DISSERTATION ON:

Exploring the role of artificial intelligence in smart cities and their benefits for entrepreneurs in Dublin, Ireland, and San Salvador, El Salvador.

Submitted By:

May Evelyn Iraheta Hernández

Student ID: 231398025

THESIS DECLARATION PAGE

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AI Acknowledgment

Tool Name	Brief Description	Link to tool
Turboscribe	Audio to text in seconds.	https://turboscribe.ai/?ref=pdf_export_upsell
TinyUrl	Short web link	URL Shortener, Branded Short Links & Analytics | TinyURL
Grammarly	Enhance grammar	Grammarly desktop
ChatGPT	AI chatbox	https://chatgpt.com/

Description of AI Usage

ChatGPT	
Interview as Participant 8 and advisor for technical topics.	
I would like to interview you in Exploring the Role of Artificial Intelligence in Smart Cities and their Benefits for entrepreneurs in Dublin and San Salvador.	I'd be happy to discuss the role of (AI) in Smart Cities and how it benefits entrepreneurs in cities like Dublin and San Salvador. Let's start the interview!
can you help me to understand what is BDA, for a teenager, and how this is important in smart cities	Sure! Let's break down what big data analytics is and why it's important in smart cities in a way that's easy to understand.
So, and what is the role of IoT and AI in BDAs, how these 3 things work together	Great question! Let's look at how the (IoT), (AI), and BDA work together to make smart cities even smarter.

Acknowledgment

I would like to express my gratitude to my research supervisor Eileen Tan, whose guidance and knowledge were significant during this dissertation. My sincere thanks also go to my classmate Lucas Vialey for his academic, emotional, and kind support.

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Last special thanks to myself, for not giving up, for overcoming all the doubts and obstacles, and for investing all my days off to write and make progress in finishing this research project.

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Abbreviations

IoT	Internet of Things
BDA	Big Data Analytics
AI	Artificial Intelligence
DT	Digital Twins
AIDA committee	The Special Committee on Artificial Intelligence in a Digital Age
SMEs	Small and Medium Enterprises
Q1	Question
P1	Participant
WIPO	World Intellectual Property

Abstract

One of the main problems that humanity is facing is urbanization and population densification in large cities: Metropolitan and Micropolitan areas, lineal cities, Megacities, and Global cities.

Some cities, in countries like China and Japan, are getting ready for this Fourth Industrial Revolution, mostly for the accelerated development of technology in terms of autonomy, all this thanks to Artificial Intelligence. For that reason, cities or megacities are becoming smart cities. This fact opens new opportunities for business for entrepreneurs involved in tech solutions, as we will see in the literature review many programs promote creativity with venture capitals, hackathons, competitions, or calls for pilot projects, to find solutions in the cities and improve the quality of life of the citizens.

For example, the Artificial Intelligence European Act has involved in their articles SMEs and start-ups to be part of the new era of AI. This potential topic of research aims to explore those changes and provide insights for future and present entrepreneurs in technologies or consultant businesses, especially in local governments in the transition of Smart Cities.

The research follows the qualitative research method, after an interpretive philosophy, using an explore method, the research question is What is the role of artificial intelligence (AI) in smart cities and their benefits for entrepreneurs in Dublin and San Salvador? With a general objective “Explore the role of Artificial Intelligence in Smart cities and their benefits for entrepreneurs in Dublin, Ireland and San Salvador, El Salvador.

Some of the significant findings are that even though entrepreneurs with tech solutions have many possibilities in this field, one of the challenges is to gain the users' trust, overcome skepticism, and work with ethics by putting the human being at the center of the solutions. If the idea offered by a start-up is successful, that idea has the potential to open the opportunity to the Global market.

However, all the success of the innovation transitions depends on the politics and measures towards the ethical implications, by improving transparency of private data usage. Also, the role of Local government is to create a safe space for experimentation and promote creativity around AI, as the AI ACT mentions, creating a sandbox for entrepreneurs. Calls for proposals for pilot projects in applied artificial intelligence have proven to be a valuable tool.

Local governments should consider projects that use AI for local entrepreneurs, not only in the technological field but in SMEs in general. Brainstorming Workshops on how AI can boost their businesses and be competitive would be useful for this.

Cities such as Bristol in the United Kingdom or Shenzhen in China are a good paradigm from which one can learn by saving time in stages already overcome, both with complete strategies or programs and equally with specific projects, in the area of entrepreneurship linked to artificial intelligence.

To conclude, The role of AI in smart cities according to all participants and literature is to improve the quality of life of the citizens by enhancing Urban management, improving public services, and enhancing mobility sustainably. And open endless opportunities for entrepreneurs.

1. Introduction

One of the problems that urban cities are facing nowadays is the density of the population, according to Yan et al. (2023) at the 41st World Expo in Shanghai in 2010 mention that more the half of the global population living in urban areas, making cities more dense populated as United Nations and World Bank make the projections about urban proportion has not only sustained but grown, rising from 51% to 55% and, according to projections by the United Nations, is set to swell to 68% by the year 2050. That is why the cities have to become smarter to react more effectively and make decisions, otherwise, cities will be behind the time.

Research background

Along the same line according to Koumetio Tekouabou, S.C., Diop, E.B., Azmi, R. et al. 2023) many are the challenges that societies around the globe are facing, such as increment in urbanization, poverty, climate change, pollution, and sustainable and inclusive development. Not only that, as well the rapidly developing technology, where AI has taken relevance, for example, based on the World Intellectual Property Organization (WIPO) (2024) China has 2014/2023 more than 38,000 generative artificial intelligence (GenAI) patents, followed by the United States with around 6,300 patent families in the same period.

Those numbers of GenAI, show us the importance in the world and give us an idea of new business opportunities. Artificial intelligence (AI) is becoming part of our daily lives and is rapidly developing, even Elon Musk and 1125 people, including AI experts according to Nolan (2023) "have signed an open letter calling for a six-month pause on advanced AI development."

We are in the era of the Fourth Industrial Revolution, as UNESCO (2023) stated that Japan is getting ready for "The transition to Society 5.0 is deemed similar to the 'Fourth Industrial Revolution', in that both concepts refer to the current fundamental shift of our economic world towards a new paradigm"

As we are witnessing all the changes that technology has made since the Internet revolution, how society has changed and adapted to disruptive innovations, for example, the mobile phone, laptop, buying behaviors, online banking, and transferring money from one country to another country. Thanks to the Internet of Things (IoT), we are in the middle of a disruptive innovation called AI, as Minevich (2023) mentions "2024 will mark a watershed moment for generative artificial intelligence, triggering a metamorphosis across the global economic landscape as businesses wake up to its broad potential."

Significance of the study

This research tends to explore the role of AI in Smart cities in Dublin and San Salvador, by identifying, the components or areas where AI will be applied, examining expert predictions, and identifying business opportunities for entrepreneurs. By generating this knowledge local governments, academia, and forward-thinking entrepreneurs can be prepared for potential business opportunities.

Some renowned universities like Harvard are talking about reskilling in the age of AI, this is particularly crucial for those who are looking to start into business, as AI presents both unprecedented challenges and opportunities.

This potential topic of research aims to explore those changes and provide insights for future and present entrepreneurs in technologies or consultant businesses, especially in local governments in the transition of Smart Cities. I believe that this exploration will add a better understanding of business practices and help us to prepare for what is coming.

Methodology

The research follows the qualitative research method, after an interpretive philosophy, using an explore method, the research question is What is the role of artificial intelligence (AI) in smart cities and their benefits for entrepreneurs in Dublin and San Salvador? With a general objective "Explore the role of Artificial Intelligence in Smart cities and their benefits for entrepreneurs in Dublin, Ireland and San Salvador, El Salvador." And has three sub-objectives:

Sub-objectives

- Identify specific benefits and challenges of AI implementation in smart cities for entrepreneurs in these two urban contexts.
- Explore how AI adoption by local government with smart cities supports entrepreneurial activities, innovation, and economic growth in both cities.
- Identify good practices and stakeholders' attitudes (feelings, opinions, or perspectives) of AI in the context of Smart Cities and entrepreneurs.

The information interview questionnaire was designed to collect the most relevant information, in total seven interviews were made and one specific to AI, about this you will find some limitations in the conclusion chapter.

In this research, you will dive into some of the most important features throughout the literature review about entrepreneurship and smart cities regarding concepts, components, IoT, BDA, AI, and digital twins. As well, as what is written about the ethical implications of AI in Smart Cities.

Subsequently, you will find the methodology in more detail, and after that, the findings chapters have been made by following the Thematic analysis method for each question.

For the analysis, we prepare a conclusion chapter and as well a discussion part that blends the literature review and participant inputs to enrich the discussion.

In the last chapter, there are some recommendations and future research ideas on this topic.

We are putting all the references in the Harvard style and adding the questionnaire interview as an appendix.

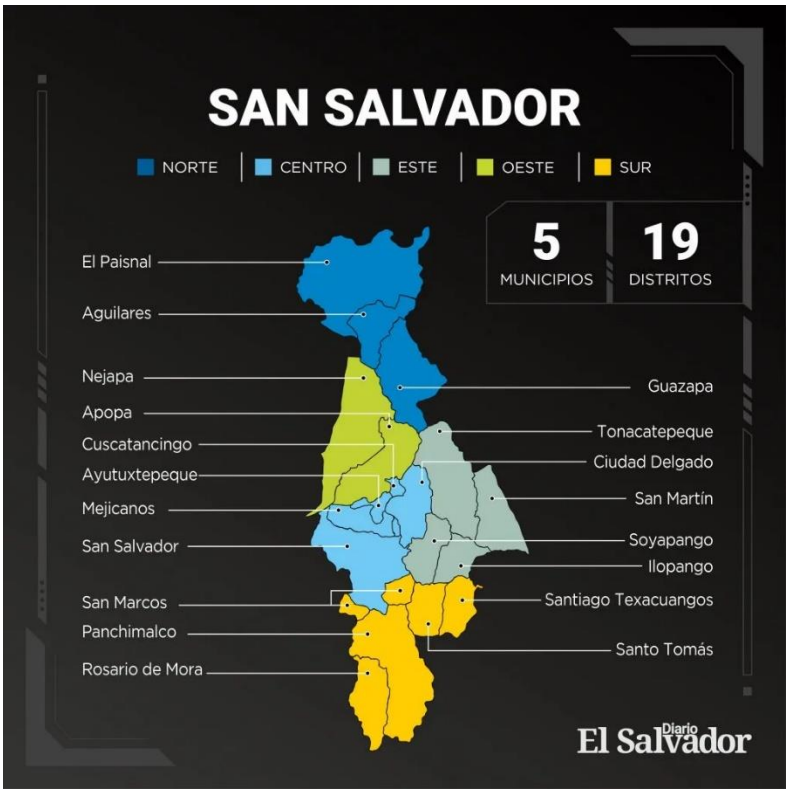
2. Context of both capitals

2.1 The City of San Salvador, Capital of El Salvador

According to the El Salvador Government (2024), El Salvador has recently established a new administrative and Territorial reform by restructuring municipalities and Districts, the current District of San Salvador is officially the capital of the Republic of El Salvador. With the current administrative reform in development, effectively implemented in May 2024, the former 262 municipalities have been converted into districts and grouped into forty-four new municipalities. Therefore, the new local government of San Salvador Centre is composed of 5 districts, which are, San Salvador, Mejicanos, Ciudad Delgado, Ayutuxtepeque, and Cuscatancingo. The local authority of San Salvador-Centre is the core of the Metropolitan Area of San Salvador (AMSS) acronym in Spanish, which consists of 14 [1]districts in five new municipalities. As you can see in the next figure.

[1]According to the AMSS

Figure 1 AMSS of San Salvador and districts



Source: Diario El Salvador, 2024

There are five categories and territorial levels that can be confused due to their names containing the word "Salvador," but it is necessary to differentiate them. These are the District of San Salvador; the Municipality of San Salvador-Center; the Department of San Salvador; the Metropolitan Area of San Salvador (AMSS); and the Republic of El Salvador.

Population

The Metropolitan Area of San Salvador, with nearly 2 million inhabitants, is considered the second-largest urban agglomeration in Central America, after Guatemala City. The Municipality of San Salvador-Center has 704,913 inhabitants. Considering only the District of San Salvador, it has 334,416 inhabitants. The official population estimate for the country, El Salvador, for 2024 was 6,350,969 inhabitants.

One of the biggest challenges faced by all municipalities, especially the District of San Salvador. Adapting to the current administrative-territorial reform.

Table 1: Six geographical categories or territorial levels with the word "Salvador" that need differentiation and their geographical inconsistencies.

Aggregations of the Territory	Area km²	population 2024
San Salvador district (before the reform)	72.25	334,416
San Salvador-Centre with 5 districts	141.6	704,913

San Salvador with 5 counties	886.15	1,729,479
AMSS con 19 districts in 6 counties	610.86	1,695,867
Six counties of AMSS with 23 districts	985.12	1,937,094
El Salvador with 44 counties	21, 041	6,350,969

Source: Estimaciones y Proyecciones de Población Municipal (revisión 2021). Central Bank El Salvador.

Some of the problems, we cannot talk about in San Salvador center on its own, the problems are correlated with all the five districts that are part of the AMSS facing, first chaotic traffic, according to Videos (2023) approximately 690 thousand people circulate every day from do an errand to the capital, for work, to go to the school. As you can the figure below from one of the national newspapers elsalvador.com

Figure 2 Photo of Traffic problems in AMSS

Source: elsalvador.com (2023)

Figure 3 One of the communities from AMSS with garbage collection problems

Source: elsalvador.com (2023)

2.2 Dublin Ireland

Dublin is the capital of the Republic of Ireland, the "City Council" has a population, according to the 2022 census, of 592,713 inhabitants; the region of Dublin has 3 counties conurbated with the city, has 1,458,154 inhabitants; Dublin's area is located in the Province of Leinster. The country had a population, as of April 2023, of 5,281,600 inhabitants. In the past, County Dublin had two councils, the County Council and the Dublin City Council. The County Council was subdivided into three separate county councils.

Table 2 Dublin and districts population

Name	Area: km²	population: 2022
1. Dublin City	115 (12.6%)	592,713
2. The administrative county of Dun Laoghaire	127 (13.9%)	233,860
3. The administrative county of County de Fingal	448 (49.1%)	330,506
4. The administrative county of County de Dublin del Sur	223 (24.4%)	301,075
	Total	1,458,154

Dublin counts with Smart City Dublin which started in 2016. According to Cudden, and Jamie (2018), this initiative was created to take advantage of "the big tech trends that are transforming how we live and work. These trends include Mobile, Cloud Computing, the Internet of Things (IoT), Big Data, Machine Learning, and Artificial Intelligence."

Cudden, (2018) mentioned that Smart Dublin is a niche for new opportunities for start-ups and entrepreneurs. He said that there is a collaboration between them and Enterprise Ireland, where

they launch a challenge to start-ups to offer solutions to the city through the program denominated "Enterprise Ireland's Small Business Innovation Research Program (SBIR)."

Figure 4 Dublin City and districts map

Source: South Dublin Volunteer Centre.

Figure 5 Public transport in Dublin

Figure 6 Waste management in Dublin

3. Literature review

In this chapter, we going to dive into existing research that will help to understand how AI would reshape the cities by improving efficiency and creating new business opportunities, identify how entrepreneurs can be involved in the smart city ecosystem.

3.1 Entrepreneurship

There is a vast definition of this term Didip and Ahmad (2020) stated that "*some of the definitions are seeing entrepreneurship as a process of a successful organization, and others define entrepreneurship as building mindset and skills. However, the final destination of entrepreneurship definition is generating job opportunities and leading to economic development",* according to Didip and Ahmad (2020) cited Croci (2016) and mentioned that entrepreneurship is a unique, specific, and independent business discipline.

Barot (2015) mentions that entrepreneurship "involves all the activities, functions and actions associated with perceiving of opportunities and creation of organizations to pursue them". He also stated that the term entrepreneurship involves five basic factors "introduction of the new product, the introduction of a new method or production, the opening of a new market, the conquest of a new source of supply and carrying out a new organization of industry"

Some entrepreneurial inventions can be consider as disruptive innovation. S. and Chen, H. (2020) explain that there are many concepts, and perspectives on disruptive innovation, the first perspective is based on four types of innovation:

1. Disruptive business model innovation, "which focuses on building a new activity system in which new partners and activities are configured in an unprecedented way compared to existing business models"
2. Disruptive technology innovation focuses on developing a more concise and convenient technology that the mainstream markets do not value to enter a niche market or new market, and then the technology is gradually improved to flow into the mainstream market from a niche market or new market"
3. Disruptive product innovation "focusing on developing simpler, less functional, cheaper but "enough good" products to serve the market which is overlooked by mainstream product" and
4. Disruptive strategic innovation: this strategy focus on not to sell or create an high quality of product but focus on a specific group of people to cover their needs.

The second perspective to define disruptive innovation is based on the evolving process, the third one is based on the effects. According to the Chirstensen Institute Disruptive innovation "describes a process by which a product or service initially takes root in simple applications at the bottom of a market—typically by being less expensive and more accessible—and then relentlessly moves upmarket, eventually displacing established competitors." They mention that to be considered as disruptive innovation must have a "components firsts in must contain an enabling technology, second it must have an innovative business model and last, "a coherent value network must exist.

Chang (2015) mentions that the art of entrepreneurship can be seen "as a form of leadership, the ability to manage the recombination of basic organizational functions (such as marketing and funding) in the face of contextual change, and as a demonstration of policy entrepreneurship."

Eisenmann, (2021), takes this definition from Professor Stevenson "Entrepreneurship is the pursuit of opportunity beyond resources controlled.", Eisenmann, (2021), also mentions that the definition of entrepreneurship is important for two reasons, first, to understand the methodology to manage the life cycle of the organization in a specific stage (i.e., startup), a specific role, for instance, the founder, or a variety of skills and personality attributes, such as, "predisposition for risk-taking; preference for independence"

Second, Eisenmann, (2021), said that entrepreneurs require tactics to manage risk and mobilize resources.

Barot (2015) points out that there are two types of entrepreneurship, " The opportunities based on entrepreneurship where the entrepreneur perceives the business opportunity, and the other is the necessity-based entrepreneurship, where the entrepreneur does not have another viable option to earn a living."

Didip and Ahmad (2020), mention the study conducted by Aulet, W., and Murray, F., (2013) where the concept was divided into two categories, the first one is based on innovation-driven with the target to "pursue the global opportunities" and the second one is the small business or small medium enterprises which have limited access to the global market "serve local markets with the traditional way with low competitive advantage."

Other categories of entrepreneurship offered by Welter et al, (2016) are High-growth, technology-enable, and venture capital-backed businesses.

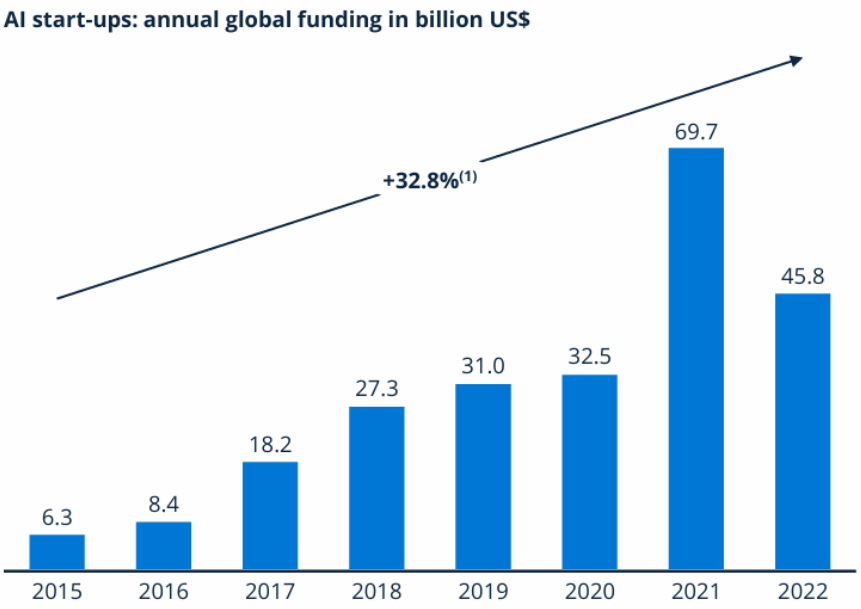
3.1.1 Entrepreneurship: Smart Cities and AI

As we pointed out before smart cities work in a more efficient way than normal cities, they use more "resource-efficient management and economy than the ordinary cities", because they require special technology and applications, as Impedovo and Pirlo (2020, p 1) stated "As such, advanced business models have emerged around smart cities, which have led to the creation of smart enterprises or organizations that depend on advanced software and computer applications. Smart cities and smart enterprises deal with the integration of artificial intelligence, web technologies, smart mobile platforms, telecommunications, e-commerce, e-business, and other technologies."

According to Statista. (2023) " One of the major factors driving the current wave of AI growth is the strong interest of Venture Capital (VC) investment in AI start-ups", nonetheless "The AI start-ups grow remarkably with over 2,600 AI start-ups across 13 categories by 2020, the annual global Founding of AI start-ups increase at a CAGR of over 32.8% from over 32.8% from 2015-2022. (See figure no.)

In terms of growth, the AI start has accumulated around "US$239.2 billion in funding during 2015-2022"

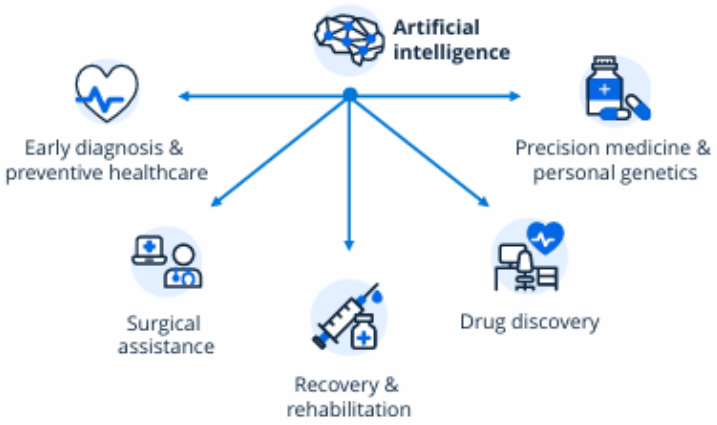
Figure 7 Ai startups: Annual global funding in billion US$



Source: Statista, (2023)

Regarding AI related to smart cities Statista (2023, p. 79) mentions various sectors like Healthcare. Education, finance, and autonomous driving are an important part of smart cities, some examples of operation models in Healthcare are early diagnosis and preventive healthcare, surgical assistance, and more (see Figure below)

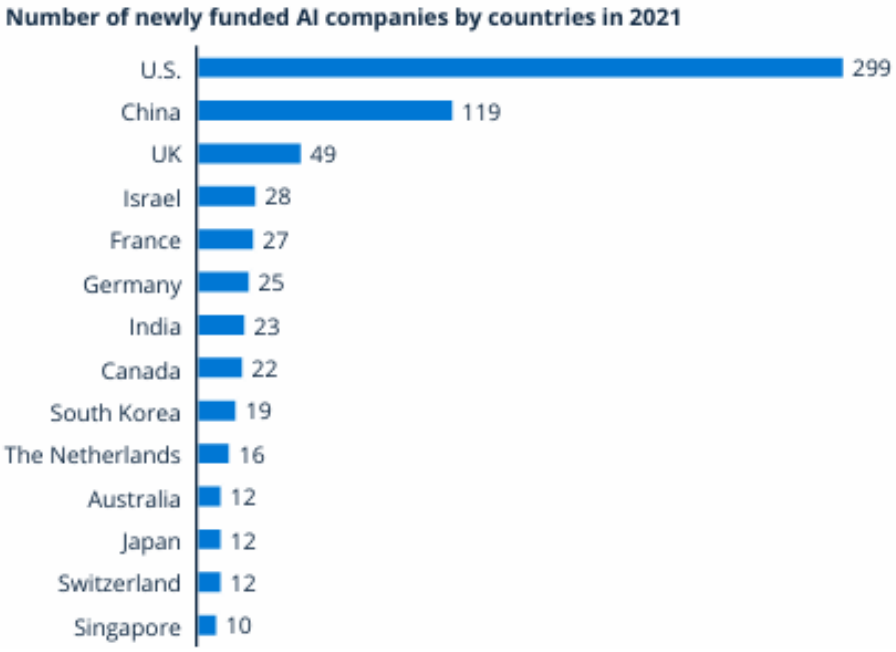
Figure 8 Artificial Intelligence in Healthcare



Source: Statista, (2023)

Statista (2023) stated that The US had nearly 300 newly funded AI companies in 2021 followed by China with 119 views the figure below. Statista (2023) states that "One of the major factors driving the current wave of AI growth is the strong interest of Venture Capital (VC) investment in AI start-ups"

Figure 9 Number of newly funded AI companies by countries in 2021



Source: Statista, (2023)

3.2 Defining Smart Cities

The concept of smart cities was used for the first time in 1992 in the book "Technopolis Phenomenon" said Calvin and Cole (2023), it has been used as the "increase application of communication and technology (ICT)". Moreover, Calvin and Cole (2023), mention that others said that ICT is the cornerstone of smart cities, however, for others it is a supplementary tool to "build social capital and enhance efficiency in daily city operations"

There are many concepts about the idea of smart cities, however de Lima, R. et al. (2022) mentions that it is commonly referred to as managing different technologies and cities, the term is often misused as de Lima stated by using other names "information cities" or "virtual cities".

Some inputs from de Lima, R. et al. (2022) define smart cities as a "complex and intelligence framework that is everywhere because of the digital networks that connect to citizens, governments, and objects, he mentions that smart cities usually have four main features: "sustainability, quality of life. Urbanization and Intelligence". At the same time de Lima, R. et al. (2022) offer a new Smart city paradigm that "Smart Cities can be seen as cloud-based entities that receive, manage and analyze data transforming it into intelligence that, ultimately, helps to improve the way we live, travel and work."

According to Hyper Tech (2019), smart cities are made of three components "The Internet of Things, Artificial Intelligence, and Big Data Analytics". They mention that smart cities are cutting-edge technology and data drive solutions to improve the life of the residents by optimizing resource usage, for instance, advanced transportation systems to efficiently energy management (Hyper Tech, 2019).

Yan, Zhenjun, et al. (2023) mention that Smart cities emerge from technological innovations like cloud computing, the internet of things, and Artificial intelligence, this technologies are used to analyze huge variety of fields for example, urban planning, urban transportation, social security, and people's living policies, and make rapid and timely responses to these fields to achieve intelligent and intelligent urban management.

Trindade, Priscila, et al. (2017). Their research identifies different characteristics of smart cities:

1. Efficiency and culture: enhanced administrative and economic efficiency to support cultural societal development, using network infrastructure,
2. Business focus: prioritize business oriented in urban development
3. Social inclusion, which includes diverse urban residents in public services,
4. High-tech industries: which recognize this and creative industries' role in long-term growth. And;
5. Social capita and Sustainability.

The concepts of Smart Cities, according to Toli and Murtagh (2020, p. 8), come from different perspectives, as a result of a holistic view of the term, after an exhaustive literature review stated that this diversification of the term makes a melting pot of dimensions presents a balanced opinion of it these are "sustainability, the environmental, the social and the economic one". Toli and Murtagh (2020) mention that the concepts oriented to environmental and social are focused on "smart cities integrate technology with governance to improve the quality of life and reduce the environmental impact of urbanism."

3.2.1 Components of Smart Cities

On the one hand, many are the components that smart cities affect if the authorities in the cities implement, which include urbanization planning, Quality of life, Creative economy, mobility, and transport, information and communication, environment and Governance (de Lima, R. et al., 2022). De Lima has created a Silicon Island Model (MODIS) map, and in the creative economy, he has considered the side of Entrepreneurship and innovation.

de Lima, R. et al. (2022), "Using the idea of a Silicon Island Model, MODIS adopts an analytical approach based on an active local innovation system permeated by initiatives such as meetups and hackathons, incubation and acceleration of startups, angel investment, venture capital funds and actions promoting a high density of startups per inhabitant. MODIS encompasses the attributes of a Smart City fit for purpose in a modern society today."

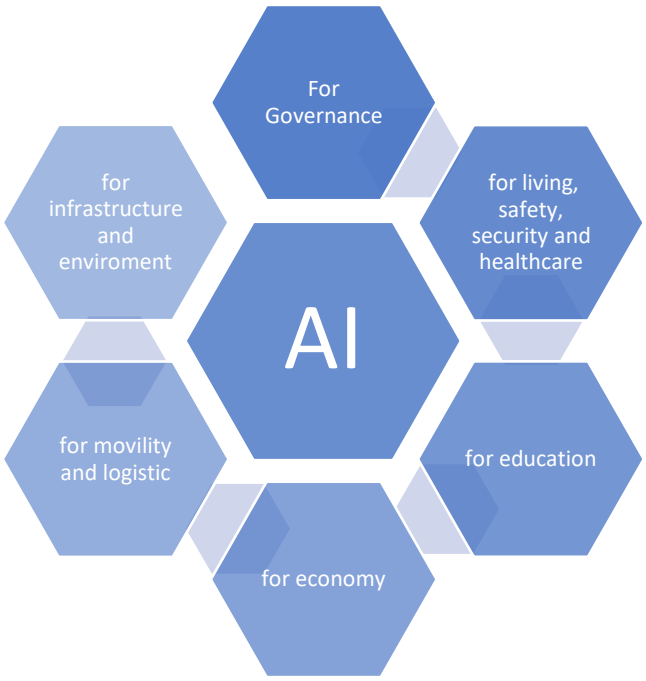
On the other hand, Joshi, S., Saxena, S., & Godbole, T. (2016) have been developing the pillars of smart cities around six factors: Social, Management, economy, legal, technology, and sustainability, which are further explained next:

1. **Social**, is the capacity of all citizens to communicate with agencies and other groups, as well as open the idea that smart cities are made of smart communities, that have access to information and are part of the design and planning process of the city.
2. **Management**: Smart governance require the participation of citizens, active political involvement, and efficient use of e-government services. In the article, Joshi et al. (2016) cited

(Odendaal, 2003) that "Smart governance relies on the implementation of smart governance infrastructure that facilitates service integration, collaboration, communication, and data exchange"

3. **Economy**: this is one of the major reasons for the implementation of smart cities, Joshi, S., Saxena, S., & Godbole, T. (2016, p 4) mention that "Operational definition of a smart economy includes factors all around economic competitiveness as entrepreneurship, trademarks, innovation, productivity and flexibility of the labour market and the integration in the national and global market"
4. **Legal**: In this case, the success evolution of smart cities cannot be possible without "legal compliances" they cited (Mauher & Smokvina, 2006) "Also councils, governments, and other political bodies influence the operation of these initiatives. So both political and legal components are crucial for smart city development".
5. **Technology**: this element is which transforms a regular city to smart city, this component is a game changer as Joshi, S., Saxena, S., & Godbole, T. (2016, p 5) mention that "Modern cities are getting smarter because of the rapid evolution of technology. Problems can be avoided, anticipated, and mitigated by analysing the huge data available. This is where Big Data comes into the picture"
6. **Sustainability:** According to. Joshi, S., Saxena, S., & Godbole, T. (2016, p 5) this term represents the balance between "economic and social development without disrupting the environment"

Figure 10 Categories of AI application in smart cities.



Source: AIDA committee (2021)

Some examples of Smart cities are in China as W.media (2024) mentions Beijing, Shanghai, Guangzhou so on, these cities are adopting "advanced technologies including artificial intelligence, the Internet of Things (IoT), big data and cloud computing in various areas, such as transport, public security, the

environment, and manufacturing", to what extent, Chandran (2020) stated that "More than 500 smart cities are being built across China, according to government data, equipped with sensors, cameras, and other gadgets that can crunch data on everything from traffic and pollution to public health and security."

3.2.2 Role of IoT, Big Data Analytics, and AI in Smart Cities

Part of the technological components of smart cities are The Internet of Things (IoT), Artificial intelligence (AI), and Big data analytics.

The Internet of Things, according to Zanella, A. et. Al. (2014), refers specifically to urban IoT, the main purpose of it is to "support smart city vision, which aims at exploiting the most advanced communication technologies to support added-value services for the administration of the city and the citizens."

According to Herath & Mittal, M. (2022. p2), the IoT in Smart cities implies the integration of a wide range of devices, then connecting layers of technologies and services for instance "home appliances, surveillance cameras, monitoring sensors, vehicles" Thus, they mention that IoT will open the creation of many applications that use a vast and diverse data produce by these devices, creating new services to individuals, businesses and government agencies.

Another example of IoT is Data Utilization which increases the efficiency of services for instance traffic management, waste management, and energy consumption (Herath & Mittal, M., 2022. p. 24), among others, enhances quality of life, this use for example can improve services, reduce or monitor pollution and improve overall the improve the life of the citizen.

Big Data Analytics (BDA)

Sabharwal, R., & Miah, S. J. (2021), explain that big data analytics (BDA) requires advances analytical techniques, "which include data mining, statistical analysis, and predictive modelling on big datasets as new business intelligence practice".

De Mauro, Greco, Grimaldi, & Ritala, P.(2018), define BDA "as information assets characterized by such a high volume, velocity, and variety to require specific technology and analytical methods for its transformation into value" in the same line De Mauro et. Al (2018) mentions that BDA has six main components for instance "data generation, data acquisition, data storage, advanced data analytics, data visualization, and decision-making for value-creation". Moreover, Statista (2023) stated that "big data is driving the improvement of AI algorithms." Therefore, the current growth of the AI industry is because of "the abundant availability of big data as it is about software and hardware (Statista, 2023). The amount of big data being generated by today's increasingly digitized economy is growing at a rate of 40% each year and is expected to reach 163 trillion gigabytes by 2025."

Pwint & Wang (2017) defined BDA as "A large volume of digital data found in government organizations which require different speed, i.e., velocity based on the requirements of the government application domains with a wide variety of data types and sources, and these government big data must be able to guarantee veracity to extract desired value for the target government organization" (p. 41) This concept suits in our purpose of Smart cities.

Artificial Intelligence

The special committee on Artificial Intelligence in a Digital Age (AIDA committee) (2021) presents a concept of urban AI that can be defined as "Artifacts operating in cities, which are capable of acquiring

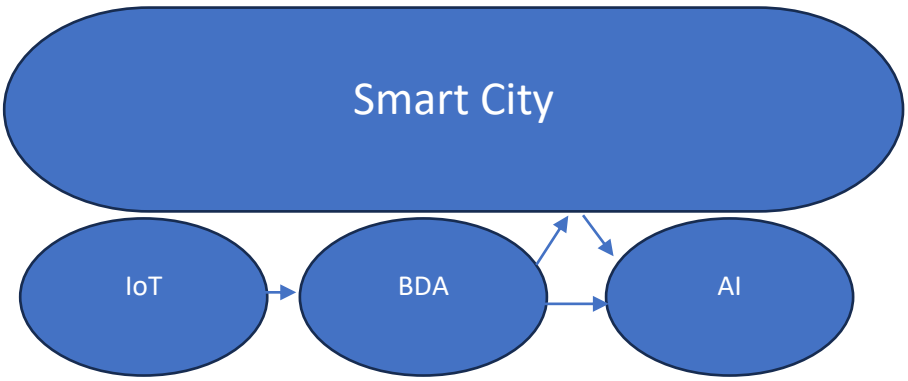
and making sense of information on the surrounding urban environment, eventually using the acquired knowledge to act rationally according to pre-defined goals, in complex urban situations when some information might be missing or incomplete". In the graphic below, it is stated the seven categories of AI applications in smart cities.

Mahor et. Al. (2022), stated that the cities as we know are about to change to a new age, "The smart city has arrived". Artificial Intelligence, mentions that transportation is one of the important industries where AI can make an impact, they said that by adopting smart transportation will be significantly improve "mobility" and its impact on social development."

Nikitas et. Al. (2020) stated that AI is a concept that "is defined as a system's ability to correctly interpret external data, to learn from such data, and to use that learning to achieve specific goals and tasks through flexible adaptation" They mention that AI is based on growth autonomous agents, and they say the AI methods that are "finding their way in transport" are "Artificial Neural Networks (ANNs), Genetic Algorithms (GAs), Simulated Annealing (SA), Artificial Immune System (AIS), the Ant Colony Optimiser (ACO), Bee Colony Optimisation (BCO) and the Fuzzy Logic Model (FLM)".

Statista (2023) stated that AI "refers to computing technologies that are inspired by the ways people use their brains and nervous systems to reason and make decisions"

Figure 11 Smart City and their relationship with three technologies.



Based on the previous literature review IoT devices are the ones that collect the data through sensors, cameras, etc and BDA processes the information, organizes, and finds patterns. Then AI makes decisions by predicting, analysing, and helping to automatization.

By diving into smart cities Digital Twins (DT) is one concept that is worth it to mention, according to the definition by Ketzler, R., et al. (2020) the term is "broadly defined as a digitally created virtual model of a physical object that leverages data to emulate the real-world behavior of the physical entity. It facilitates interaction and interoperability between the physical and virtual entities through interactive feedback, data integration, analysis, and iterative decision-making for optimized control, safety monitoring, and data analysis"

Pwc (2022) define DT as “A digital twin, in its simplest sense, is a linked virtual model of a physical object. By connecting the real-time data of the physical object or process into its digital representation programmed with mathematical models, AI and pattern recognition to faithfully recreate its sibling the digital twin comes to life.” Pwc (2022) explains that is the context of Smart cities, DT collect data from built surroundings from technologies for instance sensors, drones and mobile devices.

So, all that recollection of data Pwc (2022) explains that “This is further enhanced with data captured by smart city devices and the Internet of Things (IoT) and additionally augmented by the use of artificial intelligence (AI) and advanced analytics.”

Ketzler, R., et al. (2020) stated that DT is improving various sectors of energy management within smart cities, as “introduces an architectural framework underpinning the flow for digital twin platform development aimed at urban condition monitoring.”

Having said that, as Sujata, Saksham and Shreya (2016, p5) mentions that “Despite taking center-stage in the development of a smart city, technology has some hurdles. Use of ICT can certainly raise the standards of living but it also faces fierce challenge”, Sujate et al. (2016) mention that “Technologically sound human resource with practical skills is limited. Moreover, educating and training these employees with IT skills can be a major challenge. Politics, cultural differences and lack of inter-departmental cooperation are some of the organizational barriers that lie ahead of smart city development. “

3.3 Legislation and ethical implications

Artificial intelligence (AI)is moving around many sectors in our society, and it still unknown the implications, benefits, and ethical, challenges that we might face are not far away in the future, AI according to “refers to machine-based systems, with varying levels of autonomy, that can, for a given set of human-defined objectives, make predictions, recommendations or decisions using data. Machine Learning, a subset of AI, is software that can learn from applicable datasets to self-improve, without being explicitly programmed by human programmers.”

AIDA committee (2021) stated that AI is contributing to smart urban solutions that offer awful lots of solutions such as efficient energy, water, and waste management, reducing pollution, noise, and traffic congestion. However, this domain is for local authorities that have to deal with the new era of technology, they mention the challenges that those going to face likewise: “(i) technology and data availability and reliability, the dependency on third private parties and the lack of skills; (ii) ethical challenges for the unbiased use of AI; and (iii) the difficulty of regulating interdependent infrastructures and data, respectively”.

Asri (2023) pointed out that there are some potential risks to take into account, first and foremost, how we as a society going to regulate the bias in AI algorithms, which might lead to unfair results and extend the existence of inequalities, another risk is the “big brother” society, where the endless collection of data will be required to make the planning proposals, to extend, he mentions the cyber-attacks resonate as a possible threat.

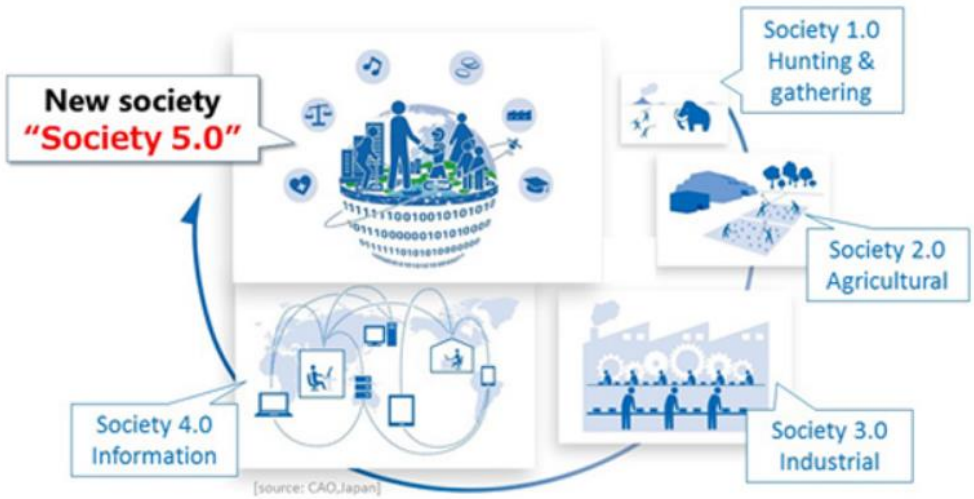
Zhon-Ren Peng (2023) mentions as well some of the concerns that had been raised regarding AI and urban planning and refers to the decision-making “capabilities of AI programs and algorithms, as there is a potential risk of reinforcing discriminatory planning practices. He added the lack of transparency, ethical and equity concerns, and more importantly the understanding of the local context and uniqueness.

Following this train of thought the Government of Ireland created the document called “AI -Here for Good” A National Artificial Intelligence Strategy for Ireland. The government wants to be the leader in using AI, so they have planned a strategy where they include the society, and the enterprise, takes care of the data collection management, to keep the ethics because they are aware of the risks and challenges that the authors have mentioned in others articles. One important thing that no one has mentioned but is in this National strategy is the reskilling of AI. Strand 6, developed AI education, skills, and talent, the aim is to avoid massive job losses

The government aims “to ensure a responsible, rights-respecting and inclusive approach to developing, applying and adopting AI. This will require a strong partnership between the Government, our enterprises and innovators, our research communities, and civil society; we are all responsible for responsible AI.” (Gov.ie, 2021. P. 15)

Chandran (2020) mentions that the use of AI in China, “raises concerns about data privacy and surveillance”, countries like Japan according to the UNESCO (2023) are “pushing ahead with society 5.0 to overcome chronic social challenges” which aim to create a super-smart society. “society 5.0 envisions a sustainable, inclusive socio-economic system, powered by digital technologies such as big data analytics, artificial intelligence (AI), the Internet of Things and robotics.” See the figure below, where the plan society 5.0 is putting humans in the center.

Figure 12 New society 5.0



Source: Cabinet Office.

3.3.1 EU AI Act: First Regulation on Artificial Intelligence

In April 2021 the European Commission created the first EU legal guide to regulate AI, the official name is the Artificial Intelligence Act, however, in the text, it is formally named “**“REGULATION (EU) harmonized rules on artificial intelligence and amending various regulations and directives”**, with the aim of according to the European Parliament (2024) “to ensure better conditions for the development and use of this innovative technology.” The European Parliament wants to make sure that AI is “safe, transparent, traceable, non-discriminatory and environmentally friendly”

The AI Act regulates the AI systems that might be considered as high risk, which is divided into two categories:

> "1. AI systems that are used in products falling under the EU's product safety legislation. This includes toys, aviation, cars, medical devices and lifts.
>
> 2) AI systems falling into specific areas that will have to be registered in an EU database:
>
> - Management and operation of critical infrastructure
> - Education and vocational training
> - Employment, worker management and access to self-employment
> - Access to and enjoyment of essential private services and public services and benefits
> - Law enforcement
> - Migration, asylum and border control management
> - Assistance in legal interpretation and application of the law." (European Parliament, 2024)

In the article 57 of the AI Act, mentions the AI regulatory sandboxes, that is defined as "*AI regulatory sandboxes established under paragraph 1 shall provide for a controlled environment that fosters innovation and facilitates the development, training, testing and validation of innovative AI systems for a limited time before their being placed on the market or put into service pursuant to a specific sandbox plan agreed between the providers or prospective providers and the competent authority. Such sandboxes may include testing in real-world conditions supervised therein."*

The AI Act regulates that in the Anexo 143, to promote innovation, it is crucial to prioritize the interest of Small and medium enterprises (SMEs) including start-ups, that provide or deploy AI systems, have to be with a registered office or branch in the Union *"with priority access to the AI regulatory sandboxes provided that they fulfil the eligibility conditions and selection criteria and without precluding other providers and prospective providers to access the sandboxes provided the same conditions and criteria are fulfilled."*

Conclusion for the chapter

Overall, the concept of smart cities involves IoT, Big data Analytics, and Artificial Intelligence, the role of the last one is to interpret the information that has been organized by BDA, and with artificial intelligence the decision-makers can create autonomous solutions for the city problems. The integration of these there components provides advance urban services support for an efficient transportation system, energy management, and public safety for example.

Moreover, as we discussed in the subchapter of Entrepreneurship, we learn that incorporating AI in Smart cities leads to a creative economy, where local governments can motivate entrepreneurs to find technological solutions for the city. And finally, how the ethical concerns regarding the vast amount of private data collected in Smart Cities remain a work and the debate of ongoing attention to data privacy and security is part of the future problems of the decision-makers and citizens in general.

As a final input, is the legislation that regulates AI through the AI Act that has effect in all the countries in the European Union, and amounts other stakeholders regulate the SMEs and start-ups that tend to work with AI in their initiatives of the business.

4. Methodology

4.1 Research Objectives

According to Saunders, Lewis, and Thornhill (2009) The question determines the purpose of the research in this case we are conducting an exploratory study which is to identify "what is happening; to seek new insights; to ask question and to assess phenomena in a new light" (Robson 2002, 59)

Topic: Exploring the role of artificial intelligence in smart cities and their benefits for entrepreneurs in Dublin and San Salvador.

Research questions:

What are Artificial Intelligence's (AI) role in smart cities and their benefits for entrepreneurs in Dublin, Ireland, and San Salvador, El Salvador?

- What are the benefits and challenges of AI implementation in Smart Cities for entrepreneurs in these two urban contexts?
- How does AI adoption by local government with smart cities support entrepreneurial activities, innovation, and economic growth in both cities?
- Is there any good practice practices of AI in the context of Smart Cities and entrepreneurs?
- What are the feelings, opinions, or perspectives) of AI in the context of Smart Cities and entrepreneurs?

Objectives

General

Explore the role of Artificial Intelligence in Smart cities and their benefits for entrepreneurs in Dublin, Ireland, and San Salvador, El Salvador.

Sub-objectives

- Identify specific benefits and challenges of AI implementation in smart cities for entrepreneurs in these two urban contexts.
- Explore how AI adoption by local government with smart cities supports entrepreneurial activities, innovation, and economic growth in both cities.
- Identify good practices and stakeholders' attitudes (feelings, opinions, or perspectives) of AI in the context of Smart Cities and entrepreneurs.

4.2 Research Methodology of this Study:

4.2.1 Research Philosophy:

The research philosophy r has the importance of highlighting the research foundation, According to Saunders, Lewis, and Thornhill, (2023, p 130-131) research philosophy is about "justifying your methodological choice and your research strategy" They mention that the research philosophy "refers to a system of beliefs and assumptions about the development of knowledge"

Saunders, Lewis, and Thornhill, (2023, p. 134) mention three types of assumptions to recognize research philosophies: ontological, epistemological, and axiological.", the first one is referred to as how we perceive reality, in this research the reality of benefits to doing business for entrepreneurs in smart cities and artificial intelligence. The second one is epistemology, which is about how we assume knowledge as Saunders, Lewis, and Thornhill, (2023, p. 134) explain "what constitutes acceptable, valid and legitimate knowledge, and how we going to communicate the knowledge" and the last one, Axiology, Saunders, Lewis, and Thornhill, (2023, p. 135) indicates "the role of values and ethics in the research process"

Saunders, Lewis, and Thornhill, (2023, p. 145) pointed out five major philosophies in business and management: Positivism, critical realism, interpretivism, postmodernism, and pragmatism.

Based on Saunders, Lewis, and Thornhill, (2023) we going to explain each of it:

Positivism: this philosophy works with an "observable social reality to produce law-like generalizations" Positivism focuses on a "strictly scientific empiricist method designed to yield pure data and facts uninfluenced for human interpretation or bias" This philosophy is typically "deductive, highly structured, large samples, measurements, typically quantitative methods of analysis, but a range of data can be analyzed"

Critical realism: This is based on how we interpret the world within our experiences and senses "What you see is what you get" and "see reality as external and independent", this philosophy claims that there are two types of ways to see the world, the first one, "there are the sensations and events we experience" and second "there is the mental processing goes sometimes after the experience" Typically is used in "Retroductive, in depth historically situated analysis of pre-existing structures and emerging agency, range of methods and data types to fit subject matter"

Interpretivism: " develop the critique of positivism but from the subjectivist perspective" p 150, "interpretivism from physical phenomena because they create meanings" "the purpose of the interpretive research is to create new, richer understanding and interpretation of social worlds and contexts" Typically is inductive small samples, in-depth investigation, space qualitative methods of analysis, but a range of data can be interpreted"

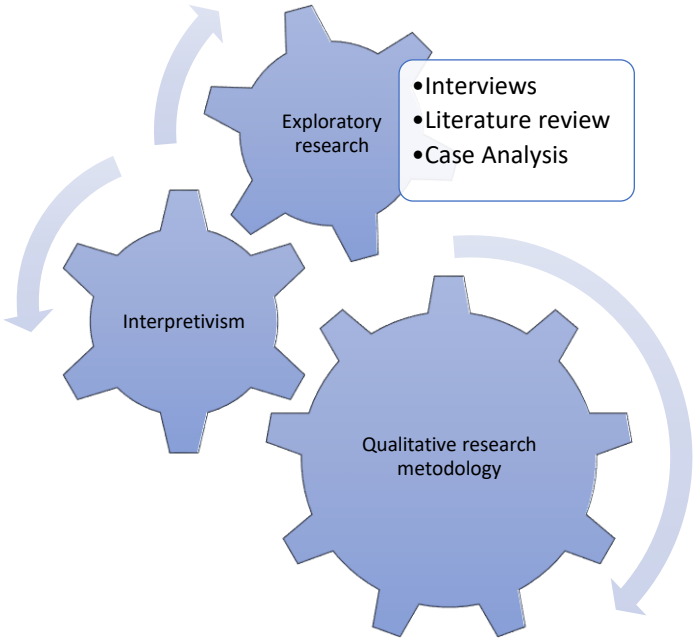
Postmodernism: "the role of language in power relations, seeking to question accepted ways of thinking and give voice to alternative marginalized" typically used in constructive methods, reading texts and realities against themselves in-depth, investigation of anomalies, silence and absences, range of data types, typically qualitative methods of analysis."

Pragmatism: this method starts with a problem, and aims to contribute practical solutions that inform future practice. P153. "are more interested in practical outcomes than abstract". Typically is used by

following the research problem and research question, range of methods: mix, multiply, qualitative, quantitative, action research emphasis on practical solution and outcomes.

This research is going to be Qualitative research, and we going to do exploratory research by using the interpretivism philosophy of the research, as Meriam and Tisdell (2016) mention that "Interpretive research, which is the most common type of qualitative research, assumes that reality is socially constructed; that is, there is no single, observable reality. Rather, there are multiple realities, or interpretations, of a single event. "Researchers do not find knowledge; they construct it." As you can see in the figure below.

Figure 13 Research methodology



4.2.2 Research approach and method

The research will use qualitative data analysis as a research approach according to Flick, Uwe, (2014, p.5) this methodology classifies and interprets the linguistic (or visual) material to make statements about "implicit and explicit dimensions and structures of meaning-making in the material and what is represented in it. Meaning-making can refer to subjective or social meanings" the final target is mention Flick, Uwe, (2014) "often to arrive at generalizable statements by comparing various materials or various texts or several cases."

Flick (2014) stated that with this approach we can describe a phenomenon in detail, as it is useful to compare many cases on what they have in common or the differences.

Regarding the analysis with the qualitative method, Flick (2014) mentions first content from that of, second formal aspects and approaches that and three combine both.

"The nature of the qualitative data collected has implications for its analysis. During analysis, the non-standardized and complex nature of the data that you have collected will probably need to be condensed (summarised), grouped (categorized), or restructured as a narrative to support meaningful analysis (all discussed later)" Saunders, Lewis, and Thornhill (2009, p. 482)

To achieve the aims of this research, qualitative methodology is used, where we have developed a open questions to gather detailed information from different stakeholders through semi-structured interviews.

At the same time, this research as we pointed out will be exploratory there are three principal ways to perform this research as Saunders, Lewis, and Thornhill (2009) "research of the literature, interview 'experts' and conducting focus group interviews", Saunders et. Al (2009)

4.2.3 Data Collection Method

- Literature review
- Interviews with specialist
- Case analysis

The semi-structured interviews, the literature defines this method as a "list of themes and questions to cover, although this may vary from interview to interview" which allows to the omission of some questions in specific interviews, as the order of the questions as well can vary depends on the conversation flow. Saunders, Lewis, and Thornhill (2009)

The interview is structured in 12 questions, consisting of 30-minute conversations, it is divided into four main topics:

1. **General questions**
2. **Shaping the future in Smart cities with AI**
3. **Entrepreneurial initiatives in AI within smart cities**
4. **Ethical and Attitudes toward AI in Smart Cities**

The interviews are well-conducted face to face or by MS Teams, using a recording app and automatic transcription from MS Teams.

4.2.4 Sampling

Overall we would like to do ten interviews 5 from Dublin and 5 from El Salvador, our profile is to identify participant specialists in AI, Smart cities, and entrepreneurship, to identify them we are planning to use platforms like LinkedIn, social media, WhatsApp groups for the word mouth method, and as soon identify the potential participant, contact them by email.

The participant must know about smart cities or AI or have expertise in urban planning or knowledge about AI and entrepreneurship.

In the email message, we are going to attach the support letter provided by the tutor from NCI.

The interview options would be: ideally face to face, MS Teams, a video call from WhatsApp, and if the participant wants to fill the interview as well option.

4.2.5 Data Analysis Method

The method of this research will be thematic analysis according to Nowell, L. S., et. al (2017) qualitative research used to identify, analyze, organize, describe, and report themes within the data set. as well can also be used as a translator between for those speaking the languages of qualitative and quantitative analysis, enabling researchers who use different research methods to communicate with each other."

Nowell, L. S., et. al (2017) some advantages can be mentioned as It can be flexible, and can be used in various studies, provides a rich and detailed account of data, is accessible for new researchers, and is useful for summarizing large data sets and highlighting similarities and differences.

Some of the downsides of this method are scarcity of literature that helps to guide and use properly this technique, for example, Nowell, L. S et. Al (2017) stated "may cause novice researchers to feel unsure of how to conduct a rigorous thematic analysis", another limitation is that because is flexible can "lead to inconsistency and a lack of coherence when developing themes derived from the research data."

Nowell, L. S et. Al (2017) mentions that this approach has six phases:

- 1: Familiarize yourself with your data by storing raw data and keeping detailed records, notes, and transcripts.
- 2: Generating initial codes by using multiple perspectives to validate findings.
- 3: Searching for themes which means diagramming the information to make sense of the theme connections.
- 4: Reviewing themes, which is recheck the raw data to make sure the themes are correct.
- 5: Defining and naming themes by giving a clear name to the themes.
- 6: Producing the report, by describing the context in detail, explaining the analysis and codification, and explaining why certain methods and choices were made.

5. Findings and Analysis

5.1 Thematic Analysis

To collect the information was necessary first to identify the potential participant, we started to looking on LinkedIn to connect with the potential specialists in Dublin and San Salvador, was a slow process in terms of answers, however, we got two contacts from that network, then, from one of the literature reviews, we found one author books and articles specialist in Smart cities and Artificial intelligence, most of the participants were contacted by email. We found good potential participants, but sadly, we did not receive any answers, others on LinkedIn did not have the message button just for premium users.

Q1. Can you briefly describe your role in the organization? How long have you been involved in Smart cities or Urban Planning? Are you working directly with the Dublin/San Salvador council or an external user of AI/smart cities?

Overall we conducted 8 interviews with seven human participants and one interview with Artificial intelligence, as we pointed out in the methodology one of the limitations was finding a specialist that ticked all the boxes required such as specialists in AI, Smart cities, and entrepreneurship. One of the participants for example was very insightful regarding understanding the big picture of smart cities and the role of artificial intelligence in the sense of good examples over the different cities but not Dublin and not in the Entrepreneurship field.

Table 3 Participants' description

Participants (P)	Date	Specialist	Dublin	San S	Mode of interview
P1	24/06/2024	Smart Dublin, engagement and citizen AI awareness	Female		MS Teams
P2	27/06/2024	Urban Planning in AMSS		Male	Fill interview
P3	05/07/2024	Lecture specialist in Artificial intelligence and smart cities	Male		Face to face
P4	04/07/2024	Urban planner consultant		Male	Whatsapp video call
P5	12/07/2024	Lecture and entrepreneur specialist in AI	Male		MS Teams
P6	22/07/2024	Architect and specialist in city planning	Female		MS Teams
P7	27/07/2024	Architect and public spaces specialist		Female	MS Teams
P8	04/08/2024	OpenAI creation		Artificial intelligence	

Q2 Has we have shown in the literature review, smart cities have the ultimate aim improve the way we live in the cities, we consider it necessary to identify the main challenges that Dublin and San Salvador are facing.

As you can see in the table below Dublin and San Salvador both cities have two problems in common: the housing crisis and public transport. However, in general terms, it can be said that most of the problems are different for each city. San Salvador's problems are more oriented towards basic development problems or the provision of basic services (topics 5 to 8). On the other hand, in Dublin, the problems are concentrated on issues related to the quality of life and services (topics 1 to 5).

Table 4 Q2 Thematic analysis Q2 Dublin and San Salvador challenges

2. What are the main problems and topics or challenges that Dublin/San Salvador city is facing?			
Theme	Code for Dublin	Code for San Salvador	Supporting
1. Housing and Affordability	• Housing crisis, • Affordable housing, Housing shortage, Room sharing, • Centralized housing	• Housing affordability • Lack of regulation • Uninhabited historic center • Gentrification	The quantity of apartments and housing is not enough for everybody. Many people need to share rooms because they cannot afford a house, and there aren't enough houses and apartments for everyone. (P6) "Otro problema ... es, Ah, como la vivienda, ... el centro histórico está deshabitado y otros lugares ... podrían como mejorarse. Pero está carísimo, ... no hay una regulación, ... un apartamento de 100 metros cuadrados puede llegar a costar 1/4 de millón de dólares." (P7)

2. Public transportation issues	• Transportation issues, • Disconnected public transport, • Bus reliability, • Limited bus service, • Slow public transit, • Improved transit connectivity	• Mobility issues, • Traffic congestion and transportation challenges • Limited public transport	Another issue is related to infrastructure, particularly public transportation. In Ireland, the public transportation system is not well connected. ... Sometimes, you're waiting for the bus and it simply disappears, or you watch the screen countdown—5 minutes, 4 minutes, 3 minutes—until the bus should arrive, but then it doesn't show up. (P5) "En temas de ciudad y de inteligencia artificial, y acá basado en San Salvador, ... puedo identificar como problema ... la movilidad, el atasco, o sea, ese es como el principal problema." (P7)
3. Cost of Living	• Cost of living, economic challenges		"I think you know the main challenge is that that we hear, you know, that has to do, I suppose the cost of living would be one of the main issues. In general. So that's, I suppose, like, you know, economic or macroeconomic issue, but it does impact that along with the housing." (P5)
4. Community and Safety	• community engagement, public safety, and security concerns		So our district, Smart Dublin, it focuses on telecoms and connectivity and engagement. So I do local community engagement. (P1) "As far as I see, the situation with the river, and now that the security is getting violent, I think the city is not prepared for these social changes that we've been witnessing." (P3)
5. Infrastructure and Development	• Infrastructure issues, telecoms, and connectivity	• Street lighting, • Road maintenance, Potholes, • Public services deficiency	"Another issue is related to infrastructure, particularly public transportation. In Ireland, the public transportation system is not well connected." (P5) "Otro problema en términos de movilidad ... la iluminación en las calles, ... la falta de iluminación, ... el mantenimiento de las mismas, ... llena de baches, etcétera." (P7)
6. Environmental and climate issues		• Climate change vulnerability, Natural disasters, Flooding, Air quality	"Smart Dun Laoghaire is on the coast, and their focus is on, like, climate resilience and climate change because they're the ones on the coast that are most affected by that." (P1) "Otro problema son las inundaciones. ... la calidad del aire, que nadie nos quejamos de eso, ... en Europa es como un gran tema, pero nosotros como que ni siquiera lo sentimos." (P7)
7. Waste management and cleanliness		• Waste management, Poor garbage service	Otra queja ... cuando vas a las comunidades o zonas superpobladas ... la basura, ... hay un mal servicio ... en la basura, ... la alcaldía ... no modernice ese tema ... (P7)
8. Socioeconomic inequality		• Socioeconomic inequality, Social exclusion, Access to basic services, Employment opportunities,	Desigualdad y Exclusión Social: Existe una marcada desigualdad socioeconómica y exclusión social, con grandes disparidades en el acceso a servicios básicos, empleo digno y oportunidades educativas. (P2)

		Educational opportunities	

Q3. With these questions we intend to evaluate what technologies local governments are using at the moment to tackle those challenges, so for instances according to the P1 in Dublin they are implementing “AI Awareness training, AI risks and benefits, smart cities evolution” “We are explaining what it is and how AI works so that local authority staff are aware of the risks and the benefits of AI when they could potentially use it in their role in the public sector." (p1)

One participant from Dublin mentioned that there is no technology in the most important service like public transport “I didn't think well because, for example, if you want to take a bus in Dublin, you need either a Leap Card or coins to pay." (p6)- "We don't have a metro system, and without a metro and well-connected buses, it's really difficult to move around the city without a car." (P6) She also mentions that “In many cities, I have traveled to in Europe, it's possible to pay by tapping your cell phone” (P6)

In San Salvador, there are some technological initiatives by the central government "The government of El Salvador is promoting several initiatives to promote digitalization and technological innovation in the country." (p2), also the police department is using in the city according to P4 "San Salvador has cameras placed in key locations, and I imagine they must be using some facial recognition programs, as well in public markets"

Table 5 Q3 Current innovation in both cities

3. Could you provide information on the current technological innovations being employed by local governments in Dublin and San Salvador to address challenges in the cities, smart cities?		
Theme	**Code**	**Supporting quotes from participants**
Technological Integration and Innovation	• AI Awareness training, • AI risks and benefits, • smart cities evolution, • Electronic billing systems; National Digital agenda, • innovation and manufacturing technology law, • GIS programs, land value mapping, • lidar topography system, and hydrological design.	"We are explaining what it is and how AI works so that local authority staff are aware of the risks and the benefits of AI when they could potentially use it in their role in the public sector." (p1) "The government of El Salvador is promoting several initiatives to promote digitalization and technological innovation in the country." (p2) "They have programs, but the problem is in feeding it, in maintaining it, in updating the information." (p7)
Public-private collaboration	• Public- Private Partnerships • Privatized public services • Smart city accessibility.	"In the European and Western context, usually the policy is very neoliberal, meaning that private companies are paid by the government, by the local government, to deliver public services." (p3) "So, it's not like the private companies are going to manage that data or information from the cities." (p3)
Urban Mobility and transport	• Public transport payment • Metro system absence • Inefficient bus service • Cycling as an alternative.	"I didn't think well because, for example, if you want to take a bus in Dublin, you need either a Leap Card or coins to pay." (p6)- "We don't have a metro system, and without a metro and well-connected buses, it's really difficult to move around the city without a car." (p6)

Security and surveillance technologies	• Surveillance cameras • Facial recognition technology and Market security systems.	"San Salvador has cameras placed in key locations, and I imagine they must be using some facial recognition programs." (p4) "I think the city council has also implemented this in the markets to curb criminal activity." (p5)
Administrative and structural reforms	• Municipal reorganization and metropolitan coordination.	"The main concern for the city council is organizational issues, especially since the municipalities are undergoing territorial restructuring." (p4) "In practice, the approach has been simple yet effective... The significant challenge, as expressed by the people, is figuring out how we will achieve economic development." (p5)

Q4: Among all problems that AI can resolve as you can see in the table below, the P3 mentions that "I don't see how AI can fix that. These are all problems that human policymakers, human planners can fix without AI" (P3) and the P1 is more concern about education and training of AI "One of my workshop programs is explaining AI to local authority staff, so they are aware of the risks and benefits of AI." (P1)

Table 6 Q4 Problems that AI will resolve

4. What are the problems do you think AI is going to resolve or improve in smart cities?		
Theme	**Codes**	**Supporting quotes from participants**
Traffic and Mobility enhancing	• Traffic management and urban mobility • Relieving traffic	"AI can optimize traffic management with smart traffic light systems, real-time data analysis to predict congestion, and suggesting alternative routes." (P2) "I don't see how AI can fix that. These are all problems that human policymakers, human planners are able to fix without AI" (P3) "We will also have help for the housing point of view because if you can construct more far from the seed centre, you will have more areas available for construction" (P6)
Energy efficiency and Sustainability	• Energy efficiency and sustainability	"AI algorithms can analyze large amounts of data to optimize energy use and help integrate renewable energy sources into the grid". (P2)
Public safety and security enhancement	• Public safety • AI for security, innovations in policing technology.	"AI systems can analyze security camera footage in real-time, detect unusual behaviors, and alert authorities to potential risks. (P2) "AI could be used to detect gunshots and coordinate responses, though it's a delicate balance with privacy concerns." (P5)
Waste management improvement	• Waste management route optimization; Trash collection and management.	"AI can use predictive data analysis to optimize waste collection routes and improve recycling efficiency. (P2) "AI could help with waste management issues, like dealing with infrequent trash pickups due to capacity problems." (P7)
Inexpensive housing solutions	• Reasonable housing projects	"In Dublin, building tall buildings is challenging. Innovative solutions could include more cost-effective construction methods." (P5)

Infrastructure Preservation and Management	• Street and sidewalk management	"A system that helps track when to repair a street or replace a streetlight could improve budgeting and investment." (P7)
Education and training for AI users	• AI education for local authorities. • No current AI use	"One of my workshop programs is explaining AI to local authority staff, so they are aware of the risks and benefits of AI." (P1) "AI can help identify and connect micro businesses to digital platforms, which also requires educating users on how to leverage these technologies." (P4)
Digital Platform access for micro businesses	• Identify networks among entrepreneurs. • Training in Digital platforms	"AI can assist in identifying connection platforms and teaching people how to access and use these platforms effectively." (P4)

Q5. In this scenario we are looking for some business opportunities that in the future might require the cities, for example, one is "predictive maintenance" where a sensor can notify the authorities when and where a public light needs to be fixed, or when is the next maintenance of the road or street according to the participant 7. See the table below for more examples.

Table 7 Q5 Services for Start-up will be required

5. In the scenario of Local government utilizing AI in smart cities, what type of services from the start-up will be required?		
Theme	Codes	Supporting quotes from participants
Smart Application Development	• Development of applications and platforms	"Start-ups whose specialty is in software development could offer mobile apps and web platforms that use AI to improve citizen interaction with government services…" (P2)
Data Management and Analytic	• Data Analysis and big data	"Start-ups focused on data analysis could help the local government manage big volumes of data generated by intelligent sensor and camera systems…" (P2)
Cybersecurity measures	• Cybersecurity solutions	"Start-ups specializing in cybersecurity could offer solutions to protect critical infrastructure and sensitive data of the local government from cyberattacks and threats." (P2)
IoT integration	• IoT devices and sensors	"Start-ups working in IoT could offer connected devices and sensors that collect real-time data on various aspects of the city..." (P2)
Augmented Reality Solutions	• Augmented and virtual reality	"Start-ups in this field could develop augmented or virtual reality solutions to improve territorial planning, infrastructure project visualization, and provide interactive experiences educating citizens about public policies and projects." (P2)
Robotic Process Automation	• Automatization and robotics	"Start-ups specializing in automation and robotics could offer solutions for the automation of industrial and logistical processes within the city..." (P2)
Cost Efficiency Initiatives	• Cost efficiency and AI integration	"Cost efficiency is one of the areas that not only the public sector but all organizations are aiming to use AI for, which is to save money in running the organization. In this case, running a city…" (P5)
Predictive Maintenance	• Predictive maintenance and energy management	"What if you can predict when the maintenance should happen using AI to save costs? Energy management such as smart grids, optimizing energy distribution, and consumption." (P5)` "Public lights with sensors that can send a message to the local government, when is damaged…. Or AI can help to have an inventory of the street and advises the next road to have maintenance" (P7)

Public Safety and Health	• AI-driven public safety and health	"We already mentioned AI surveillance for public safety and predictive policing... we haven't talked about healthcare, for example, that's another area." (P5)
Public-Private collaboration	• Public-private partnership solutions	"The government can buy those solutions, incorporate those solutions, or outsource some services where it makes sense, etc. But yeah, there's definitely a way to the idea is you're innovating using technology to solve public challenges for sure." (P5)
Improved Citizen Connectivity	• Citizen services and connectivity	"Greater interconnection between people, and knowing how to access services. People offer more material and service-based services. Technological and knowledge services. Improve and interconnect people who provide and demand products." (P4)

Q6. Do you know if there are any AI-driven solutions from start-ups to enhance city services or address urban challenges in Dublin/San Salvador?" Can you provide examples? (Collaboration) Good practices.

For this question five out of seven participants answered this question, the themes that we can analyze are the following:

1. **Engagement with entrepreneurs and start-ups**

P1. "So we just did a call for pilots. I don't know if you're familiar with that. But a call for pilots is we have 50K in funding to split between four projects in different thematic areas. So anyone can apply for this call for this pilot funding. Entrepreneurs, businesses, it's open to anyone. So that is one way we would engage with entrepreneurs if they have a smart city solution to a thematic area."

As the P1 pointed out all the information is on the website "Smart Dublin" : https://smartdublin.ie/smart-d8-call-for-pilots-2024/ and the program "Call for Pilots" for innovative ideas in three areas: community health, health literacy and environment, they potentially could select up to six pilot projects. This project is promoted by Digital Hud, St. James's Hospital, Dublin City Council, and Smart Dublin.

The projects selected can receive economical support of €12,500 in resourcing.

2. **Example of successful Smart city initiatives**

P3 "*Barcelona comes up as an example of best practice. Because compared to other smart city initiatives, it's quite bottom-up in the way it is developed. Meaning that citizens have a lot of inputs in smart city. So it is considered to be one of those examples of smart cities in which a citizen would play an active role. It's a more democratic kind of smart city*"

Support structures for entrepreneurs

P5 "*but the best place to look at is called Enterprise Ireland. They would have very good visibility of some of the best projects. The other ones are very closely connected to Enterprise Ireland, the local entrepreneur Leo. It's called Leo…As well as Smart City Dublin"*

In the recollection of the information process, we contacted some of the members of Dogpatch and they referred us to NDRC which is a program *"Designed to support ambitious entrepreneurs with globally scalable, innovative tech startups. Receive investment and coaching from accomplished mentors and Entrepreneurs in Residence."*

3. **Technological initiatives in El Salvador**

P2 *"In San Salvador there is a start-up "recirculapp" that connects users with recyclers"*

P7 "I do not remember the name of the initiative but was about local young tech enthusiasts that created a sophisticated traffic monitoring system" She mentions that "no one believes in the project and they found in Chile opportunities for their idea"

Q7. How do you image futuristic smart cities within the AI revolution? In this question we were looking at the perspective of the role of AI in the future, if we look at the table below we can see that, some of the participant's desires are improving the efficiency and sustainability in terms of traffic congestion management, waste management, optimization in energy. As well, the future of smart cities will be more automated as P3 pointed out.

Table 8 Q7 Futuristic view from smart cities

Category	Code	Theme	Participants answer
Integration and evolution	• Smart City evolution	Continuous technology integration	"I think smart cities change and evolve with every beginning of new technology...they will be incorporated into the existing smart city structure." (P1)
Efficiency and Sustainability	• Efficiency and sustainability	Improved Urban Efficiency	"Using AI, cities will be more efficient, sustainable, and funtional...we manage waste and provide public services." (P2)
Autonomous systems	• Autonomous urban services	Autonomous urban service	"The trend, in my opinion, is about increasing autonomy...So the city that operates without human inputs." (P3)
Public services	• Automated public services	Improve public services	"The goal of public service or public management in the city is to make things run better, more efficiently, but also more cost-effectively." (P5)
Real-time and Proactive Systems	• Traffic management • Real-time citizen needs response.	Real time urban Management	"Cities will become more connected, with automated systems that anticipate and respond to the needs of citizens in real-time." (P2)
Daily problem solving	• AI personal assistant		"There may be permanent access to AI advice for immediate problem-solving in the home and within the neighbourhood and city. The AI can advise on how to fix problems safely, or where to find professional or affordable help immediately at the home. Example: "I want to throw away a mattress for recycling. Is there a service that will pick it up for free?" "I have noise problems with my neighbour. What would be the best way to deal with the problem?" "My mother lives alone at that address.

			Could you take care of her by calling her twice a day?" "Where can I change the bracelet on my watch?" "Or where can I get my glasses fixed? A screw has fallen off." P4

Q8 Local government can motivate entrepreneurs to participate to be part of the solutions in smart cities, to what extent some of the participant opinions were related to tax incentives, public and private collaboration, network support, awards, and competitions, among others.

Table 9 Q8 Local Government Policies and initiatives supporting entrepreneurs

8. From your point of view, how can local government policies and initiatives support entrepreneurial activities related to smart cities?			
Category	**Code**	**Theme**	**Participants answer**
Financial incentives	• Tax incentives • Financial support	Supportive financial policies	"Local government policies and initiatives can support entrepreneurial activities through the creation of tax incentives for innovative companies...promote funding programs and technical support for startups." (P2)
Public-private collaboration	• Public and private collaboration • Partnership initiatives	Collaborative ecosystem	"Facilitating public-private collaboration in territorial technology projects." (P2)
Clear regulations	• Clear regulation • Regulatory support	Regulatory framework	"Establishing clear regulations that encourage the implementation of smart solutions in infrastructure, transport, and public services." (P2)
Infrastructure and connectivity	• Internet access • Infrastructure support	Improve infrastructure	"Free internet access...create an internal market through the internet that improves...performance costs for all producers." (P4)
Resource networks	• Resource networks • Support networks	Resource connectivity	"Set up a whole network of buying and selling...how you connect people to people to solve their life and entrepreneurial problems." (P4)
Grants and competitions	• Grants for start-ups • Entrepreneur competitions	Direct support programs	"Awards, competitions, grants...what a municipality could do to motivate external parties." (P7)
Local enterprise offices	• Local enterprise office • Enterprise support	Local enterprise support	"Enterprise Ireland...Local Enterprise Office...invest in initiatives, they give grants to entrepreneurs." (P5)

Q9 It is the research question itself, participant 2 mentions that "AI's role in smart cities is fundamental for optimizing territorial management, improving the efficiency of public services, and providing faster

responses to people's needs." Participant 3 mentioned that "It's going to be important to learn how to cooperate with AI...we have one service that is delivered by humans and AIs together." (P3)

Some of the challenges of that entrepreneurs might face in this cluster are "It's going to be a challenge to keep up with all of the changing ways AI works, and the changing regulation around AI...there are a lot of legal challenges, guidelines, ethical challenges." (P1), another challenge "There are social barriers, socio-economic barriers for people to have access to that technology...." (P1), as well as any new project entrepreneurs must value the risk of stakeholders by including them in their innovation "Citizens can play a role in saying, perhaps we want autonomous …the future is not determining us." (P3)

Some benefits that stand up are "Opportunities for entrepreneurship in this field are significant...solutions in areas like urban mobility, energy management, public safety, and healthcare." (P2) as well the opportunities for business like offering services for reskilling "It's going to be important to learn how to cooperate with AI...we have one service that is delivered by humans and AIs together." (P3)

Table 10 Q9 The future of the role of AI in Smart cities and there opportunities or challenges for entrepreneurs

9. How do you foresee (visualize) the role of AI in smart cities? What are the opportunities or challenges for entrepreneurs in this field?			
Category	**Code**	**Theme**	**Participants answer**
Regulatory and Ethical Challenges	• Legal and ethical issues	Regulatory and ethical obstacles	"It's going to be a challenge to keep up with all of the changing ways AI works, and the changing regulation around AI...there are a lot of legal challenges, guidelines, ethical challenges." (P1)
Accessibility and inclusion	• Socio-economic barriers • Technology access issues	Ensuring inclusivity	"There are social barriers, socio-economic barriers for people to have access to that technology...you don't want to gatekeep or put a wall between people who have access to technology and who don't." (P1)
Fundamental role	• Optimizing management • Improving efficiency	Essential Urban Optimization	"AI's role in smart cities is fundamental for optimizing territorial management, improving the efficiency of public services, and providing faster responses to people's needs." (P2)
Innovation opportunities	• Innovative solutions • Various urban sectors	Entrepreneurial opportunities	"Opportunities for entrepreneurship in this field are significant...solutions in areas like urban mobility, energy management, public safety, and healthcare." (P2)
Privacy and data security	• Data privacy • Security concerns	Data security concerns	"The challenges include overcoming regulatory barriers, ensuring data privacy and security, and gaining acceptance from people and local authorities." (P2)
Citizen decisions	• Citizen resistance of AI use	Citizen influence	"Citizens can play a role in saying, perhaps we want autonomous cars in San Francisco, but we don't want police robots...the future is not determining us." (P3)
Skill Development	• Cooperation with AI • Skills for AI collaboration	Developing AI Skills	"It's going to be important to learn how to cooperate with AI...we have one service that is delivered by humans and AIs together." (P3)
Problem-Driven approach	• Problem first • Curiosity and empathy	Problem-Driven Innovation	"If you go technology first, that's not necessarily the right approach...be curious

			about the problem, research and live it. Have empathy with users." (P5)

Q10 In this question, we found a lack of answers among the interviewees, because there were answers in different moments or sections of the interview, so for example in Q5 In the scenario of Local government utilizing AI in smart cities, what type of services from the start-up will be required? They mention that if the local government implements AI will reduce costs and increase efficiency affecting in positive way the budget of the local institution, as P7 "If we have sensors in the river to measure the levels of water, we can reduce the number of hours and cost by sending people much time to monitoring the river."

Participants 2 and 4 from El Salvador, their insight is improve the competitiveness and face the global market as a city and country.

Table 11 Q10 Economic advantages of using AI in Smart cities for local entrepreneurs.

10. In the future, what will be the economic advantages of using AI in smart cities for local entrepreneurs?			
Category	**Code**	**Theme**	**Participants answer**
Economic Growth	• Developing solutions • New market creation	Market expansion	"In the future, the economic advantages of using AI in smart cities for local entrepreneurs include the opportunity to develop and market advanced technological solutions. This can lead to the creation of new markets, increased operational efficiency, long-term cost reduction, and attracting investments in technological innovation." (P2)
Competitive edge	• Increase competitiveness • Efficient and effective use	Improve competitiveness	"Being more competitive against other capitals of the world. Enormous economic impact, using it more efficiently and effectively. San Salvador should accelerate the use of this technology." (P4)

Q.11 These questions collect the major concerns about using AI in the cities, the most is about privacy and data usage, how this information is going to be used and for whom, and how the institution, company, or local government going to be transparent in the information.

As P2 and P5 concerns is about "Ethical concerns include privacy and data security. There is a risk of algorithmic bias which could perpetuate existing inequalities. "Dependence on technology might also create a digital divide. Generative AI systems can have unconscious biases that affect decision-making, such as biases in housing approval processes." (P2, P5)

The P1 concern is "We can't leave people behind in the digital transformation. There is a risk of not being inclusive and actively unbiased. People are also fearful of how their data will be used and how it will affect them." (P1)

The P1 mentions as well that Dublin city is part of the "Cities Coalition of Digital Rights"

P4 mentions that cybercrime will escalate "Criminal misuse of AI includes creating fake images or voices to deceive and steal. Generative AI can produce inaccurate information or 'hallucinations' that can mislead people." (P4)

Table 12 Q11 Ethical implications of AI shaping the cities

11. What are from your perspective the downsides of using AI to shape the cities, specifically in smart cities? Or the ethical implications?			
Category	**Code**	**Theme**	**Participants answer**
Inclusivity	• Digital gap • Fear and scepticism	Digital exclusion	"We can't leave people behind in the digital transformation. There is a risk of not being inclusive and actively unbiased. People are also fearful of how their data will be used and how it will affect them." (P1)
Privacy and bias	• Data privacy • Algorithmic bias • Unconscious bias	Privacy and Bias	"Ethical concerns include privacy and data security. There is a risk of algorithmic bias which could perpetuate existing inequalities. (P5)
Transparency and control	• Lack of transparency • Control and Misuse	Governance and transparency	" Generative AI systems can have unconscious biases that affect decision-making, such as biases in housing approval processes." (P2)
Criminal purposes	• Cybercrime • Fake information	Cybercrime	"Criminal misuse of AI includes creating fake images or voices to deceive and steal. Generative AI can produce inaccurate information or 'hallucinations' that can mislead people." (P4)
Privacy vs utility	• Balancing data use privacy • Surveillance	Privacy concerns	"Installing surveillance to improve services like public transportation raises privacy concerns. It's crucial to balance data usage for service improvement with respecting individual privacy." (P6)
Social impact	• Social interaction • Local economic affected	Social impact	"The change towards automation and machines in public spaces might reduce personal interaction and impact local businesses. There is a concern about social displacement and changes in human interactions." (P7)
Reliability on AI	• Critical thinking • Accuracy of information	Over reliability and accuracy	"Generative AI can produce 'hallucinations'—plausible but inaccurate information. Over-relying on AI without critical thinking can lead to misinformation and a decline in critical cognitive functions." (P5) "we forget how to assess the situation, how to solve a problem, you know, maybe our parents know how to do it and we forget or our kids, you know, don't bother exercising a number of mental and cognitive functions." (P5)

Q12 These questions represent one of the sub-objectives in this research, what are the attitudes of using AI in smart cities? We offer the following options; b. Pragmatism and caution; c. Collaboration and community engagement, and d. Adaptability and learning:

In almost all interviewees there are mixed feelings and predictions: optimism about the potential of AI, but also concern about the ethical use of the information, especially of the personal data. As the P7 said, "I'm very excited, but I also think about the ethical implications and how my data will be handled."

Table 13 Attiudes regarding of AI in Smart Cities

12. What is your attitude regarding of using AI in Smart cities to analyse data, that will be use for decision making? Please choose the one that resonates with you, and explain why.			
Category	**Code**	**Theme**	**Participants answer**
Approach to AI Implementation	• Pragmatism and caution • Caution, optimism and learning	Balance implementation and risk management	P1: "It is essential to adequately address ethical challenges, such as data privacy and potential algorithmic biases." P4: "I find the use of AI exciting and promising... However, it is crucial to adopt a pragmatic and cautious approach." P5: "I'm cautiously optimistic about AI in general... You have to understand AI, how it works, and that there are errors and biases in it." P7: "I'm very excited, but I also think about the ethical implications and how my data will be handled."
Stakeholder Engagement	• Collaboration and community engagement	Engaging stakeholders and transparency	P3: "Transparency in decision-making... smart cities are the best fit for AI with all the information." P6: "We need to understand what needs to be done to use it in a way that is beneficial and helps address potential issues."
Regulatory and adaptive frameworks	• Adaptability and learning	Flexible use and regulatory frameworks	P6: "We will likely need some rules and laws regarding how to use the data—what is allowed and what is not." P5: "The best approach might be to start using the technology while simultaneously reviewing and refining the rules about data usage and access."

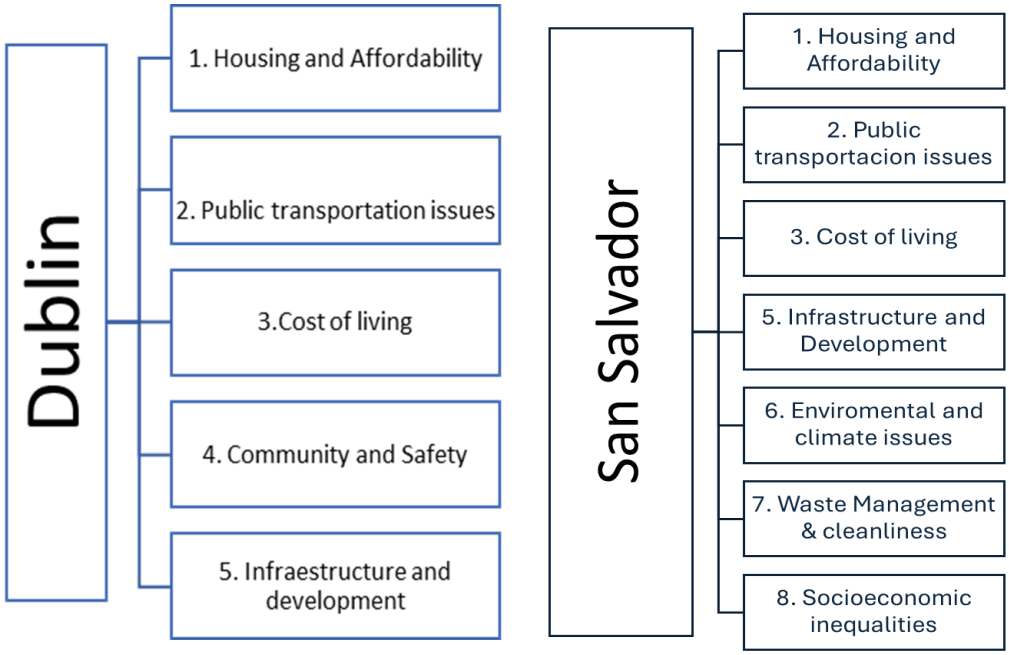
5.2 AI Interview Analysis

Before we start analysing we are aware of the disclosure of using AI like "ChatGPT can make mistakes. Check important info."

Q1 For this question AI "As an AI developed by OpenAI, I don't have a direct role in any organization or direct involvement in Smart Cities or urban planning initiatives. Instead, I serve as an information resource and provide insights based on data and research up to my knowledge cutoff date in 2023."

Q2. As a main problem, AI provided almost all themes that we got from our participants, however, he added health case accessibility for San Salvador, although in my opinion, this one applies to Dublin as well, and none of the participants mentioned that.

Figure 14 Challenges Dublin and San Salvador



Source: Own elaboration

Q3. When it comes to mentioning some examples of technological innovations used by local governments

Dublin	San Salvador
Smart Traffic management: The SCATS (Sydney Coordinated Adaptive Traffic System) is implemented in parts of Dublin, optimizing traffic signals to improve traffic flow and reduce congestion.	E-Government services: "**Innovation:** Digital platforms are used to streamline government services and improve accessibility for citizens. **Example:** Online portals and mobile apps allow residents to access various government services, pay bills, and report issues, enhancing efficiency and transparency."
Smart public transport: **Innovation:** The city employs real-time data and AI to enhance public transportation services, including predictive maintenance for buses and trams.	**Disaster Response and Management:** **Innovation:** AI and predictive analytics are utilized for disaster preparedness and response. **Example:** Early warning systems based on AI can predict natural disasters such as floods and earthquakes, enabling timely evacuations and resource deployment.
Energy efficiency: **Innovation:** Dublin has initiatives focused on smart energy management, including the use of AI for monitoring and optimizing energy consumption in public buildings. "The Dublin City Council collaborates with various stakeholders on projects like Smart Dublin, which includes pilots for energy-efficient lighting systems and smart meters."	**Smart Surveillance and Public Safety:** **"Innovation:** AI and advanced analytics are deployed in surveillance systems to enhance public safety and crime prevention. **Example:** The government uses AI-powered cameras and facial recognition technology to monitor public spaces and identify suspicious activities"

Q4: Problems that AI can improve

As the participant pointed out most of the problems and AI as well with a lot of similarity like traffic congestion, however, two things that adds AI are:

"Citizen Engagement and Services:

- **Problem:** Lack of efficient communication between citizens and local governments can hinder service delivery and civic participation.
- **AI Solution:** AI-driven platforms and chatbots can improve communication, streamline service delivery, and provide real-time support for citizen queries and issues. Open data initiatives can also foster transparency and citizen involvement."

"Healthcare Services:

- **Problem:** Access to timely and efficient healthcare services is often limited.
- **AI Solution:** AI can improve healthcare delivery through telemedicine, predictive analytics for disease outbreaks, personalized treatment plans, and efficient resource management in hospitals."

Q5 Type of services that Local Government will need from start-ups, for example for citizen engagement and service platforms, according to AI for citizen engagement " Start-ups might create platforms that enable residents to interact with local governments, report issues, and access information through user-friendly interfaces."

Q6. As examples of AI-driven solutions from start-ups in Dublin and San Salvador, AI provides the next examples. In this question, the seven participants struggle to give names of examples.

Dublin	San Salvador
Environics "has collaborated with local authorities and environmental agencies in Dublin to integrate their solutions."	Ecovate: **"Collaboration:** Ecovate has worked with municipalities in San Salvador to deploy their smart waste management systems."
StreetBees "Their platform can be used by city planners and local government officials in Dublin to gather insights on public space usage and urban dynamics."	Civic Radar: "collaborates with local government agencies and urban planners in San Salvador to support data-driven decision-making for city development." Mapxus: "has explored opportunities to collaborate with local governments in San Salvador to enhance navigation in key public spaces.
City Swifter: **"**works with Dublin's transport authorities to implement their technology and improve the public transportation network."	

Urban Volt: **"**has partnered with Dublin City Council and other local organizations to implement their energy-efficient solutions in public buildings."	

Q7 After mentioning all the futuristic visions for both cities here the Key changes

1. **Increased Efficiency:** AI will drive efficiencies across all sectors, reducing costs and improving the effectiveness of city services and operations.
2. **Greater Sustainability:** Cities will become more sustainable through optimized resource management and green infrastructure, contributing to environmental goals.
3. **Improved Quality of Life:** Personalized services, enhanced safety, and better healthcare will improve the overall quality of life for residents.
4. **Data-Driven Policies:** Decision-making will be increasingly driven by data and AI insights, leading to more informed and effective governance.
5. **Adaptability and Resilience:** AI will enable cities to adapt quickly to changing conditions and challenges, making them more resilient to disruptions.

Overall, the AI revolution will transform cities into interconnected, efficient, and responsive environments that cater to the needs of their residents, foster sustainable development, and enhance overall urban living.

Q8, this question surprisingly, tick the boxes of the participant mentions.

Q9 The conclusion of AI for "The role of AI in smart cities presents exciting opportunities for entrepreneurs to innovate and contribute to the transformation of urban environments. However, addressing the associated challenges requires strategic planning, collaboration, and a focus on creating solutions that are practical, ethical, and beneficial for both cities and their residents. By navigating these opportunities and challenges effectively, entrepreneurs can play a significant role in shaping the future of smart cities."

Q. 10 The economic advantage of using AI "The integration of AI into smart cities presents significant economic advantages for local entrepreneurs, ranging from increased operational efficiency and cost savings to new market opportunities and competitive advantages. By leveraging AI technologies, entrepreneurs can drive innovation, improve customer experiences, and achieve sustainable growth, ultimately contributing to the success of their businesses and the broader smart city ecosystem."

Q11 The ethical consideration, this part is super interesting, according to AI some of the implications of using AI in smart cities are:

1. Inequality and Accessibility

- **Digital Divide:** The benefits of AI-driven smart city solutions may not be equally accessible to all residents. Communities with less technological infrastructure or lower income levels may miss out on improvements, exacerbating existing inequalities.

- **Exclusion:** There is a risk that AI solutions may inadvertently exclude individuals who are less tech-savvy or lack access to digital devices and services.

2. Ethical Concerns in Automation: Job Displacement: Automation powered by AI can lead to job losses in certain sectors, such as transportation and administrative roles. While AI can create new job opportunities, there is a concern about the transition and support for those affected.

3. Algorithmic Bias and Discrimination

"Bias in AI Models: AI algorithms can perpetuate or even amplify existing biases if they are trained on biased data. This can lead to unfair treatment or discrimination against certain groups of people, such as in predictive policing or resource allocation.

Lack of Transparency: Many AI systems operate as "black boxes," making it difficult to understand how decisions are made. This lack of transparency can obscure the presence of bias and hinder accountability."

Q. 12 "For using AI in smart cities to analyse data for decision-making, the stance of **"Pragmatism and caution"** resonates most strongly with me. Here's why"

"**Pragmatism and caution** offer a balanced approach to implementing AI in smart cities for decision-making. This stance acknowledges the transformative potential of AI while also addressing the associated risks and challenges. By combining careful planning, ethical considerations, and community engagement, cities can harness the benefits of AI while ensuring that its deployment is responsible, transparent, and aligned with public interests."

6. Discussion

Nowadays main cities are becoming Global cities and Megacities. The urban problem is becoming more challenging and requires immediate support and attention from the decision makers to adapt politics, programs, and projects to answer to society's requirements, for that reason cities like Beijing, Shanghai, and Guangzhou in China for example are using AI to achieve another level of productivity and efficiency. We are witnessing the development of the 4th industrial revolution, where the future is arriving fast thanks to AI which is changing the way we do things. For that cities must be prepared for all the pros and cons for society. And for the entrepreneurs, be with the eyes open to grab all the opportunities that are about to revels in this field of AI and Smart cities.

Research focus

That is why the main question for this research is "What is the role of artificial intelligence (AI) in smart cities and their benefits for entrepreneurs in Dublin and San Salvador?

Additionally, this chapter will highlight and contrast some findings in the literature and insights from the participants.

Entrepreneurs in Smart cities' ecosystem

Types of entrepreneurs

As we pointed out in the literature review, the types on entrepreneurs it is important to bring back the differences of entrepreneurship Barot (2015) points out that there are two types of entrepreneurship, " The opportunities based on entrepreneurship where the entrepreneur perceives the business opportunity, and the other is the necessity-based entrepreneurship, where the entrepreneur does not have another viable option to earn a living."

Didip and Ahmad (2020), mention the study conducted by Aulet, W., and Murray, F., (2013) where the concept was divided into two categories, the first one is based on innovation-driven with the target to “pursue the global opportunities” and the second one is the small business or small medium enterprises which have limited access to the global market “serve local markets with the traditional way with low competitive advantage.”

Benefits for entrepreneurs

During our interviews, P7 asked about the types of entrepreneurs we were focused on, and it valid the question, because most of the benefits of business opportunities are more likely to be from those who are motivated based on innovative ideas with ambitious ideas of the global market, as well this comment was mention by AI when it comes to “Global market” as entrepreneurs in smart cities solutions. However, local entrepreneurs can benefit if they are aware of the endless possibilities of what AI can do for their business as well.

What are the benefits that entrepreneurs can have with this cluster, well as we found in the literature de Lima, R. et al. (2022), “Using the idea of a Silicon Island Model, MODIS adopts an analytical approach based on an active local innovation system permeated by initiatives such as meetups and hackathons, incubation and acceleration of startups, angel investment, venture capital funds and actions promoting a high density of startups per inhabitant. MODIS encompasses the attributes of a Smart City fit for purpose in a modern society today.” For this the P1 she put as an example the program implemented in Smart Citi Dublin “call for Pilot”.

One important point that P5 mentions is the bias in “support and incubate tech related start-ups and the reason is scalability because with technology you can you know you can scale something very easily whereas a service that's relies on you know.”

Opportunities and Challenges

Statista (2023) notes that a major driver of AI growth is the strong interest in Venture Capital (VC) investment in AI start-ups, which can involve collaboration between the private and public sectors as P3 mentions. In the same line, P5 mentions that in Ireland there are programs that help entrepreneurs in their initiatives, for example, Ireland Enterprise and he mentions LEO which stands for Local Enterprise Office.

P1 added that the “biggest innovation entrepreneurship hub in Dublin is Dogpatch Labs.”

However, must be aware of regulatory challenges such as the AI EU ACT, for example, Art 57 mentions SMEs and start-ups can have access to sandboxes where they can have access to “a controlled environment that fosters innovation and facilitates the development, training, testing, and validation of innovative AI systems”. As well as what kind of invention will be considered a risk and can be banned by law or as P3 states from the citizens.

Another challenge that entrepreneurs must have is the lack of trust from users in AI in Smart Cities, this can be a deterrent to using or buying the solution, as highlighted by Zhon-Ren Peng (2023) about discriminatory planning practices, that statement is also mentioned by P3 "Citizens can play a role in saying, perhaps we want autonomous cars in San Francisco, but we don't want police robots...the future is not determining us."

From the point of view of entrepreneurs, this might be a bottleneck to move forward in the business by understanding customers’ needs and concerns the final product can fit in the necessities of the users or clients.

Reducing the Technological Gap

One of the biggest concerns of P1 is the risk of leaving people behind in the digital transformation, ensuring inclusivity and unbiased implementation is crucial. As is addressing fears about data usage Sujate et al. (2016) emphasize the challenge of educating and training employees with IT skills alongside "Politics, cultural differences, and lack of inter-departmental cooperation are some of the organizational barriers that lie ahead of smart city development. " this also as P1 said the Smart city is working on the engagement of citizens and employees.

Best practices in AI, Smart cities, and Startups

Barcelona is one considered for P3 as the best practice of a smart city "Barcelona comes up as an example of best practice… citizens have a lot of inputs in smart city…play an active role… more democratic kind of smart city" as Chandra(2020) mentions that China is planning to create around 500 smart cites with sensors, cameras, and gadgets for traffic and pollution."

According to Chen and Ogan (2017), Sheng Zheng is China's Silicon Valley where everything is interconnected and all transportation is electrified. The application of artificial intelligence in municipal services has reached a new high.

Ethical perspectives and Attitudes towards AI

The feelings and attitudes towards AI go from fear, and skepticism, to concerns about privacy data "perpetuate existing inequalities" P5, as well as the apparitions of sophisticated criminal purposes using AI by creating fake faces, and voices (P4), Asri (2024) mention the big brother society and to mention cyberattack.

Another concern is about social interaction, as Participant 7 pointed that "she likes to go to the local market to buy fresh vegetables and have a conversation with them." As a society that gives cities full autonomy.

Additionally, is that we do not know jet how the black box works, as the P5 mentions "Meaning how do we know how an AI system made a decision? Can we look? So there's a black box phenomenon, meaning that we can't see inside the black box. It's not transparent. So the transparency in, you know, decision-making of AI systems."

Furthermore, the P5 mentions is that the new generation forgets how to do basic things to resolve problems or depends too much on AI use.

Even AI concerns are for the digital division that some benefits of AI solutions might not be equally accessible. At this point, cities like San Salvador were in many rural and outskirt areas with no access to the internet or knowledge whatsoever of how to use a laptop. As P3 said also "incentive. But the services are even restricted because if you can pay for it, you can access the service. If you don't have money, you are excluded from the smart city."

7. Conclusions

Every city has different challenges and necessities: San Salvador is in the process of reorganization and not only that, as well, still dealing with fulfilling basic services such as public transport, waste management, and air quality among other necessities. And Dublin for instance, is dealing with housing pricing and availability issues, the cost of living, and security in the city centre.

For example most of the participants in Dublin complaint about the services of public transport in terms of time efficiency and no option to top up by credit card o debit card the fees, however, Dublin buses are most of them electric and are quite reliable in the time commute information mostly in Google map, the point in this topic is closer to resolve the public transport than El Salvador.

As the P5 mentions the existence of bias in the programs and benefits from the public and private sector that invest mostly in Tech solutions, leaving the local entrepreneurs dealing with their own.

The participants were aware of the ethical implications and expressed skepticism, this fear can be an obstacle to seeing and taking all the benefits from the business point of view as well, as the potential to improve the quality of life.

Like all technology, it can be used to do good things or to do evil, and at some point, new technology reveals its consequences, not only positive but negative. On the negative side, there is the misuse of personal data and the loss of privacy. The latter is the greatest concern among those interviewed

Might be difficult, at the moment, to find someone, in these cities, who can have the three aspects of the profile that we are looking for, likewise, someone to know about Smart cities, AI, and Entrepreneurship.

AI can solve empirical and physical problems or problems of knowledge, but not of feelings and relationships, in which human relations intervene. Humans are gregarious beings who need other human beings, they are not a species of solitary individuals. As a city develops, there are more problems of conduct and human relations, such as loneliness, marginalization, aging, and depression. As P7 pointed out "The change towards automation and machines in public spaces might reduce personal interaction and impact local businesses. There is a concern about social displacement and changes in human interactions."

In terms of ethical implications, is not only about data usage but also, about improving the trust of the vision that citizen have for their representative in local and central government.

One of the biggest benefits that was pointed out for AI for Entrepreneurs in this topic is that if the start-up succeeds in resolving and specific problem in the city, is not only local success but can also open Global market opportunities.

- "**International Opportunities:** Successful smart city solutions can be scaled and adapted for cities around the world, offering entrepreneurs access to global markets and diverse urban environments."

In terms of benefits, the literature review shows the term creative economy, which opens the door to all those tech-enthusiastic to share their creativity to resolve social problems by using IoT, BDA, and AI.

There are a select number of cities, years ahead, with good practices from which Dublin and Salvador can learn at a strategic level, in programs and projects that link the key themes of this thesis: entrepreneurship, local government and artificial intelligence.

8. Recommendations

Ethical Considerations and Social Engagement

Knowing the ethical implications of using AI as a society, decision-makers, need to start working on implementing more social engagement programs and accelerate the reskilling at the school, workplace, and academia.

Government's preparation

Both Local government and central government, have to be careful in relying on too much AI, for example, the incident with Microsoft Office "A faulty software update causes havoc worldwide for airlines, hospitals and governments" just this example, of how fragile we were in this moment, without having a robust backup plans. That would be of be prepared in case the system crushed, and know how to work in an analogy way.

Entrepreneurial Education in AI

Entrepreneurs should incorporate an educational component in all AI projects for Smart cities, this will help to embrace the technology and use it properly, with this will help to ensure an inclusive digital adaptation.

Supporting Local Entrepreneurs and SMEs

Local government must consider projects using AI for local entrepreneurs that are not in the Tech field and SMEs, for example, workshops on how AI can boost their business and be competitive.

Get ready for workforce transformation

For all of us in general, all the sectors must be ready for the biggest changes in the way that we do our jobs, day to day new technologies with AI are appearing, to improve manufacturing.

Dublin and San Salvador, should use their public affairs to enhance, and use the knowledge about Smart Cities to these capitals.

Future Research Directions

For future research that could be explored:

- Case of Bristol as the model of a Smart City, which would be a case analysis of the application of IoT, BDA, and AI, as well as the creative economy. As China smart cities.
- The impact of AI in rural areas or conditions of inequalities.
- Deep analysis of how initiatives like Dogpatch and NDRC operate and looks at the start-ups involved in smart cities with AI solutions.

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10. Appendix

10.1 Interview Questionnaire

Exploring the role of artificial intelligence in smart cities and their benefits for entrepreneurs in Dublin and San Salvador.

General information

Name:	
Participant number:	
Date:	
Hour:	
Position:	
Organization name:	

Aim: This questionnaire is part of the thesis methodology to obtain a Master's in Entrepreneurship at the National College of Ireland, Dublin. The study aims to explore the state of artificial intelligence applied to smart cities and compare two capital cities: Dublin, Ireland, and San Salvador, El Salvador, and how entrepreneurs can benefit from these applications. The study's overall objective is to identify the key components of smart cities in Dublin and San Salvador, understand how artificial intelligence (AI) will contribute to improving or addressing those components, and identify the opportunities for doing business with entrepreneurs.

a. General Questions: This section will be adaptable by the stakeholders: Local authorities, start-ups, academia, and AI.
1. Can you briefly describe your role in the organization? How long have you been involved in Smart cities or Urban Planning? Are you working directly with the Dublin/San Salvador council or are you an external user of AI/smart cities?
2. What are the main problems and topics or challenges that Dublin/San Salvador city is facing?
3. Could you provide information on the current technological innovations being employed by local governments in Dublin and San Salvador to address challenges in the cities, smart cities?
4. What are the problems do you think AI is going to resolve or improve in smart cities?
b. Shaping the future in Smart cities with AI
5. In the scenario of local government utilizing AI in smart cities, what type of services from the start-up will be required?

6. Do you know if there are any AI-driven solutions from start-ups to enhance city services or address urban challenges in Dublin/San Salvador?" Can you provide examples? (Collaboration) Good practices.
7. How do you image futuristic smart cities within the AI revolution? Do you think the cities will change and in What way?
c. Entrepreneurial initiatives in AI within smart cities
8. From your point of view, how can local government policies and initiatives support entrepreneurial activities related to smart cities?
9. How do you foresee (visualize) the role of AI in smart cities? What are the opportunities or challenges for entrepreneurs in this field?
10. In the future, what will be the economic advantages of using AI in smart cities for the local entrepreneurs?
Ethical and Attitudes toward AI
11. What are from your perspective the downsides of using AI to shape the cities, specifically in smart cities? Or the ethical implications?
12. What is your attitude regarding of using AI in Smart cities to analyze data, that will be use for decision making? Please choose the one that resonates with you, and explain why.
a. Optimism and enthusiasm:
b. Pragmatism and caution:
c. Collaboration and community engagement:
d. Adaptability and learning:

I understand my participation in this study is entirely voluntary. I acknowledge that my responses will be used for research purposes only and will remain confidential. I consent to participate in this study and understand that I can withdraw at any time without any penalty. By ticking 'Yes, I agree' below, I confirm that I agree to participate in the study.

☐ Yes, I agree. ☐ No, I do not agree.

Signature: _____