https://www.mdpi.com/2072-666X/13/9/1471>

Santos, I. (2018). *Urban Mobility and the Sustainable Development Objectives. Confederação Municipal de Municípios. https://www.local2030.org/library/491/Mobilidade-Urbana-e-os-Objetivos-de-Desenvolvimento-Sustentvel.pdf*

Scherer, M. (2016). Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies and Strategies. *Harvard Journal of Law & Technology*, 29(2), 353-400. Spring. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2609777

Schütte, B., & Majewski, L. (2022). Private Liability for AI-Related Harm: Towards More Predictable Rules for the Single Market*. *Market and Competition Law Review*, 6(1). <https://doi.org/10.34632/mclawreview.2022.10741>

Shenzhen Municipal People's Congress. (2022). *Shenzhen Special Economic Zone Artificial Intelligence Industry Promotion Regulations. https://law.pkulaw.com/chinalaw/eb370a7e0d9edd5e8ca8bb1a5fa6a5e7bdfb.html*

Shubhendu, S., & Vijay, J. (2013). Applicability of Artificial Intelligence in Different Fields of Life. *International Journal of Scientific Engineering and Research (IJSER)*, 1(1), 2347–3878. <https://www.ijser.in/archives/v1i1/MDExMzA5MTU=.pdf>

Smart City NZ. (2021, November 17). *The Benefits of a Smart Waste Management System | Smart City. https://www.linkedin.com/pulse/benefits-smart-waste-management-system-city-smart-city-nz/?trk=organization-update-content_share-article*

Souza, J., Maranhão, A., Florêncio, J., & Almada, M. (2021). Inteligência artificial aplicada ao direito e o direito da inteligência artificial 1 Artificial intelligence applied to the law and the law of artificial intelligence. *Suprema: revista de estudos constitucionais*, 1(1), 154-180. https://cadmus.eui.eu/bitstream/handle/1814/71840/MARANH%C3%83O_et_al_2021.pdf?sequence=1

Spiecker, I. D. (2022) *AI and Data Protection*. in Dimatteo, L.A., . Poncibò, C., & Cannarsa, M. (2022). *The Cambridge Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*. Cambridge.

Stanford University. (n.d.). *Autism Glass Project*. <https://autismglass.stanford.edu/>

State Council. (2017). A New Generation of Artificial Intelligence Development Plan. *The foundation for Law and International Affairs*, 35. <https://flia.org/wp-content/uploads/2017/07/A-New-Generation-of-Artificial-Intelligence-Development-Plan-1.pdf>

Surden, H. (2020). Machine Learning and Law: An Overview. *Research Handbook on Big Data Law*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3686055

Syndio. (2023). Build an equitable workplace. <https://synd.io/>

Tai, K., Creemers, R., Laskai, L., & Webster, G. (2021, October 18). *Translation: Guiding Opinions on Strengthening Overall Governance of Internet Information Service Algorithms*. DigiChina. <https://digichina.stanford.edu/work/translation-guiding-opinions-on-strengthening-overall-governance-of-internet-information-service-algorithms/>

Textio (n.d.). *Inclusive talent attraction*. <https://textio.com/products/recruiting>

Thaler v. Vidal. No. 21-2347 (Fed. Cir. 2022) <https://law.justia.com/cases/federal/appellate-courts/cafc/21-2347/21-2347-2022-08-05.html>

The European Coordinated Plan on Artificial Intelligence's strategy acknowledges AI's potential to improve cybersecurity while simultaneously emphasises the hazards presented by AI-based cyber attacks and the need to address them. Retrieved from Communication From The Commission To The European Parliament, The European Council, The Council, The European Economic And Social Committee And The Committee Of The Regions. (2018). *Coordinated Plan on Artificial Intelligence*. COM(2018). <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52018DC0795&rid=3>

The European Pillar of Social Rights (EPSR) is an initiative by the European Commission which consists in a list of 20 principles to reaffirm social rights and labour rights, within an inclusive European community. For more information, please check European Commission. (2017, November 16). *The European Pillar of Social Rights*

in 20 principles. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/economy-works-people/jobs-growth-and-investment/european-pillar-social-rights/european-pillar-social-rights-20-principles_en

The Global Goals. (2022, March 15). *Goal 9: Industry, innovation and infrastructure*. <https://www.globalgoals.org/goals/9-industry-innovation-and-infrastructure/>

The National New Generation Artificial Intelligence Governance Specialist Committee. (2021, October 21). *Ethical Norms for New Generation Artificial Intelligence*. <https://cset.georgetown.edu/publication/ethical-norms-for-new-generation-artificial-intelligence-released/>

The New Urban Agenda - Habitat III. (2016, December 23). *Habitat III*. <https://habitat3.org/the-new-urban-agenda/>

“The Union’s aim is to promote peace, its values and the well-being”, “it shall combat social exclusion and discrimination, and shall promote social justice and protection...”. Retrieved from the European Union. (2007). Consolidated version of the *Treaty on European Union*, 13 December 2007, 2008/C 115/01. OJ C115/13. art. 3. https://eur-lex.europa.eu/resource.html?uri=cellar:2bf140bf-a3f8-4ab2-b506-fd71826e6da6.0023.02/DOC_1&format=PDF

Thornberry, W. M. (MAC). (2020). National defense authorization act for fiscal year 2021. *House of representatives*. <https://www.congress.gov/116/crpt/hrpt617/CRPT-116hrpt617.pdf#page=1210>

Thorwirth, Z. (2021, January 09). *AI Winter: The Highs and Lows of Artificial Intelligence*. History of Data Science. <https://www.historyofdatascience.com/ai-winter-the-highs-and-lows-of-artificial-intelligence/>

Toews, R. (2021, June, 1). *What can Artificial Intelligence still can't do*. Forbes. <https://www.forbes.com/sites/robtoews/2021/06/01/what-artificial-intelligence-still-cant-do/?sh=6a5b0b4666f6>

Trindade, E. P., Hinnig, M. P. F., da Costa, E. M., Marques, J. S., Bastos, R. C., & Yigitcanlar, T. (2017). Sustainable development of smart cities: a systematic review of the literature. *Journal of Open Innovation: Technology, Market, and Complexity*, 3(1). <https://doi.org/10.1186/s40852-017-0063-2>

TRIPS: Agreement on Trade-Related Aspects of Intellectual Property Rights. (1994). Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 [hereinafter TRIPS Agreement].

Tumescheit, A.M. (2022, May 17). *How Smart Cities are Driving down Air Pollution with Smart Traffic Flow Optimization*. Fujitsu Blog - Global. <https://corporate-blog.global.fujitsu.com/fgb/2022-05-17/01/>

U.S. Department of State. *Artificial Intelligence (AI)*. <https://www.state.gov/artificial-intelligence/>

UN General Assembly. (1972, December 15). *United Nations Conference on the Human Environment*. Stockholm. <https://www.refworld.org/docid/3b00f1c840.html>

UN General Assembly. (2000, September 8). *United Nations Millennium Declaration*. <https://www.ohchr.org/en/instruments-mechanisms/instruments/united-nations-millennium-declaration>

UN General Assembly. (2015, October 21). *Transforming our world: the 2030 Agenda for Sustainable Development*. <https://sdgs.un.org/2030agenda>

UN General Assembly. (2020). *Resolution A/RES/74/299*, <https://documents-dds-ny.un.org/doc/UNDOC/GEN/N20/226/30/PDF/N2022630.pdf?OpenElement>

UN Secretariat of the Committee for Development Policy. (2019). *Are some SDGs more important than others? Revealed country priorities from four years of VNRs*. <https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/Note-SDGs-VNRs.pdf>

UN Sustainable Development Goals. *Goal 11 - “make cities inclusive, safe, resilient and sustainable”*. <https://www.un.org/sustainabledevelopment/cities/>

UN Sustainable Development Goals. *Goal 13 - “take urgent action to combat climate change and its impacts”*. <https://www.un.org/sustainabledevelopment/climate-change/>

UN Sustainable Development Goals. *Goal 3* <https://www.un.org/sustainabledevelopment/health/>

UN Sustainable Development Goals. *Goal 4* <https://www.un.org/sustainabledevelopment/education/>

UN Sustainable Development Goals. *Goal 5* - “empowering all women and girls and achieving gender equality”.

<https://www.un.org/sustainabledevelopment/gender-equality/>

UN Sustainable Development Goals. *Goal 7* - “ensure access to clean and affordable energy”. <https://sdgs.un.org/goals/goal7>

UN. Department of Public Information. (1993). *Agenda 21 : programme of action for sustainable development, Rio Declaration on Environment and Development, statement of forest principles : the final text of agreements negotiated by Governments at the United Nations Conference on Environment and Development (UNCED)*. United Nations Digital Library System. <https://digitallibrary.un.org/record/170126?ln=en>

Unesco. (2021). *Recommendation on the ethics of artificial intelligence*. <https://unesdoc.unesco.org/ark:/48223/pf0000380455>

UN-Habitat. (n.d.). *Greener Cities Partnership Blog Series* <https://unhabitat.org/greener-cities-partnership-blog>

UNICEF. Safeguarding girls and boys: When Chatbots answer their private questions.

<https://www.unicef.org/eap/media/5376/file/Chatbots%20and%20safeguarding.pdf>

United Nation. *13 Climate Action: Take Urgent action to combat climate change and its impacts*. <https://www.globalgoals.org/goals/13-climate-action/>

United Nations (n.d.) *Article 24 – Education*. <https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities/article-24-education.html>

United Nations General Assembly. (1948). The Universal Declaration of Human Rights (UDHR). New York: United Nations General Assembly. art. 2 <https://www.un.org/sites/un2.un.org/files/2021/03/udhr.pdf>

United Nations General Assembly. (1979). Convention on the Elimination of All Forms of Discrimination against women. <https://www.ohchr.org/sites/default/files/cedaw.pdf>

United Nations. (1968). *Vienna Convention on Road Traffic*, Treaty Series 1719.
https://treaties.un.org/doc/Treaties/1977/05/19770524%2000-13%20AM/Ch_XI_B_19.pdf

United Nations. (1984). *Universal Declaration of Human Rights*.
https://www.un.org/en/udhrbook/pdf/udhr_booklet_en_web.pdf

United Nations. (2006). *Convention on the Rights of Persons with Disabilities*. Treaty Series 2515, art. 24.
<https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities/article-24-education.html>

United Nations. (2015). *Paris Agreement*.
https://unfccc.int/sites/default/files/english_paris_agreement.pdf

United Nations. (2017). *The New Urban Agenda*. <https://habitat3.org/wp-content/uploads/NUA-English.pdf>

United Nations. (n.d). *OHCHR and women's human rights and gender equality*.
<https://www.ohchr.org/en/women>

United Nations. (n.d) *Take Action for the Sustainable Development Goals*.
<https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

United Nations. *Goal 1 “End poverty in all its forms everywhere”*.
<https://www.un.org/sustainabledevelopment/poverty/>

United Nations. *Goal 11 “Make cities inclusive, safe, resilient and sustainable”*.
<https://www.un.org/sustainabledevelopment/cities/>

United Nations. *Goal 12 “Ensure sustainable consumption and production patterns”*.
<https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>

United Nations. *Goal 13 “Ensure sustainable consumption and production patterns”*.
<https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>

United Nations. *Goal 13 “Take urgent action to combat climate change and its impacts”*.
<https://www.un.org/sustainabledevelopment/climate-change/>

United Nations. *Goal 15 “Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss”.*

<https://www.un.org/sustainabledevelopment/biodiversity/>

United Nations. *Goal 3 “Ensure healthy lives and promote well-being for all at all ages”.*
<https://www.un.org/sustainabledevelopment/health/>

United Nations. *Goal 4 “Quality Education”.*
<https://www.un.org/sustainabledevelopment/education/>

United Nations. *Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all.*
<https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>

Van Rijmenam, M. (2022, November, 24). *The Need for Longtermism to Ensure a Thriving Digital Future.* The Digital Speaker | Strategic Futurist.
<https://www.thedigitalspeaker.com/need-longtermism-long-term-approach-thriving-digital-future/>

Vanti Analytics. (2022, January 27). *Vanti Analytics raises \$16M A round from Insight Partners to unlock AI at scale for manufacturers.*
<https://www.prnewswire.com/il/news-releases/vanti-analytics-raises-16m-a-round-from-insight-partners-to-unlock-ai-at-scale-for-manufacturers-301469670.html>

Vanti. (2022, December 20). *AI-based Defect Detection – A Brief Overview.*

Vanti. <https://www.vanti.ai/an-overview-of-ai-based-defect-detection/>

Violante, A. (2020, July 8). *Textio named to Forbes AI 50: America’s Most Promising Artificial Intelligence Companies.* Textio. <https://textio.com/blog/topic/andrew-violante>

Violino, B. (2022, September, 13). *Artificial intelligence is playing a bigger role in cybersecurity, but the bad guys may benefit the most.* CNBC <https://www.cnn.com/2022/09/13/ai-has-bigger-role-in-cybersecurity-but-hackers-may-benefit-the-most.html>

Waas, B. (2022) *Artificial Intelligence and Labour Law.* Hugo Sinzheimer Institute for Labour and Social Security Law. https://www.hugo-sinzheimer-institut.de/fpdf/HBS-008498/p_hsi_wp_17.pdf

Wahl, T. (2020, April 1). *Commission: White Paper on AI*. Eucrim. May 2022 in <https://eucrim.eu/news/commission-white-paper-ai/>

Wendehorst, C. (2022). *AI liability in Europe: anticipating the AI Liability Directive*. Ada Lovelace Institute. <https://www.adalovelaceinstitute.org/wp-content/uploads/2022/09/Ada-Lovelace-Institute-Expert-Explainer-AI-liability-in-Europe.pdf>

Wendehorst, C. (2022). *Liability for Artificial Intelligence: The Need to Address Both Safety Risks and Fundamental Rights Risks*. In Voeneky, S., Kellmeyer, P., Mueller, O., & Burgard, W. (Eds.). *The Cambridge Handbook of Responsible Artificial Intelligence: Interdisciplinary Perspective*, 192. Cambridge: Cambridge University Press. doi:10.1017/9781009207898.016

Wendehorst, C. (2022). *Liability for Artificial Intelligence: The Need to Address Both Safety Risks and Fundamental Rights Risks*. In Voeneky, S., Kellmeyer, P., Mueller, O., & Burgard, W. (Eds.). *The Cambridge Handbook of Responsible Artificial Intelligence: Interdisciplinary Perspective*, 192. Cambridge: Cambridge University Press. doi:10.1017/9781009207898.016

White House Office of Science and Technology Policy. (2022). *Blueprint for an ai bill of rights making automated systems work for the american people*. <https://www.whitehouse.gov/wp-content/uploads/2022/10/Blueprint-for-an-AI-Bill-of-Rights.pdf>

Winkowska, J., Szpilko, D., & Pejić, S. (2019). Smart city concept in the light of the literature review. *Engineering Management in Production and Services*, 11(2), 70–86. <https://doi.org/10.2478/emj-2019-0012>

Woo, J., Whittington, J., & Arkin, R. (2020). Urban Robotics: Achieving Autonomy in Design and Regulation of Robots and Cities. *Connecticut Law Review*, 52 (1), 319- 410.

World Commission on Environment and development. (1987). *Report of the World Commission on Environment and Development: Our Common Future* (Brundtland Report). <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>

World Economic Forum. (2022). *Global Gender Gap Report 2022*, Insight Report. https://www3.weforum.org/docs/WEF_GGGR_2022.pdf

World Health Organization. (2021, October 28). *WHO kicks off a Decade of Action for Road Safety*. <https://www.who.int/news/item/28-10-2021-who-kicks-off-a-decade-of-action-for-road-safety>

World Health Organization: WHO. (2022, November 28). *Household air pollution*. <https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health>

World Intellectual Property Organization. (1884). *Berne Convention for the Protection of Literary and Artistic Works*. <https://www.wipo.int/wipolex/en/text/283693>

World Intellectual Property Organization. (1996). *Copyright Treaty*, S. Treaty Doc., <https://www.wipo.int/wipolex/en/text/295157>

WSA. (2017). *WienBot – a chatbot for the city of Vienna*. <https://wsa-global.org/winner/wienbot-a-chatbot-for-the-city-of-vienna/>

Wu, Y. (2022, October 14). *AI in China: Regulations, Market Opportunities, Challenges for Investors*. China Briefing News. <https://www.china-briefing.com/news/ai-in-china-regulatory-updates-investment-opportunities-and-challenges/>

Xinhua News Agency. (2022, March 20). *The General Office of the Central Committee of the Communist Party of China issued the "Opinions on Strengthening the Ethical Governance of Science and Technology*. <http://english.www.gov.cn/>

Zhu, X. (2019). Introduction: From the Industrial Economy to the Digital Economy: A Giant Leap—Research on the “1 + 10” Framework of the Digital Economy. In *Management for professionals*. Springer, Singapore. https://doi.org/10.1007/978-981-13-2628-8_1

Ziosi, M., Hewitt, B., Juneja, P., Taddeo, M., & Floridi, L. (2022). Smart cities: reviewing the debate about their ethical implications. *AI & SOCIETY*. <https://doi.org/10.1007/s00146-022-01558-0>

