STUDY

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Artificial Intelligence and Urban Development

Policy Department for Structural and Cohesion Policies
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RESEARCH FOR REGI COMMITTEE

Artificial Intelligence and Urban Development

Abstract

This research paper explores the role of artificial intelligence (AI) in urban areas, and its impact on socio-economic and territorial cohesion. It argues that expectations surrounding AI are high, especially in the context of smart-city initiatives, but that the actual benefits are yet to be fully assessed. To avoid potential risks, local and urban authorities need to fulfil a series of conditions that are inherently challenging. The EU's AI Policy and its Cohesion Policy, in particular, may help, but they need to address the territorial dimension of AI more explicitly.

This document was requested by the European Parliament's Committee on Regional Development.

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DISCLAIMER

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LIST OF ABBREVIATIONS

ADM	Automated Decision Making
AI	Artificial Intelligence
CAP	Common Agricultural Policy
DG	Directorate General
DG AGRI	Directorate General - Agriculture and Rural Development
DG CLIMA	Directorate General – Climate Action
DG CONNECT	Directorate General – Communications Networks, Content and Technology
DG EMPL	Directorate General – Employment, Social Affairs and Inclusion
DG ENER	Directorate General – Energy
DG GROW	Directorate General – Internal Market, Industry, Entrepreneurship and SMEs
DG REGIO	Directorate General – Regional and Urban Policy
(E)DIH	(European) Digital Innovation Hub
EFSI	European Fund for Strategic Investments
ENRD	European Network for Rural Development
ESIF	European Structural and Investment Funds
EU	European Union
EUR	Euro (currency)
EXAC	Ex-Ante Conditionality
GPS	Global Positioning System
H2020	Horizon 2020
ICT	Information and Communication Technologies
IoT	Internet of Things
JRC	Joint Research Centre

NASA	National Aeronautics and Space Administration
OECD	Organisation for Economic Cooperation and Development
R&D	Research and Development
S3	Smart Specialisation Strategy(ies)
SME	Small and Medium-sized Enterprise(s)
TO	Thematic Objective
UAV	Unmanned Aerial Vehicle
USA	United States of America

GLOSSARY

Artificial Intelligence	Field of computer science wherein machines perform "human-like" tasks, such as learning, reasoning, planning and problem-solving.
Big Data	The treatment of a large and exponentially growing amount of data that cannot be processed using traditional methods.
Blockchain	A mathematical structure for storing data in a manner that is nearly impossible to fake. It can be used for all kinds of valuable data, including cryptocurrencies.
Cloud Technologies	The delivery of different services through the Internet. This includes tools and applications such as data storage, servers, databases, networking and software.
Distributed Databases	Combination of data replication and duplication to ensure data consistency and integrity. It allows data sharing while enforcing privacy and providing transparency as to how data is being used.
Internet of Things	Network of physically connected devices, such as vehicles or home appliances, that enable these "things" to connect and exchange data.
Smart City	An urban area where traditional networks and services are made more efficient via the use of digital and telecommunication technologies, for the benefit of inhabitants and businesses. A smart city goes beyond the use of ICT for (e.g.) better resource use and fewer emissions. It means smarter urban transport networks, upgraded water supplies and waste-disposal facilities, and more efficient ways to light and heat buildings. It also means a more interactive and responsive city administration, safer public spaces and fulfilment of the needs of an ageing population.[1]
5G	The fifth generation of cellular data technology. Its benefits include faster speeds, low latency and greater capacity.

[1] Adapted from https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

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EXECUTIVE SUMMARY

Background and objective

Artificial intelligence (AI), signifying human-like cognitive capabilities as performed by machines, is expected to bring about deep transformations in peoples' daily lives, in patterns of economic functionality and in the way governments operate. High expectations have been placed on AI in an urban context. While there are debates about the pros and cons of AI in general, there is less discussion about **the specific impact of AI on cohesion within and between urban areas**. This study explores the state of available knowledge regarding the role of AI within urban development, its potential advantages and risks, and the foreseeable implications for socio-economic and territorial cohesion.

Main findings

AI-based technologies are still at an early stage of development, within which AI systems perform narrowly defined tasks driven by data analysis. Recent progress includes the development of machine-learning algorithms that can self-improve without detailed instructions from humans. When combined with other digital technologies (Big Data, Internet of Things, Cloud and telecommunication infrastructure) in an urban context, AI can unite and synergetically exploit the huge amount of data produced by normal city life. This is a prerequisite for the full exploitation of interconnectivity, i.e., an integrated system whereby data from different sources are combined to produce meaningful information. As such, AI **contributes to the full realisation of the smart-city model.** There is no single definition of what a smart city is, but it generally refers to an integrated set of initiatives aimed at using digital technologies, including AI, to improve well-being and quality of life. Not all smart cities are necessarily AI-based, although the most advanced ones typically are. Nonetheless, the smart-city concept is broader than the concept of a digitalised city. It requires that mechanisms be in place to "govern" technological developments, such as citizen participation.

AI in an urban context can provide numerous solutions in different areas, ranging **from improved urban management and support for decision-making, to the release of new or improved services for citizens and the creation of new economic opportunities.** Thus, AI within smart cities can exercise a **far-reaching impact** in numerous areas of application. Many of these areas are critical for city management and urban development, and include (but are not restricted to): local government, health, safety, mobility and energy. *Inter alia,* AI is expected to facilitate efficiency gains, better governance, democratic engagement, and improved environmental sustainability.

Nevertheless, the application of AI in urban development is **fraught with a number of risks**, some of which are common to other digital technologies. First, the handling of private data incurs security and privacy risks. Performance risks, meanwhile, refer to the so-called black-box effect created by self-learning AI algorithms, which can generate or reproduce bias and lead to unfair decisions. Other cited risks are of an economic nature, such as the controversial displacement effect of AI (job destruction as the result of automation vs. net job-creation effect as the result of new economic activities and creative destruction).

These different risks, to varying extents, can **jeopardise socio-economic and territorial cohesion**. There are two broad types of risk specifically related to AI from an urban/territorial perspective, namely those pertaining **primarily to social and economic cohesion within cities** on the one hand, and on the other, risks to **territorial cohesion between cities, and between cities and rural areas in particular.** For example, displacement effects impact the most vulnerable workers, and this problem may in turn have a territorial dimension, if the inhabitants negatively affected are concentrated in specific districts or neighbourhoods. Moreover, biases that are apparently technical in essence can bring about unwanted (or even intentional) discrimination at the expense of the most fragile populations, with possible negative consequences for cohesion *within* towns. The development of AI can also negatively affect cohesion *between* towns – notably, between those enjoying the benefits of smart-city status and those without the capacity to deploy AI solutions. It may also jeopardise cohesion between towns and their surrounding (rural) areas, if the frontier of the smart city abruptly falls between the two, or in case of adverse impact on the surrounding areas, creating a digital divide.

In the face of the expected advantages, and potential risks, of AI as deployed in cities, there is a lack of systematic evidence about the territorial impact of AI in an urban context. There has been *even less* focus on the subject in the context of rural-urban relations, which can be expected to be significantly impacted by the diffusion of AI solutions. Hence, apart from the experience of a few frontrunners (generally large and advanced cities), **there is still little evidence (so far) that the positive effects of the smart-city paradigm, as powered by AI, will actually materialise on a large scale**.

To mitigate risks and seize the potential of AI, urban authorities must ensure that **a series of necessary conditions are met.** These range from data access, interoperability and legal frameworks to more intangible elements, including an appropriate governance structure, administrative capacity and relevant skills. A further essential condition is that citizens should actively participate in the development of AI-based smart cities, to design adapted solutions and generate the necessary trust and familiarity with AI.

The policies adopted by the European Union (EU) can make a decisive contribution towards the fulfilment of these conditions. The EU has been developing numerous initiatives linked to AI in smart cities, mostly based on networking, partnerships and the diffusion of good practice. Furthermore, Cohesion Policy contributes to a significant share of investments and interventions in the area, even if this is **not always visible or coherently measured.** Nevertheless, the **overarching strategic approach of the EU regarding AI is largely oblivious to territorial and urban issues**. In general, moreover, it is difficult to engage in “policy learning” or to leverage policy achievements. Two promising initiatives concerning AI for urban development are **Digital Innovation Hubs** and **Smart Specialisation Strategies,** both of which integrate a territorial dimension and usefully support local and urban authorities in rolling out effective AI / smart-city strategies.

Conclusions and recommendations

This study argues **in favour of a place-based approach** to AI in an urban context, focusing on the needs of citizens and addressing the diversity of cases and contexts. The urban level is the optimal level to facilitate both citizens’ engagement *and* collaborative partnerships. Such an approach also makes it possible to engage all the relevant levels of governance (i.e., not only urban authorities, but also authorities at regional, national and EU levels) and to mobilise the relevant knowledge and skills necessary to reap the benefits of AI and minimise risks. More specific recommendations include the following:

- **Mobilise Cohesion Policy effectively and explicitly to address AI in an urban context.** The REGI Committee of the European Parliament should call on the Commission to ensure that the following aspects are adequately addressed during negotiations with Member States:
    - **Explicitly integrate considerations vis-à-vis AI within smart cities** into strategic and programming documents that underpin Cohesion Policy at Member State level;
    - Encourage a shift from experimentation to **scaling-up smart-city initiatives**;
    - **Improve the monitoring system** for Cohesion Policy, better to account for the use of AI in an urban context.

The European Parliament should also contribute to the following efforts:

- **Coordinate the different EU initiatives in favour of AI in cities within the Urban Agenda**;
- **Consolidate a knowledge base** concerning the benefits and risks of AI for urban development. Moreover, a methodology for assessing benefits and risks of AI for territorial cohesion in an urban setting should be consolidated in the context of the update of the Better Regulation Guideline;
- **Mobilise Digital Innovation Hubs** to support local and urban authorities in rolling out effective AI and smart-city strategies;
- **Foster awareness among citizens** regarding the enormous potential, but also the concrete risks, around AI and city development. This can be done through appropriate education and awareness-raising campaigns at the initiative of the European Parliament.

1. INTRODUCTION

1.1 Background

Artificial Intelligence (AI) is expected to transform people's lives, the overall functioning of economies and the manner in which government operates. Nonetheless, there is no consensus on the nature and the extent of the impact of AI. On the one hand, it may boost productivity and economic growth while increasing the efficiency of public services. On the other, it may also exacerbate imbalances in the labour market and increase inequalities within and between countries.

The use of AI in city management is already a reality and is often associated with the smart-city concept.[2] Nevertheless, its adoption depends on many factors, including the availability of digital infrastructure and capacities, and its acceptability in the eyes of business and citizens. The existing literature on AI and urban areas in and beyond the European Union (EU) covers many aspects of the technology, such as the relevant enabling conditions and the possible applications and benefits. Conversely, there is little research on the impact of AI on cohesion within urban areas and on the relationship between urban areas and their broader territorial settings.

In recent years, the European Parliament has consistently given increasing attention to the use of AI in multiple sectors of the economy and the public sphere. Several EP committees have been active in this field, the importance of which is also highlighted by the setting up of the Special Committee on Artificial Intelligence in a Digital Age (AIDA). The "Digital Agenda" and its links with Cohesion Policy have been discussed in the Committee on Regional Development (REGI Committee), which has addressed concerns regarding the uneven impact on the different territories of the EU. Nonetheless, discussions of the importance of AI for regional development, and the significance of EU Cohesion Policy regarding the funding and enabling of AI development, have been marginal. In addition to this, financial data on individual projects is limited, and project examples are not properly highlighted.

Against this background, the REGI Committee requested an in-depth analysis of the role of AI in urban areas, its potential implications for cohesion, and an exploration of future cohesion-policy measures that adequately respond to the opportunities and challenges posed by AI technologies.

1.2 Objectives and research questions

This study provides updated and pertinent information to the Members of the European Parliament on the actual and potential implications of the use of AI in urban areas, and it does so by collecting evidence from the EU and beyond. It illustrates how AI technologies have started to shape a new way in which to manage urbanisation and territorial cohesion and to deliver "smart services" to citizens. A comprehensive approach to the contribution of AI to urban development has been adopted, including consideration of the cases of cities of different sizes and in different regional settings. The study investigates untapped opportunities, existing risks and challenges, drivers and barriers, and research gaps, in order to elaborate a number of policy recommendations relevant to the REGI Committee concerning EU cohesion and Cohesion Policy.

In particular, the study addresses the following research questions:

- What is AI, and how is it used in urban development?
- What are the enabling factors and barriers?

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2 For definitions, see the Glossary and Chapter 2.

- What are the opportunities and risks of using AI in urban development, and the implications for territorial cohesion within cities and between cities, and their broader territorial settings?
- What are the research gaps that will require further analysis?
- What EU policies and programmes support the uptake of AI in urban development?
- What might be the role of the EU Cohesion Policy in helping cities seize the benefits of AI while mitigating their social and ethical consequences?

1.3 Methodological overview and structure of the study

This study is based on extensive desk research drawing upon policy documents and grey and academic literature, as well as the most recently available published data on the deployment of AI in general, and in an urban context in particular. The analysis also benefited from the contributions of AI experts in science, industry and public institutions: these contributions helped provide a better insight into the challenges and opportunities of an increased use of AI-based technologies in urban planning and management of European cities. To acquire a more concrete understanding of the forms that Cohesion-Policy support can take in this area, illustrative project examples from the Operational Programmes in Italy and Denmark were selected.[3]

The variety of information sources deployed within this study contributes to a mitigation of the high levels of uncertainty related to the future development of AI, as well as to the controversial issues related to its social and ethical implications.

The study is organised as follows. In Chapter 2, it sets the conceptual framework to clarify relevant notions and provide a simple account of technological issues at stakes. Chapter 3 explores available evidence on how AI is being used in an urban context, in the EU and beyond. Chapter 4 reviews the expected advantages of AI, its risks with a specific focus on risk for socio-economic and territorial cohesion, and the conditions to secure advantages and mitigate risks. Chapter 5 analyses the policy response adopted by the EU and its adequacy to address the challenges that AI poses to local and urban authorities. Finally, the concluding chapter draws the lessons and proposes some lines of action, within the competence of the European Parliament. A glossary provides succinct definitions of technical terms used in the study.

[3] Country selection based on data availability and contrasting representativeness in terms of digital technologies' development levels, geography and Cohesion-Policy funding amounts.

2. ARTIFICIAL INTELLIGENCE AND CITIES

KEY FINDINGS

- AI broadly consists of a range of "human-like" cognitive capabilities performed by machines. It can be both software-based and / or integrated into specific hardware. AI-based technologies are still at an early stage of development, within which AI systems perform narrowly defined tasks driven by data analysis. Recent progress includes the development of machine-learning algorithms that can self-improve without detailed instructions from humans.
- The use of AI in city management relates to the collection, interpretation and analysis of data in support of policy-related decision-making and planning. AI can exert far-reaching impacts in numerous application areas, and several of these are critical for city management and urban development, including local government, health, safety, mobility and energy.
- Progress in combining AI with other digital technologies (Big Data, Internet of Things (IoT), Cloud and telecommunications infrastructure) making possible full interconnectivity is driving the development of smart-cities, aiming to make the most of such technologies to increase the quality of life and wellbeing of citizens.

2.1 Artificial intelligence: the basics

AI is a dynamic and broad scientific field of research, and generally consists of several human-like cognitive capabilities, as performed by machines. The High-Level Expert Group on Artificial Intelligence appointed by the European Commission in 2018 defined AI as, "software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behaviour by analysing how the environment is affected by their previous actions."[4]

AI-based systems can be purely software-based (e.g., conversational assistants, image-analysis software, search engines, speech and face recognition systems) or can be integrated into hardware devices (e.g., autonomous cars, drones, medical devices, advanced robots) (Delponte & Tamburrini, 2018). Due to the flexibility and diversity of AI-based applications, AI has emerged as an enabling technology cutting across several fields of application. While AI systems are still in an early stage of development, AI-based services and products are already pervasive within our daily lives. Nowadays, many products of common use are already based on machine learning and other AI technologies, and these include virtual digital assistants, biometric recognition systems, and planners and optimisers used in transport and logistics. Many more AI-based technologies are being developed, but their deployment has been delayed by technological limitations, as well as by ethical and safety concerns (e.g., driverless cars). The wide-ranging potential applications of AI and its fast development make it a

[4] https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai Another commonly used definition is in the EC Communication "Artificial Intelligence for Europe" (EC, 2018b, p.2).

transformative technology with potentially disruptive and far-ranging economic and societal repercussions (Delponte, 2018).

The lack of a mutually agreed definition on what *constitutes* AI technologies has made measuring and mapping AI developments more difficult. An operational definition that links core AI domains (the human-like capabilities simulated by AI) with technological areas, however, has been developed by the EU supported AI Watch platform[5] (Table 1:). This AI taxonomy integrates political, research and industrial perspectives and is particularly useful for classifying and describing AI-related activities. It also effectively describes the broad spectrum of AI subdomains that can subsequently be linked to specific real-life applications of AI. The table below illustrates the far-reaching nature of AI and the myriad uses of AI-based technologies.

Table 1: An operational taxonomy of AI core technologies and fields of application

	AI domain	AI subdomain
Core	**Reasoning**	Knowledge representation
		Automated reasoning
		Common-sense reasoning
	Planning	Planning and scheduling
		Searching
		Optimisation
	Learning	Machine learning
	Communication	Natural language processing
	Perception	Computer vision
		Audio processing
Transversal	**Integration and interaction**	Multi-agent systems
		Robotics and automation
		Connected and automated services
	Services	AI Services
	Ethics and Philosophy	AI Ethics
		AI Philosophy

Source: JRC, 2020 (Joint Research Centre)

The literature identifies three stages of AI development, starting with narrow or weak AI. Narrow, task-driven AI can perform specific and specialised intelligent tasks, and this already comprises many important industrial applications. It can, for instance, work with big data to perform pattern recognition of unstructured text and images. Although these systems may give the impression of thinking like human beings, they cannot perform outside or beyond the tasks that are assigned to them.

At the next level, general or strong AI comprises computing and robotic systems that achieve wide-ranging, flexible and integrated cognitive abilities, such as those possessed by humans. In the last stage of development, which is known as artificial super-intelligence, AI putatively becomes "better" than human beings.

5 AI Watch is the Commission's knowledge service for monitoring the development, uptake and impact of artificial intelligence (AI) within Europe, launched in December 2018.

Currently, AI is properly described as "narrow artificial intelligence". The current developments in AI science are driven by data and by progress in the development of algorithms for machine learning (i.e., algorithms that autonomously improve their performance by training themselves on data). In machine-learning systems, AI emulates human intelligence by collecting, processing and analysing data, and subsequently reaching a decision based on these steps (European Parliament, 2019a). On the other hand, the possibility of developing general AI or artificial super intelligence is still uncertain. While a general AI "take-over scenario" is considered a remote and distant possibility by most AI scientists, the increased use of narrow AI already entails significant social and ethical implications. As AI systems are set to act with increasing autonomy and to become more widely used, AI safety, transparency, and accountability concerns, including those related to poor decision-making, discrimination bias, job losses, and malicious uses of AI become more and more relevant in the AI policy agenda (Delponte, 2018).

Progress in AI has been enabled by technological advances and competitive pressure. AI originated in the late 1950s as a multifaceted computer-science research programme. Nevertheless, the main underlying ideas and proof-of-concept computer programmes had already been developed in the late 1940s by Alan Turing, and other pioneers of computer science and computer engineering, on both sides of the Atlantic Ocean. Still, only in recent years has AI made rapid advances, thanks to six converging factors: i) increased computer-processing power; ii) big-data availability; iii) increased global connectivity; iv) the availability of open-source software and data; v) improved algorithms; and vi) increased returns for business using automated and intelligent processes (World Economic Forum, 2018).

Due to the COVID-19 pandemic, organisations have invested even more in automation through AI, in order to expedite remote working, telemedicine, distance learning, and autonomous stores, thereby also improving their resilience to the dramatic changes brought about by lockdowns (World Economic Forum, 2021). Data, AI and supercomputers have been used to detect patterns in the spread of the virus and to identify potential treatments. Data analysis in real-time facilitated the prediction of the spread of the infection in specific locations, while simultaneously estimating the needs for beds, drugs and healthcare specialists (Alsunaidi *et al.*, 2021). Robots have been employed in hospitals to reduce human interaction and the risk of spreading the contagion. Data will also be crucial for devising recovery strategies based on accurate data analysis.

AI is seen as a disruptive technology that can help humanity to address the most pressing societal challenges. AI is also perceived by many as the catalyst that is facilitating a Fourth Industrial Revolution based on unprecedented technological progress. There are up to nine applications within which AI can be a "game changer": i) autonomous and connected electric vehicles; ii) distributed and smart energy grids; iii) smart agriculture and food systems; iv) next-generation weather and climate prediction; v) smart disaster response; vi) AI-designed intelligent, connected, and liveable cities; vii) decentralised water (smart meters and water pipelines), and oceanic-data platforms; and ix) the Earth Code Bank for biodiversity[6] (World Economic Forum, 2018).

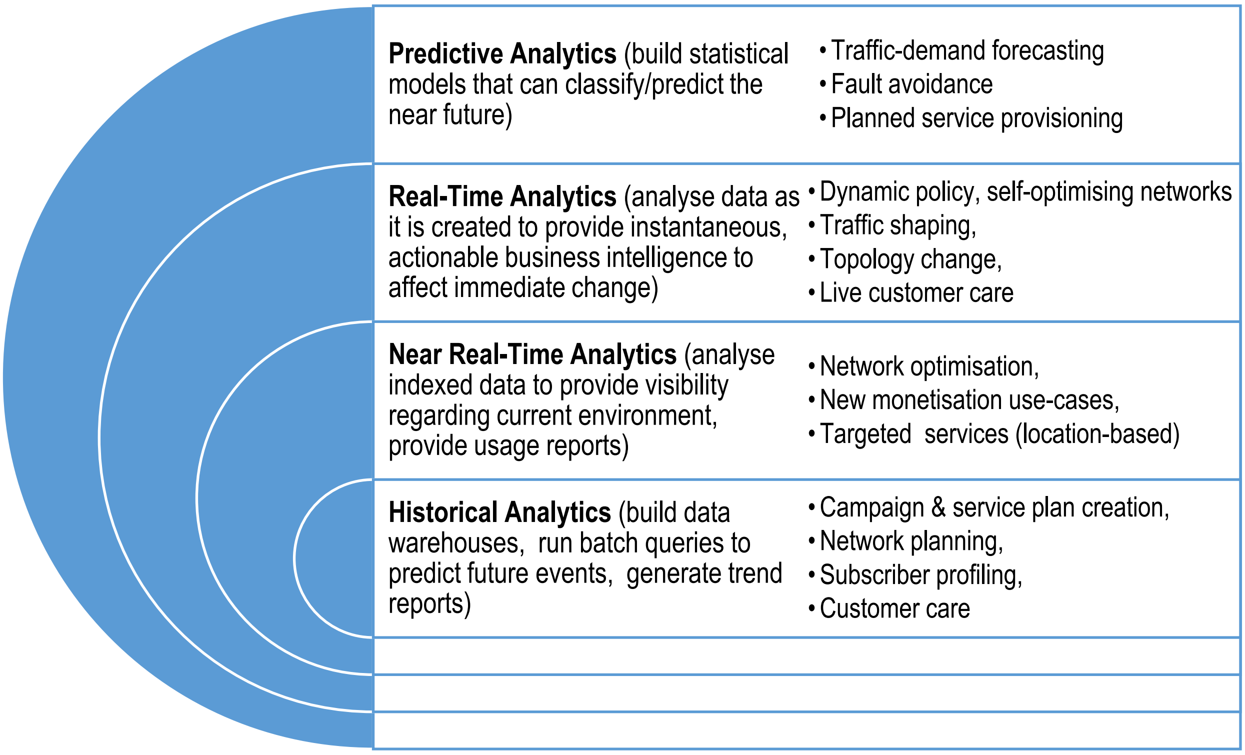
6 A vast collection of genetic sequences for the natural world.

2.2 Artificial Intelligence in urban development and city management: the link with smart cities

2.2.1. AI in an urban context

Technically, the use of AI in city management relates to data collection, interpretation and analysis in support of policy decision-making and planning and improved delivery of services of public interest (Figure 1:).

Figure 1: Data analytics applied to city management



Source: Authors, based on Khoa Nguyen, 2018

By seizing the opportunities offered by data-analytics techniques, AI can provide a large range of solutions, which can have far-reaching impacts in several areas (Figure 3:). There are virtually countless application areas where AI can be mobilised to enhance the internal operations of a city or to handle service provision (OECD, 2019a). Different categories of application area are referenced in the literature: these include, for example, economy, people, governance, mobility, environment and living (Mark & Anya, 2019).

Figure 2: Examples of AI use in city management

City of Dublin
Ireland

The Dublin Beat
Analysing citizen opinions on social media

Contribution of AI
Public tweets are collected and analysed in order to give a regular overview of citizen's most pressing concerns in the Dublin Area

Amsterdam city
The Netherlands

AI to discover illegal renting
Predicting fraudulent renting of homes

Contribution of AI
Use of AI to identify housing fraud to track down people renting out their houses illegally, replacing the process previously done in full by humans

City of Copenhagen
Denmark

Corti AI
Detection of cardiac arrests in emergency calls

Contribution of AI
Corti assists the Emergency Medical Dispatch Center in Copenhagen to recognize arrests in emergency calls

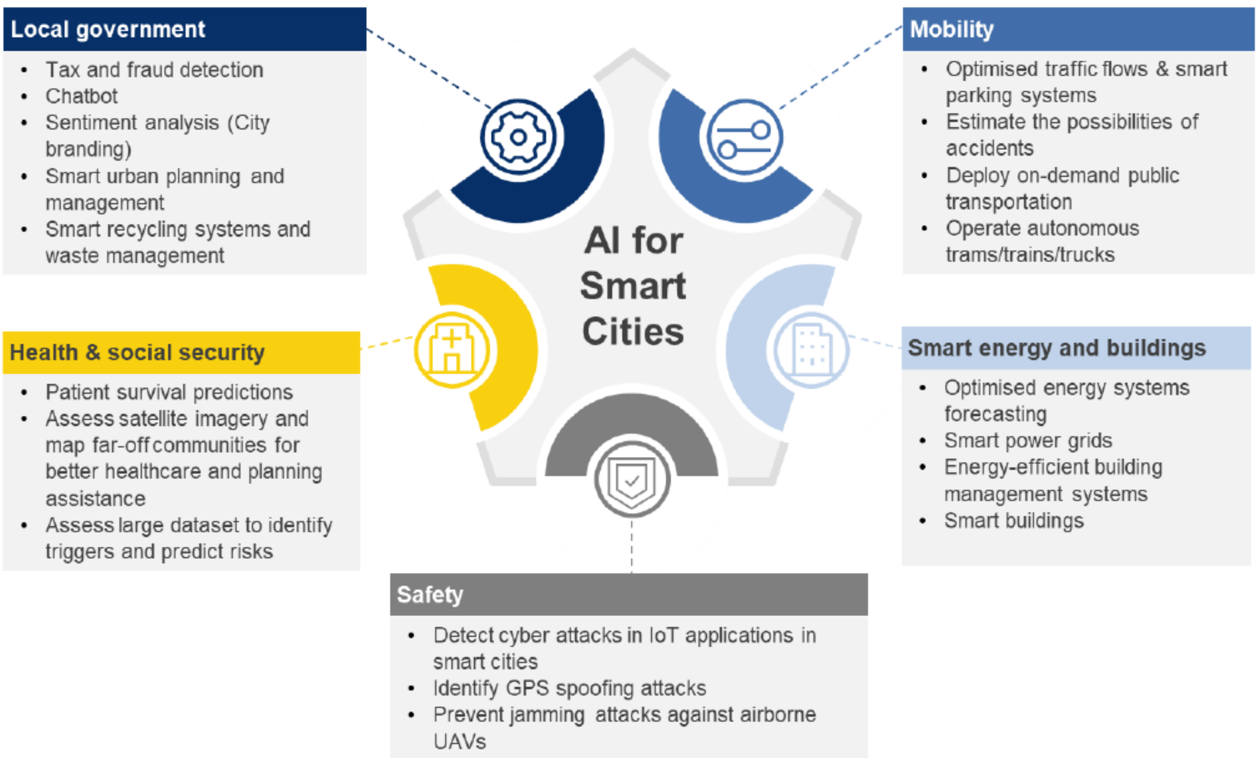
Municipality of Fuengirola
Spain

AI for measuring beach attendance
Controlling the capacity of public spaces

Contribution of AI
The Fuengirola Town Hall aims to use AI in order to control the capacity of beaches and other public spaces

Source: https://digital-strategy.ec.europa.eu/en/library/dih-webinar-artificial-intelligence-smart-cities

Figure 3: AI for smart cities



Source: European Commission, 2020a

2.2.2. AI and the smart-city concept

The OECD defines smart cities as *"initiatives or approaches that effectively leverage digitalisation to boost citizen well-being and deliver more efficient, sustainable and inclusive urban services and environments as part of a collaborative, multi-stakeholder process"* (OECD, 2019a). Smart cities are therefore at the interface between social and technological dimensions.

The technological dimensions of smart city and the role of AI

While urban and local authorities can resort to AI to improve the efficiency of a given decision-making process or enhance the delivery of a public service, **AI actually makes the most of its potential in a smart-city environment**.

The combination of AI and other digital technologies (big data, Internet of Things, cloud and telecommunication infrastructure) enables the development of smart cities. The increasing use of digital devices, sensors, the Internet of Things and the unprecedented growth in data generation have made cities "smart", at least nominally and theoretically. In particular, the surge of data and increased capacity for (big) data processing have opened multiple opportunities for the deployment of AI-based technologies in city management. Smart cities are at the forefront of digitalisation enabled by local data-platforms, alongside the integration of data from multiple sources that facilitate the development of AI-enabled services.

Box 1: The technologies that drive the digital transformation of cities alongside AI

Internet of Things is a network of physically connected devices, such as vehicles or home appliances, that enables these "things" to connect and exchange data.

Security and privacy technologies are essential when building trust. An example of such a technology is blockchain, a mathematical structure for storing data in a manner nearly impossible to fake. It can be used for all kinds of valuable data. In smart cities, blockchain technologies are fundamental, since they eliminate the need for intermediaries and establish the basis for trust, although there are issues with the scalability of this technology. Alternative approaches can be used to secure trust and data integrity, such as centralised databases, centralised ledgers, and distributed databases.

Cloud computing comprises the delivery of different services through the Internet. This includes tools and applications such as data storage, servers, databases, networking and software. The mass of data produced by smart cities requires significant storage and computing capacity that can be accessed remotely, independently of the city location.

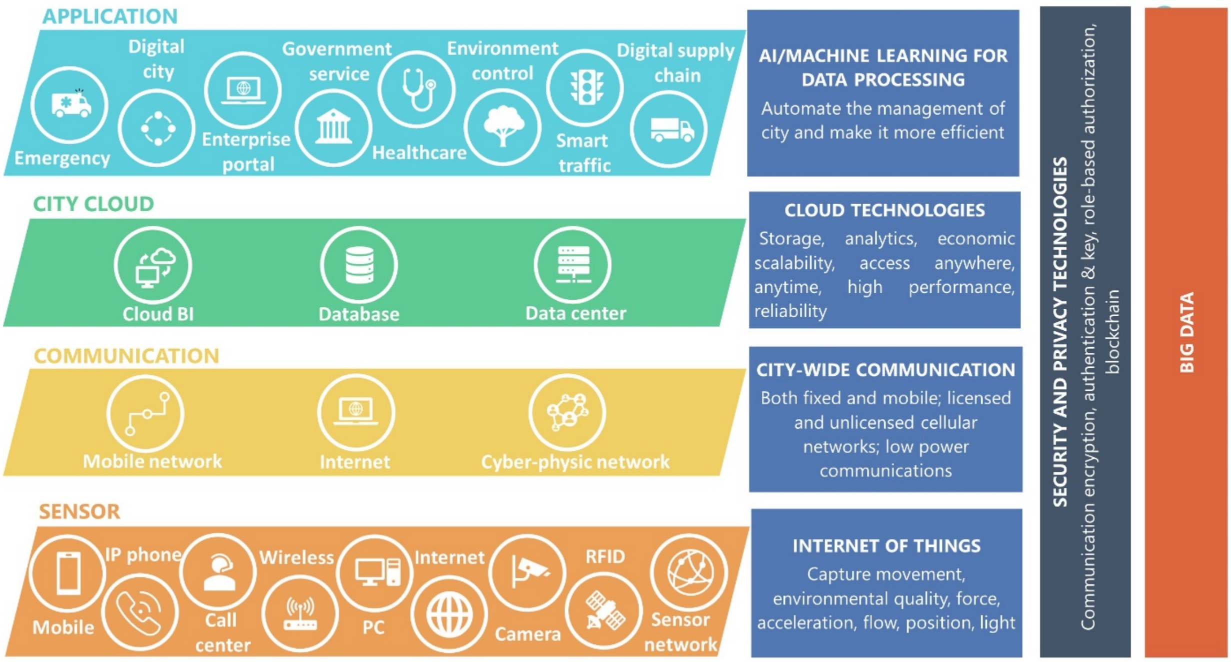
Big Data refers to the treatment of a large and exponentially growing amount of data that cannot be processed using traditional methods. In smart cities, big data are generated by sensors and processed by AI.

5G is the fifth generation of cellular data technology. Its benefits include faster speeds, low latency and greater capacity. As such, 5G infrastructure is set to unleash smart-city applications.

Source: Authors' own elaboration

From a narrow technological point of view, the smart-city concept indeed relies on a combination of rapidly evolving digital technologies, including – but not restricted to - progress in AI-based applications. The combination of sensors, hardware, data storage, microprocessors, and software transforms urban objects and infrastructure (cars, buildings, bikes, waste bins) into smart devices that are always connected and embedded in broader and unified ecosystems, which in turn re-shape the city fabric (Figure 4:). AI-based applications establish a connection between the physical and digital worlds to improve efficiency, reduce cost and waste, and ultimately improve city life. AI allows data to be analysed more deeply than ever before by processing big data that humans alone cannot view, process, or analyse. From this perspective, AI constitutes the last layer wherein seemingly incoherent data are converted into meaningful information.

Figure 4: AI is one of the key technologies driving cities' digital transformation



Source: Authors, based on Khoa Nguyen, 2018

In particular, machine-learning applications can analyse different urban patterns from both a spatial and a temporal point of view, within one integrated system. These systems can enrich the information derived from satellite and drone imaging with specific metadata, such as insights regarding building usage or transportation timetables. The digital transformation within cities intensifies quickly as human activities continue to create data trails (through smartphones and electronic transactions), objects become smart and transfer data wirelessly, the cost of environmental sensors and network devices continues to drop, and the ICT industry generates ever-more processing power, storage capacity, and analytical software.

Overall, the long-term vision of smart cities is improved quality of life in different dimensions, thanks to **full interconnectivity** made possible and exploited by AI (e.g., self-driving cars and buses connected to smart highways, parking spaces and traffic lights). In this sense, **AI brings the smart-city model to its full accomplishment**. The notion of digital twins described in the box below is a further illustration. While not all smart cities are necessarily AI-based, the most advanced ones typically are. This is the reason why in general, as documented in the rest of this study, AI and smart city are indissociable topics.

Box 2: Digital Twins

In cities with a high level of digital maturity, advanced AI applications that permeate city planning and management become possible. A notable example is the development of digital twins. A digital twin is a virtual replica of a physical system (e.g., a city) created by combining vast amounts of data. Digital-twin technology deeply integrates hardware, software, and IoT technologies to enrich and improve virtual entities that, in turn, provide insights through data modelling beyond what is currently seen. This approach was first developed by NASA for the aircraft and aerospace industries and quickly spread to other industrial sectors. The construction of a digital twin city requires a data foundation (the massive amount of data generated by sensors and cameras, along with the digital subsystems generated by municipal departments) and a technical foundation (technologies such as the IoT, cloud computing, big data, AI and, finally, 5G, which delivers data to the cloud to be analysed by AI). Digital-twin approaches display four main attributes:

- Accurate mapping, via a comprehensive digital modelling of the physical city;
- Virtual-real interactions, e.g. traces left by human beings and objects;
- Software definition, via the virtual model based on the physical city and the simulated behaviour of people and objects in the virtual realm; and
- Intelligent feedback, i.e., an early warning system of possible adverse effects combined with feasible mitigation measures (Deren, Wenbo & Zhenfeng, 2021).

In urban management, the digital-twin concept establishes a platform whereby policymakers can improve urban governance, enhance citizens' participation and monitor government decisions (Deng, Zhang & Shen, 2021). It can thus be applied for short-term operational, but also for more long-term and strategic purposes. For instance, the digital-twin technology can simulate the impact of the change of a given street to a pedestrian area or of the removal of a parking space. Furthermore, city-data storage and data-driven insights from one city could be used to define a smart-city blueprint that might be transferred to other city contexts and accelerate the smart-city transition.

Source: Authors' own elaboration

The social dimension of AI

As illustrated in the OECD definition above, **the smart-city concept is broader than the concept of a digitalized city**. Techno-optimism regarding smart cities should indeed be questioned (Inclezan & Pradanos, 2017). Smart cities have moved away from their initial supply-side and sector-driven dimension, and they are no longer seen as mainly led by the private sector, with the latter defining both the problems and the solutions (OECD, 2019a).

Smart cities should combine elements of better governance, inclusion and sustainability, alongside the digital transformation enabled by new technologies[7]. They should respond to citizens' concerns and ultimately contribute to improving their quality of life. The ITU (International Telecommunication Union) describes a sustainable smart city as an, "*innovative city that uses information and communication technologies (ICT) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects*". Operationally, the **smart-city concept rests on three pillars**: i) smart governance, i.e., a framework that enables collaboration across city departments to ensure coherent and realistic city planning; ii) smart policy, meaning the identification of those priority areas where smart concepts can be developed and applied; and iii) smart technologies. This is an important feature to bear in mind when identifying the conditions to profit from AI in urban development.

[7] In this respect, see the UN Habitat people-centred smart city flagship programme : https://unhabitat.org/programme/people-centered-smart-cities and the citizen-focus and city led digital transformation through the Living-in.eu community: https://living-in.eu/ . The latter is further addressed in Chapter 5 of the present study.

3. HOW IS ARTIFICIAL INTELLIGENCE BEING USED IN CITIES? AVAILABLE EVIDENCE

KEY FINDINGS

- There is evidence that smart cities that use AI are growing fast, in particular in the aftermath of the COVID-19 crisis. Yet aggregate quantitative evidence is difficult to collect, in part due to the multiplicity of the forms smart cities can take, and their use of AI.
- More qualitative evidence from specific examples shows that the use of AI by local urban authorities is still mostly restricted to simple tasks. In general, incremental approaches are adopted to gradually develop initiatives and capacities in the area of AI.
- There are showcase examples of larger and/or high-income cities, which have been early adopters of the smart-city concept and which show remarkable progress in the diffusion and exploitation of AI.
- There is overall little systematic evidence on the rolling out of AI strategies and their effect.

3.1 Aggregate evidence

There is converging evidence that smart cities that use AI are growing fast, driven by a rising urban population and increasing uptake of digital technologies. Increasing urban populations have driven the adoption of the smart-city concept, which is intertwined with digital technologies in addressing cities' challenges. By 2050, nearly 68% of the world population is projected to live in urban areas (United Nations, 2018). UN data also shows that Europe is already one of the most urbanised regions globally, with over 74% of its population living in cities. Urban growth has brought many challenges in terms of providing public services for all city residents (housing, transportation, energy, healthcare and education), as well as resource depletion, environmental degradation and the pollution of air, soil and water.

According to IDC data from the Worldwide Smart Cities Spending Guide, global spending on smart-city initiatives will total nearly EUR 101 billion in 2020, an increase of almost 19% over 2019[8]. Other sources confirm strong upward trends in different indicators, thereby underlying the development of smart-city initiatives across the globe. For example, technology spending on smart-city programmes is forecast to more than double between 2018 and 2023 (from USD 81 billion to USD 189.5 billion) (Statista, 2021).

The impact of the COVID-19 crisis is as yet unmeasured. Still, it could have been considerably mitigated by the use of digital solutions by cities to deal with several aspects of the crisis, for example, by relaying real-time life-saving information, by supporting the delivery of essential services (e.g., telemedicine) and by addressing social isolation (OECD, 2020a).

Beyond the collection of objective aggregate data on funding and uptake, qualitative-quantitative monitoring of smart-city development is not a simple task. If anything, it requires a shared definition of what a smart city is. Different indices and composite indicators are available to identify, classify and rank smart cities according to a set of criteria (e.g., ITU, 2021; OECD, 2020a). Nonetheless, the fact that

8 Please note that these figures are not restricted to AI, but cover all smart city-related expenditure.

there is no uniform, one-size-fits-all model or definition of a smart city makes measurement difficult (OECD, 2019a).

In particular, obtaining a detailed picture of the development of smart cities across the EU is challenging. Indeed, several catalogues of initiatives exist, but they typically operate with different definitions and are not exhaustive. Previous studies have attempted to quantify their number, but they tend to be relatively old and are unlikely to capture the current situation fully. For example, in 2014, it was estimated that 240 EU cities, with at least 100,000 residents each, had implemented or proposed initiatives falling under the definition of smart cities[9] (European Parliament, 2014), with a clear underrepresentation of the Eastern Member States.

Larger cities tend to be more advanced in this area, with 43% of cities between 100 000 and 200 000 residents having some characteristics of smart cities, as compared to 90% for cities above 500 000 residents. Unfortunately, among these, it is impossible to identify those with an explicit AI dimension. Smart cities with a particular, dedicated focus on AI, such as Amsterdam[10], still appear to be a minority at this stage compared to cities with a more traditional ICT orientation. Systematic assessments of small or medium-sized smart cities are even more scarce, and also tend to be older (Vienna University of Technology, University of Ljubljana, and Delft University of Technology, 2007). Nevertheless, the forthcoming Local and Regional Development Indicators (LORDI) should address this shortcoming. They are currently being developed within the Living-in.eu community (see section 5.1.3), under the coordination of the Committee of the Regions and the European Spatial Planning Observation Network (ESPON).

3.2 Evidence from specific examples

Obtaining a full picture of the use of artificial intelligence in cities at the aggregate level is thus still difficult, owing to the relatively recent emergence of these technologies, the plurality of definitions used, and scepticism regarding their benefits. Nonetheless, a common alternative is to reflect on **samples of specific examples** that can inform us as to the variety of potential applications, as well as the importance of contextual factors for their successful implementation.

A recent report from AI Watch[11] comprises an exploratory mapping of the use of AI in the public sector, based on a high-level review of policy documents, together with an analysis of the grey literature, public administration websites and contacts with Member States' authorities. According to this mapping, a total of 230 examples of AI were identified across various public services. Predictably, there are several limitations to this mapping, including issues of definition, translation and coverage, but this remains a rich overview of the current EU landscape. In particular, the report reveals that about 30% of the detected AI initiatives (i.e., 70) could be attributed to the local level (JRC, 2020a). Moreover, the authors note that **local authorities** (especially cities) are recognised as **leading stakeholders in experimenting with AI technologies,** with a view to dealing with different policy issues at an urban / infra-regional scale. In consequence, they may be more common than the mapping suggests.

In terms of examples, the recorded initiatives provide insights regarding the **wide variety of uses of AI**, both in **terms of typology** (e.g., predictive analytics, chatbots, automated decision making, etc.) but also of **sectoral use** (e.g., welfare, public services, social protection and transportation). It seems that in most cases, AI is used to improve performance (e.g., by enhancing the delivery of a specific

9 A smart city is defined here as, "a city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership".

10 See https://sciencebusiness.net/data-rules/news/ai-opens-new-avenues-smart-cities

11 See https://publications.jrc.ec.europa.eu/repository/handle/JRC120399

service). Interestingly, one finding is that, despite their potential to foster disruptive transformations, those AI applications implemented thus far seem largely to bring about *incremental* changes implemented gradually (JRC, 2020a). The following box shows an example that highlights how AI has been used to gradually improve applications surrounding welfare in the context of a Swedish city.

Box 3: AI for automated public services: the case of Trelleborg

City name: Trelleborg (Sweden)

Population: 45,877 (2020)

Regional innovation level: "innovation leader" (Scania, (EC, 2019c)[12]

Digital performance level: "high performance" (Scania, (EP, 2018a))[13]

The small city of Trelleborg in Sweden was the first city in that country to use Robotic Process Automation technologies to manage several application systems for welfare / social assistance. Consequently, it is a prime example of the potential, and the risks, linked to the use of AI in this sensitive area, as the latter impacts policies such as homecare, sickness benefits, unemployment and taxation.

Before the introduction of AI, municipal employees had manually to assess received welfare applications, which took time and incurred costs. The use of AI, as developed in collaboration with Valcon, a local consultancy, was seen as a way to improve waiting times and to reduce costs. It should be noted that, at present, the workers themselves still handle rejected applications.

In terms of effects, the automation process has indeed significantly reduced waiting times for applicants. Some municipal employees have also been transferred to other tasks.

Nonetheless, this case also shows that there are notable concerns and resistance linked to the use of AI for these policies. In particular, many social workers were hesitant to embrace the system due to fears of unemployment, the risk of passing sensitive tasks to computers and concerns about the meaning or flexibility of social work. Moreover, the deployed algorithm has been criticised for being a "black box" lacking transparency, even with its readily available source code.

Source: The authors, based on Algorithmwatch; City Population, 2021a; European Commission, 2019c, 2019c; European Parliament, 2018b; JRC, 2020b

The **incremental approach** seen in much of Europe could be a positive development, provided it **helps to deal with certain remaining issues** (e.g., privacy, mitigating risks) and **gradually increases the social acceptability** of these technologies for further applications. In this sense, the current examples can pave the way for different future routes to digital transformation.

3.3 Different routes to digital transformation

Cities can take different routes to their respective digital transformations, depending on the availability of infrastructure and the uptake of digitalisation in public administration and citizens' lives. One challenge is to choose whether to develop an AI solution for an entire city (i.e., *some elements* of the smart city deployed throughout the whole urban area) or to develop a comprehensive AI system merely for *some parts* of a metropolitan area.

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[12] According to the European Innovation Scoreboard, see https://ec.europa.eu/growth/sites/growth/files/ris2019.pdf

[13] According to a classification in European Parliament (2018) *Digital agenda and cohesion policy*. available at: http://op.europa.eu/en/publication-detail/-/publication/a58141b0-f9d2-11e8-a96d-01aa75ed71a1/language-en/format-PDF

Some urban areas are **very advanced in the uptake of AI and the concretisation of their smart-city models**. They have already reached a high level of AI integration in multiple policy areas, sometimes in an integrated manner. For instance, the cities of Singapore, New York, Seoul, Stockholm and Amsterdam have pioneered the use of digital technologies in city management, thanks to the availability of ultra-high-speed communication networks and extensive low-power wide-area networks[14] (McKinsey Global Institute, 2018). The domains in which AI is deployed also vary considerably, depending upon local policy priorities as well as the size of the town / city. As an example, the Helsinki Energy and Climate Atlas aims to support that city's ambition to reach carbon neutrality by 2035, and it thus uses semantic models of data for solar energy and heat. In Amsterdam, the main focus is on mobility (data from traffic and public transport), the human environment (air quality), and energy transition (using, e.g., data from solar panels installed on buildings in the area, while information on wind-turbine outputs and building efficiency is also integrated).

Box 4: AI in an advanced smart city: the case of Amsterdam

City name: Amsterdam (the Netherlands)

Population: 862,965 (2018)

Regional innovation level: "innovation leader –" (North-Holland, (EC, 2019c))[15]

Digital performance level: "high performance" (North-Holland, (EP, 2018a))[16]

Amsterdam has a particular place in the landscape of smart cities, given its very advanced stage of development. Indeed, the municipality of Amsterdam has integrated digital issues and a smart-city vision into its development agenda for more than a decade. In 2018, Amsterdam launched its own policy for digital rights and installed a Deputy Mayor dedicated to protecting human rights in the digital arena. In concrete terms, these efforts are now backed by the active participation of civil society in the city's digital transformation. This is achieved, for instance, through structures such as the Amsterdam Smart City (created in 2010), well-grounded infrastructures and a data policy that facilitates collection, processing and storage.

Thanks to this very high level of digital readiness, the city of Amsterdam has been able to act as a pioneer of AI applications at the urban level, affording some valuable lessons on how to address preconditions for the success of such applications and their potential uses. The city not only tries to apply AI to improve service delivery and to develop applications for the public good (e.g., the reduction of AI discriminatory bias), but also stimulates the use of these technologies in that direction through a consortium involving businesses and universities. Overall, the city puts "public good" and digital rights before striving to be a "smart city" *per se*. For instance, it actively advocates for a strong regulatory approach to AI and data collection as part of the Cities Coalition for Digital Rights.

The city's policy on transparency is a major pillar of digitalisation, and this also applies to AI applications. For example, Amsterdam has been refining its open-data approach since 2012. A specific effort has been made to involve the different city departments in centralising various extant datasets, alongside thematic discussions and groups (e.g., energy, mobility, etc.). Dedicated

[14] A class of wireless technologies that are well suited to the specific needs of IoT devices, since they offer a low-cost and power-efficient wireless option that leverages existing networks, global reach, and strong built-in security.

[15] According to the European Innovation Scoreboard, see https://ec.europa.eu/growth/sites/growth/files/ris2019.pdf

[16] According to a classification in European Parliament (2018) *Digital agenda and cohesion policy*. available at: http://op.europa.eu/en/publication-detail/-/publication/a58141b0-f9d2-11e8-a96d-01aa75ed71a1/language-en/format-PDF

programme managers also work specifically on the open-data policy. Indeed, Amsterdam's open data is freely available on an online portal[17]. This has allowed the development of several applications while securing the privacy of personal information.

Since 2020, the city of Amsterdam has been developing an open AI register, aiming at ensuring transparency in the use of AI and building trust with citizens. This initiative details where and how AI applications are being used by the municipality, the source datasets that can be used to train the algorithms, the assessment of AI structures for potential biases or risks, and the ways humans may interact with AI-powered services. The register also allows citizens to provide feedback. At the time of writing, the register is still in development, but it already presents several examples of AI in the city in a clear manner accessible to laypeople. It may help to build and concretise a localised, bottom-up approach to AI as a public service. For instance, AI is used in the city for the automated detection of illegal holiday-rental housing. It also serves as a best-practice model to encourage businesses to be transparent about the way they use AI in the city.

Moreover, in collaboration with a private partner, Amsterdam has also developed a digital twin of the city, using the wealth of data it has collected in different areas (e.g., traffic flows, public transportation, parking occupancy, energy production, building-related energy labels, air pollution, etc.). This digital twin is a 3D representation of Amsterdam, using open standards and enriched with specific information on the city and its status.

Moreover, the digital twin is presented on a dashboard that allows for the visualisation of different performance indicators. As such, it supports decision-making for immediate actions. Research on other applications, such as tools for predicting future traffic flows, is also performed based on this twin city.

Source: The authors, based on European Commission, 2019c; European Commission, Joint Research Centre and CAS (Centre for Advanced Studies), 2021; European Parliament, 2018b; National League of Cities, 2016; Urbistat, 2021

More generally, larger and/or high-income cities have been early adopters of the smart-city concept, but smaller cities can also benefit from a process of gradual digitalisation, in which AI can play a role. When resources are constrained, or there is a shortage of in-house high-level skills and digital infrastructures, cities are discouraged from pursuing smart-city ambitions. Cities with more urgent needs may also face criticism when trying to develop smart-city projects. Nevertheless, the examples of large cities that have embraced a digital transition show that this was pursued in a gradual manner and, at least initially, for only a limited number of municipal operations. For cities that start this process, it makes sense to begin with simple interventions that increase awareness and build trust amongst businesses, citizens and the public sector. Often, the main issue is not the availability of the technology, but rather the establishment of sound governance and the availability of the necessary skills to extract value from the data generated by urban functionalities. A more gradual implementation also has the advantage of allowing policymakers to examine costs, benefits, viability and constraints along each stage of development. Furthermore, this approach helps to secure trust, while enhancing the social acceptability of the new technologies and of the related practices being rolled out. The box below presents an example of "smart" interventions on a reasonable scale that used existing technologies (not, necessarily, AI in a direct sense) and exploited existing data to improve city services and citizens' well-being. The box focuses on the gradual adoption of a digital twin with an AI dimension in the medium-sized city of Pilsen, which has a moderate level of digital maturity.

[17] https://data.amsterdam.nl/

Box 5: Categories of small-scale intervention for a smart-city transition

Digitalisation of city administration consists of projects that explore ways to improve administrative functions (e.g., record keeping and data governance via the application of Cloud technologies, process enhancement through the creation of digital processes). Data analytics have been employed in city fleet management to reduce costs and fuel consumption. These systems can be developed in sequential stages, starting with basic record-keeping for vehicles and gradually extending to real-time monitoring.

Environmental interventions comprise the application of smart interventions that collect and analyse data on natural-resource consumption or pollution levels, in order to improve understanding of both the problems and the effectiveness of solutions. Low-cost IoT devices can collect data to monitor dust, air and soil pollution, as well as many other environmental-quality parameters, to provide an accurate and real-time picture of critical situations.

People and the city's relationship with them: this field includes all types of intervention that increase trust in the use of data and support digital literacy for citizens and businesses. It comprises projects that address the ethical and social consequences of employing AI in the urban context and aims at making smart cities more inclusive, moving beyond a purely technocentric approach. Health Apps have proven highly relevant during the COVID-19 crisis in monitoring the spread of the infection at local level and informing citizens.

Experiences of the city includes interventions about the day-to-day life quality of citizens, e.g., projects related to mobility. Integrated public-transport information systems combining data from different transport-service providers help citizens and visitors to identify optimal choices for moving around the city. More sophisticated systems can also use dynamic transit schedules by checking vehicle positions in real time.

City resilience projects include initiatives that address the three main aspects of urban resilience, namely: i) structural resilience, which refers to the "systemic and infrastructure aspects of resilience"; ii) integrative resilience, which highlights the "complex interconnections of the system"; and iii) transformative resilience, which examines broader capacity issues and longer time horizons in terms of distributed governance, foresight capacity and innovation and experimentation. One notable area of application that has emerged is the mitigation of the effects of climate change, with examples in the Netherlands and Denmark that seek to prevent the risk of flooding.

Source: U4SSC, 2021

Box 6: Pilsen Digital Twin

City name: Pilsen (Czech Republic)

Population: 165,000

Regional innovation level: "moderate +" (Pilsen region, (EC 2019c)) [18]

Digital performance level: "moderate +" (Pilsen region, (EP 2018a))[19]

Pilsen is a medium-sized city in the Czech Republic. It faces multiple issues with transport planning and urban development. In recent years, Pilsen has implemented a smart-city paradigm in different policy areas (e.g., mobility, living, environment, economy, and eGovernment). Nonetheless, the smart city here is still in its early stages of development, with data-based planning still fragmented between sectoral silos.

To circumvent these issues and consolidate its smart-city approach, the city participates in the Digital Urban European Twins project (H2020), by implementing a digital-twin concept focusing on transport, mobility, urban planning, the environment and well-being. It will particularly target noise pollution.

This project builds upon previous research projects (H2020) regarding traffic modelling and tools for policy-making (OpenTransportNet,[20] PoliVisu[21]). These models will be exploited in the digital twin via the development of tools for model-model interactions between traffic, air-quality and noise-pollution paradigms. Consequently, the city will be able to simulate different scenarios of urban development, including road construction/closure, and their impacts on various outcomes, such as noise, the environment, and citizens' well-being. For instance, a tool for traffic modelling is available online[22].

Source: Authors, based on Digital Urban European Twins; European Commission, 2019c; European Parliament, 2018b; Jedlicka *et al.,* 2020

In **very small cities**, or in places where **technological or social preconditions are not in place**, the **uptake of AI** in terms of implementing a smart-city/community vision **may not be warranted**. In these cases, building up basic ICT infrastructure and ensuring the development of initial skills may be the most appropriate approach.

[18] According to the European Innovation Scoreboard, see https://ec.europa.eu/growth/sites/growth/files/ris2019.pdf

[19] According to a classification in European Parliament (2018) *Digital agenda and cohesion policy*. available at: http://op.europa.eu/en/publication-detail/-/publication/a58141b0-f9d2-11e8-a96d-01aa75ed71a1/language-en/format-PDF

[20] https://cordis.europa.eu/project/id/620533

[21] https://www.polivisu.eu/

[22] https://plzen.trafficmodeller.com

4. ADVANTAGES AND RISKS OF AI IN URBAN DEVELOPMENT

KEY FINDINGS

- The expected benefits from AI in smart cities are huge. They range (e.g.) from efficiency gains, new services, new business opportunities and better governance to increased citizen engagement and improved environmental sustainability. Nevertheless, aside from the cases of a few frontrunners (generally mega cities), there is still little evidence that these positive effects actually materialise.
- Possible risks may also bring about important unwanted consequences. These consist of technological failure, ethical dilemmas, negative economic consequences, and social/territorial discrimination.
- To mitigate risks and realise the potential of AI, urban authorities must ensure that a rather challenging series of conditions are met, from data access, interoperability and legal frameworks to more intangible elements, including an appropriate governance structure, administrative capacity, skills and overall popular awareness.
- If these conditions are not met, there are risks to cohesion both within and between cities and, indeed, between cities and their surrounding (rural) areas.

4.1 Expected benefits

In a smart-city environment, the possibilities offered by the integration of data from multiple sources, and the subsequent delivery of value for citizens, are enormous. AI systems use vast amounts of data, apply learning algorithms, and learn patterns from historical data to predict outcomes and possible scenarios. Machine learning can replicate what a human being might do with the best available data. Through this process, and via the availability of more and more data to analyse, algorithms eventually evolved and became better at performing their tasks. By analysing large volumes of data from multiple sources, AI can better support decision-making, help predict events and allow for more personalised services (Tomer, 2019).

In aggregate terms and by using these technologies, according to a report by the McKinsey Global Institute (2018) that analyses the current application of digital solutions in city management, cities could **improve some quality-of-life indicators by 10–30 percent** (McKinsey Global Institute, 2018). These include positive outcomes such as reducing fatalities, accelerating emergency responses, reducing commuting time and cutting greenhouse-gas emissions. Of course, such aggregate figures conceal different factors, and they may fluctuate with different methodological hypotheses and approaches. This section relies, however, on studies within the literature that adopt a more qualitative and descriptive approach.

There are **high expectations regarding the benefits of AI and smart cities**. These expectations are associated with the smart-city model, and with AI. The advantages and benefits of AI either accrue directly from AI, or they can be attributed to the smart-city model, which in turn runs more effectively and efficiently thanks to AI.

As per the ultimate objective of smart cities, they are expected to contribute to a better quality of city life on multiple levels. From the point of view of local / urban authorities, it is useful to distinguish between two broad categories of expected benefits, namely, the improved provision of public services and improved management and governance. There are also direct and indirect expected effects regarding economic activities and environmental sustainability, as detailed below.

The use of digital technologies and AI to enhance smart cities can both **improve existing services of public interest and create new ones**. These services are expected to be "citizen-centred" and to improve different aspects of citizens' everyday life. In principle, AI within the smart city can foster the better engagement of citizens through participation and feedback. Moreover, since it can rely on a more exhaustive evidential basis (open data, crowdsourcing, etc.), AI can assist in better identifying citizens' needs and preferences and in providing those citizens with adapted tailored solutions. Examples include car-sharing, home-sharing, automated vehicles (AV), transport mobile applications, etc.

Further, policy decisions can be taken on the basis of stronger evidence and greater efficiency. A specific quality of AI is that it allows for the integration of urban systems (transport, energy, water, waste, etc.), which facilitates targeted real-time interventions and more accurate predictions. This contributes to improvements in the overall efficiency of urban management (OECD, 2019a). For example, smart grids help to adjust demand and supply for energy. Additionally, traffic management can generate improvements through real time as well via predictive data analytics. Other examples are the use of IoT in port cities to improve the management of shipping, the activation of street-lamps and parking metres, etc.

Overall, AI can enhance the efficiency of public services, reduce red tape, disrupt silos, increase transparency, foster organisational change and improve overall governance.

In the private sphere, too, smart cities powered by AI are expected to bring several benefits. AI in the smart-city context can generate new **business opportunities**, often directly through the provision of new services, which create opportunities for start-ups and service providers. Indirectly, meanwhile, the smart city is a testing ground for experimenting with new solutions, and it thus becomes a hub for innovation activities, attracting skilled workers and opening up new economic opportunities that may ultimately impact positively on job creation.

The specificity of digital investments, and of AI in particular, is noteworthy in this respect. An initial investment can yield high returns to scale because of a temporary exclusivity based on first-mover advantages, intellectual property right, brand reputation, or network effects. In the specific case of AI, this advantage is reinforced because learning from data is a cumulative process; hence, a small initial comparative edge can rapidly transform into a dominant advantage. This favours creative destruction and allows newcomers into the market, but it also catalyses a winner-takes-all effect and the concentration of economic activity (see section 4.2 on "risks" below).

Of specific interest is the fact that smart cities powered by AI are expected to contribute to **better environmental sustainability** and **resilience**. AI can expand our capacity to understand and tackle environmental challenges by providing actionable evidence on the state of the environment and interactions between the economy, society and the environment (UNEP, 2019). As one example, AI can help forecast and better manage natural disasters. Furthermore, the different services cited above can have a positive effect on environment sustainability by matching the demand and supply of energy, fostering a circular economy and, in general, facilitating more efficient energy management. The following box presents an example of the application of AI in urban air-quality monitoring.

Box 7: Autonomous Air-Quality Monitoring: the SynchroniCity project in Santander

City name: Santander (Spain)

Population: 173,375 (2020)

Regional Innovation level: “moderate” (EC, 2019c) [23]

Digital performance level: “moderate “ (EP, 2018a)[24]

Santander is a medium-sized city on the north coast of Spain, whose economy is mostly driven by tourism. The city benefits from an infrastructure of sensors (Internet of Things) that implements various smart services (e.g., energy efficiency and waste management).

In particular, the city was involved in a European project known as “SynchroniCity”. Within this framework, an autonomous air-quality management solution to enhance air quality in public premises and buildings was developed by different stakeholders, including Multi-Agent Technology Ltd and Metosin Ltd. The solution covers different steps, from the collection of air-quality data via sensors to analytics, automatic alerts, follow-up and reporting requirements. As a result, it can help citizens to access information on air quality and ensure a responsive approach to air pollution, while saving costs and reducing health risks. Moreover, this solution aims at avoiding vendor and city “lock-in”, which are major risks around the uptake of AI in urban areas. (It achieves this through interoperability points, designed to interact with a common SynchroniCity platform and common data models.)

Source: Authors, based on City Population, 2021b; European Commission, 2019c; European Parliament, 2018b; Rodriguez de Lope, 2018; SynchroniCity, 2021

To some extent, the benefits described above also apply to AI in **rural areas**. The latter evince various special features in terms of demography, economic dynamics and social structures. Nonetheless, they also share a set of features, including the high importance of sectors such as agriculture, lower population densities than urban areas, and a tendency to suffer from different divides (e.g., digital divides) and problems (e.g., talent loss) (e.g., for the US: Microsoft, 2015). As a result, some specific reflections have identified **potential benefits** of AI in these areas, provided they possess the required preconditions (e.g., solid ICT backbone infrastructures).

Expectations are particularly high for the **agricultural sector**, with AI considered a means to automate activities, and with applications including crop-disease treatment, storage management, pesticide control, weed suppression, irrigation and water management, and pollution control (Jha *et al.*, 2019), but also biodiversity monitoring (ENRD, 2017).

Another major field where AI could bring valuable benefits to rural areas is considered to be **e-health** (see, e.g., Guo & Li, 2018 for the case of developing countries). Indeed, under the right conditions, AI applications may improve the professional level and efficiency of medical work in rural areas, enhance care availability and reduce the gap with relatively well-served urban areas.

The more territorial concept of **smart villages** is currently emerging (Visvizi & Lytras, 2018). These are not only the counterpart of smart cities for rural areas, but are also of specific relevance to the social fabric of these locations (e.g., citizens’ involvement) (European Parliament, 2021e). They can deploy AI via potential applications in several areas, including public services (power supply, security, distance

[23] According to the European Innovation Scoreboard, see https://ec.europa.eu/growth/sites/growth/files/ris2019.pdf

[24] According to a classification in European Parliament (2018) *Digital agenda and cohesion policy*. available at: http://op.europa.eu/en/publication-detail/-/publication/a58141b0-f9d2-11e8-a96d-01aa75ed71a1/language-en/format-PDF

learning, transport), public management (environmental monitoring, e-administration) and private enterprise (online trade, rural tourism, sharing of goods and services). The actual benefits remain to be fully assessed, but expectations are high.

Moreover, it is reasonable to consider that Artificial Intelligence may also have applications in terms of **rethinking the linkages between urban and rural areas,** however very little evidence is available in the literature (Carnegie Mellon University, 2021).

4.2 Different types of risk

4.2.1. Risks inherent to AI

Although AI can potentially deliver many benefits to improve a city's functions and its citizens' quality of life, the use of these technologies also poses significant technical, social and ethical challenges[25]. The COVID-19 outbreak of 2020 exacerbated risks related to the use of AI by public authorities, including at both local and urban level. For example, public authorities developed various tracing devices and had rapidly to organise the online delivery of public services. In fact, the COVID-19 crisis essentially amplified trends and risks that were already at work before that crisis (Digital Future Society, 2021).

Several incidents occurred that, while sometimes widely publicised, also contributed to increasing a sense of defiance among citizens towards the handling of AI by policymakers. This illustrated, *inter alia,* the need for more accountable and explainable AI algorithms, and for the design of evaluation frameworks capable of assessing the performance of AI and its benefits for citizens in an impartial way (Digital Future Society, 2021).

There are a number of risks intrinsic to AI, and these accrue irrespective of whether AI is applied in an urban setting. The chart below depicts one possible form of categorisation for the generic risks resulting from the unregulated and unguided development of AI.

Figure 5: Risks linked to the deployment of AI

1. Performance risk • Risk of errors • Risk of bias • Risk of opacity (i.e., "black-box" risk) • Risk of poor explainability • Risk of performance instability	**2. Secutiry risk** • Cyber-intrusion risks • Privacy risks • Open-source software risks	**3. Control risk** • Risk of AI going "rogue" • Inability to control malevolent AI
4. Ethical risk • "Lack-of-values" risk • Value-alignment risk • Goal-alignment risk	**5. Economic risk** • Job-displacement risks • "Winner-takes-all" risk of the concentration of power • Liability risk • Reputational risk	**Societal risk** • Risk of autonomous weapons proliferation • Risk of "intelligence divide"

Source: (World Economic Forum, 2018)

[25] See Chapter 5 for a review of the EC measures taken to mitigate risks, including ethical risks for example through the ethical guideline https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

Within the context of the smart city, some of these risks take on a specific relevance. The different generic risks commonly associated with AI may first be briefly reviewed, while risks surrounding socio-economic and, especially, territorial cohesion are further discussed below.

Performance risks refer to the "black-box effect" generated by self-learning AI algorithms (their increasing degree of autonomy), which may result in inability to understand AI output. They also refer to the risk of making errors, or of producing biased or unstable outcomes. It is interesting to note that AI may simply reproduce forms of bias already at work in society, which in turn may discriminate against specific categories of the population (in general the most vulnerable). This may manifest even in mundane or apparently trivial issues, such as the more diligent reporting of road potholes in wealthier or more digitally-advanced districts. The quality of the data and the accuracy of the algorithm are key in this respect.[26] In a related sense, **control risks** arise from uncontrolled interactions between autonomous AI systems that, in turn, may yield unexpected outcomes. These different types of risk raise issues in terms of **liability**. When AI systems evolve spontaneously, they can create uncertainty regarding accountability for the outcomes obtained.

Security risks reflect the potential intrusions of hackers, which may deflect algorithms from their initial purpose, possibly with harmful intentions. They also cover **privacy risks** related to the possible malevolent or illicit use of private data - a highly sensitive issue when (e.g.) health or medical data are concerned. This requires optimal decisions as to which data to publish and how long they may be stored.

Ethical risks result from the growing use of algorithms to make decisions and reduce human involvement, which may create ethical dilemmas.[27] A case in point is the use of Automatic Decision-Making Systems (ADMS) to perform sensitive tasks such as the provision of social-benefits entitlement. A recent notable example is the case of the secretive AI-based Fraude Signalering Voorziening (FSV) system, which supported incorrect risk analyses that led to people being incorrectly labelled as fraudulent in 2020, and caused the resignation of the Prime Minister of the Netherlands in early 2021 (Digital Future Society, 2021). To mitigate this sort of risk, it appears necessary to preserve human intervention, which can and should retain the power to challenge AI decisions. A recent notable example is the case of the secretive AI-based "Fraude Signalering Voorziening" (FSV) system, which supported incorrect risk analyses that led to people being incorrectly labelled as fraudulent in 2020, and caused the resignation of the Prime Minister of the Netherlands in early 2021 (Digital Future Society, 2021). To mitigate this form of risk, it appears necessary to preserve human intervention, which can and should retain the power to challenge AI decisions.

Beyond this, AI provides government with unprecedented capabilities to monitor citizens, which raises the ethical stakes associated with the rolling out of AI in conformity with the rule of law, and with the human rights that provide the foundation of democracies (Digital Future Society, 2021).

4.2.2. Risks for "digital cohesion" within cities

Several risks inherent to AI may have detrimental effects on socio-economic and territorial cohesion within cities. They include some of the issues cited above, but also the economic consequences of the rolling out of digital technologies, and in particular of AI in an urban context.

AI may present **societal risks** with the potential to exacerbate exclusion and create a new "digital divide", affecting specific groups or communities within towns. First, specific groups of citizens /

[26] The issue arises when the algorithm is proprietary and cannot be scrutinised, which is often the case.

[27] On this question, see the SHERPA project, "Shaping the Ethical Dimension of Smart Information Systems", funded by Horizon 2020, https://www.project-sherpa.eu/

inhabitants may have difficulties in accessing the smart-city system. This may be caused by so-called digital illiteracy, or simply by a lack of digital devices and access to bandwidth. Such factors imperil citizens' engagement in civic life and deepen inequalities affecting digitally marginalised groups. Moreover, some categories of citizens may be the victims of (un)conscious biases. As illustrated above, this risk should be taken very seriously in the context of numerous, recent and controversial examples that show how AI can yield decisions causing serious prejudice vis-à-vis specific communities – communities, indeed, that are often already discriminated against. For example, the application of AI to detect urban crime can be a significant source of discrimination, as documented by several sources (Benbouzid, 2016; Babuta & Oswald, 2019). Discrimination may be at work against communities without the skills, culture or even the material conditions necessary to maintain a voice, and obtain a fair share of the benefits promised from AI, within the smart city. Finally, some citizens may fall victim to the dismantlement of the institutions and regulatory provisions that traditionally offer protection to them, and that are being dismantled as a result of the new opportunities arising from the development of digital / AI technologies in an urban context. The fact that the rolling out of AI within towns and smart cities questions traditional consumer protection, as well as regulations ensuring fair competition, is a source of concern in terms of economic and social cohesion.

Beside societal risks**, economic risks** resulting from the deployment of AI should be considered. These result from the possible displacing effects of AI. Besides creating new economic opportunities, as illustrated above, disruptive technologies such AI may also bring about **concentration and winners-take-all effects,** with slower adopters left behind. This creates monopoly situations, e.g., via an unequal distribution of job opportunities.

Even more detrimentally, **job destruction and unemployment** are also predicted by the literature, with more or less devastating effects, extending from displacement effects to (in the worst-case scenario) massive unemployment (Frank *et al.*, 2019; Kassens-Noor & Hintze, 2020). A growing polarisation among workers, between those digitally educated and those who are not, may take root. As mid-level skilled tasks are increasingly automated, the most vulnerable workers towards the lower end of the skill-distribution range are hit first. Unemployed people who have thus far lost their jobs, more or less temporarily, due to the substitution effect triggered by the diffusion of AI-related solutions are in general less-skilled workers, and these individuals are particularly vulnerable. Depending on the location of negatively affected communities, some parts of a city may develop more slowly than other, wealthier areas. The detrimental effects of AI on socio-economic cohesion within cities thus acquire a territorial dimension if the people affected are concentrated in specific neighbourhoods.

4.2.3. Risks for territorial cohesion among and within cities, towns and rural areas

Another type of adverse effect on territorial cohesion relates to the fact that **some cities and suburban areas are insufficiently equipped** to meet the different preconditions for seizing the potential of AI, and for mitigating its associated risks (see section 4.3 below). This affects territorial cohesion between cities of different capacities and sizes. Some argue that wealthier cities could increase their productivity by up to 40%, while poorer cities that cannot afford to implement AI solutions would be left behind in the resultant economic race (Mark & Anya, 2019). In particular, due to the unequal distribution of employment, it is expected that **small cities will face a higher impact on employment from automation** (Frank *et al.*, 2018).

Moreover, an important case of potential cohesion risk concerns **rural areas surrounding cities** that undergo digital transformation. Digital technologies and AI are expected to benefit rural areas *per se* (see section 4.1), even if it can be argued that they face greater difficulties than their urban counterparts in securing certain necessary preconditions (e.g., in terms of availability of relevant data, of the potential to establish integrated platforms, etc.). Far more sensitive, by contrast, are the **interactions between these rural or semi-urban areas** and the **towns in their vicinity that aim to become smart cities.** Rural areas will likely have a lower capacity to generate, collect, store and use data in an interoperable way with the nearby smart city (OECD, 2020b). A relevant issue in this respect concerns the "digital twins", described above, that represent the next frontier for the smart city. Where exactly will the city's frontiers stop? Will models be designed to ensure continuity between the city and its suburbs and surrounding areas? If this is not the case, there is a risk of introducing an additional digital divide linked to advanced AI applications. Furthermore, smart cities may become attractive hubs of economic activity with a resulting brain drain, to the detriment of surrounding areas (unless the latter benefit from a reverse trend initiated by the COVID-19 crisis, see below).

4.3 Enabling factors

The technologies needed to run smart cities powered by AI already exist, but technological factors are merely part of the story, and different enabling factors, drivers, and obstacles are at work to determine whether or not the tremendous potential of AI in cities can be seized. The literature identifies several preconditions necessary to secure the expected benefits of AI. They are presented below.

- **Data**

To take advantage of AI for urban development, large amounts of high-quality data regarding different relevant aspects (economic, urban, geographical, technical, climatic, health, etc.) must be available. Such data can be privately or publicly owned, with various models of availability (e.g., open data, shared data).

Alongside the availability of quality data, the capacity to use it is obviously critical. This requires a proper data-management system (ensuring data availability and sharing, and dealing with data incompatibility, data governance and stewardship, as well as shared data models and standards). This in turn requires the availability of dedicated staff with appropriate skills - see below.

- **Digital infrastructure**

IT infrastructure and computing power are the next conditions. A digital infrastructure is necessary to collect, categorise and store data. An important feature of this digital infrastructure is that it should ensure interoperability. It should have big-data analytic capacity and facilitate network-related innovation to coordinate and harmonise systems.

- **Specific, specialised digital skills and technological capacity**

IT experts with appropriate skills are necessary to create datasets, design accurate algorithms to process data, set up appropriate digital infrastructures, and select technologies that can work together efficiently. This is a condition that is particularly challenging to meet within public city administrations.

- **Legal framework**

An appropriate legal framework is necessary to deal with privacy and liability issues, and generally to cope with regulatory challenges posed by the advent of the digital economy, since the latter disrupts established regulatory frameworks and questions traditional models of (urban) governance in areas such as competition, labour law, etc. (OECD, 2020b). The regulatory framework should adapt to these new ways of doing business; it should protect citizens without discouraging innovation.

- **Conscientiousness and engagement of citizens**

Digital literacy is necessary to ensure citizen participation / engagement. Citizens are expected to contribute to the smart-city model, be aware of potential risks and possible mitigation measures, and - eventually - to draw the intended benefits from that model. This is a primary condition for avoiding risks of exclusion and for ensuring that all decisions are centred on citizens' well-being. Different mode of participation and engagement are possible, such as co-production, co-decisions, etc. (OECD 2019a).

- **Partnerships**

Beyond the engagement of citizens, partnerships of different kinds are necessary. Different stakeholders must be mobilised in smart-city initiatives: this includes the private sector (large companies, but also entrepreneurs and start-ups), urban planners, city mayors, citizens and users. Indeed, partnerships should involve both the public and private sectors, as well as the third sector, including non-profit organisations, NGOs and academia (OECD 2019a). New forms of public-private partnership, inter-municipal partnership and multi-level governance are better suited to address challenges such as megatrends, regulatory issues and infrastructures.

- **Governance**

The different elements above require that a sound governance system be in place to secure them. Various features should characterise such a governance system. First, it should have a **sound multi-sectoral dimension**, to make possible an integrated approach, breaking up silos, and bringing together data from different origins (public, private, semi-public, etc.) and sectors covered by the smart-city initiative (e.g., transport, energy etc.). For example, according to the OECD, "urban climate resilience and environmental sustainability are often addressed in separate strategic documents, [so] their integration into smart-city initiatives would eliminate silo approaches and provide co-benefits […]". Likewise, "smart urban transportation initiatives can be integrated with land-use, urban planning and related policy frameworks" (OECD, 2019b).

The governance system should also have a **multi-level structure** (multi-level governance). A place-based approach is necessary in order to tailor the strategy and the plans to specific, local features of the towns considered (e.g., skills levels, sectoral composition, relations between public institutions etc.). Local public authorities in charge of city management and urban development are best placed to understand local needs and to mobilise local stakeholders, but they also need support from the national level (e.g., to access data, to take advantage of an effective legal framework and to draw on investment) and from the EU level (e.g., to learn from good practice elsewhere and to access necessary complementary guidance and funding).

Overall, a system of **governance "with and of" AI rather than "by" AI** should be developed (Digital Future Society, 2021). In fact, city governance that uses AI (governance "with" AI) and that seeks to draw benefits from it while recognising and addressing risks (governance "of" AI), ensures that AI is not an end in itself, and that it does not supersede the human factor which remains so important in determining the final outcome. (It thus avoids governance "by" AI, where decisions are entirely based on AI outcomes without human intermediation or interpretation.)

An appropriate governance structure should be designed to overcome both silo mentalities and resistance/fear of change. This in turn requires the adoption and implementation of a vision of how to transform the city, translated into a strategic plan for digital change, with operational guidelines and milestones (see European Parliament, 2018a).

For this, planning skills (and not only technological skills) are necessary, as well as leadership. Indeed, political leadership, more than human-resource management, is capable of fostering innovations and their social acceptance. Not least, appropriate levels of funding and a suitable budget are needed to cover investment costs. A monitoring and evaluation system is necessary to assess, not only the technical performance of the smart-city system, but also - and especially - its effects on citizens' lives.

An interesting example of participatory governance around AI in a smart city is presented below, namely, via the case of Rennes.

Box 8: 3DEXPERIENCity Virtual Rennes: bridging AI and a participatory approach

City name: Rennes (France)

Population: 207,922 (city proper, 2017); 425,745 (metropolitan area)

Regional innovation level: "strong -" (Bretagne, (EC, 2019c))[28]

Digital performance level: "moderate +" (Bretagne, (EP 2018a))[29]

The metropolitan city of Rennes has been engaged in a partnership with Dassault Systems (a leading European software company) since 2017 to design a digital twin, relying on a cloud-based platform. This builds upon a previous 3D digital model of the city originally started in 1999.

The underlying rationale of this twin is to facilitate an approach to the complexity of the city via the adoption of a systemic approach, involving the various different stakeholders, and allowing the simulation of urban evolutions. Consequently, it entails the sharing of data produced by different actors and on different scales.

In fact, the digital twin can be used to visualise the entire city in 3D and to study various phenomena and policy options. Thus, it is not a simple 3D model, as it incorporates different types of data and allows the modelling of key issues, including mobility and the environment. As one example, the digital twin has been used to analyse energy issues surrounding buildings.

The digital twin can be used as a working tool to help people reflect on different issues and to design better public policies. It thus has a strong collaborative and participatory orientation. In that sense, it brings opportunities both for internal and external use. For instance, the digital twin was used as a basis for public consultation during the revision of the city's urban plan.

The Metropolitan city of Rennes is a member of the Living-in.eu movement, which includes an iconic project on the subject of the "Local Digital Twin".

Source: Authors, based on Eurocities, 2019; European Commission, 2019c; European Parliament, 2018b; French Ministry of Housing, 2019; Ham Kim, 2020; INSEE, 2021

4.4 The balance between risks and opportunities

In reality, the list of **benefits and risks,** identified in somewhat abstract terms above, **may apply to different degrees depending on the context,** the field of application, the characteristics of a specific city, etc. It has to be acknowledged that little systematic evidence is yet available beyond singular cases. There are few hard facts and little concrete evidence, beyond hypotheses, that can shape overall definitive lessons to be valid across many cases.

There is often a **delicate balance between risks and opportunities**, alongside contrasting views emphasising one or the other. In short, AI in the smart city can be a double-edged sword. A well-known case in point is the impact of AI on labour. On the one hand, one might reasonably expect smart cities powered by AI to unleash potential for innovation and new business opportunities. On the other, opposing views emphasise the risk of AI hollowing out cities (i.e., creating ghost cities) by taking over tasks traditionally done by humans (Kassens-Noor & Hintze, 2020). These are opposing outcomes at two extremes of probability, with the actual outcome likely to be somewhere in between.

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28 According to the European Innovation Scoreboard, see https://ec.europa.eu/growth/sites/growth/files/ris2019.pdf

29 According to a classification in European Parliament (2018) *Digital agenda and cohesion policy*. available at: http://op.europa.eu/en/publication-detail/-/publication/a58141b0-f9d2-11e8-a96d-01aa75ed71a1/language-en/format-PDF

One must also consider the expected, positive impact of AI/smart cities on environmental sustainability. As argued above, AI within a smart city can make a decisive contribution to the objective of environmental sustainability that such cities may pursue, for instance via advanced monitoring. At the same time, the mobilisation of AI and other digital technologies is itself energy- and resource-intensive. This in turn, should be assessed against efforts on 'greening ICT' so that additional ICT, data processing and storage should not generate additional negative impact (rebound effects) on the environment. Overall, the net environmental benefit remains to be assessed. "To be reliable, such assessment will need to include not only AI experts but all relevant stakeholders, coupled with robust methodology and tools" (European Parliament, 2021a).

The **impact of the COVID-19 crisis** on human settlements and the role of digital technologies, including AI, is also largely unknown for the moment. Will the large cities lose their attractiveness to the advantage of medium-sized towns or rural areas – and will the latter be able to offer comparable services and experiences in terms of well-being, when compared to their larger counterparts?[30]

The table below illustrates advantages and risks, in the context of digital technologies applied to urban mobility. It shows how difficult it is to assess the net benefits, which (moreover) strongly depend on the particular context.

Table 2: Advantages and risks of smart-city technology in the case of urban mobility

Advantages	Risks
Improvements in travel time	Rebound effects may generate additional travel, which may erode many potential benefits
Changes in the quality of travel time	Smart mobility can improve equity outcomes, but it can also diminish them
Safety improvements	There is uncertainty and lack of robust evidence regarding impacts – e.g., on safety
More efficient use of capacity (roads and vehicles)	Benefits from smart mobility may not scale well
Reduced environmental impact	Tensions exist surrounding the privacy impacts of smart mobility data
Lower travel costs	Conflicts and friction arise from asymmetric data production and access
More equitable accessibility	Traditional regulatory tools and processes may not be adapted to new technologies and services

Source: OECD, 2020c.

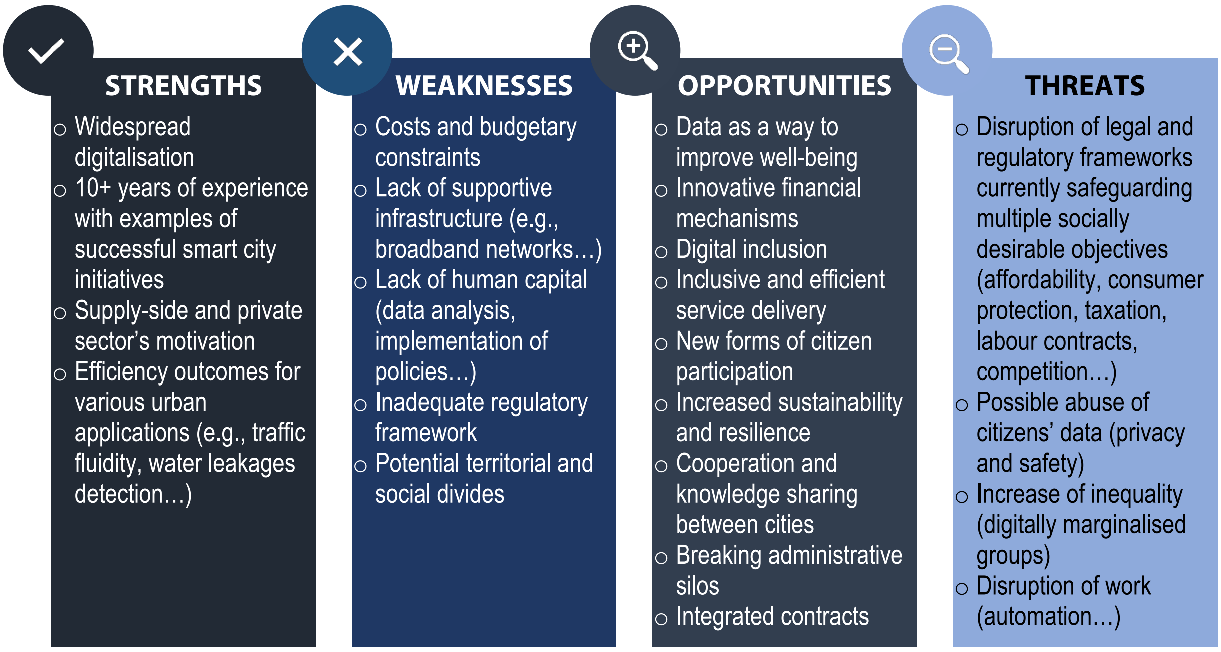
The relevance of AI application areas as units of analysis to assess and compare risks and benefits justifies the "risk approach" to applications adopted by the EU strategy for AI (see the following section).

In global terms, it is possible to propose a "SWOT analysis" of smart-city initiatives; this implicitly also applies to AI, which underlies several of the developments around such initiatives (see figure below).

[30] In terms of COVID-19 impact on the urban fabric, there are debates among experts, but a plausible view is that it may be felt at the neighbourhood level (see Andres Rodriguez Pose: https://www.ft.com/content/d7c6cdc6-5e5c-47bd-bc3f-1719953c2ef0)

On the basis of slightly more than a decade of experience, it can be demonstrated that smart cities make efficiency gains possible. Nonetheless, the expected improvements in quality of life, increased inclusiveness and engagement of citizens comprise an opportunity yet to be realised. Conversely, while the necessary conditions for seizing the benefits from smart cities are difficult to meet, the risks are already extant, both inherent to the technology and in terms of "digital cohesion" (OECD, 2020b).

Figure 6: SWOT Analysis of Smart City initiatives in OECD countries



Source: Authors, reproduced from OECD, 2020b

5. THE URBAN AND TERRITORIAL DIMENSIONS OF EU SUPPORT TOWARDS AI

KEY FINDINGS

- Since 2018, the EU has developed a policy explicitly dedicated to AI, and it has done so by combining different types of intervention (i.e., coordination, regulation and funding). A notable specificity of the EU approach compared to its competitors, such as the US or China, is the emphasis on ethical considerations and risks.
- The EU AI policy does not devote explicit attention to territorial or urban development issues at an overarching strategic level. Nonetheless, the EU implements some specific initiatives that can, in practice, connect AI and urban/territorial issues, such as smart cities-related initiatives and Digital Innovation Hubs.
- At the strategic level, the regional policy of the EU does prioritise digitalisation, but not AI *per se.*
- Tracking Cohesion-Policy expenditure, as linked to AI and urban development, is difficult, as the monitoring system was not established with this particular focus in mind. It constitutes a knowledge gap. It may however be estimated that about EUR 2 035 million and EUR 1 107 million of EU funding will be dedicated to Smart Cities and Smart Grids (respectively) for the 2014-2020 programming period.
- Cohesion between and within cities could be more systematically and explicitly addressed by EU policies both AI policy and regional policy, including for the 2021-2027 period.

5.1 The integration of territorial issues by the EU AI policy

5.1.1. The development of a distinctive EU approach to AI

a. The emergence of an EU strategy towards AI

Even if Europe has been a major player in the field of AI-related basic research for a considerable period, the EU has only very recently started to introduce explicit policies and strategies to deal with the industrial and social challenges linked to these technologies (European Parliament, 2018b), with several initiatives introduced from 2018 onwards. It has been slower than countries such as Canada, which introduced the world's first AI policy in 2017, or indeed China, which presented a highly comprehensive strategy in the same year (Stanford University, 2021). Conversely, it has at least been faster than the US, which only finalised its official policy in 2019.

Still, the relatively recent emergence of its AI policy should not give the impression that the EU has been entirely inactive regarding this issue. Before this date, AI issues had mainly been addressed in the context of the overall digital policy of the EU, namely through strategies such as the **Digital Agenda for Europe and the Digital Single Market** (European Commission, 2018a). These digital and EU-wide strategies have notably contributed to diverse enablers of Artificial Intelligence (European Commission, 2018a), including infrastructures, skills, standards and business investments. A major feature of these strategies thus consists of the adoption of a holistic approach, with the latter considering not only technological but also social and economic aspects (see European Parliament, 2018b for a detailed review). In this context, Artificial Intelligence has been seen as one of the technologies that will allow the derivation of benefits from an increasingly large mass of available data (European Parliament, 2018a).

This explicit attention to AI at the EU level from 2018 onwards can be explained by the perceived, increased competition from the US and China regarding AI, as well as increased calls for action from different stakeholders (e.g., industry, academia, policy-makers). It has prompted the EU to devise a **framework to steer and coordinate future EU legislation and investments** in this area (European Parliament, 2018b).

In concrete terms, several initiatives were launched by the European Commission and the Member States in the April-June 2018 period to shape the future of AI (European Commission, 2019a). These notably included the "**Artificial Intelligence for Europe**" Communication (see box).

Box 9: The pillars of the "Artificial Intelligence for Europe" Communication (2018)

The "Artificial Intelligence for Europe" Communication has different objectives, structured around three complementary pillars (European Commission, 2018b):

- **Boosting the EU's technological and industrial capacity and AI uptake across the economy** (public and private sectors). This notably entails support for fundamental AI research, the development of industrial applications and the provision of research infrastructures. Increasing investments to these ends are based on the leverage of EU funds (e.g., EFSI, Horizon Europe, VentureEU), combined with national, regional and private resources. The avoidance of dependence on imports for these technologies, as well as the use of SMEs as a focal point, are key elements of the EU approach (European Parliament, 2018b).
- **Preparing for socio-economic changes catalysed by AI.** This area focuses on addressing evolutions linked to AI uptake, especially in the labour market. It notably builds upon the New Skills Agenda for Europe and focuses on adapting skills, training for digital competence and promoting diversity and interdisciplinarity (European Parliament, 2018b).
- **Ensuring an appropriate ethical and legal framework in line with the EU's values.** This aims at protecting personal data, assuring safety and asserting product liability. Notably, the Commission set up a High-Level Expert Group on AI in 2018, and this body released Ethical Guidelines for implementing this approach in 2019 (European Commission and Independent High-Level Expert Group on Artificial Intelligence set up by the European Commission, 2019).

Source: Authors, based on European Commission, 2018b

The EU vision regarding AI is thus centred around the concept of "ethical AI", which may be a distinctive feature compared to other countries, including the USA and China (Stix, 2019). Indeed, the US has been slower to introduce a policy at federal level to regulate this technology (Zevenbergen, 2018), and tends instead to focus on its development (Stanford University, 2021). By contrast, the Chinese strategy mostly emphasises that nation's emergence as a global AI leader. Meanwhile, the specific EU focus on trust has been reaffirmed with a 2019 Commission Communication on Building Trust in Human-Centric AI (European Commission, 2019b).

In parallel, the Commission has worked with the Member States to **coordinate AI actions and facilitate their smooth implementation**. This objective has taken the form of the Digital Day Declaration, focusing on principles, and of a Coordinated Plan, targeted at specific actions. These were both released in 2018 (EIT Digital, 2020). In particular, the Coordinated Plan has introduced the idea of designing national AI plans in the different Member States. A multi-stakeholder partnership on AI, called the European AI Alliance, was also launched in 2018 to assist policy development (European Commission, 2021i).

Work continued in the same direction in 2020 with a dedicated White Paper on Artificial Intelligence, paving the way for future actions and regulations in line with the stated EU principles of trust and excellence (European Commission, 2020d). AI in the EU will also be influenced by the **EU strategy for data of 2020**. Indeed, access to relevant data is critical to the design and implementation of successful AI algorithms (European Commission, 2020b). This notably entails the creation of a single market for data across the EU, stressing both the accessibility and governance of this key commodity.

The **European Parliament** has been active in the formulation of the EU AI policy, in particular through its **Special Committee on Artificial Intelligence in a Digital Age** (AIDA)[31] and its **Committee on the Internal Market and Consumer Protection** (IMCO), as well as **its Committee on Legal Affairs** (JURI). The Parliament's contribution has, most pertinently, taken the form of a series of **three Resolutions in late 2020**, focusing on **civil liability, ethical aspects and intellectual-property rights** (European Parliament, 2020c, 2020b, 2020a). From this perspective, the Parliament was one of the first institutions to put forward concrete recommendations regarding the content of AI rules, paving the way for further developments (European Parliament, 2020d). In particular, the Parliament's recommendations for ethics included several guiding principles (e.g., transparency and accountability, safeguards against bias, and privacy and data protection) and an emphasis on the importance of human oversight (e.g., with teachers retaining control over decisions affecting students' future opportunities) (European Parliament, 2021c). Proposals regarding civil liability focused on making the operators of high-risk AI strictly liable for any resulting damage, with an insurance system similar to those for motor vehicles. Finally, the intellectual property-rights Resolution stresses the balance between protection, human interests and EU ethical principles. It particularly distinguishes between AI-assisted human creations and AI-generated creations, while highlighting the fact that AI entities should not have legal personalities.

Recently, in **April 2021,** the efforts initiated in 2018 culminated in the publication of an **AI package by the European Commission** (European Commission, 2021b). This includes a dedicated communication reaffirming the willingness of the EU to balance the risks and opportunities of AI (by regulating the latter proportionately), to mobilise public sources of funding and to ensure continued coordination between Member States on the matter (European Commission, 2021f). The package also proposes a draft regulation to render the established principles operational in a dedicated framework (see the following box, which highlights the EU's specificities), as well as an evaluation of the coordination plan established with the Member States in 2018.

[31] This special committee of the Parliament focuses on the horizontal issues linked to AI. It has no legislative power as such, but it paves the way for the work of the Parliament on these issues. Its activities include organising hearings and workshops with relevant stakeholders. It will run until 2022 and will publish a report with its findings and recommendations.

Box 10: AI package regulation proposal (COM/2021/206 final): the cornerstones of the EU approach

In 2021, the European Commission proposed a regulation that would constitute the first ever legal framework on AI, which addresses the risks of AI and positions Europe to play a leading role globally. In a nutshell, the ambition of the EU is to invest in excellence, ensure that AI is developed according to specific rules and standards, and make sure that the potential of AI for industrial applications is fully exploited (e.g., with an upcoming update of the EU Industrial Strategy).

The proposed regulation of the AI package defines a framework for the EU risk-based approach to AI on the basis of these objectives. It highlights the fact that this technology is beneficial and is to be developed, but that it also requires a suitable approach to build trust and avoid risks (safety, fundamental rights, legal uncertainty, mistrust, discrimination, etc.). In order to do so, it:

- **Provides a definition of Artificial Intelligence** that is technologically neutral and aims at covering all AI (e.g., traditional symbolic AI, Machine Learning, hybrid systems, etc.): "A software that is developed with one or more of the techniques and approaches listed in Annex I and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments [it or] they interact with" (Article 3);
- **Identifies four different levels of risks regarding AI system**s (unacceptable, high, specific transparency obligations, minimal/no risk), which will be subject to **different rules** (from unrestricted permission to prohibition). Most AI systems will fall into the lower risk categories;
- **Introduces specific requirements for high-risk systems** (including safety, transparency and human oversight, among others) **and operators across the AI lifecycle;**
- **Bans applications** that are considered **contradictory to EU values** (e.g., subliminal manipulation, exploitation of children or disabled persons, general-purpose social scoring, remote biometric identification for law enforcement in public spaces);
- **Supports innovation in AI**, especially in industry and SMEs.

Source: Authors, based on Breton, 2021; European Commission, 2021c

This proposal of the Commission was **welcomed by the European Parliament AIDA** and its Chair Dragos Tudorache (Renew Europe) in April 2021. In particular, the Chair highlighted the innovative nature of this regulation and its explicit focus on protection, rights and clarity (European Parliament, 2021b). The proposal is to follow the precepts of ordinary legislative procedure involving different Committees, the conclusion of which might take years. At the time of writing, the committee work was still ongoing, with **several additional debates expected in the upcoming months**. Once finalised, the regulations will be directly applicable across the EU, thus highlighting the key **importance of the work of MEPs** in reaching a text aligned with the different priorities at play. In particular, the Chair of the IMCO (Anna Cavazzini, Greens) previously stated that the Committee wanted to avoid fragmentation of the Digital Single Market while also ensuring safety and fundamental rights (European Parliament, 2021d).

The emergence of an EU strategy towards AI has thus been consolidated in recent months and will continue to be subject to debates. Moreover, this approach is backed by a series of instruments to operationalise it, as described in the following section.

b. Rendering the EU AI strategy operational

On an operational level, **specific instruments with substantial funding** are expected to contribute to the realisation of the EU AI strategy, either directly or by developing the required preconditions (e.g., through digital infrastructures and skills).

This financial effort includes funding of up to EUR 134 billion for digital transition within the Recovery and Resilience Facility of the Recovery Plan, following COVID-19. The Recovery Plan complements funding from other EU programmes that will contribute to the development of AI (European Commission, 2021f):

- The new **Digital Europe Programme (total of EUR 7.5 billion)** aims at building and strengthening the core AI capacities of the EU (e.g., data resources, shared libraries of algorithms) while satisfying the principles enshrined in its regulations. Digital Europe will also make these capacities accessible to various stakeholders across the EU (Stix, 2019).
- The **Horizon Europe Programme** for Research and Development will also support the development of AI technologies. This will take place in continuation with the investments of EUR 1.5 billion for AI under **Horizon 2020 for 2018-2020** (European Commission, 2020c).
- **InvestEU** will also contribute to AI funding, in line with the European Fund for Strategic Investments.
- According to the European Commission's claims, the target is to gradually increase investment in and around AI to about EUR 20 billion each year during the 2020s (European Commission, 2021b).

Funding has also been complemented by **several initiatives** aiming at speeding up the development and uptake of specific technologies of relevance to AI, such as 5G, high-speed connectivity, the European Processor Initiative[32], Big Data Value Public-Private Partnership[33], etc. (European Commission, 2018a). AI is also increasingly integrated into **various sectoral policies** at the EU level, such as transportation (e.g., Third Mobility package) or Energy (Clean Energy for all Europeans package) (European Commission, 2018a).

Overall, the key **principles and rules are well established** at the EU level. According to interviewees, the **main challenge is now their implementation on the ground**. In particular, regarding urban aspects (e.g., smart cities), the promised benefits are still largely to be delivered.

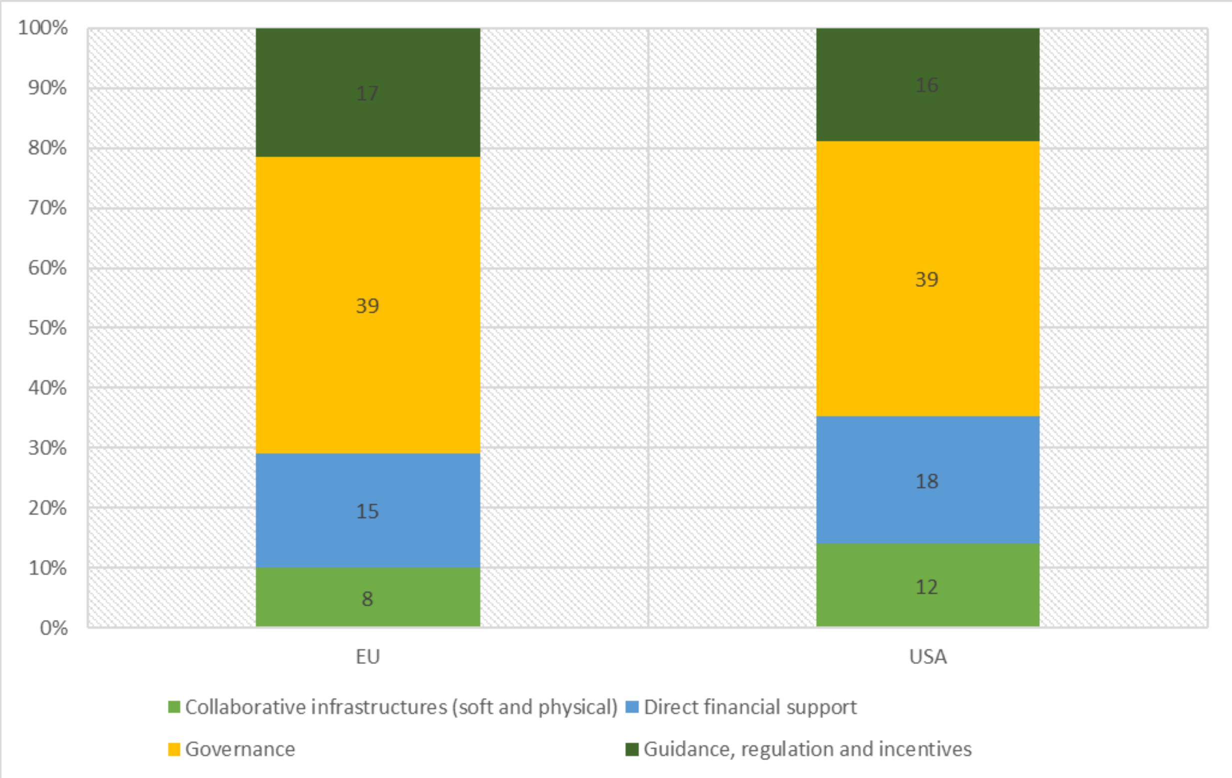
c. The distinctive features of the overall EU approach towards AI, as compared to other countries

The EU approach that emerged during the 2018-2021 period thus **combines different types of intervention** (coordination, regulation, funding) with a view to **developing AI in a way that is consistent with EU values**. Overall, according to the OECD AI Observatory, many EU policy initiatives for AI revolve around either issues of governance (49%) or those of guidance, regulation and incentives (21%), with relatively less focus on infrastructure (10%) or on direct financial support (19%). This pattern may be observed when compared to the approach of the United States, although differences are not extreme.

[32] The European Processor Initiative is a research project to design and build a new family of low-power processors (RISC technology) that will be used for applications in supercomputers, Big Data analytics and High-Performance Computing applications (e.g., machine learning). It is led by a consortium of European universities and private companies, with funding from Horizon 2020. See https://www.european-processor-initiative.eu/

[33] The Big Data Value Public-Private Partnership aims at fostering the development of a functional data market and economy in the EU. Through this partnership, the European Commission, academic stakeholders and companies (large ones and SMEs) have identified Research and Innovation priorities within a strategic agenda. The partnership is implemented through a series of calls for proposals under Horizon 2020, in the fields of demonstrators, experimentation actions, technical projects and networking. See https://www.bdva.eu/

Figure 7: Distribution of AI-related policy initiatives by type in the EU and the USA (2021)



Source: Authors, based on OECD, 2021 (data extracted on 27-04-2021)
Note: Only *public* policies and initiatives

Of course, the number of initiatives cited here is not a full or complete reflection of the AI approaches of the EU and the USA. A full international comparison should also account for differences in budgetary magnitude, the distribution of competencies across the levels of government (which critically differs between the EU and the USA), and the actual content of specific AI initiatives.

A qualitative review of policy documents reveals that a **distinctive feature of the EU** is its stated emphasis on **ethical aspects and risks** (Stix, 2019). This is especially visible in comparison with countries like China, where recent policy initiatives under the Xi Jinping presidency have pushed for the development of AI applications allowing for the mass surveillance of citizens (e.g., in smart cities) (USCC, 2020). Moreover, according to interviewees, the EU approach also emphasizes **the role of government and the public sector** in deploying AI. This can be demonstrated via the 2021 Coordinated Plan, which encapsulates a series of policy actions (e.g., setting enabling conditions, favouring labs-to-markets transitions, safeguarding the social benefits linked to AI, etc.) whereby the public sector has a key role, including in steering private actions. This perspective has a decisive importance, including for cities, given the potential risks of permitting private initiatives to be the exclusive force shaping AI decisions, which can themselves alter urban spaces.

Nonetheless, the EU also faces some **specific difficulties from an international comparative perspective,** including limited investment compared to its peers (especially through venture capital). For instance, it is estimated that, in 2016, venture capitalists invested about EUR 6.5 billion in the EU for AI, compared to EUR 39.4 billion in the USA (Stix, 2019). Moreover, the US policy towards AI is strongly geared towards maintaining its leadership in the field and towards geopolitical aspects (White House, 2020). By contrast, the EU has a weaker position (especially in the private technological sector), which may explain some of pertinent policy differences. Under the new Biden administration, it is likely that the US will dedicate more attention to the scientific and social dimensions of AI (MIT Technology Review, 2021), while retaining strong geopolitical prioritisation. Last but not least, the distinctive attention of the EU towards ethical considerations and risks may prove a limitation if its implementation is too restrictive, as it could impede the securing of AI benefits for EU citizens and companies.

5.1.2. Limited strategic prioritisation of territorial issues in the EU's AI policy as a whole

The EU strategic approach towards AI focuses on regulation, enabling conditions and investments. It also deals with risks, e.g., by attempting to protect privacy and to counter potentially adverse effects at the individual/social level, such as job losses due to AI. Nevertheless, **the key AI strategic documents of the EU do not assign a strong priority to spatial issues**, such as territorial inequalities, how AI alters relationships between cities and other areas, differences in impact/potential across the EU either between or within cities, etc. The **territorial dimension of the EU's AI policy is thus weak,** as demonstrated by the very limited references to cities or territories in the EU strategic documents (see Table below).

Table 3: Reference to territorial and/or urban aspects in the main EU strategic documents dedicated to AI (extracts)

Stakeholders	Document	Number of occurrences of urban/territorial-related words
European Commission	2018 Commission Communication on Artificial Intelligence for Europe	0
	2019 Commission Communication on Building Trust in Human-Centric Artificial Intelligence	0
	2020 White Paper on Artificial Intelligence – A European Approach to excellence and trust	2 (rural areas mentioned twice)
	2021 Commission Communication on Fostering a European Approach to Artificial Intelligence	0
European Parliament	2020 Parliamentary Resolution on the Framework of Ethical aspects of Artificial Intelligence, Robotics and Related Technologies	0
	2020 Parliamentary Resolution on a Civil-Liability Regime for Artificial Intelligence	1 (but in a generic sense)
	2020 Parliamentary Resolution on Intellectual Property Rights for the Development of AI Technologies	0
	2021 Parliamentary Resolution on AI in Civil and Military uses	1 (territorial integrity)
Council of the European Union	2019 Council Conclusions on the Coordinated Plan on the Development and Use of AI Made in Europe	0
	2020 Council Conclusions on the Charter of Fundamental Rights – Focus on AI and Digital Change	0
European Economic and Social Committee	2018 EESC Opinion on the Commission Communication on Artificial Intelligence for Europe	0
	2021 EESC Opinion on the Coordinated Plan for Artificial Intelligence	(ongoing)
	2021 EESC Opinion on the Regulation of Artificial Intelligence	(ongoing)
Committee of the Regions	2019 COR Opinion on Artificial Intelligence for Europe	6
	2020 COR Opinion on the White Paper on Artificial Intelligence	0

Source: Authors' own elaboration based on mentioned documents
Note: Urban- or territorial-related words are the following: city/cities, urban/rural, territory/territorial

This analysis regarding the *limited* attention to territorial aspects within the EU's AI strategic approach is confirmed by bodies such as the Committee of the Regions, which stated in a 2019 opinion on the EU's AI policy that, "the stated measures do not cover the public sector at the local and regional level and [the Committee] believes that these two levels of governance and administration should not be overlooked" (Committee of the Regions, 2019). This limited attention may pose a **risk in terms of power relations** between **private ICT stakeholders** and **local public authorities**, with the latter interacting with the former for various AI projects in the urban context (e.g., smart cities).

Nonetheless, there are some explicit references to the local level in some AI strategic documents, such as the **updated Coordinated Plan with Member States of 2021**. Indeed, this plan pushes for the **development of AI within the public sector in the different Member States, including local administrations** (e.g., through the development of AI-enabled application catalogues for administrations, public procurement for AI, etc.) (European Commission, 2021d). The Annex of the April 2021 Commission Communication also highlights the importance of Digital Innovation Hubs. Moreover, EU analyses from the JRC show that in practice, several local and regional authorities use AI in their public services (JRC, 2020a). Overall, however, it **does not seem that the issues of urban development and territorial challenge are explicitly targeted by the strategic framework dedicated to AI in the EU**. In particular, cohesion between places and within cities is not put forward as a major concern in strategic documents. This limited policy attention contrasts with the fact that **AI is likely to have strong territorial impacts, especially on smaller cities** (Frank *et al.*, 2018).

In this field, the EU tends to be comparable to **other countries**, such as China or the United States. Indeed, they **also allocate a low priority to these issues in their AI policies,** with the noticeable exception of China's focus on surveillance technologies for smart cities (Roberts *et al.*, 2021).

5.1.3. Digital initiatives combining AI with territorial issues

The **limited strategic prioritisation of the intersection between AI and territorial issues does not imply that no specific EU-funded programmes or initiatives take this aspect into account.** This section addresses initiatives the main focus of which is upon digital/AI aspects (e.g., those put forward by the relevant DGs, such as the Directorate-General for Communications Networks, Content and Technology - DG CONNECT), that also consider territorial issues to a high degree. Interventions that are traditionally connected to the EU urban/regional policy (i.e., Cohesion Policy), and which may also include a digital/AI perspective, are addressed in section 5.2. Obviously, this distinction is somewhat blurred in reality, especially for smart cities[34].

The considered initiatives are typically focused on **digital investments or technologies as a whole, rather than being AI-specific**. Indeed, only a subset of their interventions can thus be considered as contributing to or benefiting from AI in the strict sense. They are also **not always explicitly presented as initiatives contributing to territorial cohesion** (i.e., to the reduction of disparities between or within territories), but may rather be framed as targeting specific issues (e.g., environmental monitoring) with a territorial basis.

Examples of these initiatives, which are numerous and varied, include **Digital Innovation Hubs** and various actions linked to the concept of **smart cities and communities** (including smart villages, with a more rural focus).

[34] Nonetheless, as the related initiatives primarily emerged from the EU digital policy, they are presented in this section

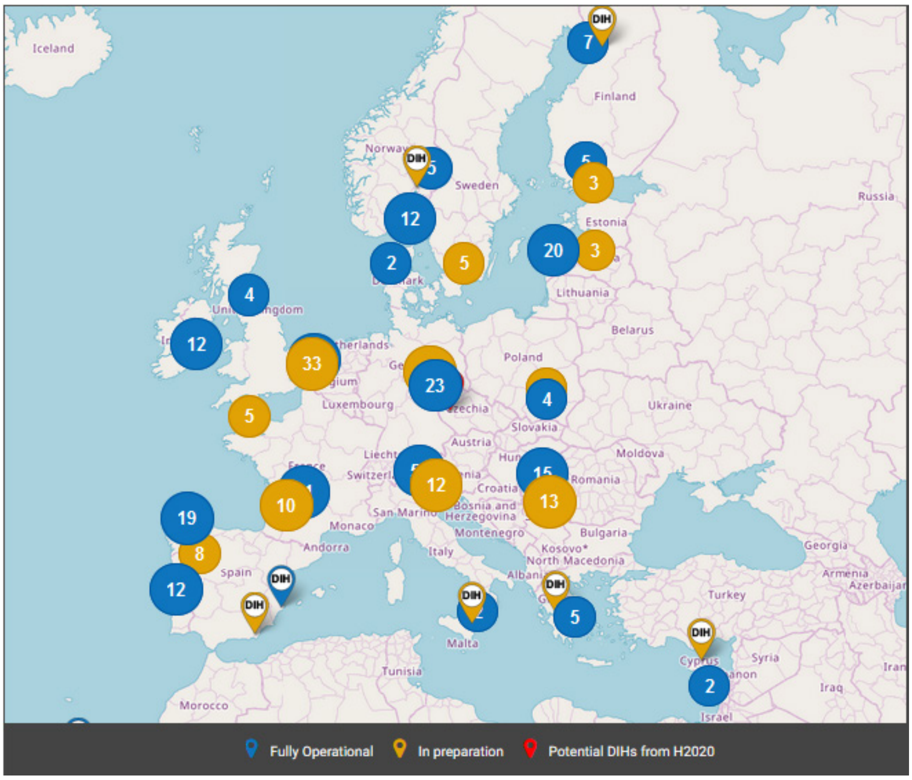
a. Digital Innovation Hubs: a territorialised action with an ICT focus

Digital Innovation Hubs are a good example of an important EU initiative with a territorial dimension that aims at the development of ICT, including AI. Its focus is not on territorial cohesion/urban development *per se,* though there is definitely some attention to geographical balance, as explained in the following box.

Box 11: Digital Innovation Hubs and Artificial Intelligence

Digital Innovation Hubs (DIH) were launched in 2016 in the framework of the Digital Single Market as one of the many initiatives of an Action Plan for the Digitisation of the EU. Financed under the Horizon 2020 programme for the 2014-2020 period (EUR 500 million) with the support of DG CONNECT, these hubs are regionalised one-stop-shops that aim to support businesses (especially SMEs but also other companies) in increasing their competitiveness through digitalisation (e.g., by favouring the uptake of digital technologies, the development of ICT-backed business models, specific services and products, etc.). They provide technical expertise, testing services (experimentation before large-scale investments), training and innovation/advisory services.

As such, DIH are a specific form of multi-partner regional cooperation, mobilising different stakeholders (including companies, public services, government, universities and research centres) around ICT in the context of a specific territory. They are implemented by Member States and are often built up from existing initiatives, where the latter exist. For the 2021-2027 period, renewed European Digital Innovation Hubs (EDIH) will be financed under the new Digital Europe Programme. This will be more oriented towards the broad uptake of specific technologies, including Artificial Intelligence. Moreover, previous DIH from the 2014-2020 period will be eligible to apply to become EDIH. Some of these DIH have specific expertise in the field of Artificial Intelligence. As of 2021, 412 of these Hubs were active or in preparation across the different Member States, as shown in the following map:



Of these DIH, some are also members of a specific group of AI-specialised hubs, called the AI DIH network[35], and benefit from a dedicated training programme to promote cross-border collaboration, as well as common systems and governance. The programme started in March 2019 and addressed different technologies of interest (e.g., AI, robotics, medical technology, etc.).

The DIH thus follow a territorialised logic, by structuring services around ICT (and in some specific cases, around AI in particular) for a given region. They also contribute to the development of regionalised Smart Specialisation Strategies, within the framework of Cohesion Policy.

Source: European Commission, 2021d, 2021e; European Parliament, 2018b; JRC, 2018, 2021

b. "Smart" cities, communities and villages: a wide array of EU initiatives

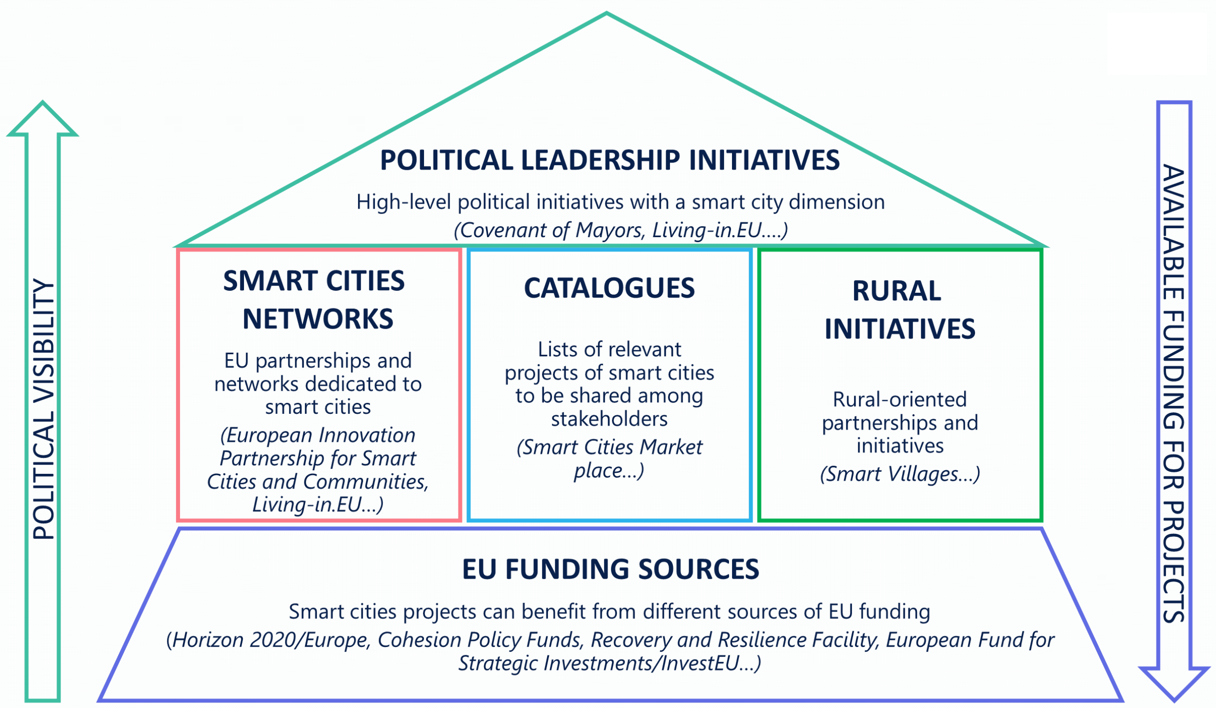
Smart cities are increasingly popular in policy-making, and this includes the EU. Smart cities have a particular place in the connection between urban development and ICT, and this extends to AI in some cases, as noted in Chapter 2.

Notably, the European Commission has set up a **series of initiatives** to promote smart-city development, **involving different DGs and partners with their own specific focus** (e.g., transportation, environment, energy, etc.). These initiatives are fragmented and may be fuelled by different rationales, even if the technological enablers / infrastructure issues are under the remit of DG CONNECT. In this context, it is difficult to provide a **precise single definition** under which all EU initiatives and projects regarding smart cities might fall. Nonetheless, a recent definition provided by the European Interoperability Framework via the Smart Cities and Communities Project seems **to apply well to a wide range of EU initiatives for smart cities**. According to this definition, a smart city can be conceptualised as, "A sustainable and inclusive city/community aiming at the well-being of its inhabitants, businesses, visitors, organisations and city/community administrators by offering digitally-enabled services" (NIFO, 2020). Moreover, in the broader EU context, **the concept has been widely understood** to cover not only smart cities but also smart communities and smart villages (with a distinctive "rural flavour"[36]).

These initiatives are of **different types**, including political leadership/coordination initiatives at a high level, specific partnerships and networks dedicated to smart cities or communities (including the sharing of catalogues of projects/best practices), and the use of EU funding (European Commission, 2015b; European Parliament, 2018a; European Commission, 2021d). These different types of EU initiatives are briefly presented in the following figure, before being detailed below.

[35] https://ai-dih-network.eu/
[36] https://enrd.ec.europa.eu/enrd-thematic-work/smart-and-competitive-rural-areas/smart-villages_en

Figure 8: Types of EU initiative dedicated to smart cities and communities



Source: Authors

Some of these initiatives do not *solely* focus on smart cities and communities (i.e., those addressing political leadership initiatives and EU funding sources), but they are instrumental in terms of their prioritisation or implementation on the ground.

Indeed, several **political leadership initiatives**, such as the **Covenant of Mayors** for climate change, or the Climate Adaptation of the Directorate-General for Climate Action (DG CLIMA), are involved in the promotion of smart cities at the EU level (European Commission, 2015b; European Parliament, 2018a). EU energy and transportation policies also have features linked to the promotion of smart cities (European Commission, 2021n).

Nevertheless, the core of the EU initiatives specifically dedicated to smart cities and communities comprises **partnerships and networks of various forms** (including bottom-up networks and catalogues of best practices), such as the European Innovation Partnership for Smart Cities and Communities, or Living-in.EU (see below). These initiatives between stakeholders are seen by interviewees as especially important, especially for public authorities in countries where such networks may not exist at the national level. Still, they are typically not dedicated exclusively to AI, although they cover these technologies with various levels of intensity.

For instance, the **European Innovation Partnership for Smart Cities and Communities**, following the previous Smart Cities and Communities Initiative launched in 2011, is supported by the European Commission (Directorate-General for Energy - DG ENER, Joint Research Centre – JRC, etc.) with the goal of combining ICT, energy and transport management while addressing major urban issues. It involves different types of stakeholder (cities, industry, SMEs, banks, academia), favours the coordination of smart-city projects between stakeholders, and contributes to the emergence of demonstration projects in this field (JRC, 2016). Specifically, it comprises an expert group, alongside a dedicated **Smart Cities Marketplace** to favour networking and investment-seeking and to showcase innovative solutions. As of 2021, a total of 82 successful projects, with an EU contribution of EUR 808 million, are listed on the marketplace (European Commission, 2021l)[37]. Some of these projects, though not all, will use AI. For instance, the city/port of **Rotterdam has implemented a "digital twin" of the city**, i.e., a 3D model of its physical city. AI can use this model to make predictions regarding several areas of urban planning, such as long-range infrastructure investments or near-real-time service operations (European Commission, 2019d).

Box 12: Living-in.EU

Recently, various organisations representing cities (Open and Agile Smart Cities, Eurocities, European Network of Living Labs, Dutch Association of Municipalities), supported by the European Commission (mainly DG CONNECT, but also others such as the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs - DG GROW) and the Committee of the Regions, have launched **a new initiative to promote the digital transformation of cities across the EU**, the "European way". Focused on a number of principles, while promoting interoperable and open standards-based platforms, respect for citizens' digital rights, algorithm transparency and the use of unbiased algorithms, the community is preparing to bring European smart cities to the next phase of digitisation and will facilitate the use of AI-enabled Local Digital Twins.

The **Living-in.EU movement** was launched in 2019 and is a **collaborative platform,** designed to accelerate the effort outlined above in a way that is consistent with shared European values (e.g., citizen-centricity, ethically and socially responsible usage of data, open standards, etc.) (European Commission, 2021g). It is integrated with several EU strategies, including the European Green Deal and the Urban Agenda. The originality of this initiative lies primarily in the direct contact between the European Commission and the municipalities. The Living-in.EU initiative regroups more than 90 cities and communities from across Europe, of various sizes and digital-maturity levels (early stage, intermediate or advanced cities, with adapted support ranging from awareness building to the deployment of AI-powered systems). Nonetheless, certain types of cities (especially from the Nordic countries) appear to be overrepresented[38]. In practice, the platform is, in particular, advocating the **greater use of AI in cities** by promoting **scale-up solutions** (standards-based platforms, data accessibility, etc.). In concrete terms, the initiative addresses different types of issues encountered by local authorities regarding AI (e.g., trust, technology or vendor-lock-in) through different thematic groups. The latter include financial (sources of funding), technical (interoperability, standards), education and capacity building (skills and capacities of local administrations), monitoring and measuring.

In particular, the initiative focuses heavily on the **development of digital twins,** i.e., "virtual representation of the city's or community's physical assets, processes and systems that are connected to all the data related to them and the surrounding environment" (European Commission, 2021o). These "twins", moreover, can use AI algorithms for both short-term applications and long-term strategic planning. According to the interviewees, the European Commission intends to explore such functionalities further in the future, by mapping the demand and supply sides for digital twins and creating a local digital-twin toolbox of reusable solutions, open standards and technical specifications.

Source: Authors, based on multiple sources

[37] See https://smart-cities-marketplace.ec.europa.eu/projects-and-sites/projects
[38] See the list of signatories on: https://living-in.eu/declaration/we-signed

Rural areas also benefit from specific initiatives linked to smart communities. In particular, the concept of **Smart Villages** was introduced by a 2017 EU Action (European Parliament, 2021e). This model is not included in the legislation but can be defined as, "communities in rural areas that use innovative solutions to improve their resilience, building on local strengths and opportunities. They rely on a participatory approach to develop and implement their strategy to improve their economic, social and/or environmental conditions, in particular by mobilising solutions offered by digital technologies" (ENRD, 2017). In fact, the actions and initiatives surrounding smart villages are primarily based on **policy development, networking and pilot projects**, while being integrated with wider rural/agricultural EU and national strategies. In particular, important EU initiatives for smart villages include the **preparatory action on smart rural areas of the Directorate-General for Agriculture and Rural Development - DG AGRI**, which consists of 21 smart-village innovations that will be used to support future CAP interventions in the field (ENRD, 2017). At the same time, the preparatory action also contains large-scale pilot projects for **rural smart communities** (European Commission, 2021m). Nevertheless, it seems that most of these projects address ICT as a whole (and especially broadband), rather than AI *per se.* An example is the Hungarian village of Uppony, one of the 21 smart villages referenced above, that intends to use AI algorithms to identify species in its botanical and fauna survey without human intervention (E40, 2020).

Most of these initiatives have **relatively small budgets** and focus on activities such as networking or standard-setting. As such, their direct impact on the absolute number of smart cities/communities will likely be small, although their indirect influence might be much larger, especially in the future. Consequently, beyond the initiatives specifically dedicated to smart cities, **different sources of EU funding** (e.g., Horizon 2020 / Horizon Europe, the European Fund for Strategic Investments / InvestEU, Cohesion-Policy Funds, etc.) contribute to the development of these various smart-city and smart-community initiatives or to individual projects. Yet the share dedicated to AI *per se* is difficult to estimate (European Parliament, 2018a). For instance, Horizon 2020 has contributed to research projects in this field[39]. Significantly, from 2021 onwards, the European Commission will fund the Digital Europe programme (total budget, EUR 7.5 billion – see section 5.1.1), which can be deployed to foster the adoption of AI at the local level (European Commission, 2021d). For instance, it will fund the Digital Innovation Hubs but also training programmes for ICT/AI experts.

The **contribution to cohesion** from these initiatives is **difficult to assess**. Several of them, such as the Living-in.EU movement, **have the ambition to address the needs of all cities**, regardless of those cities' current forms or levels of digitalisation. This is a focus on cohesion *between* cities rather than within them. Moreover, Smart Villages are explicitly concerned with the interactions between rural areas and their surroundings. In practice, however, it seems **likely that some territories will have more difficulty than others in benefiting from these initiatives**, because of the particular features or requirements of local AI projects (hesitancy of administrations, ethics, privacy, discrimination, capacity, procurement, etc.).

Last but not least, this wide array of EU initiatives dedicated to smart cities does not imply a strong attention to territorial/urban issues in the overarching AI policy approach, as documented in the following section.

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[39] See https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/artificial-intelligence-ai_en

5.2 The place of AI in EU regional policy

The EU regional policy or Cohesion Policy (under DG REGIO and EMPL) explicitly considers territorial issues, making it worthwhile to consider how it integrates AI, both strategically and in practice. This section mostly focuses on the 2014-2020 period, with some insights on the future 2021-2027 period.

5.2.1. A strategic and regulatory framework prioritising digital issues, including AI

Cohesion Policy is a major EU policy, accounting for about one-third of the total EU budget. It is concerned with reducing territorial disparities while contributing to long-term investments that match EU-wide strategic objectives. As a consequence, Cohesion Policy is briefly mentioned in the EU AI strategic policy documents as a key source of funding.

The linkages between urban development and AI under Cohesion Policy ought to be understood in the context of the latter's **strategic and regulatory framework**, but also regarding its **concrete budgetary allocations and funded projects** (see section 5.2.2).

a. Cohesion-Policy strategy and priorities: an emphasis on ICT as a whole, rather than AI

In terms of **strategy and priorities**, Cohesion Policy contributes to the **EU's digital policy**, enshrined in various strategies since the 2010s, such as the Digital Agenda, Digital Single Market and the EU Digital Strategy (Pellegrin & Colnot, 2020). It emphasises the bridging of digital divides (socially, geographically, economically) while allowing the different EU regions to reap the benefits of ICT. In particular, EU strategies promote a **holistic approach** towards ICT and digitalisation, which does not *only* take into consideration technological aspects, but also social and economic issues. This perspective has found its expression through Cohesion Policy (Pellegrin & Colnot, 2020). It is clearly demonstrated by the **wide diversity of ICT investments** funded by the Cohesion Policy (European Parliament, 2018a), encapsulating digital skills (ESF), investments in SMEs, R&D projects, ICT infrastructures, etc. Nevertheless, the aforementioned **strategies do not explicitly prioritise AI (or smart cities) *per se*.** This implies that Cohesion-Policy funding for AI is **not linked to strong, explicit goals**, but is rather a result of its all-encapsulating approach. The influence of Cohesion Policy in promoting AI in urban development should thus not be over-emphasised. For the **2021-2027 period**, the **strong prioritisation of digital investments** within Cohesion Policy will continue (European Commission, 2021e), and it is likely that the focus on AI will increase and become less implicit.

Beyond the digital strategy, the EU also considers urban issues, namely through the **Urban Agenda**, to which Cohesion Policy is a major contributor. This initiative was launched by the ministers for urban affairs via the Pact of Amsterdam of 2016, with the support of the European Parliament and its relevant groups (European Parliament, 2019b). Its goal is to secure the potential of urban areas and actualise their contribution towards national and EU objectives, while respecting the principles of subsidiarity and proportionality. The Urban Agenda also intends to develop a coordinated and integrated approach to EU policies and better integrate urban authorities in EU affairs (European Commission, 2017). In concrete terms, 12 policy themes with a particularly high level of priority for urban issues have been identified, including **Digital Transition** (European Commission, 2016). These policy themes are supported via action plans, drafted through consultation with the relevant stakeholders (European Commission, Member States, cities, and others). They define key objectives and highlight specific actions to achieve them. Resources to help local authorities are also published within this framework.

In the context of the Digital Transition priority of the Urban Agenda, some attention is dedicated to Artificial Intelligence (e.g., in the 2018 Action Plan[40]), though this is not the core of the activities.

Last but not least, Cohesion Policy is clearly identified as an investment source for the **emerging EU AI policy** (as highlighted in section 5.1.1), given its importance in the EU budget.

b. Specific Cohesion-Policy mechanisms supporting the deployment of AI across regions

The Cohesion-Policy framework also features a series of specific mechanisms that can support the deployment of AI initiatives across regions, even if they were not necessarily conceptualised with this specific goal in mind.

Specifically, one of the **thematic objectives** of Cohesion Policy for 2014-2020 (TO2), i.e., a field where its investments will be steered, aims at, **"Enhancing access to, and use and quality of, information and communication technologies"** (Article 9 of the Common Provisions Regulation (CPR))[41]. This is **not explicitly oriented towards AI *per se,* however**. Indeed, Artificial Intelligence projects require a series of conditions that may not be fully secured for all places across Europe. In particular, there are notable gaps in the digitalisation of public services between small, medium and large cities (with smaller cities less digitalised) and across geographical boundaries (with Northern countries' cities much more digitised than elsewhere). For instance, about 80% of services are digitalised in large Northern cities, compared with only about 30% in Western towns (ESPON, 2017). Given the focus of Cohesion Policy and the overall EU urban and regional policy, this may partly explain the attention awarded to digitalisation as a whole, rather than to AI explicitly. For the **2021-2027 programming period**, Thematic Objectives are replaced by a **smaller list of 5 policy objectives** that are aligned with EU-wide priorities[42]. It includes the **policy objective 1 "a more competitive and smarter Europe"**, with dedicated specific objectives defined for the ERDF and the Cohesion Fund[43]. The specific objectives include focus on "reaping the benefits of digitisation for citizens, companies, research organisations and public authorities", also relevant for AI.

Moreover, the Cohesion-Policy framework (through its regulations for 2014-2020) aims at, **"ensuring that the necessary conditions for the effective and efficient use of funds are in place"** in the different regions (European Commission, 2015a). In practice, this is performed through Ex-Ante Conditionalities (EXAC), i.e., policy documents that are drafted as a requirement for performing investments in certain areas. These include EXAC related to ICT, such as Digital-Growth Strategy and Next-Generation Network Plans (See Article 19 and Annex XI of Regulation (EU) No 1303/2013). Theoretically, this approach could help the different regions to design and implement AI projects with an urban dimension, though this is not the sole concern of these EXAC (which focus on ICT as a whole), and their actual contribution is subject to debate (Pellegrin & Colnot, 2020). More critically, Cohesion Policy has also introduced **Smart Specialisation Strategies (S3)**. S3 are innovation strategies at the regional level that emphasise a prioritisation approach towards specific R&D topics by leveraging territorial strengths. They are based on a bottom-up process involving local stakeholders, designated

40 https://ec.europa.eu/futurium/en/system/files/ged/digital_transition_action_plan_for_dgum_300818_final.pdf

41 Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006, OJEU L 347. p. 320.

42 Article 5 of Regulation (EU) 2021/1060 of the European Parliament and of the Council of 24 June 2021 laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, the Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and financial rules for those and for the Asylum, Migration and Integration Fund, the Internal Security Fund and the Instrument for Financial Support for Border Management and Visa Policy, OJEU L 231, p. 159

43 Article 3 of Regulation (EU) 2021/1058 of the European Parliament and of the Council of 24 June 2021 on the European Regional Development Fund and on the Cohesion Fund, OJEU L 231, p. 60

an "Entrepreneurial Discovery Process". The rationale is to rely on these exchanges to identify a limited number of priorities with high potential for the region, and to concentrate resources accordingly. S3 are also an EXAC for R&D investments under Cohesion Policy 2014-2020. Critically, about half of all regions selected ICT as one of their priorities within the EU for 2014-2020 (JRC, 2021a). Notably, this could include attention to Artificial Intelligence or its enablers, such as Big Data (present in about 26% of ICT-related Smart Specialisation Strategies). An estimated 18 strategies have made an explicit reference to Artificial Intelligence, i.e., about 10%. Similarly, about 40 regions or countries made reference to smart cities in their S3 for 2014-2020, with examples including Apulia, Basse-Normandie, Lower Silesia or the Western Netherlands. This shows that the approach may be used to bridge the gaps between the urban issues and technological challenges at play for smart cities, while taking into consideration the specificities of local conditions (even if the success of the approach in this regard ought to be assessed on a case-by-case basis). According to some interviewees, the S3 may be especially valuable instruments for involving different stakeholders and attempting to reconcile their potentially conflicting visions regarding AI in cities. Based on the experience of the 2014-2020 period, **S3 are also required for the 2021-2027 period.** They are now considered as an **enabling condition** (that are the successors of ex ante conditionalities laid down in Article 15 and Annexes III and IV of Regulation (EU) 2021/1060) for the above mentioned policy objective 1 and are linked to a series of fulfilment criteria (e.g., analysis of innovation bottlenecks, responsible institution for the strategy's management, entrepreneurial discovery process, etc.).

Overall, the strategic and regulatory framework of Cohesion Policy for 2014-2020 provides for a **prioritisation towards ICT**, and the latter may include AI, even if it is often not explicitly emphasised. The linkages between urban development and AI are not strongly and explicitly conceptualised within the strategies to which Cohesion Policy will contribute, and this includes the Urban Agenda, wherein attention to smart cities could make these connections relevant. Still, **this does not mean that the Cohesion Policy does not contribute to actual projects that connect urban development and AI**, such as smart cities and Digital Innovation Hubs (European Commission, 2021e).

For the **2021-2027 programming period**, the strategic and regulatory framework of Cohesion Policy still highly prioritises ICT. The European Commission also tends to make more explicit references to AI than in the past (e.g. on its webpages). It retains some relevant mechanisms to favour the development of smart cities and related initiatives, such as the S3 or thematic concentration towards ICT (through the policy objectives system). Still **linkages between AI and urban/territorial development remain elusive in key regulatory documents**. For instance, in the 2021-2027 Cohesion Policy regulations, "smart villages" are only mentioned twice, and "smart cities" only once (Official Journal of the European Union, 2021, L231).

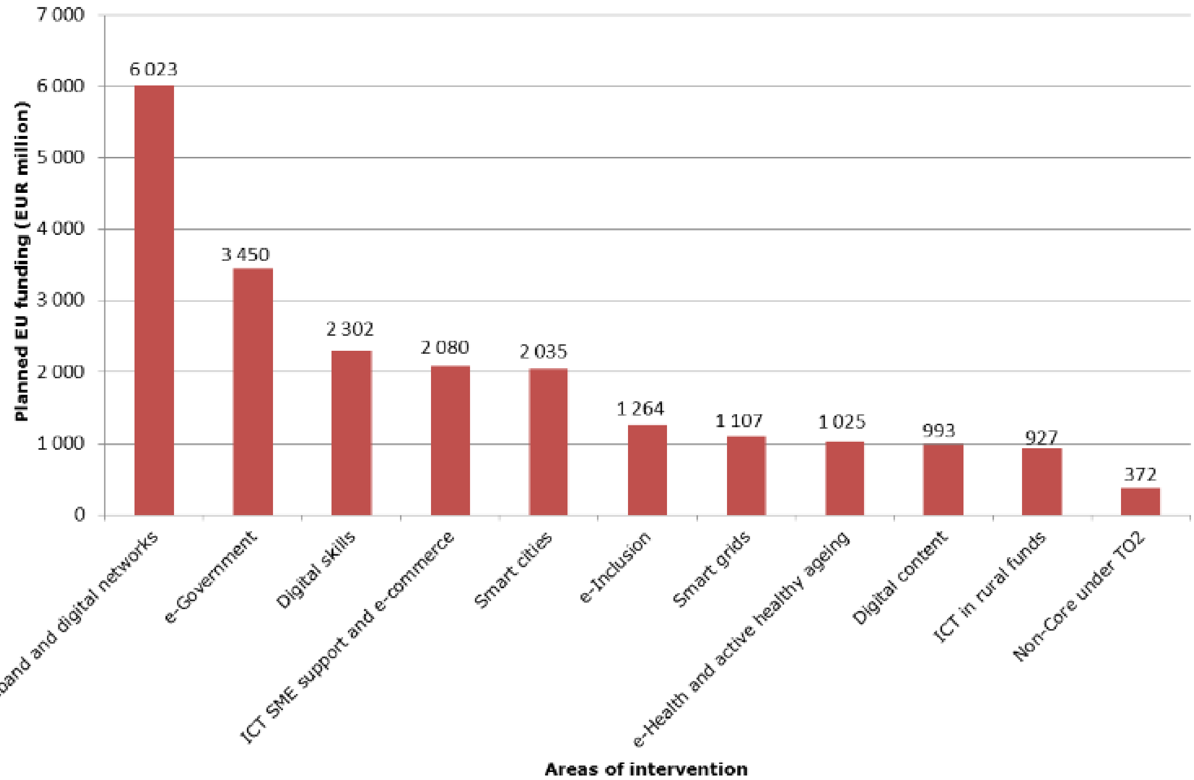
5.2.2. The concrete contribution of Cohesion Policy in connecting AI and urban development in the EU

Even if the contribution of Cohesion Policy to linking urban development and AI is often not explicit at a strategic/regulatory level, there are many examples of **relevant projects funded by the policy** during the 2014-2020 programming period. For instance, Cohesion Policy provides funding for **Digital Innovation Hubs** and **smart cities** (European Commission, 2021e), as mentioned in section 5.1.3, and such investment **may have an AI dimension**.

a. Overview of the Cohesion-Policy contribution to AI projects, with an emphasis on territorial issues, for 2014-2020

Precise estimates for the amounts dedicated by Cohesion Policy to urban development and AI, or even just AI, are not readily available. This situation stems from **methodological limitations due to the categorisation system of Cohesion Policy**, which was not designed to account for this particular category of spending. Indeed, data is broken down by Thematic Objectives (which include TO2 dedicated to ICT as a whole), or more precisely by Categories of Intervention. Some of these categories are linked to ICT investments (as identified, e.g., in Sorvik and Kleibrink, 2016). These include certain categories of particular relevance to AI, such as investments in Smart Grids (intelligent energy-distribution systems) or Smart Cities (intelligent transport systems) (Sorvik and Kleibrink, 2016). The following graph presents estimates of the planned amounts dedicated to different categories linked to ICT under Cohesion Policy for the period 2014-2020.

Figure 9: Areas of intervention linked to ICT, as funded by Cohesion Policy for 2014-2020



Note: includes ERDF, CF, ESF, EAFRD and YEI – planned amounts
Source: European Parliament, 2018b based on JRC data[44]

In particular, planned Cohesion-Policy investments for ICT, for the period 2014-2020, included EUR 2 billion for Smart Cities and EUR 1.1 billion for Smart Grids. These categories were likely to contain AI investments, but they also covered other forms of spending, and AI investments may also be funded under other categories.

[44] The same methodology could be applied to actual amounts in the future.

Despite these current limitations in the categorisation system, some ongoing studies have the potential to provide more detailed information regarding the categories of investment to be financed under Cohesion Policy in the future, such as the REGIO Monitoring study.

Box 13: The REGIO Monitoring study and Cohesion-Policy investments

The REGIO Monitoring study commissioned by the European Commission (DG REGIO) aims at developing a unified database of Cohesion-Policy investments across the different Operational Programmes. Different contractors (CSIL, Prognos, PPMI) are currently working on this project (as of June 2021, with an expected ending in 2022).

The developed database will adopt harmonised definitions and identify different clusters of investment based on the description of actual projects, i.e., it will not rely solely on the already defined categorisation systems. In consequence, it may inform future evaluations and studies with a high level of quality and detail. Depending on data availability, AI investments could be more precisely identified, even if feasibility levels were still to be confirmed.

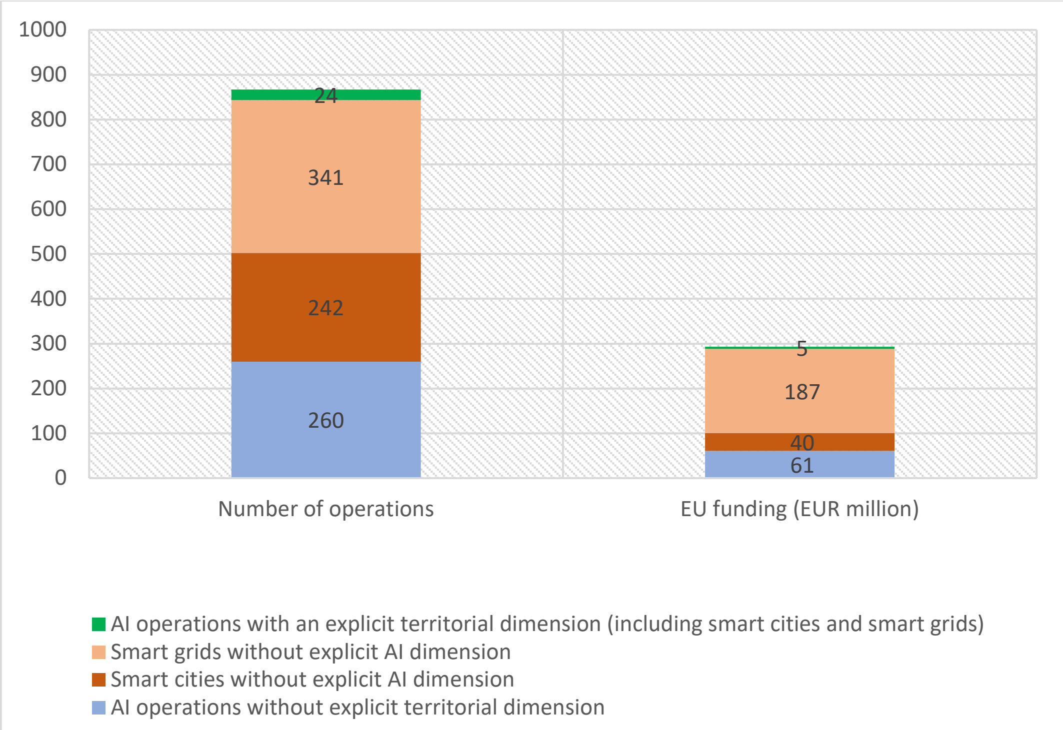
Source: Authors, based on https://www.csilmilano.com/project/study-on-the-monitoring-data-on-erdf-and-cohesion-fund-operations/

b. Focus on specific cases and projects, illustrating the contribution of Cohesion Policy

There are thus major uncertainties surrounding the total amounts linked to AI that have been, and will be, channelled via Cohesion Policy at the EU-wide level; obtaining **a full-picture of the situation would require further detailed studies**. To provide a short overview of the types of projects that may obtain funding and of the related patterns, this study presents the **examples of the Italian and Danish situations**. Indeed, these two countries cover an interesting range of the AI paradigms in Europe, in terms (especially) of the development of digital technologies, as well as in terms of geography and Cohesion-Policy funding amounts.

For instance, in Italy, the OpenCoesione website facilitates the identification of Cohesion-Policy projects by virtue of their detailed descriptions. Based on this dataset, the following relevant operations have been identified for Italy:

Figure 10: Cohesion-Policy operations in Italy (2014-2020 programming period)

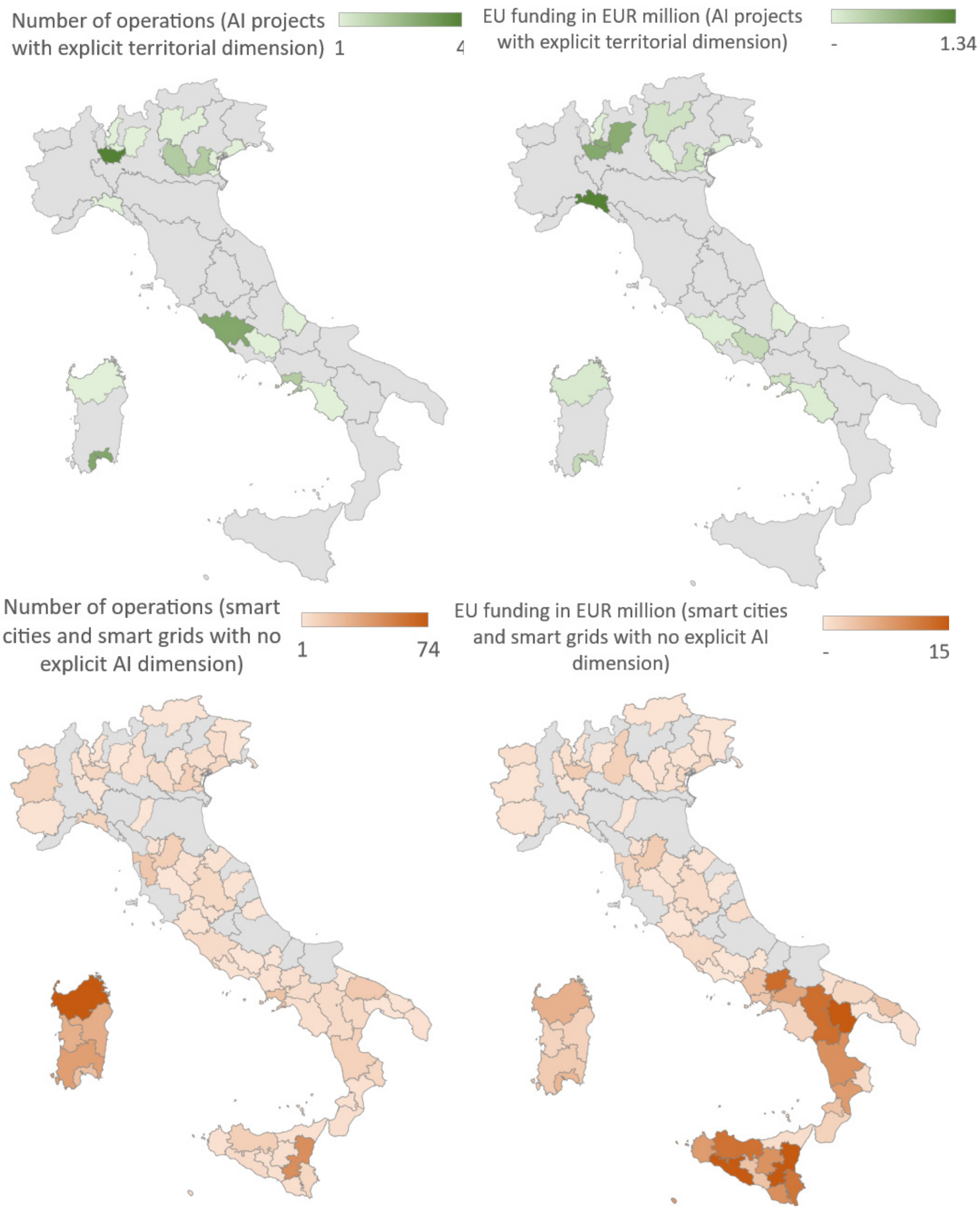


Source: Authors, based on https://opencoesione.gov.it/en/progetti/, extracted on 11.05.2021 using the keywords Intelligenza Artificiale, Artificial Intelligence, Smart Grid, Smart Grids, Smart Cities and Smart city. Manual identification of AI projects with an explicit territorial dimension.

From these data, it is clear that **operations directly combining Artificial Intelligence and a territorial dimension** (i.e., urban or regional) are **only a small fraction of the overall projects**. Nonetheless, when one expands the definition to Smart-City and Smart-Grid operations that do not *explicitly* mention AI in their respective descriptions, the figures rise substantially, to 583 operations financed by EUR 227 million of EU funding. AI-related operations lacking a territorial dimension are also numerous, as 260 of them could be identified for a total of EUR 61 million.

Moreover, these operations are **not uniformly distributed within the Italian territory**, as shown in the following maps.

Map 1: Location of AI-related operations with an explicit territorial dimension, and Smart-city / Smart-Grid operations without an explicit AI dimension, as funded by Cohesion Policy in Italy (2014-2020)



Source: Authors, based on OpenCoesione data

Smart-City and Smart-Grid projects without an explicit AI dimension are broadly “scattered” across the country, with some hotspots in Sardinia and Sicily. Related funding is particularly concentrated in Southern, less developed regions of the country, to a larger extent than the number of operations. For projects with a territorial dimension and an explicit attention to AI (including those pertaining to Smart Cities and Smart Grids), the picture is quite different. Indeed, these tend to be concentrated in the most urbanised, richer, Northern regions, although there are some exceptions. This suggests, at least in the Italian case, that **the explicit incorporation of AI in urban development projects** (including Smart Cities / Smart Grids) **is dependent upon specific characteristics, such as the local level of development**. This hypothesis must be confirmed by further analyses. If sustained, this paradigm could impede the ability of less developed regions to benefit from the advantages of AI for urban development, but it could also indicate that these regions have not yet unlocked the requirements (e.g., ICT infrastructures and skills) to implement this type of projects.

In terms of project objectives, **operations explicitly combining AI with a territorial dimension** tend to be **fairly diversified** in the case of Italy, ranging from regional assessment of exposure to pollutants to digital services and urban monitoring. An example from the small city of Monserrato (Sardinia) is presented in the following box.

Box 14: An example of an Italian Cohesion-Policy project combining AI with an explicit urban dimension: the Observatory for Road Safety (OSCAR)

Monserrato is a small Italian city of about 20 000 inhabitants, located on the island of Sardinia. The municipal police of the city maintain an “observatory” for road safety (OSCAR). Thanks to Cohesion-Policy support (EUR 250 000 against a total budget of EUR 500 000), the police department of the city will develop an AI platform that will help it to monitor and manage road accidents. The platform will use a system of noise sensors and cameras to monitor traffic, thereby helping police to understand the severity and characteristics of accidents, and thus to request the relevant emergency services.

Source: Authors, based on https://opencoesione.gov.it/it/progetti/1sa00000201131-apratt1132020175/

In **Denmark**, which is a smaller Member State with a high level of development, receiving less Cohesion-Policy support than Italy, about 16 projects linked to Smart Cities could be identified in 2014-2020 (as referenced by the authors, based on Danish project databases[45]). They amount to a total EU contribution of EUR 58.7 million. Among these, three made **an explicit reference to AI** and benefited from EUR 11.5 million of EU funding. A notable characteristic of these Danish projects was their **focus on environmental aspects,** including waste management, water management, climate-change mitigation and energy efficiency/carbon reduction. These projects were conducted in different contexts, including small or medium-sized cities, as demonstrated by the Smart Spildevand project.

Box 15: An example of a Danish Cohesion-Policy project using AI for urban water management: the Smart Spildevand project

The Municipality of Kolding, a medium-sized city of about 60 000 inhabitants located in Southern Denmark, has set a up an innovative water-management project with the collaboration of the water company Blue Kolding. Called the Smart Spildevand, or Climate Water, the project benefits from about EUR 4.8 million of EU Funding under Cohesion Policy.

[45] https://regionalt.erhvervsstyrelsen.dk/projects-denmark

The project combines smart, alternative solutions for managing water runoff with urban development and recreational activities. It also relies on the significant involvement of citizens and the dissemination of climate-protection awareness in urban areas. The project deploys its innovative solutions across different areas. For instance, the Kolding Slotsø / Vifdam area benefits from automatic damper systems, connected to Blue Kolding's control system, to divert surface water, relieve the existing sewer system, and mitigate environmental impact and risk. In particular, the solution uses a computer model (AI) to add an intelligent control option based on the weather. Dissemination efforts include annual events promoting sustainable activities, targeting citizens and municipalities. This example shows how AI can be used at the territorial level to deploy solutions combining multiple dimensions, including social and environmental factors.

Source: Authors, based on https://regionalt.erhvervsstyrelsen.dk/eu-smart-spildevand-1

To conclude, there are **concrete examples** of projects funded by Cohesion Policy that combine AI and urban development in different Member States, as demonstrated by the instances of Italy and Demark. Nonetheless, **obtaining a full picture of the situation is hampered** by the paucity of information available in the monitoring systems, since the latter typically do not allow an explicit identification of the most relevant projects. Moreover, the **long-term sustainability** of the funded projects may be subject to further inquiry. In many cases, indeed, it seems likely that such projects should be seen as **pilot initiatives** that cities (especially smaller ones) may use to test their readiness, better to assess costs and benefits. They may thus be interpreted as a form of experimental support in the context of Cohesion Policy.

6. CONCLUSIONS AND RECOMMENDATIONS

It is likely that AI will exert a major impact on urban development and city management, mainly through its contribution to the expansion of smart-city initiatives. AI can help improve city management and the delivery of new services to citizens; most crucially, it can integrate, and exploit, the huge amount of data produced by normal city life, and thus bring the smart-city model to its full realisation. Overall, AI has the **potential to respond to many challenges that cities and towns must address in the years to come,** including the uncertainties related to the post-COVID-19 era.

At the same time, the **risks of unwanted outcomes or missed opportunities are high**. These dangers relate, in part, to the intrinsic technological risks of AI. Issues also arise, however, because in the context of smart cities, the conditions for reaping the benefits of AI while mitigating its associated hazards are difficult to manage, at least for the vast majority of towns and cities. There are exceptions, as a few frontrunners (usually large cities with a pre-established history of digital innovation, such as Amsterdam) show some promising signs vis-à-vis the use of AI in smart cities. In this context, however, a scenario in which a few cities benefit from a **"winner-takes-all" effect** is realistic, while a host of middle-sized towns may be left behind. The latter may also be unable to reap the full advantages of the dynamics triggered by the post-COVID-19 period – dynamics that *may* offer an unprecedented opportunity for a territorial redistribution of populations between urban, semi-urban and rural areas. The risks of marginalisation may be even higher for those local (rural) authorities that surround larger and more advanced AI-adopting cities, if these same peripheral jurisdictions are not properly involved.

In the face of the expected huge advantages *and* numerous potential risks of AI, as deployed in cities, there is relative uncertainty and a lack of systematic evidence. While the socio-economic impact of digitalisation in general, and AI in particular, are topics already widely researched, there is no corresponding level of interest in the territorial impact of AI in an urban context. This is particularly notable in the case of rural-urban relations, which will be significantly impacted by the diffusion of AI solutions.

Despite an imperfect evidential basis, it is nonetheless almost certain that AI and smart cities will put territorial cohesion at risk if no proactive measures are taken to overcome the sometimes heavy disadvantages that characterise some municipal authorities, specifically in terms of means and capacities. **This does not appear to be a concern that ranks especially high on the policy agendas** of public authorities either inside or outside the EU, or on that of the EU itself. The EU has adopted a specifically "human-centric" approach to AI, based on a careful risk assessment aimed at respecting fundamental EU values (e.g., human rights). Nonetheless, **at a strategic level, issues surrounding the impact of AI on urban development, and on territorial cohesion, remain tangentially addressed at best**. This is the case not only within EU AI Policy, but also within Cohesion Policy.

Still, on the ground, **many EU initiatives contribute to linkages between urban development and AI**. EU initiatives open up support for all types of cities, irrespective of size and capacity, adapting that support to the level of development of the cities in question. These initiatives mainly consist of networking and sharing platforms, the fostering of learning among urban authorities and (thus) the palliating of potential lack of support at the national level. Much expectation is also centred on Digital Innovation Hubs (those specialised in AI, in particular) and Smart Specialisation Strategies. In financial terms, the EU mainly relies on **Cohesion Policy and its funds,** which comprise a significant budget to support the uptake of AI by municipal authorities and other stakeholders. Yet, the difficulty of tracking urban-related AI investments via the monitoring systems in place makes it challenging either to engage in "policy learning" or to leverage policy achievements.

Overall, a place-based approach to AI in urban development, i.e., an approach designed at local level and based on local specificities, would appear especially appropriate. Several factors support this approach. First, there are considerable variations in the objectives pursued, and in the enabling conditions needed to implement successful digital transformation across cities and towns. Furthermore, it is at the *local* level that citizens are most likely to feel the impacts of AI and smart cities, and it is also at this level that they can be most actively engaged. Finally, this is a policy field where combined action on the part of different levels of governance is advisable, in order to capitalise on different sources of knowledge and to deal with the preconditions for a successful integration of AI at the urban level.

Recommendations

Based on the evidence collected in this study, we suggest that the European Parliament could contribute to the following actions:

- **Mobilise Cohesion Policy effectively and explicitly to address AI in an urban context.** The REGI Committee of the European Parliament should call on the Commission to ensure that the following aspects are adequately addressed during the negotiations with Member States:
    - **Explicitly integrate considerations regarding AI in smart cities into strategic and programming documents underlying Cohesion Policy at the MS level** (e.g., Partnership Agreements and Operational Programmes). Potentially, Cohesion Policy can provide decisive support to those cities and towns that aim to develop inclusive and fair smart-city initiatives. It can help them fulfil the stringent conditions necessary to seize the potential of both AI and the smart-city model (for instance, by improving administrative capacity and digital skills). Cohesion Policy should also encourage a shift from experimentation to scaling-up smart-city initiatives (funding and related support). Moreover, it should steer funding towards applications that can deliver better public services for citizens - for example, in the context of Smart Specialisation Strategies. The EC should provide MS with all the necessary guiding materials, differentiating between cities/regions based on their level of digitalisation;
    - **Ensure that monitoring systems** of Cohesion Policy deployed at MS level account for smart city related investments, including the use of AI. Because AI is an enabling technology (with a cross-cutting dimension), a "flagging" system may be best suited to this goal.

The European Parliament should also contribute to the following efforts:

- **Properly coordinate the different EU initiatives in favour of AI in cities within the Urban Agenda.** This should be done both to increase their coherence and visibility, and to ensure they consider the territorial dimension of AI. Several initiatives around smart cities have arisen from different EU stakeholders (DG CONNECT, DG ENER, DG MOVE, etc.), but they lack an explicit and overarching prioritisation, with debates around the different visions of smart cities, and indeed, around which of these the EU should favour. To achieve the objectives referenced here, the European Parliament could collaborate closely with the Committee of the Regions;
- **Mobilise Digital Innovation Hubs,** as these have a key role to play in supporting local and urban authorities in rolling out effective AI and smart-city strategies. In particular, the AI-specialised DIH should also address the specific needs of public authorities;

- **Consolidate a knowledge base regarding AI in an urban context, in order to improve policy-making**. It should be possible to capitalise on the wealth of experience already accumulated by the different platforms of exchange, as activated by the European Commission, to derive useful indications for local and urban authorities. The context of the update of the Better Regulation Guidelines and Toolbox, ongoing since 2019, may also afford an opportunity to reinforce tools for tackling knowledge gaps in the field of AI and urban development. This particularly applies to Territorial Impact Assessments, which are expected to be strengthened according to the Commission Communication on Better Regulation of April 2021.[46] The Report on Economic, Social and Territorial Cohesion, published every three years by the Commission, could provide a dedicated section to describe the progress made in this respect;
- **Increase awareness among citizens regarding the enormous potential, but also the concrete risks, surrounding the relationship between AI and city development.** This should be done in terms of socio-economic and territorial cohesion, and with respect for the foundations of our democracies. The European Parliament has a major role to play in facilitating awareness-raising campaigns about these issues, and indeed, it should hold regular discussions on related matters.

[46] https://www.europarl.europa.eu/legislative-train/theme-a-new-push-for-european-democracy/file-better-regulation/06-2021

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This research paper explores the role of artificial intelligence (AI) in urban areas, and its impact on socio-economic and territorial cohesion. It argues that expectations surrounding AI are high, especially in the context of smart city initiatives, but that the actual benefits are yet to be fully assessed. To avoid potential risks, local and urban authorities need to fulfil a series of conditions that are inherently challenging. The EU's AI Policy and its Cohesion Policy, in particular, may help, but they need to address the territorial dimension of AI more explicitly.

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