

# Covid-19 Impact and the Potential of Smart IoT for Cities

Silvia Fernandes

Faculty of Economics, University of Algarve, Campus de Gambelas, Faro, Portugal

## Abstract

Covid-19 crisis has halted many activities and sectors. People and workers' habits and behaviors have changed dramatically. This is where the use of technologies and connections, virtual reality and remote support are enhanced. Businesses and cities have been forced to adapt quicker to the new challenges. Digital technologies allow better public services to people when there is an improved use of resources. Smart cities have a great potential in linking people to works and services as never done before. Also, the data obtained from the technological convergence on their basis can enhance interactions and decisions toward the "new normal". This research aims to assess how Portugal is prepared to respond to the accelerated process that this context demands to cities. Portuguese SMEs have developed a good capacity for entrepreneurship and innovation. However, they are still behind in converting the knowledge acquired in sales and export. And there is still a low collaboration at the public-private level. Smart cities' acceleration through IoT (Internet of Things) may encourage changes in these issues.

## Introduction

Across the globe, the Covid-19 crisis has halted business operations of many types and sizes. But essential sectors, such as construction, have soldiered on. Many works and activities involve people going to factories, but suddenly Covid-19 altered these habits. This is where the use of technologies, like IoT (Internet of Things), augmented reality (AR) and remote support of frontline workers, is accelerated. The objective is to enable experts to be productive in helping to resolve production issues remotely.

Economies have been forced to adapt quicker to these challenges. But now employers have a clue of the operational and financial results digital processes can deliver, causing a major rise in their adoption [1]. Thanks to IoT development, job sites are being reimagined from the ground up. Many of the changes are here to stay, even after the pandemic outbreak is contained. With capabilities like real-time tracking and monitoring, IoT is opening up a set of possibilities for businesses and cities. Digital technologies translate better public services for residents, when there is an improved use of resources with less impact on the environment [2]. Also, when they allow a more transparent communication between government and citizens.

## Smart Cities' Potential

Smart city is the new trend in the development and governance of cities, by applying new technological platforms (Tp) that allow citizens free access and use of information and applications about their city. The dimensions of smart cities are based on parameters ranging from governance, urban mobility, environment, innovation to connectivity and social inclusion [3,4] see Figure 1. Smart cities are distinguished by participatory governance, and its monitoring, in order to plan investment resources in the most deficient areas or that require preventive maintenance actions.

A city that is more connected to its population works better. Small steps are taken towards smart cities when improving smart living in cities. Such steps are materialized through cyber-physical applications that allow citizens to be proactive about their surrounding activities. Smart cities are those with active policies that use technology to improve urban infrastructure and make urban centers more efficient. That means incorporating sensors and other technologies into a destination to monitor and collect data on everything from traffic

## Publication History:

Received: August 30, 2021

Accepted: November 17, 2021

Published: November 19, 2021

## Keywords:

IoT, Smart city, Covid-19, Digitization, Portugal

to energy use. The data is then communicated through wired and wireless connections, through the well-known Internet of Things (IoT) in which everything is interconnected [5]. This data is then analyzed to assist decision making by the government and companies.

## The importance of data analytics

The results (outputs) of digital urban information systems are still static and simple. They usually appear in the form of simple queries, devoid of data analysis from various sources over time to assist the decision-making process in urban management.

One of the keys to building a smart city today is the integration of heterogeneous urban data from various sources. In addition, there is a need to manage urban infrastructure and the ability to quickly view and update multidimensional spatial and temporal data. Emerging advances in web and sensor technologies, in processing and storage capacity, and reduced cost of sensor production, allow the 'leap' for the design, planning and development of smart cities [6,7] see Figure 2.

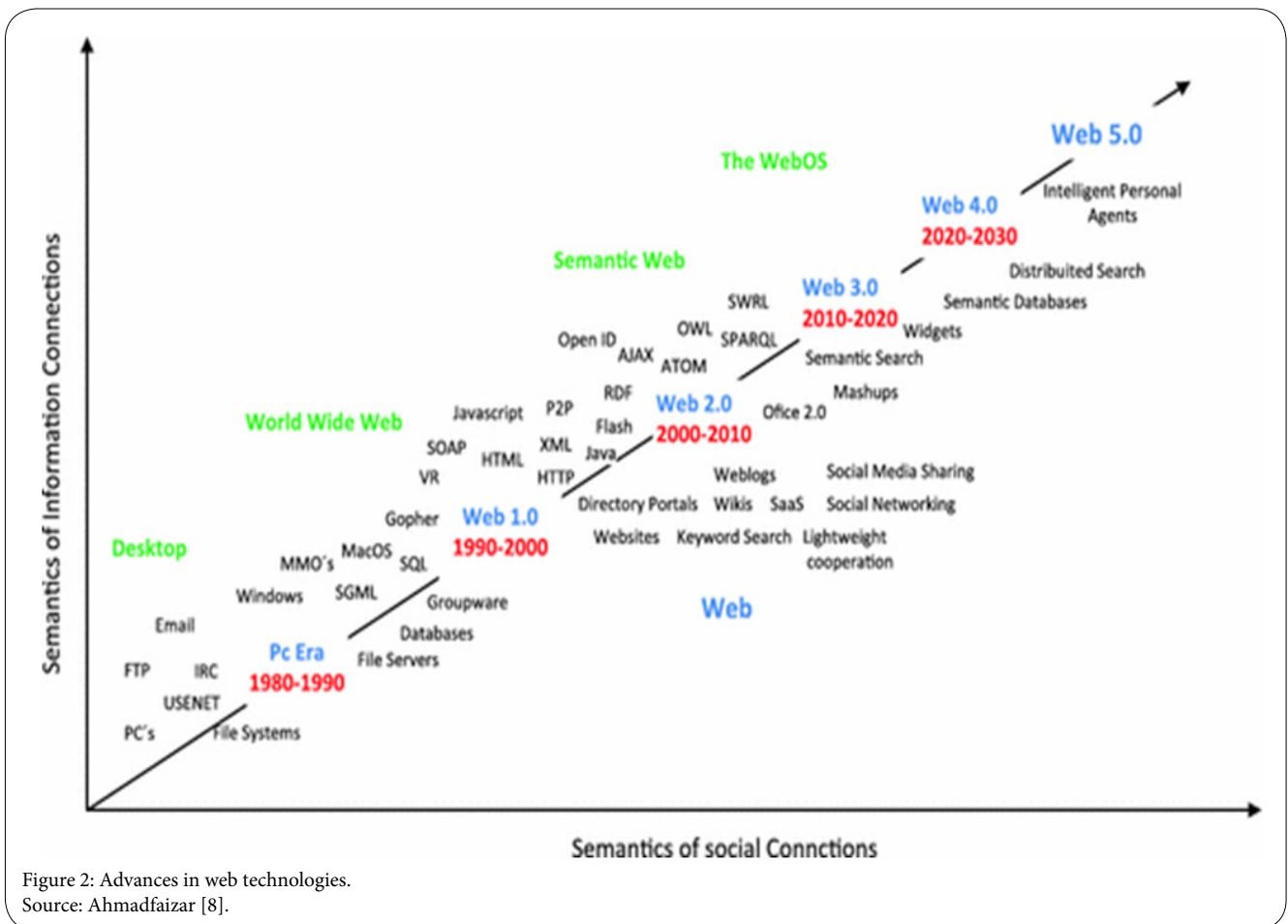
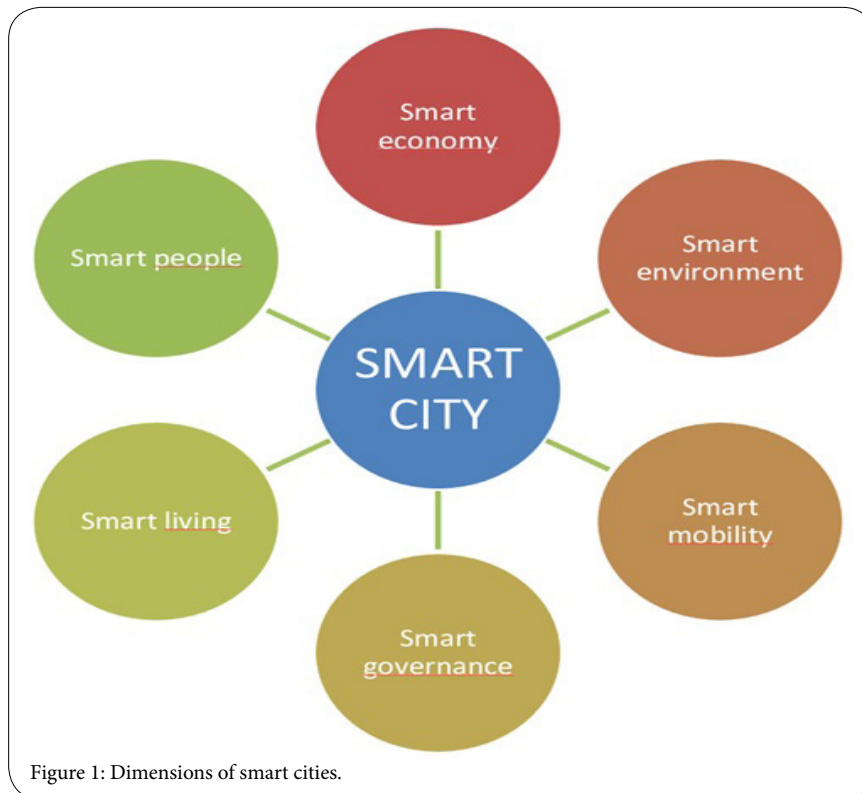
The more technologies and systems imitate and respond to human needs in society, the higher levels of web, wi-fi and connection are needed. Technologies like BigData and IoT have allowed more innovative and creative developments for smart cities [9]. Also, artificial intelligence (AI) and machine learning (ML) make computers able to process large amounts of such data. Extracting meaning and knowledge from these data is crucial for governments and businesses to support their strategic and tactical decision-making.

IoT is an integral part of the FIE (Future Internet Ecosystem) that will have a major impact on the development of e-services. It provides an infrastructure that identifies and connects physical objects to their

**Corresponding Author:** Dr. Silvia Fernande, Faculty of Economics, University of Algarve, Campus de Gambelas, 8005-139 Faro, Portugal; E-mail: [faivlis.fernandes@gmail.com](mailto:faivlis.fernandes@gmail.com)

**Citation:** Fernande S (2021) Covid-19 Impact and the Potential of Smart IoT for Cities. Int J Comput Softw Eng 6: 171. doi: <https://doi.org/10.15344/2456-4451/2021/171>

**Copyright:** © 2021 Fernande. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.



virtual representations, on the internet [10]. As a result, any physical object can have its virtual reflection in cyberspace. This gives the opportunity to replace actions on physical objects with operations on their virtual representations, resulting in faster, cheaper, and more comfortable services. This can open up a wide space for the development and implementation of new business models [11] see Figure 3.

In this sense, several applications have been developed whose cases are briefly described below.

### Cases of Smart Cities and Common Aspects

Some cases of smart cities in the world and their main aspects are described below [12]:

1. New York was voted the smartest city in the world by the IESE Center for Globalization and Strategy. In collaboration with Cisco, the city launched an interactive platform that converted old public telephone systems to provide Internet access for all residents. In addition to providing information about local events, neighborhood news and entertainment lists, the platform also provides security alerts. In traffic, for example, the Department of Transport started to manage city traffic using real-time data. Almost 300 sensors and cameras provide statistics and modify traffic light patterns, resulting in a 10% improvement in travel times;
2. the city of Amsterdam is a pioneer in Europe in terms of investing in technology and sustainability. It has a platform that offers support and incentives for institutions, companies and citizens to develop green projects, which can benefit the quality of urban life for all inhabitants. The infrastructure department has developed innovative products and services in the field of urban mobility, providing data on traffic and available transport options, in addition to the availability of parking, taxis and cycle paths. The city also invests in the development of mobile technologies (such as Drive Carefully, an application that alerts drivers when they are driving near a school to slow down). In

addition, several houses and buildings have been adapted with efficient insulation to reduce energy costs, automatic dimming switches, smart electricity, etc.

3. Tokyo is also known as the capital of technological and futuristic novelties. This includes developing efficient measures to control the amount of energy used in homes and commercial buildings. Japan's biggest companies have taken on the responsibility of developing and spreading smart technology to revolutionize the city. Panasonic, for example, built an eco-friendly neighborhood where its old factory was located. All houses are based on the use of renewable energy.

Other examples in this line are the cities of: San Francisco, Vienna, Copenhagen and Curitiba. The common aspects to these projects, in terms of the sectors in which they focus, are: transport; 'green' city (waste recycling, air quality, renewable energy); and urban mobility applications.

Regarding the pandemic and mobility issues, thermal cameras in IoT systems can capture workers' heat profiles. From there, an AI agent acting as a virtual safety inspector can help ensure that appropriate distances are maintained between people. Alongside bluetooth-based tracking technology, this is being employed to contact trace assets and individuals in areas such as construction sites, factories, and hospitals [13]. To simplify things, an on-site employee can capture images and videos with a camera and share them with team members and regulators. Thanks to IoT, they are able to monitor supply chain logistics, inspect sites, and ensure the safety of on-site workers.

Even in tourism those online technologies contribute to reinvent experiences. In spite of not being the same as real travelling, they can contribute in terms of fun/entertainment and discovery/research of unknown aspects about destinations. A way is to involve tourists with the city itself to make their experience memorable, through augmented and sensitive reality (AR/SR). For example, when virtually visiting a place, the use of AR/SR besides being a way to replace the real visit, can also enrich the associated experience [14]. Here, a trend will be the intensification of smart and sensory characteristics in IoT and AR (combining image, video, audio, ubiquity).



Figure 3: A wide potential for new business models.

Urban tourism is driven, in part, by major events such as: concerts, fairs, sporting events, etc. Intelligent crowd management is a way for smart urban tourism to take advantage of IoT to optimize the services provided. However, due to the present pandemic context, those technologies can be used for control. If well planned, such a platform can help move people elsewhere, build services based on their behavior, and even target ads to where people will be at a foreseeable time. If several information technologies and systems interact in the IoT paradigm, it will be possible for a smart city to respond better to a more sustainable tourism because necessary assets such as public health, security, transport, and logistics will be more and better safeguarded [15].

### Relation between innovation and city smartness

Portugal is increasingly a country of smart cities, as more and more municipalities are betting on the concept of smart city. In many cases, people do not even realize that this technological infrastructure is supporting part of their lives. For example, there are those who continue to dispose of garbage in eco-points, but do not know that this eco-point communicates its capacity in real time and that this information influences the waste collection circuit [16].

The Smart Cities Section, founded in 2016 by the Association of Portuguese Municipalities (ANMP), comprises 136 municipalities from north to south of the country (in a total of 308 municipalities). Among these, 27.3% have a Smart City strategy and 16% have an urban intelligence platform. The main bets of national smart cities are public wi-fi network (80%), 'fix my street' system (48%), intelligent public lighting (41%), intelligent management of urban solid waste (36%),

intelligent tourism (36%) and intelligent management of green spaces (30%). In practice, such sustainability and efficiency efforts have implications in saving resources [17]. According to IDC, a market intelligence consulting company, the implementation of smart systems in cities allows a better management of: water waste, lighting costs on public roads (with return on investment in six years), urban solids, parking systems (smart parking, with investment recovered in two years).

From the charts below, based on Eurostat related indicators, we can acknowledge what is the potential of Portugal for more projects in this area. Recently, Portugal became a 'strong innovator' due to the values achieved in several of its innovation indicators. Portugal is close to the United Kingdom, Spain, France and the European average itself in terms of broadband connectivity in companies. However, in relation to individuals using the internet to interact with public services, they still have values below these and other countries (Figure 4). But it has been evolving in the digital inclusion of its citizens.

Another aspect, in which Portugal has been improving, is the training it provides to company workers in terms of their ICT (information and communication technological) skills (Figure 5).

According to the European Innovation Scoreboard [19], Portugal went from 'moderate' to 'strong' innovator. The dimensions or variables (of the composite innovation index used) that mostly have contributed to this change in classification, i.e., the strongest variables in the Portuguese innovation ecosystem are:

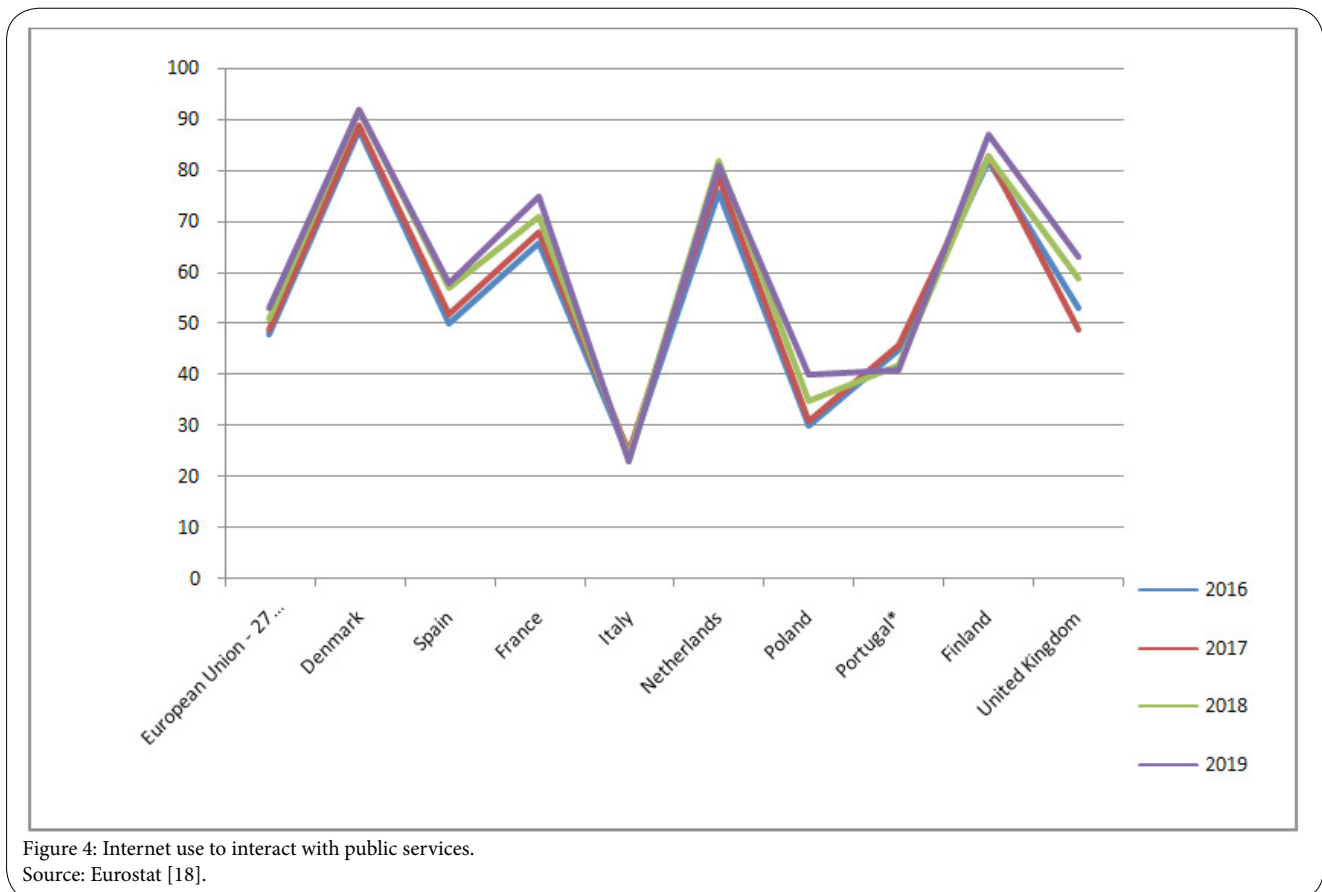


Figure 4: Internet use to interact with public services. Source: Eurostat [18].



1. Number of innovators
2. Favorable innovation environment
3. Attractive research systems
4. SMEs (small and medium enterprises) innovating internally
5. Broadband expansion
6. SMEs having product and process innovations
7. Number of foreign PhD students

However, there are still dimensions to (re)analyze and improve, as they are the weakest in our innovation ecosystem, such as:

1. Impacts on sales
2. Connections
3. Intellectual assets
4. Exporting knowledge intensive services
5. R&D expenses in the business sector
6. Private co-financing of public expenses in R&D
7. Public-private (co)publishing

Portugal has been offering a favorable environment for innovation and attracting talent. And SMEs have developed a good capacity for entrepreneurship and internal innovation. Where Portugal is further behind is in the translation or conversion of the knowledge acquired in sales and exports (internationalization). And there is still a low propensity for collaboration, especially at the public-private level. Thus, private investment in R&D has been low, making this activity more dependent on public incentives. The technological convergence

smart cities assume may encourage changes in these critical aspects. The country is already giving steps in this matter, through a program called Portugal Smart Cities Summit.

### Conclusion

Due to the pandemic context, e-learning/work and e-commerce/business have been accelerating in a way never done before. Digital transition is an essential instrument of Portuguese strategy, in alignment with the objectives of European investments. It is one of the six priorities of the *Preparing Europe for the Digital Age* mandate, which aims to ensure that technology is at the service of people and gives added value to their daily lives. Thus, Portugal is aligned with the strategy defined to face the challenges inherent to digital evolution. However, it is important to know if it is prepared to respond to the accelerated process that the change in habits/behaviors of citizens demands to be made in cities.

Portugal is well in terms of broadband connectivity in companies. However, in terms of internet use to interact with public services, it still has values below many other countries. The country has been offering a favorable environment for entrepreneurship and innovation. However, more than 50% of its citizens still have basic digital skills [20]. That is why the country still has a low conversion of the knowledge acquired in sales and exports. Also, private investments in R&D have been low, making this activity more dependent on public incentives. The technological convergence smart cities assume may encourage changes in these issues.

A university business school can serve as an entrepreneurial ecosystem to settle the baseline for a smart city. As it aims at creating

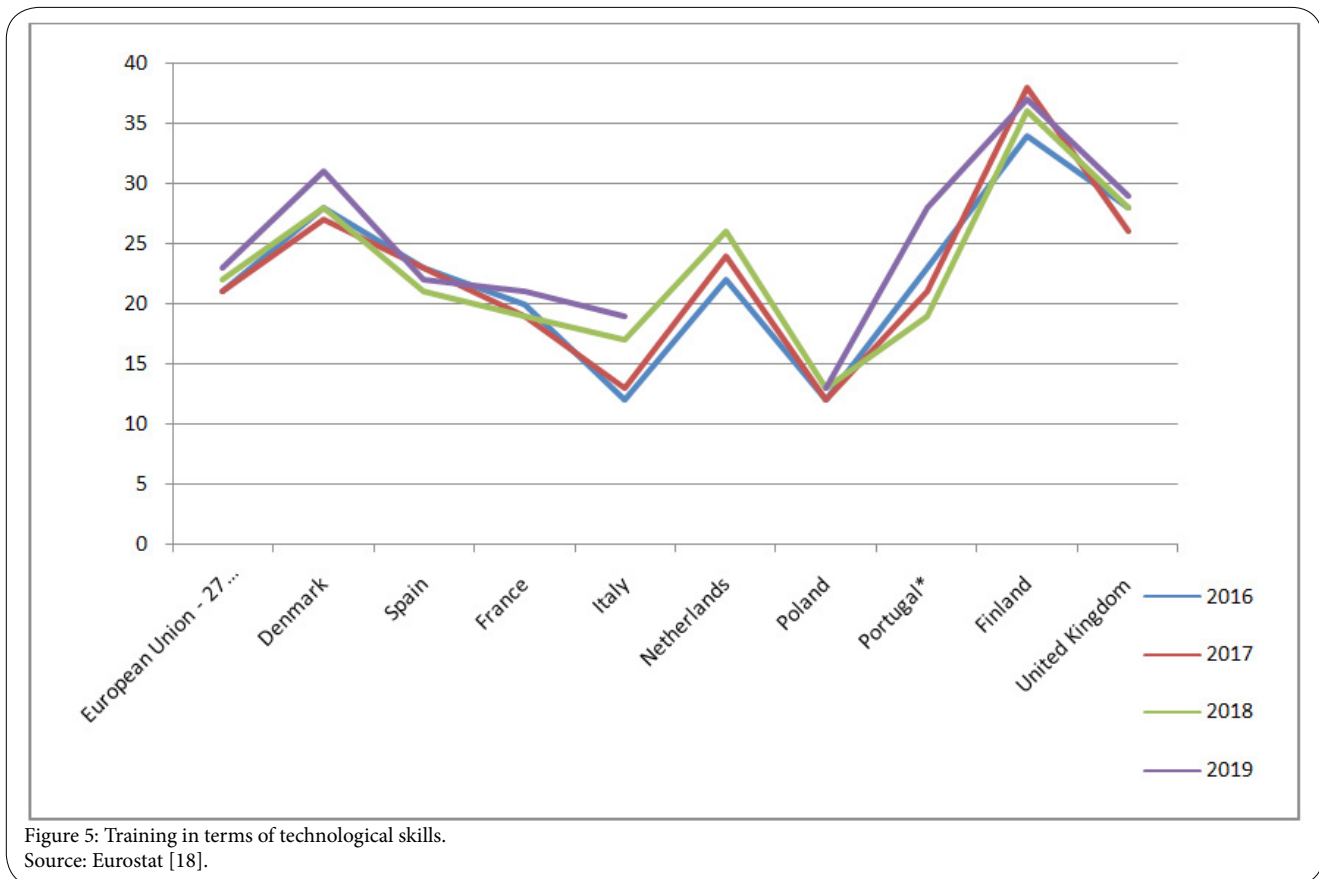


Figure 5: Training in terms of technological skills. Source: Eurostat [18].

innovative technology-based service businesses, it stimulates economic development and generates employment [21]. Emphasis is placed on the need to develop strong collaboration among key stakeholders for building an extensive entrepreneurial ecosystem based on a quadruple-helix system (university-enterprise-government-society).

## Competing Interests

The author declare that there is no competing interests regarding the publication of this article.

## Funding

This paper is financed by National Funds provided by FCT- Foundation for Science and Technology through project UIDB/04020/2020.

## References

1. Heppelmann J (2020) Covid-19 accelerates use of augmented reality.
2. Mohanty SP, Choppali U, Kougianos E (2016) Everything you wanted to know about smart cities: The internet of things is the backbone. IEEE Consumer Electronics Magazine 5: 60-70.
3. NP (2019) Portugal, o país das cidades inteligentes.
4. Khan M, Woo M, Nam K, Chathoth P (2017) Smart city and smart tourism: A case of Dubai. Sustainability 9: 1-24.
5. Wyane S (2016) How smart cities are leading the way to smart tourism.
6. Samih H (2019) Smart cities and internet of things. Journal of Information Technology Case and Application Research 21: 3-12.
7. Benito-Osorio D, Peris-Ortiz M, Armengot C, Colino A (2013) Web 5.0: The future of emotional competences in higher education. Global Business Perspectives 1: 274-287.
8. Ahmadfaizar (2020) Evolution of the web.
9. Rotuna C, Cirnu C, Smada D, Gheorghita A (2017) Smart city applications built on Big Data technologies and secure IoT. Ecoforum 6: 3.
10. Balandina E, Balandin S, Koucheryavy Y, Mouromtsev D (2015) IoT use cases in healthcare and tourism. IEEE 17th Conference on Business Informatics.
11. Belli L, Cilfone A, Davoli L, Ferrari G, Adorni P, et al. (2020) IoT-enabled smart sustainable cities: Challenges and approaches. Smart Cities 3: 1039-1071.
12. Alves N (2018) Smart City: As 7 cidades mais inteligentes do mundo.
13. Dogtown Media (2020) 5 Ways COVID-19 Has Accelerated the Construction Industry's Adoption of IoT.
14. Bismart (2019) Smart City Tourism: The Future of Tourism.
15. Info Barcelona (2019) Municipal innovation at the Smart City Expo World Congress.
16. Ferreira R (2018) Smart cities: 22 projetos que estão a criar um Portugal mais inteligente.
17. Silva B (2020) Quão inteligentes e sustentáveis são as cidades portuguesas? Municípios dão a resposta no Smart Cities Tour.
18. Eurostat (2019) Digital economy and society - Benchmarking digital Europe: key performance indicators.
19. European Innovation Scoreboard (2019) Internal market, industry, entrepreneurship and SMEs.
20. Amado M (2020) Covid-19 as an accelerator of digital transformation of cities.
21. Allahar H, Sookram R (2019) A University business school as an entrepreneurial ecosystem hub. Technology Innovation Management Review 9: 15-25.