

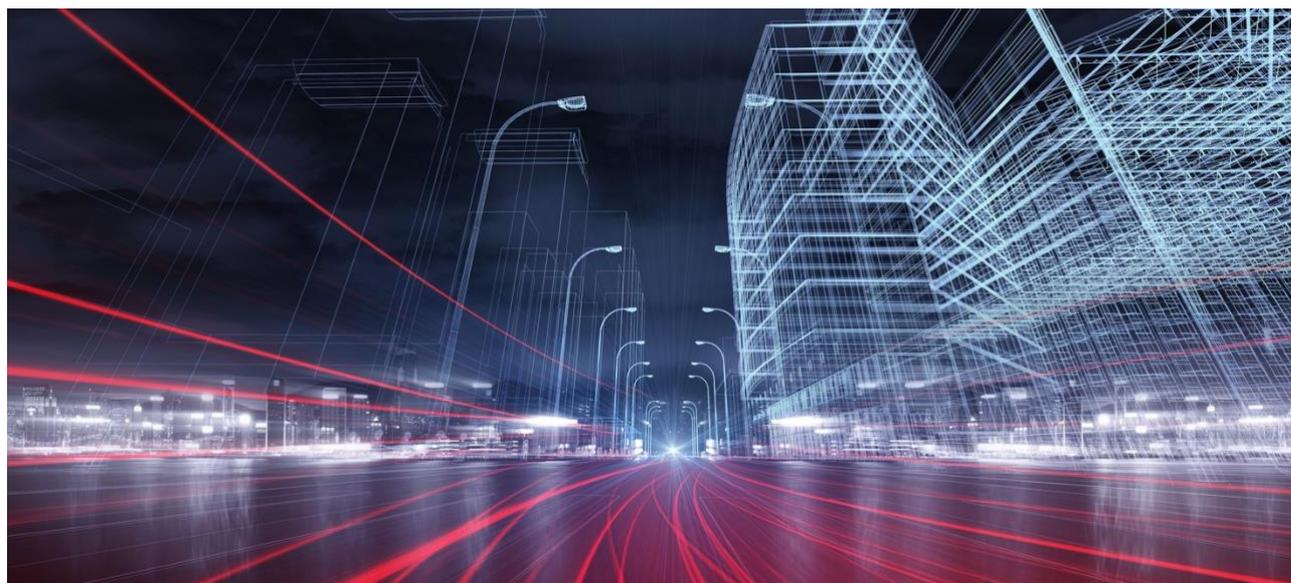


DIGITAL CITIES CHALLENGE

Assessment report for the city of Guimarães

Build Guimarães' Digital Future

July 2019



Digital Cities Challenge

Assessment report for the city of Guimarães

Paulo Novais (lead expert)

Augusto Ferreira (thematic expert)

Carlos Neves (local expert)

with the contributions of the Digital City leadership team

Ricardo Costa (city project manager)

Sérgio Gonçalves (city representative)

Ricardo Machado (economic and business representative)

Table of contents

1.	Introduction to the Digital Cities Challenge	4
2.	Key sectors of the local economy and DCC focus.....	6
3.	Digital maturity level of the city: outcomes of the Self-Assessment Tool and Key Performance Indicators.....	9
3.1.	Outcomes of the Self Assessment Tool	9
3.2.	Key Performance Indicators	13
4.	The local digital ecosystem: leadership and governance.....	18
5.	The use of digital solutions by local companies.....	19
6.	Community engaged in digital transformation.....	22
7.	The state of local digital and physical infrastructure	24
8.	Digital solutions enabling the modernisation of business environment	27
9.	Data-driven innovation.....	28
10.	Skills and entrepreneurial culture	31
11.	Digital transformation SWOT analysis	34
	Appendix I: Table of abbreviations and definitions.....	36
	Appendix II: Bibliography	38

1. Introduction to the Digital Cities Challenge

According to the recent data, 72% of the EU's population lives in cities, towns and suburbs, making them the engines of the continent's economy. Cities generate 85% of Europe's GDP, they also face multiple, interconnected challenges, including energy and climate change, employment, migration, social inequality, and water, air and soil pollution.

However, through advanced digital technologies, Europe has the opportunity to re-invent the way we manage our cities' development and respond to the big societal challenges, such as efficient health management, cleaner environment, green mobility, and offering great-value jobs. Due to their high density, cities are put in a very good position to create innovative ecosystems made up of a wide array of different stakeholders from government, industry, finance, academia, communitarian organisations, social partners, etc. Cities have the capacity to make policies become reality.

In this context arises the **Digital Cities Challenge**, an initiative of the European Commission with the main purpose to support the cities in their path to digital transformation. DCC offers policy advice and support to 15 cities in Europe, namely **Alcoy**, **Algeciras** and **Granada** in Spain, **Arad** and **Iasi** in Romania, **L'Aquila** in Italy, **Kavala**, **Patras** and **Thessaloniki** in Greece, **Sofia** in Bulgaria, **Ventspils** in Latvia, **Grand-Orly Seine Bièvre** in France, **Pori** in Finland, **Rijeka** in Croatia, and **Guimarães** in Portugal. The support to be offered will speed up the digital transformation and the industrial modernisation of cities in order for them to take full advantage of the 4th industrial revolution.



This initiative draws inspiration on the recommendations set out in the "**Blueprint for cities as launch pads for digital transformation**". In addition, it will reinforce the networking among

model cities, facilitate their participation in on-going European initiatives in similar policy fields, strengthen stakeholder collaboration, cross-regional partnerships and stimulate investments.

The selected Digital Cities receive support in the form of field advisory services to be provided by a group of high level experts and peer reviewers, and offer the possibility for city representatives to participate in a series of capacity building and networking seminars. These activities take place in four Academy seminars during which cities share practices, take advantage of peer to peer learning and work together and in thematic groups on the steps of their transformation trajectory.

This document has been developed in the framework of the field advisory services being delivered in the Guimarães. It represents the main output of the first step of the digital transformation strategy: setting the digital vision and ambition for digital transformation. The assessment report has been developed by the Digital City team on the basis of:

- The results of the Self-Assessment Tool and collection of Key Performance Indicators at the city level which took place between November and January. A total of 22 valid replies were collected through the SAT.
- A literature review of key documents provided by the local leadership team, including reports, policy documents and project plans. (cf. Appendix II for full list of documents consulted).
- An assessment visit which took place on early of September and second week of January and a vision and ambition workshop which took place on 22nd February.

This document represents the key input to the work to be performed during the forthcoming phases of the digital transformation trajectory (i.e. definition of the city strategy and roadmap).

2. Key sectors of the local economy and DCC focus

Key Sectors

The main economic sectors of Guimarães are manufacturing, services, tourism and agriculture. Together, they represent 43% of existing establishments, 66% of employed persons, 53% of Turnover and 67% of GVA. In 2017, Guimarães exported 1403,2M €, against 765,8 M€ of imports. Although heavily industrialised and exporting (in every 2 people employed, one works in the industry), this territory keeps alive its cultural heritages, associated with the natural and built heritage, with densely populated urban areas intricate in landscapes of high agricultural character.

Industry

In 2017 the industrial sector generated a GVA of 700,7M€ and was responsible for the employment of 34.335 people. In this sector, the textile industry stands out, which in itself represents a volume of exports of 882,9 M€, footwear (19,1 M€), cutlery (24,8 M€), machinery and equipment (72,8 M€). Many of these companies are small in size but work for all parts of the world and are often represented at international fairs and trade shows. The main challenges faced by these industrial sectors relate to competition with other areas of the globe where production costs are cheaper, namely on human resources, and the continuing need to distinguish itself from competition for the development of high-quality products. In this context, innovation and digital technologies plays an important role because it will allow the development of global and intelligent strategies that strengthens the industrial sector of Guimarães to remain at the forefront of international trade.

Services

Guimarães concentrates countless companies related to advanced services in the areas of communications, accounting and finance technologies. These sub-sectors are joined by important installed capacities in the areas of scientific research and development, a circumstance that results from the presence of the University of Minho and the Polytechnic Institute of Cávado and Ave, several spinoffs and startups emanating from that academic environment. As a whole, consultancy, technical or scientific services, administrative activities

and public administration (excluding education) employ more than 6.000 people (9,1% of the total employed population) and generate a GVA of 71,6 M€. The main challenges facing the sector are to design Guimarães as an international centre in the area of science, technology and R&D in key sectors (namely textile industry). In this field, digital plays an important role since it will provide the city with the necessary resources in areas related to fashion design, creativity, science and research.

Tourism

Guimarães is known for being the birthplace of the Portuguese nation. Here are important values-symbol of nationality, reason why the tourist vocation from the beginning was felt. However, it was essentially in the last two decades, particularly after the recognition of its historic centre as a UNESCO world heritage site that this vocation has developed more. The sector as a whole aggregates housing, catering and others, being responsible (2017) for a GVA of 31,2 M€ and the employment of 2.914 people. Specifically in the subsector of the accommodation, this generates a turnover of 14, 8 M€, with 39 establishments and a capacity corresponding to 2.289 beds. The main challenges posed to the sector are to keep intact the historical and cultural heritage that supports it, not to exceed the associated load capacity and raise some indicators, namely the current average stay per tourist (1,7 nights). Digital plays a key role here in being able to put Guimarães in a network with the main European (and worldwide) tourist centres, in the "quiet transformation" of the city and its capacity as a marketing tool.

Agriculture

This sector also includes the animal production developed in small units of production of meat or milk. The historical weight of agriculture and livestock is what gives value to the sector: for centuries this territory has always been characterised by a strong rurality, being agricultural activity of the polyculture type (small agricultural areas but great diversity of crops – vineyards, corn and horticulture, among others – for local consumption or sale) and extensive cattle breeding (meat and milk) in winter meadows known as "*lameiros*". Today, the sector employs less than 1,2% of the population, mirroring the usual path of industrialised societies, and less than 0,4% of GVA, but its strong rooting keeps most families dependent on the sector, each having a small garden or leaf of land, where it explores horticultural or creates some heads. The main players in the agricultural sector are, therefore, the families themselves, although some products are emerging, namely wines – even as an export product. The digital here is of extreme importance because it will promote the territory through its strong characteristics of

rurality, creating a bond of linkage and promotional marketing among all the economic sectors mentioned above.

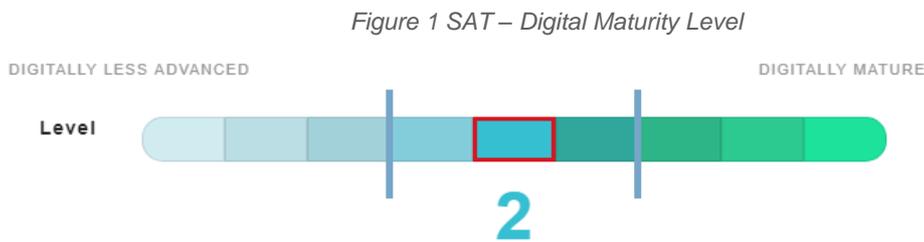
3. Digital maturity level of the city: outcomes of the Self-Assessment Tool and Key Performance Indicators

3.1. Outcomes of the Self Assessment Tool

The results of the Self-Assessment Tool at the city level which took place between November and January. A total of 22 valid replies were collected through the SAT.

Digital Maturity Level

The overall results show that Guimarães stands at the level indicated below on the path of becoming Digitally Mature.



As the results show, Guimarães is well on the way to becoming digitally mature. Continuing on this trajectory will create innovation ecosystems that will drive job creation and economic growth. This level of maturity is even better shown in the next figure, where the eight dimensions of assessment were subjected to the city stakeholders evaluation.

The overall assessment shows that Guimarães stands at a mid to low-level of digital maturity, especially in three of the eight dimensions, namely Open Data, Finance and Community. In the other five dimensions, related to Governance, Digital Skills, Support Services, Infrastructure and Digital Competencies of Companies, Guimarães is placed at mid-level of digital maturity. Notwithstanding the foregoing, this overall assessment indicates an important margin for digital improvement to all dimensions in the city of Guimarães.

Digital Maturity per Subdimension

Assessment per sub-dimension of the SAT shows a good performance, reaching a level of digital maturity, in the domains of Innovation Labs and Acceleration, Coordination, Implementation and Monitoring. In the domains of Other Support Services, Shared Vision and Digital Infrastructure, the results shows an entry level of digital maturity. By the other hand, digitally less advanced are the Usage of Open Data and Training for Employees.

Figure 2 SAT – Results per Dimension

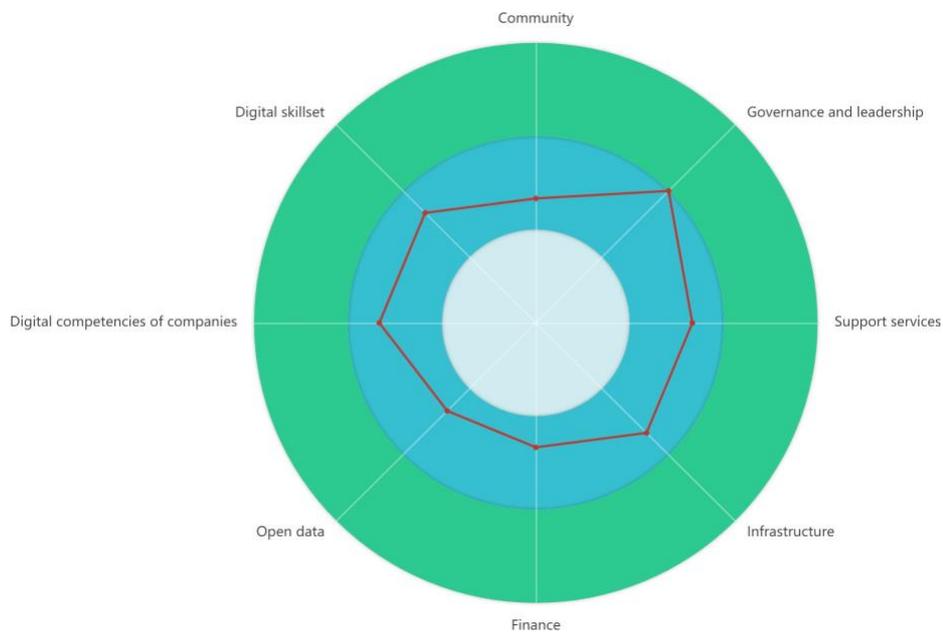
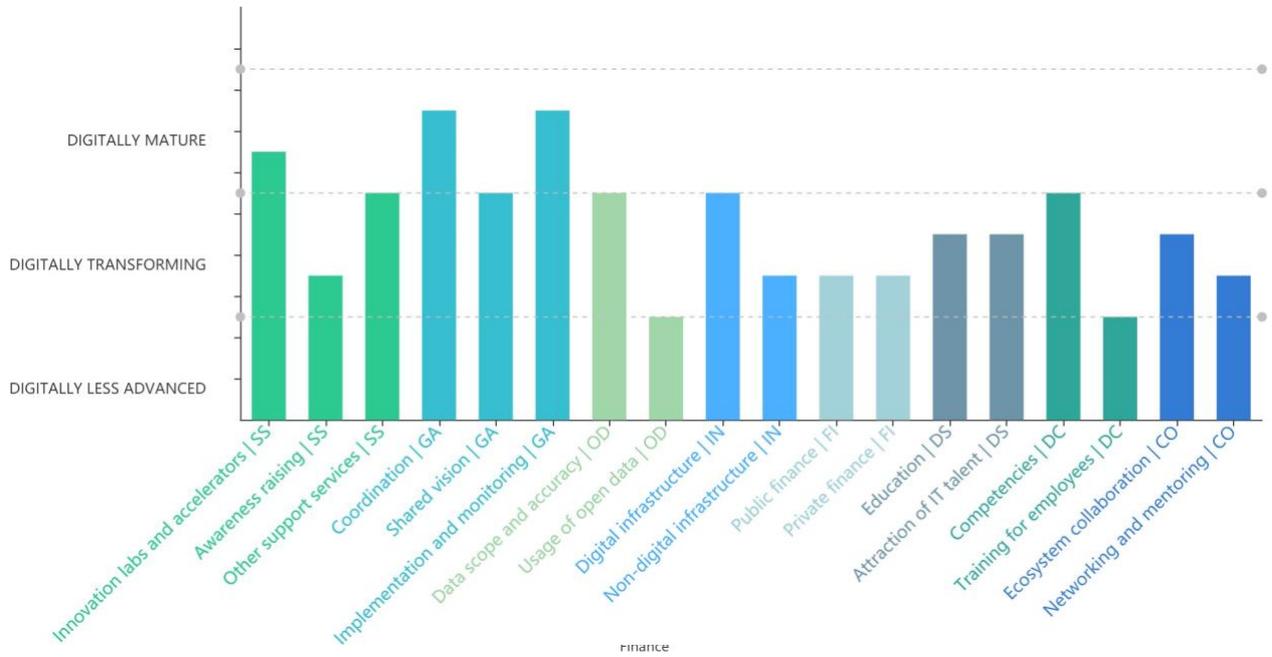


Figure 3 SAT – Results per Subdimension



Legend

- IN = Infrastructure (2)
- OD = Open data (2)
- DS = Digital skillset (2)
- DC = Digital competencies of companies (2)
- SS = Support services (3)
- GA = Governance and leadership (3)
- FI = Finance (2)
- CO = Community (2)

Maturity Assessment by Type of Stakeholders

SELECTION: All dimensions



Figure 4 SAT – Results by Type of Stakeholders – All Dimensions

The large majority of the stakeholders that used the SAT, place Guimarães at mid-level of digital maturity. In fact, among the 22 individual assessments, only 23% consider that the overall digital maturity of the city is low, while 68% place it at a mid-level of maturity and 9% at the level of digital mature. Stakeholders from industry (14%) and from City (14%) assess digital maturity at higher level. This assessment reveals the divided character of the city between an advanced ICT industry and digitally non-mature other sectors of the local economy, especially those that were classified in the Utilities type.

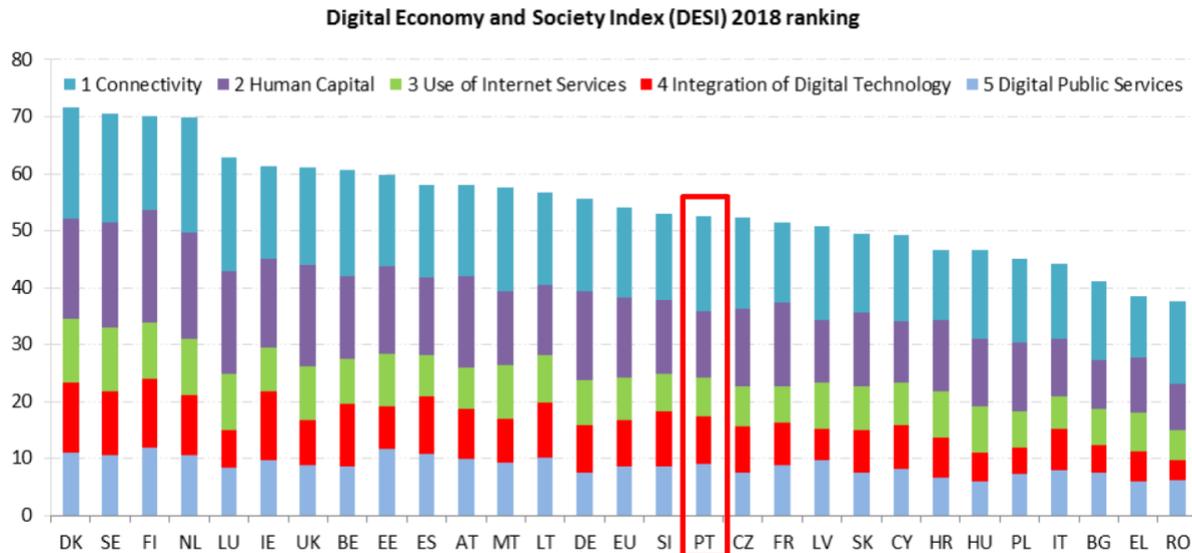
Combining these results from SAT with those from the interviews made in the visits, it is possible to resume the following topics:

- Guimarães technological framework objective is to develop innovative technological solutions, both digital and social innovations, which tackle challenges faced by the daily needs and difficulties of the citizens;
- Guimarães has an interesting digital infrastructure as a baseline for the digital transformation of the city;
- There is a reasonable level of digital education in the available workforce thanks to the excellent role played by the University of Minho, the Polytechnic Institute of Cávado and Ave and supported by other scientific, technological and educational stakeholders;
- There is an insufficient number of open data set in the city;
- Insufficient inter-business and business-academia collaboration. While it is absolutely necessary for the digital transformation of the city, the collaboration culture is rather limited;
- Enterprises require, normally, two types of talent: 1) general digital knowledge (available in the city) and 2) specialised skills focused on edge technologies (due to the difficulty in retaining and attract talent in the city).

3.2. Key Performance Indicators

The DESI report from 2018, shows that Portugal ranks 16th out of the 28 EU Member States.

Figure 5 DESI 2018 Ranking



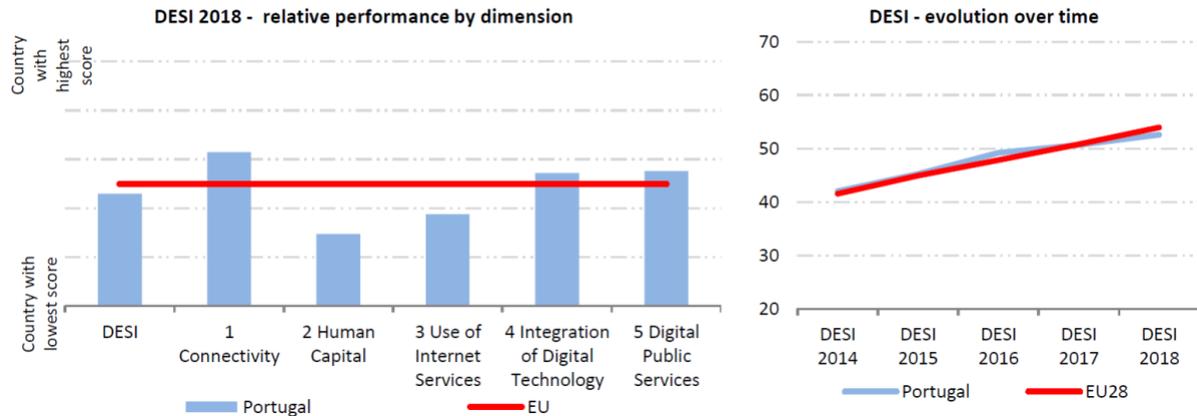
The country's overall score increased slightly, although in a smaller proportion than the EU average. Portugal's scores have gone up in all DESI dimensions except for integration of Digital Technologies. [9]

	Portugal		Cluster	EU
	rank	score	score	score
DESI 2018	16	52.6	54.7	54.0
DESI 2017	15	50.7	51.5	50.8

Portugal belongs to the medium-performing cluster of countries, composed by Spain, Austria, Malta, Lithuania, Germany, Slovenia, Portugal, Czech Republic, France and Latvia.

Noteworthy improvements relate to take-up of fixed and mobile broadband services as well as internet usage by citizens, although there is still room for further improvement in all of these areas. Although Portugal progressed faster than the EU average in all components of the Human Capital dimension, low digital skills levels, particularly among the elderly and those with low levels of education or on low incomes, continue to entail risks of digital exclusion and hinder progress in most of the other dimensions of DESI. These figures are in line with the assessment of the digital Guimarães reality, based on the SAT and interviews performed.

Figure 6 DESI – Performance by Dimension and Evolution Over Time



Over the course of 2017, Portugal launched and started to implement two comprehensive policy initiatives on digital competences and digitisation of the economy: *INCoDe.2030* and *Indústria 4.0*. These relevant initiatives needs to be more effectively deployed at a regional level in order to impact the policies of the local authorities and companies.

Table 1 presents the Key Performance Indicators (KPIs) that were selected by the team as the most suitable that demonstrates how effectively achieving the key objectives of this project is based on the specificities of the city of Guimarães.

Table 1 Key Performance Indicators (KPIs) for Guimarães

ID	KPIs	Baseline	Target	Source/definition	Explanation
DIGITAL INFRASTRUCTURE					
10	Number of unique devices connected to wireless internet freely available at public spaces in last 12 months	15.000	TBD	Public Administration	The public administration to inquire the data on unique devices connected during the last 12 months to the company(-ies) in charge.
NON-DIGITAL INFRASTRUCTURE					
15	Availability of coax or fibre network at main business parks [Y/N]	TBD	Full coverage	Public Administration	This is a yes or no indicator to be inquired by the relevant public administration representatives. The information should be provided by main business parks.
17	% of Individuals who used the internet for interaction with public authorities (average for the last three years)	9.150	TBD	Eurostat Individuals who used the internet for interaction with public authorities (isoc_r_gov_i) NUTS 2 level	This indicator is available in Eurostat: Individuals who used the internet for interaction with public authorities (isoc_r_gov_i) NUTS 2 level (unit of measure=% of individuals;

ID	KPIs	Baseline	Target	Source/definition	Explanation
					time=last three years; calculation=average). Note: If the city is not included in the Eurostat database it would need to be explored if such data can be collected by the public administrator. If possible, a distinction between households and enterprises need to be made.
G1	N° of e-services offered by the city	5	TBD	City	Number of public local e-services, offered by de municipality or NGOs.
DATA SCOPE & ACCURACY					
18	Availability of open datasets [Y/N]	33 (2,84%)	TBD	Public Administration	This is a yes or no indicator to be acquired from public administration representatives. This includes an assessment of the relevance of national level open data for the city in focus.
DIGITAL EDUCATION					
24	% of students in digital subjects over the last 5 years [%]	TBD	TBD	Educational establishment/ SAT	Numerator: # of students in tertiary education (i.e. post secondary education) on a digital subject related diploma (e.g. computer engineering, big data, cybersecurity, web design, artificial intelligence etc.). Data to be inquired to all educational establishments in the city.
25	% of ICT graduates employed in the city over the last 5 years	TBD	TBD	Educational establishment (alumni database)	Numerator: # ICT graduates employed in the city. Denominator: # ICT graduates. Data to be inquired at alumni databases of higher education institutes
ATTRACTION OF IT TALENT					
27	Number of employees in digital companies [#]	TBD	TBD	National register (INE)	N° of employees in ICT companies. The definition of ICT companies is based on the NACE rev.2 classification as defined by the OECD and the EU project PREDICT
COMPETENCIES					
31	Number of companies with internet website [%]	TBD	TBD	National register (INE)	Numerator: # of companies with internet website; Denominator: # of companies Database to be inquired by the national register of companies. This assumes

ID	KPIs	Baseline	Target	Source/definition	Explanation
					that the presence of a website is a compulsory input.
TRAINING FOR EMPLOYEES					
36	Share of companies offering training to their employees that are aimed at enhancing their digital skills [%]	TBD	TBD	Industry Associations	Numerator: # of companies offering training; denominator: # of companies By main sector
PUBLIC FUNDING					
42	Grants / tax incentives provided at city level to support non-digital companies for digital projects in last 12 months [EUR]	TBD	TBD	Public Administration	Support to non-digital companies for digital projects in the form of grants in EUR granted in the last 12 months and tax incentives measured according to the initial revenue loss method of the Frascati manual (2015): the amount by which tax revenue is reduced as a consequence of the introduction of tax expenditure, based upon the assumption of unchanged behaviour and unchanged revenues from other taxes.
INNOVATION LAB & ACCELERATORS					
47	Number of innovations labs / accelerators [#]	TBD	TBD	Public Administration	This indicator captures the local presence of innovation
48	Number of start-ups / companies attached to innovation labs / accelerators [#]	TBD	TBD	Public Administration	# of start-ups/companies that have taken their ideas to innovation labs/ accelerators/ incubators.
SHARED VISION					
51	Availability of digital strategy [Y/N]	NO	YES	Public Administration	This is a yes or no indicator to be inquired by the relevant public administration
GOVERNANCE AND LEADERSHIP					
G2	Nº of neighbouring cities collaborating with Guimarães	TBD	TBD	Public Administration	Indicator to be inquired to the relevant public administration representatives.
G3	Nº of organisations involved in the delivery of new online services in the fields of education, culture, sport,	TBD	TBD	Public Administration	Indicator to be inquired to the relevant public administration representatives.

ID	KPIs	Baseline	Target	Source/definition	Explanation
	tourism and environment				
G4	Nº of events in digital art	TBD	TBD	Public Administration	Indicator to be inquired to the relevant public administration representatives.

4. The local digital ecosystem: leadership and governance

Guimarães has now a strong momentum for innovation and a digital & smart strategy. Guimarães innovation strategy aims to plan, organise and implement municipal policies in urban and public space, social and community intervention, education, environment, culture and sport, providing services to citizens.

In order to bring citizens closer, Guimarães created a set of digital initiatives, pointed towards transparency, simplicity and speed of access to the services provided by the municipality.

Making use of new functionalities and betting on pioneering services, this ecosystem values the proximity relationship with citizens, in this way, it has reinforced the added value brought by computer networks, which privilege the interactivity with people, granting them tools, which allow them to have access to the municipal services without having to go to the City Hall building.

Promoting channels of dialogue and communication between Guimarães inhabitants and the Municipal structure is thus a permanent goal in a society increasingly linked to information technologies.

Guimarães innovation ecosystem key vectors relies on knowledge as the driver for development. Therefore, it is the municipality goal to improve the quality of life and urban environment, attractiveness (talent, resources, ideas, innovation, jobs and entrepreneurship), openness to innovation, fostering creativeness, quality of public services, security and safety of public realm, intra-community dialog as keystones of success for the city. This can only be possible with an integrated approach supported by a solid strategy namely at the digital level.

5. The use of digital solutions by local companies

The main economic sectors of Guimarães were characterised in Chapter 4. They are basically manufacturing, services, tourism and agriculture. Although there are some medium and large companies, the vast majority are SME's with a huge diversity of activities and capacities.

This framework of local companies has a very diverse use of the digital solutions and technologies. We can find a very sophisticated use of ICT in some medium and large industrial companies, with intensive digitalised models and business processes, aligned with the principles of Industry 4.0 paradigm. Some SME's have the same level of digital maturity, both in Industry and Services sectors, especially if they are Start-up's or belong to the supply chain of larger and digitalised industries.

The most significant part of local companies, from all types of dimensions or sectors, still reveal a relevant lack in the use of digital solutions and technologies in order to support growth, innovation and competitiveness. Even though almost all companies use the excellent connectivity coverage of the broadband, fixed or mobile, and a wide range of business software applications (e.g. ERP, CRM, etc), there is still a residual use of e-commerce and integrated digital solutions to foster business in the local companies.

This gap of digital maturity for most of the companies relies on several barriers that are preventing a part of the private sector from making a more intensive use of digital solutions. The most relevant barriers are: lack of digital awareness, cultural habits, lack of funding, lack of digital skills in common workforce.

Industry, Services and Tourism sectors have a high potential of adopting digital solutions and, simultaneously, transform their business model and gain global competitiveness. The use of more advanced technologies related to Cloud Computing, Data Analytics, AI, Machine and Deep Learning could make real difference on the business of this sectors companies.

However, both financial and human resources are crucial. That's where the local companies, especially SME's have more difficulties to compete with the larger ones and with those that have a strong technological base. The access to funding for digital projects is still very difficult

to local companies which do not have a global market orientation. Additionally, IT professionals are rare and much more attracted to large well-paid projects.

The city of Guimarães, in its digital transformation strategy, aim to foster the process of digitalisation of the local economy and firms, targeting primarily the most important economic sectors. The hope is such a process shall generate opportunities for the development of local companies and the creation of new jobs. The increased use of digital technologies by companies and other organisations will also lead to the creation of new start-up companies that will explore new business opportunities. For achieving this purpose, high-quality incubation support services are foreseen to be provided by the city.

In order to address these common challenges in the private sector, the city of Guimarães has already identified the roadmap of actions to the following topics:

I. Digitalisation of Local Businesses

- Availability of public and private funding.
- Businesses' awareness of the need to invest in digital technologies and in new business models, generating a sense of urgency for this purpose.
- Businesses' capacity building in digital technologies (e.g. e-commerce, social networking, big data, robotics, artificial intelligence etc).
- Businesses' capacity to retain digital competence.
- Businesses' capacity to support investments in digital technologies.
- Support to companies for digital transformation, including programmes for awareness raising, advice and training.
- Engagement of the relevant business associations.

II. Creation of New Job Opportunities

- Answer to fast job market dynamics that ask for specific skills.
- Identify and narrow the gap between the skills of workers (particularly young people) and the demand for qualified personnel by companies.
- Businesses' and organisations' capacity to adapt traditional jobs to the new environment.
- Provision of support to companies for digital transformation, including programmes for awareness raising, advice and training.

- Create quadruple helix communication mechanisms between the city, Higher Education Institutions, companies and the community in order to adjust human resources skills to the needs of the labour market.
- Collaboration with local Higher Education Institutions in order to ensure the availability of qualified talent in the digital field for companies and other organisations.
- Partnerships with training organisations and other entities for the provision of training actions.
- Capacity of local companies and organisations to attract and retain talent.
- Engagement of the relevant business associations.

6. Community engaged in digital transformation

The Guimarães' tech community is structurally formed around the University of Minho, with its Engineering and Science Schools, its technology transfer centres, several spin-offs from UMinho, the tech based private companies and some public services from the municipality. However, the major component of this community are the Guimarães citizens with its strong sense of belonging to the city challenges and identity.

Most of the cooperation between business-academia is done through the technology transfer centres of the university (e.g., Centre for Computer Graphics (CCG) and TECMINHO), These units act as an Interface Centre that develops and fosters research and innovation processes, with the objective of accelerating the integration of new processes, services or products based on scientific knowledge and high value-added technology in companies and industry.

Despite the relevant driver of the UMinho, and more recently from the Polytechnic Institute of Cávado and Ave, the private companies, both from the ICT and Industry sectors, plays an important role in the engagement of the community to the digital transformation issue.

The collaboration between digital and non-digital companies from various sectors (e.g., government, financial services, healthcare, energy & environment) is in an early stage of development but is starting to accelerate, busted by some incentives from the public policies, basically supported by European funds and, more recently, by the need for becoming more competitive in the market. Although it is observed a systematic movement towards the digital transition, there is still a long way to go and the community engagement is a crucial goal that's not yet achieved.

From this starting point, the city of Guimarães with its digital strategy aim to involve the whole community to use digital technologies and services in their daily social, cultural and leisure activities. Local organisations working in areas as diverse as education, social assistance, culture, tourism, sport and environment will be encouraged to produce and use digital services and applications within an environment where all will be both creators and users of digital resources. Particular attention will be paid to the creation and dissemination of digital material related to Guimarães' identity and heritage. Digital art activities will be specifically supported.

Last but not least, the digital strategy is to be widely disseminated all over the city so that it can be developed, shared and experienced with the entire community

Several ideas were identified to play an important role to build a Digital Community in Guimarães, as follows:

Promote the city's digital future. Promote the city's digital future through online and other channels to local residents, potential new residents, local businesses, potential new businesses and digital programme partners. Present compelling messages about the future that the city aspires to, and the strategies, programmes and resources that will help achieve that future.

Establish a regional digital art competition. Encourage a competition for the development of engaging digital art works by artists in the city by partnering with relevant organisations (local schools, art galleries etc).

Review and extend current digital promotion activities. Review current use of digital and online services for promoting the city and its events. Extend the use of relevant digital technologies including mobile apps.

Promote the city through digital channels. Develop and implement online promotion strategies for local areas including strategies to target potential visitors, potential residents and potential investors. Rich, compelling digital and social media resources could be created for each target group.

Support the creation of digital resources about local heritage. Support the creation of digital resources by communities that provide engaging content about local heritage, history and environment by working with schools, cultural institutions, indigenous communities and community organisations.

Commission the development of apps that support outdoor recreation activities. Support the development of mobile device apps, which support outdoor recreation activities in local areas. In some areas, apps could be developed about local walking trails.

Promote digital art. Support and promote digital art and digital artists in local areas. The means of support would depend on local factors and may include commissions of works, place-based festivals and shared studio spaces.

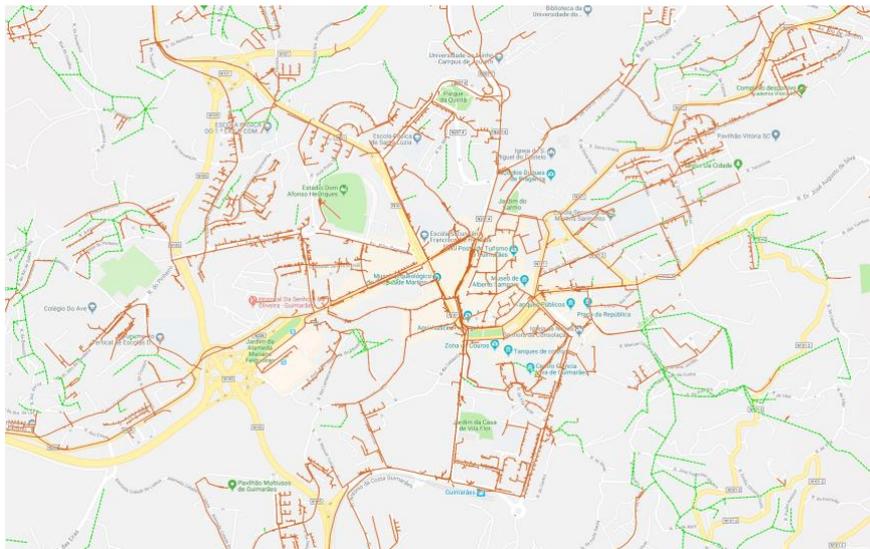
7. The state of local digital and physical infrastructure

Digital infrastructure

GUIMARAES WIFI project intends to respond to the strategy of Smart City defined by the Municipality of Guimarães for 2014-2020. This project emerges as a major ambition aiming at innovation for the future, for its citizens, towards urban innovation and global change oriented to the "European dream". With a special focus on information and communication technology adoption in cities. This project goals are to implement a set of state-of-the-art technological solutions related to the better digital infrastructures, such as optical fibre coverage, WiFi network technologies in an urban context, making them accessible to citizens and tourists, so that they can effectively respond to current societal challenges, and futures.

As part of this strategy Guimarães has been promoting the expansion of fixed and wireless network infrastructure, with public and private investment, which already reaches more than 80% of the city.

Figure 7 City fixed network infrastructure (extracted from ANACOM – Autoridade Nacional de Comunicações)

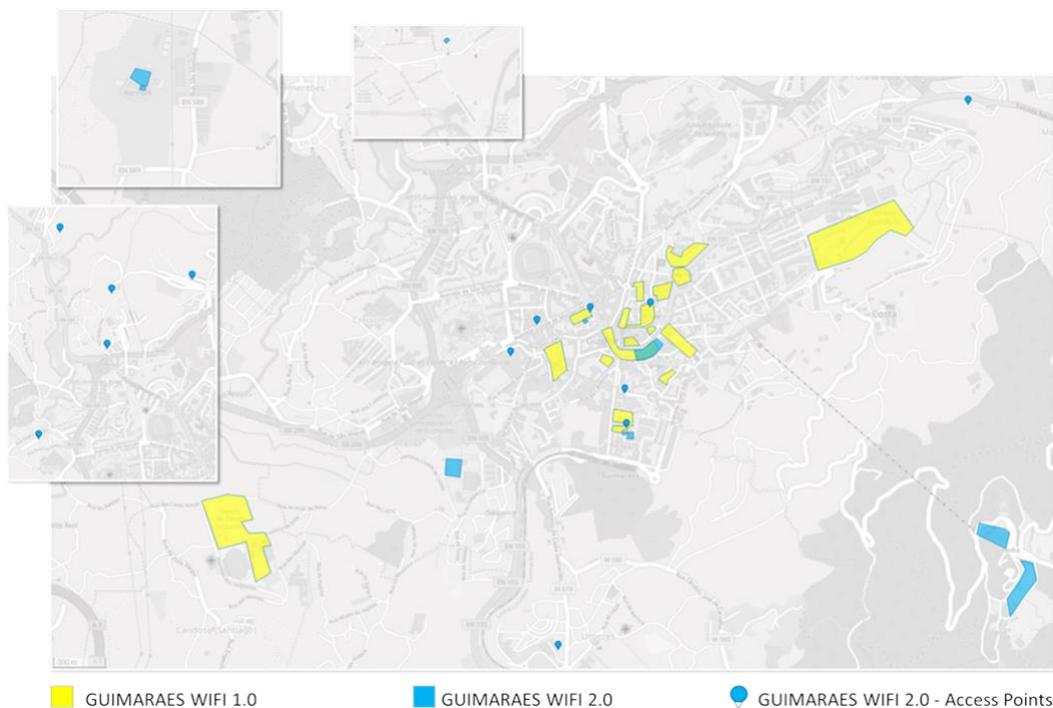


According to information available on official statistical websites, the internet reaches almost all households by broadband, about 77% increasing this year by two percentage points compared to 2016.

In 2017, 80% of connected people accessed the Internet on a mobile device and the percentage of people that contacted public administration services over the internet was 55%. Related to electronic commerce, 37% of the population uses internet to make online purchases. INE, National Institute of Statistics, says that by 2018 in Guimarães region, 98% of companies with 10 or more employees have access to the Internet and 67% access the Internet through mobile broadband. According to the same info all companies with Internet access do it through broadband, with an increase of around 13 percentage points in the penetration rate of this type of connection.

As part of this strategy, the Municipality of Guimarães updated its WI-FI phase one network offering now a wireless network access, within a mesh of 43 hotspots and more than 68.000 registrations since 2012.¹

Figure 8 City fixed Wi-Fi infrastructure – Guimarães Internal information



Within EU WIFI4EU framework project, it is already planned to extend the scope in more locations such as: Stadium D. Afonso Henriques area and surroundings, Civic Centres in the

¹ This second phase counted with more than 20 more hotspots, and covered areas like: Sta Catarina mountain, Penha Camping Park and Sanctuary, Tourism Office at São Tiago Square, Welcome Center, Bus station, House of Memory, Rehearsal Rooms at Jordão Theater, Internet Space of Vila Flor Cultural Center, Platform of Arts and Creativity - Blackbox and foyer, Vila Flor Cultural Center - larger auditoriums, Avepark - Auditorium, foyer and adjacent square, Social Buildings at Azurém, Mataduços, Monte de S. Pedro, Coradeiras, Mesão Frio, Urgezes and Creixomil.

9 Villages of the Municipality, Industrial Parks, Taipas Camping Park and Avepark - Park of Science and Technology.

According to data from the largest telecommunication companies in Portugal, the 4G network coverage in the city is 100% outdoors (Vodafone, Altice Meo, Nos).

Figure 9 City fixed 2G, 3G, 4G and 4G+ wireless infrastructure – (Extracted from nPerf Map)



8. Digital solutions enabling the modernisation of business environment

Guimarães technological framework objective is to develop innovative technological solutions and digital/social innovations, which tackle challenges faced by the daily difficulties of the citizens.

This framework is based on four important dimensions: social, digital, mobility and environment. These vectors should take benefits from technology, such as efficient and effective public services, innovation, sustainable growth, energy efficiency, environmental strategy, circular economy, optimisation and efficient management process, better mobility solutions and better living environments for everyone, addressing and prioritising it to real community problems and citizen's empowerment.

The digitalisation of the Guimarães city started a several years ago with the several initiatives and projects, as mentioned in the section 3.1.

Guimarães is developing an integrated strategy as a smart sustainable city. The basis for this strategy relies also on the use of information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness.

9. Data-driven innovation

“Techniques and technologies for processing and analysing large volumes of data, which are commonly known as “big data”, are becoming an important resource that can lead to new knowledge, drive value creation, and foster new products, processes, and markets.” [11]

Producing innovative outputs from data is known as “data driven innovation” (DDI). DDI presents huge potential for economic and social advancement, with varying effects on different businesses. According to the OECD [10] data-driven innovation takes place when different technologies and techniques are used to “define and capture” relevant data, process and analyse it in order to produce innovative outputs in several innovation-related areas:

- Enhancing research and development (data-driven R&D);
- Developing new products (goods and services) by using data either as a product (data products) or as a major component of a product (data-intensive products);
- Optimising production or delivery processes (data-driven processes);
- Improving marketing by providing targeted advertisements and personalised recommendations (data-driven marketing);
- Developing new organisational and management approaches or significantly improving existing practices (data-driven organisation). [10]

According to OECD, DDI is a source of economic growth and development through two distinctive “channels”:

- The economic properties of data suggest that data is an infrastructural resource which in theory can be used by an unlimited number of users and for an unlimited number of purposes as an input to produce goods and services.
- The value-creation mechanisms of data analytics, which include using data analytics to Gain insights (knowledge creation) and Automate decision-making (decision automation). [11]

According to the Deloitte study [12] for the Israeli economy, the following diagram illustrates the government’s DDI-implementing roles and the expected benefits of effectively fulfilling these roles.

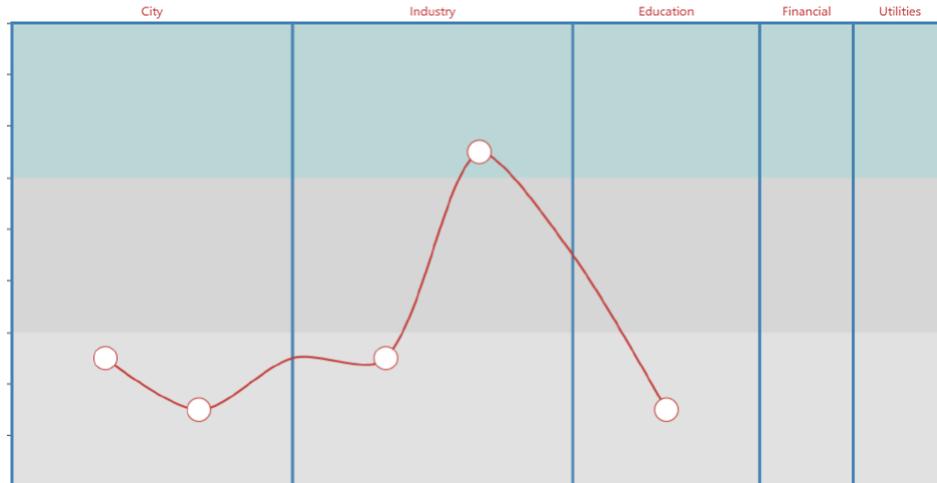
Figure 10 Government's DDI-implementing roles – Israel Use Case [12]



As exposed above, DDI has a huge potential on economic and social development of a city, region or country.

Related to Guimarães, the level of DDI maturity has still a lot to improve and Open Data infrastructures are still in an early stage of deployment. The assessment by the stakeholders of Guimarães shows that reality and pinpoint the huge opportunity for improvement in this field.

Figure 11 Assessment by Guimarães Stakeholders – Usage of Open Data



Currently, Guimarães has several datasets in result of data collection from the city services, namely:

- 4 Weather Stations (Penha, Taipas School, Landscape Laboratory and Historic Centre);
- Udometers installed in the Ribeira de Couros Basin;
- Real-time water quality monitoring sensors and flowmeters (Landscape Laboratory);

- Retention Basin Monitoring;
- Vehicle Count in Historic Centre;
- Quintã Air Quality Station;
- Electric Charge Station Network - CEiiA and Mobi.E – State and location of the Stations;
- Parking Information – Number of vehicles that access and park;
- Event management - MyHomeCity Application (occurrences, state of occurrence).

These assets of data are not still open to the community, are only being used by the municipality services for the daily management.

Local companies are seeking for a wide range of public data to foster their business and to take more accurate decisions in their own strategies. The types of public data more frequently requested contemplates: permits for housing construction and retrofit; typologies of companies sectors based on business parks; mobility information about routes, public transport schedules and mobility services (e.g. car sharing, car pooling, etc); electric power and broadband capacities in business parks; human resources competencies availability; industrial waste mapping; typologies of industrial capacities that could be shared with other companies; availability of incentives and grants.

Guimarães is making a relevant investment effort to turn available different types of data regarding Mobility, in terms of Traffic, Public Transportation and Parking. City councilmen have the expectation that this data could enable the private sector to innovate in urban mobility services. The hope is that more companies could follow the example of **Edge4All** platform (<https://www.digitalsign.pt/smartcities/>). This solution was developed in a partnership between the Municipality, an IoT Lab from University of Minho and a private company (Digital Sign). Basically, it is an open platform that constitutes a truly integrated solution to meet the smart city requirements, designed according to the best cybersecurity standards, and covers the most significant points of control of the city (air quality, traffic, water levels/pollution, temperature, humidity, noise).

10. Skills and entrepreneurial culture

Historically known for its strong industrialisation, namely in the manufacturing industry and in the textile sector, Guimarães is one of the most entrepreneurial and industrial cities in Portugal, having over the past years consistently ranked in the top 10 of the best Portuguese cities for investment, quality of life and tourism (source: *Bloom Consulting Portugal City Brand Ranking*).

This strong entrepreneurial environment has made the companies located here particularly resilient to the latest economic cycles. Even with a high percentage of companies working in the so called “traditional sectors”, the business community has been able to respond to modern challenges. “*Innovation and tradition*” is today a paradigm followed by the most successful companies in the city, with significant investments in product, technological, organisational, and marketing innovations.

New start-up companies have also played a relevant role to boost innovation in the local economy. Highly innovative start-up firms in the areas of ICT, electronics, mechanical engineering, nanotechnology and new materials, many of them university spin-off companies, have contributed to innovate in older sectors such as textiles, clothing, footwear and metallurgy. In some cases, those start-ups have helped to create some critical mass in sectors with previous little expression in the region, as is the case of biotechnology.

This momentum around the launch of new companies has contributed the city's policy of creating suitable conditions for businesses incubation. Following the investment made over the years in several business incubators, it was decided to create in 2018 “Set.UP Guimarães”, a super-incubator that supports innovative businesses through three sub-incubators: PevFactory (industrial businesses), TecPark (technological businesses) and LabPac (creative businesses).

The number of young graduates from local Higher Education Institutions in engineering and ICT fields allow the city to have relative abundance of high qualified skilled labour.

The School of Engineering of University of Minho, the main Higher Education Institution based in the city, has its headquarters in Guimarães and teaches more than 4,000 students just in Guimarães' campus (15% PhD students). The School of Engineering holds a number of renowned research centres that carry out activities of relevance to digital technologies, namely the ALGORITMI centre (information systems and technologies, computer science and

technology, computer communications and pervasive media, industrial electronics, systems engineering and operational research etc), HASLab centre (software engineering, distributed systems, and cryptography and information security), and CMEMS (modelling computation, and development and micro/nano fabrication of devices and components).

There are also four University of Minho's Technological Interfaces Centres with the industry that are based in Guimarães: **CCG** - Centre for Computer Graphics, which works in the fields of computer vision interaction and graphics, software engineering process and maturity models, perception interaction and usability, urban and mobile computing; **PIEP** - Innovation in Polymer Engineering, whose main expertise lies in processing technologies, product engineering, and new materials; **CVR** - Centre for Waste Valorisation, supporting industry in the management of a wide variety of industrial waste streams; and **TecMinho** that acts as the overall technology transfer organisation of the University. All these research and technological centres create an important potential of knowledge that is being progressively exploited by companies.

The quality of teaching provided by the local Higher Education Institutions is recognised by the business community, although the high competition for these professional profiles leads many of the young people to be recruited by employers from other cities and even from other countries.

Avoiding brain drain in the area of digital technologies is therefore a priority for the times ahead, which can only be achieved by increasing the presence of companies and other entities that employ staff in this area.

Although it was not possible to obtain official figures that can demonstrate what is the situation baseline, the information collected from important stakeholders reveal that digital employment has significantly increased in the city over the years. However, the nature of most of the local business fabric, which is made up of SMEs operating in relatively low value-added sectors, has somewhat prevented greater use of the digital talent (especially young) that is available.

While finding highly qualified staff has not been in general a major problem for the local industry, more integrated profiles in the engineering field would be appreciated by local firms, combining for instance mechanical, electronics and ICT backgrounds. In the future, as industry 4.0 expands, demand for such more hybrid profiles will most likely increase.

As regards intermediate qualifications, it will be necessary to intensify the preparation of young technical specialists to work on the practical use of digital or computerised devices, methods and systems. As the proliferation of digital technologies will require new skills and reorientation

of existing ones, more vocational training actions for companies' personnel will be needed, as well as vocational retraining schemes for both employed and unemployed workers.

In order to ensure that required profiles will not be missing in the future, it will also be necessary to undertake awareness actions to motivate young people to work with digital technologies, particularly in industrial environments.

11. Digital transformation SWOT analysis

	Strengths	Weaknesses
 Infrastructure	<ul style="list-style-type: none"> > Full broadband coverage (100Mbps) > Fiber between public building & tech parks & universities > Open and free WiFi in the main areas of public interest > Many e-Gov services supported by UNU e-Gov University 	<ul style="list-style-type: none"> > Reduced adoption of (intelligent) sensing systems > Real-time transport / traffic monitoring system not available
 Access to data	<ul style="list-style-type: none"> > Policy support via mission of Intelligent Systems division > Interoperability platform for on-request data provision 	<ul style="list-style-type: none"> > Early-stage Open Data Platform and Open Data APIs > Lack of open and real-time datasets > On-request only use of data by companies/citizens
 Digital skillset	<ul style="list-style-type: none"> > University focused on Engineering, ICT and IoT > Polytechnic institute and tech centers focused in Industry > United Nations University focused in e-Government 	<ul style="list-style-type: none"> > Inexistence of a plan for the retention of IT talents in the city > Difficult dialogue business <-> academia > Difficulty to respond to fast job market dynamics that for specific skills
 Companies' digital competencies	<ul style="list-style-type: none"> > Majority of companies have a digital presence > Several Mobile Apps for many application domains that are frequently used by citizens > Territorial marketing strategy for digital promotion (Guimarães Marca/Branding) 	<ul style="list-style-type: none"> > Weak digital marketing approach in SMEs/micro-enterprises > Fragmentation of Mobile Apps leading to difficulties of use > Lack of e-commerce platforms in local enterprises
 Community	<ul style="list-style-type: none"> > Availability collaborative/participative portals (e.g. Participatory Budget, Associativism Portal) > DTx (Digital transformation Collaborative Laboratory) > UNU eGov (UN University on Digital Transf. & eGov) 	<ul style="list-style-type: none"> > Weak relations between academia and industry > Lack of openness of 1st generation entrepreneurs to perform in a collaboration/cooperation environment > Different timing of academia/industry & non-mature solutions
 Finance	<ul style="list-style-type: none"> > Social Angels to promote creation of micro businesses > Micro-credit for SMEs (FINICIA programme) > Municipal tax reduction for strategic interest projects (PEIM) 	<ul style="list-style-type: none"> > High interest rates for credit on investment > Lack of investment programmes capitalization > Bureaucratic complexity on processes
 Support services	<ul style="list-style-type: none"> > Set.Up Guimarães super incubator (joining TecPark, LabPac, Pev.Factory incubators) > Virtual incubation facilities > Rich plan of events around digital transformation / innovation 	<ul style="list-style-type: none"> > Establish existing incubators as Digital Innovation Hubs > Need of Integration with other incubators at National/EU level > Target events in the area of digital transformation /I4.0 / etc.
 Governance & leadership	<ul style="list-style-type: none"> > Strong digital vision and strategy in-place > Monitoring framework for digital implementation > Dedicated/transversal team on digital themes (~20 people) 	<ul style="list-style-type: none"> > Bureaucratic complexity on processes > Improved monitoring instruments for digital evolution

	Opportunities	Threats
 Infrastructure	<ul style="list-style-type: none"> > Emergence of 5G networks > Partnerships with academia to deploy sensing solutions > Establishment of an IoT Security Lab (LabSecIoT) 	<ul style="list-style-type: none"> > Network saturation due to use of IoT devices > Security of the ICT and IoT deployed infrastructure > Support/ continuity for solutions developed by academia
 Access to data	<ul style="list-style-type: none"> > Availability of Urban transport mobility data > Availability of open datasets for new solutions > Real-time information dashboards for all > Data-Informed decisions by city authorities 	<ul style="list-style-type: none"> > GDPR regulation and bureaucracy, Data security > Handling / Storing Big Data > Overwhelming citizens due to data flows
 Digital skillset	<ul style="list-style-type: none"> > Creation of industry incubator for training and job conversion > Creation of City-Business-Academia communication vehicle > Definition of mechanisms for attraction & retention of talent 	<ul style="list-style-type: none"> > Neighbour cities that compete to attract skilled individuals > High payroll in metropolitan neighbour cities > Knowledge retention of highly-skilled employment (ICT)
 Companies' digital competencies	<ul style="list-style-type: none"> > Manufacturing processes improvement / cost reduction > Access to new markets / new market opportunities > Better awareness, empowerments of citizens > Improved tools for territory management by municipality 	<ul style="list-style-type: none"> > High implementation costs on digital technologies > Individuals' Digital Competences impacting businesses > Failure to retain digital competence inside companies
 Community	<ul style="list-style-type: none"> > Strengthen academia-industry-administration cooperation > Further develop cooperation and networking by linking and collaborating with relevant National and European initiatives > Set-up of instruments to assure support and survivability of the solutions developed in cooperation with academia 	<ul style="list-style-type: none"> > Negative effect of old-school entrepreneurs that could hinder the development of a strong cooperation environment > Conflicting interests of clusters, associations and industries > Difficulties in being able to decide the most effective initiatives to team-up and thus spending many resources
 Finance	<ul style="list-style-type: none"> > Improve the instruments/bureaucracy of the submission and execution of research, development & innovation projects > Explore liaisons with funding entities (banks, venture capital) > Establish services for helping companies accessing grants 	<ul style="list-style-type: none"> > Weak economic cycles impacting business development and availability of funds for public / private investment > Difficulties for companies to be competitive on securing and executing research & innovation grants
 Support services	<ul style="list-style-type: none"> > Innovation academy for industry > Centre of Excellence for Smart Cities > City Living Lab for smart systems 	<ul style="list-style-type: none"> > Keeping up-to-date with many initiatives (LivingLab, DIH, etc.) > Increasing need of resources / funds for keeping support services active and effectively providing its services
 Governance & leadership	<ul style="list-style-type: none"> > Agreed triple-helix Digital Strategy (Administration-Industry-Academia) > Development of Intelligent Systems division at city hall > Enrichment of the DT plan more towards the outside 	<ul style="list-style-type: none"> > Difficulties on communication between public administration, Industry and academia > Complexity and costs related to the Digital Transformation plan development, implementation and monitoring

Appendix I: Table of abbreviations and definitions

Digital Cities Challenge (DCC)

The Digital Cities Challenge initiative, was launched by the European Commission in November 2017 and scheduled to run until August 2018. It helps cities (The Digital Cities, referred as DC) develop and implement digital policies that can transform day to day life for residents, businesses, workers, and entrepreneurs.

Digital City Teams (DCT)

Each participating Digital City has a Digital City Team which will be in charge of managing and coordinating the involvement of the city in the Challenge. Digital City teams will include a) the core team which consists of one Lead Expert, one Local Expert, one Support Consultant as well as Thematic Experts; and the b) the Digital City leadership team which is made up of representatives of the city (i.e. local elected officials, local public servants, and the designated project management team).

Digital Transformation Trajectory (DTT)

The Digital Transformation Trajectory refers to the evolutionary path a city follows while taking part in the initiative, from the preliminary assessment of the digital potential of the City, to the definition of the City's digital transformation strategy and roadmap.

Field Advisory Services (FAS)

Field Advisory Services are services provided by the Digital Cities Challenge to Cities throughout the duration of the initiative. The Field Advisory Services include the organisation of one assessment visit and a number of local workshops, which will gather local stakeholders involved in defining the digital transformation strategy of the City.

Key Performance Indicators (KPIs)

The objective of the KPIs is to collect data that can diagnose the current status in terms of digital maturity and measure the progress made by cities during and at the end of the Digital Cities Challenge initiative. The KPIs will facilitate the activities of the policy makers and stakeholders of cities when identifying and addressing the bottlenecks and obstacles of the

processes of digital transformation and industrial modernisation. They will also enable the right identification of the key success factors of the different initiatives and actions undertaken.

Self-Assessment Tool (SAT)

The objective of the SAT is to identify the starting points for discussion on how to (further) develop, reshape and improve the digital transformation strategies of European cities. It is an online-tool developed by the project with a set of questions and corresponding response options to be filled in collectively by a set of stakeholders such as industry representation, utility companies, education and research and financial institutions. The SAT covers eight key dimensions: Infrastructure, Open data, Digital skillset, Digital competencies of companies, Community, Finance, Support services, Governance and leadership.

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