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AN AFFILIATE NETWORK OF HARVARD BUSINESS SCHOOL

Competitiveness of Cities: Making Madrid Smart

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1. Smart Madrid

Madrid is the capital of Spain and the largest metropolitan area in the country with more than 6,6 million inhabitants. The city experiences each year an important population growth. Indeed, according to the world population review (2020), the population grew by 1.24% each year since 2015 bringing new challenges and opportunities for the development of Madrid into a smart city. Furthermore, Madrid represents one of the top destinations for tourists in Europe. The city offers unique activities in different fields such as sport, art, and food (Jones, 2018). The influx of tourists pushes the public services and infrastructures to the edge and emphasizes the need for smarter solutions within the city. As a big urban area, Madrid is divided into 21 districts.

The city council, as a main incubator of smart city projects, seems to understand the challenges that Madrid is facing and have already set up several interesting projects to optimize the city's management and configuration. A priority that Madrid's city council has is to emphasize the role of citizens in the elaboration of the smart city. In fact, Madrid sets up numerous platforms and software that facilitates residents' participations and gives access to fundamental city data. A second objective observable of the city council that could be observed are the environmental issues and the air quality within the city. Madrid implemented a plan for air quality and climate change that follows 30 different steps or measures that would considerably improve the quality of the air inside the city center (Las 30 medidas – Plan de Calidad del Aire y Cambio Climático, n.d.). A third goal smart Madrid attempts to optimize is the mobility. The EMT, a municipal company in charge of public transportation puts in lots of effort in order to facilitate and promote the use of public environmentally friendly vehicles.

The city presents many strategies and programs towards smarter urban development. Following the approved six dimensions model, the next section presents and evaluates in detail the different projects and activities that Madrid set up in order to become a smart city.

¹ This case study is mainly based on a study of Basile de Raemy, Center for Competitiveness of the University of Fribourg (de Raemy, 2020)

2. Key Dimensions of Madrid Smart City

2.1 Smart Economy

The evolution of Madrid's economy to its current status was far from being obvious at the beginning. The city did not benefit from inherent natural resources or wealth for its economic development (Connell, 2020). However, despite this disadvantage, Madrid became a preeminent center for economic activities in Spain. The city hosts the Spanish Stock Market, one of the busiest in Europe and his home of several clusters such as automotive, metalworking technology, electric power generation and transmission, environmental services, aerospace and biopharmaceutical (European Cluster Collaboration, 2020). Furthermore, thanks to its strategic location, Madrid grew into a solid logistic and transportation center in the Iberian Peninsula.

As a smart city, Madrid wishes to offer the best atmosphere for workers, local startups and multinationals. Even though Madrid often lacked entrepreneurial and innovative vision compared to other European metropolis, the government seems today, with the incentive of Mayor Manuela Carmena, aware of the crucial benefit of innovation and startups. According to Martin (2019a) the Spanish capital can today be considered as one of Europe's biggest startup hubs. This recent evolution derives from the development of several initiatives from the government to foster entrepreneurial talent and innovation.

One prominent initiative was the promotion of La Nave, a multifunctional space where principal actors in knowledge creation can join their effort in the development of innovative projects (Martin, 2019a). The public facility is a 13'000 square meter former factory converted into a meeting point for university, companies, investors and citizens and hosting the Madrid's Innovation Campus. La Nave seeks to create a dynamic professional and innovative network which aims at accelerating ideas and projects to transform the city of Madrid (La Nave Madrid, 2018). Furthermore, the public agency promotes training and favors employability of citizens. Therefore, La Nave is not only a startup hub that fosters entrepreneurship and innovation spirit but also a space where citizens can connect, learn and boost their ideas.

Another similar project that aims to boost local economy appears in the plan, introduced by deputy mayor Begoña Villacis, to turn Madrid into a startup innovation hub. The city is currently working on the creation of "Mercado de Toledo", a future technology and innovation center in a currently unused 20'000 square meter building owned by the government (Martin, 2019a). The innovation super-hub will host networking and coworking spaces as well as a new city innovation agency with the main mandate: to ease all administrative tasks that entrepreneurs and small companies face. The main goals of the innovation center are to act as connector of the city's entrepreneurial ecosystem and to promote sustainability, environment, safety and general wellbeing of citizens initiatives (Martin, 2019b). Furthermore, Mercado de Toledo will support new training programs for young unemployed citizens that aspire to become entrepreneurs or participate in the development of small and medium businesses. A promising project that will considerably improve the smart economy status of Madrid.

Comparable institutes encouraging knowledge creation and dissemination already exist in Madrid. An example is the google campus which represents, since 2015, an essential meeting-point for businesspeople and entrepreneurs. A second institution, the Matadero Madrid was built from an ancient slaughterhouse in 2006 and quickly became an important complex focusing on culture and the creative industries (Matadero Madrid. Centro de creación contemporánea, 2020 & Martin, 2019a). Impact Hub Madrid is another important institution devoted to innovation developed in 2010 (Martin, 2019a). The institution has 6 different locations in Madrid designed for networking, working, and training sessions. The organization helps and inspires citizens who want to impact Madrid's society. Finally, one last important meeting point for entrepreneurs is The Cube Madrid. The organization is considered as one of the biggest innovations and entrepreneurial hubs in Madrid with 9'000 square meters, hosting 10 promising startups and accounting for 20'000 visitors each year (TheCUBE | Hub de inspiración y tecnología en Madrid, 2020). Furthermore, The Cube is home of the MIDE (Madrid Innovation Driven Ecosystem), the first collaborative platform to encourage innovation and entrepreneurship in Madrid. Additionally, the Madrid city council brings considerable support to the Avalmadrid organization. An entity created by SMEs and for SMEs and entrepreneurs with the main objective to facilitate and favor access to financial resources with preferential terms, fees and conditions than the one offered by traditional banks (AVALMADRID - Financiación para PYMES y Autónomos, 2017).

It is worth noting that the city offers a comfortable environment for small business and startups. All these organizations and spaces stimulate the innovation within the city. Moreover, training programs available for citizens improve their employability and can have a significant impact on the unemployment rate. Consequently, Madrid has seen multiple local startups growing up during the last decade, developing smarter urban environment for citizens and tourists traveling to Madrid. Bipi, Wetaca, Woom, and Spotahome are startups born in the city and appear as the best example of the attractive environment offered by the metropolitan area (Martin, 2019a).

However, startups and small businesses are not the only area that Madrid focuses on. The city also provides important support for foreign investments and aims to attract some of the biggest multinationals in the world. Spain appears already as a rising competitive region in Europe. At its own level, Madrid sets up a regional office for assisting foreign investors called "Invest in Madrid".

Madrid, in terms of smart economy, currently seems to have a strong focus on the innovation and entrepreneurship.

2.2 Smart Governance

Smart governance became an important aspect of Madrid's smart city concept. Madrid promotes a smart city for its citizens and that is made by its citizens. Additionally, the city council attempts to be as transparent as possible with the different projects for the city in order to always attract new ideas and propositions from the resident and from private companies.

The action plan for transparency 2017-2019 focuses on 3 main axes of essential activities: active advertising for transparent information, access to public information, and open data and reuse of public information (DIRECCIÓN GENERAL DE TRANSPARENCIA Y ATENCIÓN A LA CIUDADANÍA MADRID, 2017). The main objective comprised in the 2017-2019 transparency project, is to promote the transparency portal of the city council, available since 2012, by improving the design, the visibility, and the accessibility of the public information (DIRECCIÓN GENERAL DE TRANSPARENCIA Y ATENCIÓN A LA CIUDADANÍA MADRID, 2017). The transparency portal gives access to information in different sections including the human resources, legal information, economy and budget, public relation, and transparency by sector² (Portada - Portal de transparencia del Ayuntamiento de Madrid, 2017).

Furthermore, Madrid launched an additional online tool that reinforces transparency within the city. The open data portal of the city council allows citizens and private companies to access multiple public data which can be freely analyzed, reused, or shared. This portal encourages people among the city to develop and research for new creative tools to attract and serve Madrid citizens (Qué contiene el portal - Portal de datos abiertos del Ayuntamiento de Madrid, 2016). A catalog with various public data such as traffic data, road accident data, waste management data, meteorological data and so on are available on the open data portal. In addition to the open data portal, the city council provides a section of the official website dedicated to statistics of the city related to different domain going from health and safety to consumption, price and life quality.

Madrid, true to its citizen-centric approach, created in 2016 a participative platform for Madrid's residents named "Decide Madrid". On this platform, citizens have the possibility to initiate referenda, debate issues, and take part in a citywide participatory budgeting process (Ulrich, Marshment-Howell and Van Geest, 2016, pp. 22-23). Therefore, residents over 16 years old can, at any time, make a proposal online through the "Decide Madrid" platform. Then, the citizen's proposal can receive support from other inhabitants. If a proposal receives more than 1% support from active users (eligible citizen registered to vote in Madrid, 27'064 people), the city council evaluates the viability of the project and organizes a vote concerning the proposal. The propositions that received the most votes are finally realized with the participatory budgeting of the city (Propuestas ciudadanas de Madrid - Decide Madrid, 2020). In 2016, a total of 60 million Euro was kept aside for the participatory budgeting.

The city adopted in 2015 the Madrid Intelligence Project (MiNT), a system that allows residents to warn the city council of any problem concerning the management and quality of urban public infrastructures and services (Berrone and Ricart, 2019, p. 47).

Furthermore, Madrid made considerable efforts to provide most of its citizenship procedures and services online. Since 2010, citizens and companies can register on the web portal "sede.madrid.es" an electronic desk where various information and procedures can be found. The web portal also gives the possibility for residents to book an appointment in one of Madrid's city council assistance offices. Location, contact numbers and further information such as accessibility for people with reduced mobility or the disposition of adapted infrastructure

² Observations from the author on October 5th, 2020

for deaf or visually impaired person are available on the city electronic desk³ (Oficinas de asistencia en materia de registro del Ayuntamiento de Madrid - Gestiones y Trámites, 2018). In addition to the online services and procedures, Madrid's official website offers the possibility to make procedures and requests via social media such as Twitter and Facebook (Portal web madrid.es - Ayuntamiento de Madrid, 2018). Further, Madrid's city council can be reached through the "Línea Madrid" (@Lineamadrid) pseudonym.

2.3 Smart Environment

Madrid tried over the last decades to increase the quality of the environment throughout the urban area. Many measures and projects were conducted in order to provide the best urban environment for their citizens. Madrid counts among the cities with the most tree-lined streets in the world and has an average of 18m² of green area per resident, a number superior to the minimum limit a city should have of 15m² set by the WHO (Plan Verde para la ciudad de Madrid - Ciudad Sostenible, 2018). Despite the good disposition of green areas, the city is still trying to improve and develop its green spaces within the urban center. Indeed, Madrid introduced the "Plan de infraestructura verde y biodiversidad" which established a set of strategies, guidelines, and global planning regarding the green areas of the city with the aim of obtaining the greatest environmental benefit (Plan de Infraestructura Verde y Biodiversidad - Ayuntamiento de Madrid, 2018). The plan takes into consideration the different benefits that plants bring to the urban life. Aspects such as biodiversity and sustainability and further the connectivity between green areas within and outside the city are considered. The city was recognized by FAO and the Arbor Day Foundation as one of the 59 "Tree city of the World 2019", fulfilling in the following standards requested by the organization (Madrid, reconocida 'Ciudad arbórea del mundo 2019' por la FAO y la Fundación Arbor Day - Ayuntamiento de Madrid, 2020):

- Existence of a structure dedicated to tree management
- Availability of a tree census
- Definition of financial resources for trees
- Annual organization of events to promote and raise awareness about importance of trees

Since the early 2000s, Madrid has constantly tried to improve the quality of the air of the metropolitan area. A succession of plans and initiatives has been set up and built to counter air pollution. In total, 4 main strategies were presented and used over the last 15 years. Each of these plans and strategies brought significant changes and improvements for the air quality in Madrid urban center. The city government seems to understand the issues related to air quality but shows hesitation when it comes to choosing the right strategy to tackle the problem. One example of the opinions' division on this manner appeared in the "Central Zero Emissions project". According to the Madrid city council (2017, p. 41) the "Central zero Emissions project" also labeled as Madrid Central program is a "Delimitation of a closed perimeter Central Zone with restricted access in which traffic will be banned. The aim is to promote a new model of low emission mobility which prioritizes pedestrians, cyclists, public transport and, in general, the least polluting vehicles". The restriction of old and more pollutant cars in the center of Madrid appeared as smart environment initiative reducing pollution and

³ Observations from the author on October 6th, 2020

noise disturbance. Furthermore, the project encourages people to use public transportation or cycling as an alternative to pollutant private vehicles. The initiative was considered as the most significant actions taken by European city to improve air quality and revealed amazing results a month later with a 38% reduction in emissions of nitrogen oxide (NO₂), a polluting gas released by vehicles. Additionally, carbon dioxide (CO₂) emissions dropped by 14.2% during the same month (Medina, 2019 & Glasco, 2019). Despite the promising results, the Madrid Central program was put under pressure and threatened by the divergent opinion of the new and current mayor in place José Luis Martínez-Almeida. As he took the office, Martínez-Almeida tried to dissolve the Madrid Central program, an action blocked by the courts. Today, the program remains, drivers need to have proper vehicles or permissions to enter the center of Madrid (Planelles and Medina, 2019). Central Madrid program appears as the smartest movement and most ambitious plan for the environment and a better air quality established by the city of Madrid. However, according to the European Air Quality Index (2020) the Spanish capital still shows alarming peaks of poor air quality mostly due to the NO₂ gas emission.

An additional initiative to increase the quality of the air came from Vodafone Spain. The company deployed a decontaminating advertising banners that absorbs 85% of the polluting gases in a perimeter of 40 to 60 meters (Instalan lonas publicitarias que absorben la contaminación en Madrid y Bilbao - ESMARTCITY, 2017).

Madrid is trying to improve the water management. The system for treatment of wastewater allows to clean 100% of the wastewater since 1984. The city has eight wastewater treatment plants that continuously clean up the water for the population (Sistemas de depuración de aguas residuales en Madrid - Ayuntamiento de Madrid, 2020). More recently, with the help of new technology, the city tested the European iWESLA project, a cyber-physical system optimizing the water consumption efficiency and guaranteeing its safety. The intelligent water management tool, using IoT and Big Data, can detect and monitor in real time leakages or abnormal water consumption. Therefore, with the iWESLA system, users can observe and control their own consumption and make responsible decisions to reduce their consumption (Gestión inteligente del agua en Madrid con el proyecto europeo iWESLA • ESMARTCITY, 2020).

Energy saving represents another big aspect of Madrid's smart environment management. The city recently partners up with Acciona to improve energy efficiency in 400 municipal buildings such as schools, sports centers and social and cultural center. The objective in the long term is to reduce energy consumption by managing the demand-side and installing more innovative technology to produce and distribute the energy efficiently and ecologically. Moreover, the city of Madrid started in 2016 the Mad-Re action plan. A regeneration strategy that targets residential buildings with lowest construction standards. According to the Madrid Recupera Plan (2018), the initiative comes with the goal of "promoting building interventions that would improve energetic performance, reduce energy consumption and emissions, enhance accessibility, solve problems posed by existing architectural features, as well as foster restoration works, and preserve and improve the state of the buildings".

Currently, the city council provides subsidies for the renovation and replacement of coal and diesel boilers. Subsidies act as an incentive to change for highly energy efficient systems. This will be maintained until 2023 with the main objective to completely remove coal boilers by 2022 and decrease by 50% the use of diesel boilers

(Las calderas de carbón y gasóleo que se sustituyan en 2020 contarán con subvención municipal - Ayuntamiento de Madrid, 2020). This smart initiative stemming from the city government has an impact on the sustainability of the urban environment.

One last area of the smart environment Madrid needs to be developed and managed is the waste management system. On the surface, the city seems far behind in terms of recycling and reusing waste, indeed, the city has trouble meeting the EU recycling target of 50% (Waste Collection Goes Organic in Madrid, 2020). However, the city started lately to tackle the problem related to garbage by targeting separate collection of organic waste. In 2017, 10 districts started benefiting from the collection of organic waste. Today, the entire city except for the center district are involved in organic waste separation (Waste Collection Goes Organic in Madrid, 2020). Organic waste collection is a considerable step towards a smart environment. It requests a rigorous participation of the resident and could have a significant impact on the urban quality of the air. According to CORDIS | European Commission (2020), if Madrid succeeds with its organic waste collection and awareness, it would avoid 2.4 million tonnes of CO₂ emissions in the region representing the equivalence of removing half a million cars off the road.

Furthermore, the city launched other initiatives in order to reduce the amount of waste. The ReMAD platform is one smart initiative introduced by the city council allowing citizens of Madrid to publish objects that are going to the trash and give them a potential second chance. On the other hand, citizens interested in specific objects, shown in the platform catalog, can reserve it and pick it up at one of the 16 clean points available in the city of Madrid (ReMAD, n.d.). The exchange process between citizens avoids unnecessary waste and allows neighbors to reuse objects that were destined to the trash.

Finally, more recently, the city started to install new smart waste bins in public areas. The bins run on solar energy and are equipped with sensors that measure the filling level and estimate the collection time (Madrid comienza el despliegue de 1.300 papeleras inteligentes por toda la ciudad • ESMARTCITY, 2020). In total 1'300 smart bins are deployed in Madrid. This helps prevent overflow, reduce the collection frequency and consequently, lower the costs and emissions of CO₂. This represents an additional step forward in a smarter environment for the capital city of Spain.

2.4 Smart People

Madrid made consequent efforts to optimize their citizen's participation, it would be counterproductive to fail in offering an adequate and smart education to the residents.

A first initiative for smarter citizen emerged in schools. The STARS Madrid program encourages children to go to school by foot or by bike. A project supported by the European Union and Madrid city council. The main objective of STARS program is to raise awareness and educate young students on the crucial role they have in preserving the environment, the importance of individual efforts in the fight against climate change, and the benefits of physical activities for health (Qué es STARS - STARS Madrid, 2018). Further, Madrid encourages learning a second language early in the educational system. The "Programa Bilingüe", or Bilingual Program in

English, gives students from primary education to Baccalaureate the possibility to learn English in addition to Spanish, the native language. In the bilingual's schools at least 30% of weekly school hours are taught in English (Madrid Comunidad Bilingüe, 2018). Similar programs are available in certain public schools with French and German languages broadening the options for young students willing to develop their language skills earlier.

At the higher educational level, Madrid accounts a large percentage of students in Spain. According to the Sistema universitario madrileño (2020), the city represents the largest student community in Europe. In fact, the community of Madrid hosts 6 public universities. Moreover, Madrid is home of the headquarters of the UNED, the largest university in Spain offering distance learning to more than 250'000 students enrolled in 27 different official degrees (La UNED, 2020). The community also welcomes some of Europe's best business schools such as the IESE Business School, IE Business School, ESCCP Europe School of Management, and ESADE Business School (Talent pool and an outward-looking education system, 2020). The number of students enrolled in the community of Madrid in the 2019-2020 academic year was 322'748 in total (Sistema universitario madrileño, 2020).

As an educational center for Spain and Europe, Madrid needs to keep its education system up to date. The government of Madrid funded the Excellence Network about educational technology called "eMadrid". According to Delgado Kloos *et al.* (2017, p. 31) "The aim of the network is to provide leadership and perform advanced research in the area of educational technology, including technology transfer to companies". EMadrid allows actors in the educational system to communicate and learn about new types of technology that improve distance education as well as develop new technologies in physical classrooms.

2.5 Smart Mobility

Recently, Madrid made efforts to make the mobility smarter within the urban area. The implementation of Central Madrid initiative is an example among others. The establishment of "Plan A" and "Madrid 360" in the recent years, considerably changed the way people can move and strengthened the smart mobility vision of the city. The two plans foster soft and shared mobility rather than polluting and individual vehicles. Furthermore, the appearance of new technologies and smartphone applications facilitate access to transportation facilities and stimulate citizens to adopt public mobility. Madrid offers multimodal transportation network, thus improving the mobility efficiency and experience in Madrid.

Madrid city council's first initiative for cleaner and durable mobility came with the launch of solid financial incentive to renew polluting vehicles. The city offers a subsidy for individuals willing to purchase a cleaner vehicle. A total of 25 million Euros per year is planned for the renewal of individual vehicle. Furthermore, a budget of 10 million Euros per year is provided for freight vehicles that circulate in the city (MADRID 360, la estrategia para cumplir con los objetivos de calidad del aire de la Unión Europea - Ayuntamiento de Madrid, 2019). Lastly, the taxi sector will receive subsidies for purchasing eco-friendly vehicles. The budget for the taxi sector is 5 million Euros. These financial incentives strongly encourage individual vehicles owners to renew their fleet with less polluting ones. This approach allows citizens with polluting vehicles to enter the center of Madrid only with a high occupancy (2 passengers). This new modification aims to promote shared travel and

reduce traffic in the city. However, it also gives more time for citizens to adapt their vehicles to the future low emission zone in Madrid. In fact, the environmental sustainability strategy will follow a gradual ban of all polluting vehicles over the period 2020 to 2025 (Mendez, 2020):

A different initiative that aims to change mobility habits in the Spanish capital is the modification of parking distribution and parking rate. The community of Madrid wants to double the number of parking spots for bikes and motorcycles in order to encourage residents to use this type of vehicles considered as less polluting than cars (Mendez, 2020). The local government also bet on the creation of 10'000 new dissuasive parking spots in 14 different location situated in the periphery of Madrid. The parking system, also called, "Park & Ride" encourages drivers to leave their vehicles outside the city and use shared transportation to enter the center of Madrid. In addition to these new parking spots, the parking rate will differ and be more advantageous for people holding an environmentally friendly vehicle. Indeed, parking discounts will be offered as followed (Mendez, 2020):

- Electric cars park for free
- Environmental "ECO" label has 50% discount
- Environmental "C" label receives a 10% discount

Madrid also puts a lot of effort into the promotion of cycling and walking trips throughout the city. The local government plans to create new bicycle lanes in and outside the M-30⁴ area. Additionally, bicycle parking spaces will considerably increase and reach 21'000 spots by the end of 2023 (MADRID 360, la estrategia para cumplir con los objetivos de calidad del aire de la Unión Europea - Ayuntamiento de Madrid, 2019).

Public transportation represents an additional facet of the smart mobility dimension. Madrid's main objective is to provide a safe, clean, and efficient public transportation network. The metro link is a first mean of public transportation available for citizens. It accounts more than 300 stations deserved by 13 different lines. According to Zimmerman (2020), it is the fastest and most efficient public transportation in the city with a frequency that can go from every 3 minutes to 15 minutes depending on the time of the day. The city launched the Station 4.0 project which refers as the digital transformation of metro station by rethinking the ICT architecture resulting in a more efficient operating and maintenance model, and an improvement of the service provided (Bravo and Aguirre, 2018). The project enhances the use of new technology in diverse fields such as traveler information and comfort, security and control, and supervision and accessibility services. A second smart initiative related to the metro in Madrid is the Train2Car one. An innovative system that takes advantage of the energy produced by metro braking to feed power into a grid for electric car (ERDF Operational Programme and R+D+i Projects, n.d.). A smart initiative that saves electricity and thus reduces the carbon footprint of the metropolis.

The EMT provides another public transportation mean. The company is responsible for the bus offer downtown and in the residential areas. It accounts more than 2'000 buses from which 68 are running exclusively on

⁴ Highway surrounding the center of Madrid

electricity (MADRID 360, la estrategia para cumplir con los objetivos de calidad del aire de la Unión Europea - Ayuntamiento de Madrid, 2019). Buses represent a big amount of Madrid's traffic and mobility. The plan "Madrid 360" stipulates that the main goal regarding buses' sustainability was to renew 100% of all EMT fleet. In eight years, the EMT electric buses will increase from 68 to 668 (MADRID 360, la estrategia para cumplir con los objetivos de calidad del aire de la Unión Europea - Ayuntamiento de Madrid, 2019). An initiative that would reduce the CO₂ emission in the city. Furthermore, the city already optimized the efficiency of these electronic buses by installing inductive recharging system. An instrument allowing buses to feed their batteries quickly, several times a day, at the extremities of their routes (Circula en Madrid la primera línea de autobuses cero emisiones con recarga por inducción - ESMARTCITY, 2018). This smart tool gives EMT buses more autonomy and allows electric buses to run throughout the entire day. On top of that, the local government implements a smart initiative, called "Zero Line" or "Linea Cero", which represents two bus lines with zero emission going respectively from north to south and from east to west. The particularity of these two lines is that it is free of charge for all travelers (MADRID 360, la estrategia para cumplir con los objetivos de calidad del aire de la Unión Europea - Ayuntamiento de Madrid, 2019).

Moreover, Madrid made further work in order to increase the accessibility and the multimodality of the entire public transportation ecosystem. The "Chipi" application appeared as a first initiative from a private company to inform citizens in real time about prices, waiting and traveling time offered by the multiple transport available within the city. The mobile application considers the different means of transportation provided inside the urban area going from shared vehicle services to bus and metro offers (Una App móvil compara en tiempo real precios y tiempos de espera de cada transporte en Madrid, Barcelona y Málaga • ESMARTCITY, 2018). This represents a consequent movement toward smarter mobility and citizens' awareness of the various traveling offers available in Madrid. Another tool developed by a Spanish startup to inform residents about the transportation options is the "Wondo" mobile application. It helps users to find the fastest and most efficient route throughout the city integrating public transportation and shared vehicle options (Un planificador de viajes que incluye rutas en coches compartidos en la Comunidad de Madrid • ESMARTCITY, 2018). These two mobile tools built by private companies pushed the EMT to establish their own smart mobility application. The transportation ecosystem is vast and complex. It involves several private and public operators that act in different facets of the mobility.

The Mobility-as-a-Service (MaaS) initiatives gives access to all transport services in one single digital mobility application. It integrates active mobility, shared vehicles, and public transportation. The main objectives behind MaaS is to unify the transportation service in one ecosystem and offer the best information and services to users (Bernardo, 2019b). An innovative application that, while planning a trip, takes into consideration the comfort and experience of travelers. As Bernardo (2019b) explained the application is made for "user or citizen who has a wide range of possibilities of mobility – a "multimodal user". In this regard, without deviating from the first two factors that are always taken into account when deciding a trip – travel time and cost – a third factor will come into play that is becoming more and more relevant: the user experience". The development of such a tool required a strong collaboration between public and private city's mobility operators. To reinforce the collaboration, the EMT developed a secure, integrated, and combined payment service (EMTPay) which gives

users the possibility to pay directly with the application for the multiple means of transportation (Bernardo, 2019b). MaaS Madrid represents a significant step towards smart mobility. It is the first time a city offers such a complete platform to its citizens. The initiative facilitates residents' and tourists' trips throughout the city and considerably reinforces the multimodality of transportation services and its attractiveness.

2.6 Smart Living

The Decide Madrid participatory budget 2019 results have seen original projects that improve inhabitants' life. Among these projects, José Lopez, a citizen, suggested to install outdoor circuit trainings with different gymnastics equipment in every district of Madrid (Circuitos Biosaludables en Todos los Distritos de Madrid, 2019). An initiative that allows young and old people who cannot afford a gym membership to have access to fitness equipment. It would significantly improve the health condition of citizens and give them a place where sport enthusiasts can meet and socialize. A different initiative from Sergio A., a citizen, was to install slides for kids in the 10 biggest parks of the community of Madrid (Toboganes gigantes en 10 de los mayores parques de la ciudad, 2019). The slides would encourage physical activities for children as well as foster communication between kids within the green spaces of the city. One last smart proposal from the participatory budget was to set up parasols in streets exposed to heat (Parasoles en calles, 2018). This initiative would help reducing the "heat island" phenomenon and enhance the livability of the city. Decide Madrid appears as a smart system for the improvement of the viability and sustainability of the city. The community benefits from individual creativity and participation.

Beside Decide Madrid citizens' projects, other smart living initiatives were developed to improve the quality of housing and buildings. This includes the deployment of smart meters within the houses in Madrid community. 1'141'151 users in total enjoy the new technology that facilitates meter reading of supply and records the exact consumption in real time (Los contadores inteligentes de Unión Fenosa alcanzan a más del 98% de clientes en Madrid - ESMARTCITY, 2018). The installation of smart meters is a step toward the implementation of smart grids in the future. Thanks to the smart meters, distributors do not have to visit anymore each building to check the consumption meter. The equipment allows distributors to charge consumers with the exact amount that has been utilized during a given time period. This is a new tool that facilitates procedures related to the energy consumption. It improves the smartness of housing and building in the community of Madrid.

A different project influencing housing and building of residents comes from the installation of new smart mailboxes. These mailboxes were developed by a startup called "Citibox". This new product allows users to receive their online orders at home without being there. Citibox noticed an increasing need with the expansion of online purchases and e-commerce trend. The smart mailbox closes once the postal worker leaves the package inside. Thanks to new technologies, the resident receives a notification on their smartphone once the package has arrived at home through the Citibox application (Los buzones inteligentes comienzan a integrarse en más de 3.500 viviendas de Madrid y Barcelona - ESMARTCITY, 2018). The innovation allows safer and more efficient delivery services, saving time for residents and transportation companies. Smart mailboxes encourage

citizens to shop online and avoid stress due to the theft of a delivered package. This is a smart technology that brings more serenity for citizens and transportation companies.

The local government also aims to facilitate citizens' life. Regarding this, the city council launched a mobile application called "Tasas", or Taxes in English, which offers the possibility for Madrid residents to pay taxes or public fees online with their mobile phone (La App móvil "Tasas" permite hacer el pago de impuestos y precios públicos en la Comunidad de Madrid - ESMARTCITY, 2019). Therefore, citizens can at any time and without traveling to a physical location pay public fees. The application also allows to pay by scanning QR codes written on public bills. Furthermore, users can save and repeat the payment that are periodical (La App móvil "Tasas" permite hacer el pago de impuestos y precios públicos en la Comunidad de Madrid - ESMARTCITY, 2019). The application facilitates the payment process for citizens. It also saves time and avoids stress related to delayed payments. This represent a smart living initiative that brings more comfort for citizens but also eases the government process linked to the taxations.

Further, smart development in public infrastructures was made in order to make citizens' life more enjoyable. The development of digital technologies in elevators maintenance appear as a bounce forward in smart living dimension. Indeed, Madrid set up the "MAX" system for more than 156 elevators located in the metro (From Barcelona to Madrid, Spain's smart cities inspire change, 2016). These elevators give a safe access to handicapped passengers and improve their experience in metro stations. Another smart advancement in public infrastructure includes the installation of smart sport courts lighting. An application, called "Aluzina", connects citizens with the lighting system of public sport fields. Thanks to Aluzina citizens can turn on and off the lights of several sport courts in the metropolis (Iluminación conectada en pistas deportivas y manejable desde el móvil de los usuarios, así es Aluzina Madrid - ESMARTCITY, 2018). The light can be controlled by the smart phones of inhabitants. A system that encourages citizens to go out and play sports overnight. It enhances physical activities and social contact among citizens.

Generally seen as a safe city, Madrid developed smart tools in order to make the urban life safer for its citizens. A step toward more secure public spaces included the installation of more than 29'000 security cameras, respectively 4.4 per 1000 inhabitants (Laffon, 2019). A consequent amount which make the Spanish capital one of the top 5 most guarded cities in Europe. The video surveillance allows 24 hours monitoring and reduces time needed for interventions. Moreover, the community recently added "electronic eyes" in the surveillance system. A camera with analytical software able to detect odd behavior and alert the police (West and Bernstein, 2017, p. 20). This is a new technology that improves the time to recognize incidents and thus reduces the time for an intervention.

As for the other smart dimension, Madrid also gives a key role to citizens ensuring safety within the urban area. The community set up two interesting mobile phone applications which reinforce the security within the city. "Mejoric Tu Ciudad" is an application that allows citizens to directly communicate with the municipality about diverse incidents. The main objective of the application is to use citizens' knowledge of the city to make smart modifications in urban planning and reinforce security in strategic locations based on resident's information. The second application concerns the security of women in the urban area. Indeed, Madrid adopted "free to be"

a crowd-mapping tool that allows women to share their feelings and experiences in specific public spaces within the city (Free to Be - Women's Safety Map | Plan International Australia, 2020). Therefore, women can identify locations to avoid based on previous experiences of other female citizens. The map also shows safe spots located in the city. A smart tool that reinforces women's security in Madrid. Furthermore, the software could be used by the municipality to identify unsafe spots where change could be made in order to strengthen the safety feeling for women and inhabitants in general. Once more, Madrid empowers citizens to participate for the smart development of the city.

Health is another important aspect of smart living that Madrid must consider in the smart city development. In 2019, the local government tried to boost innovation in the healthcare field by turning San Carlos Clinical Hospital into a smart health center (El Hospital Clínico San Carlos será Smart Health Center, 2018). A center that prioritizes the development of technological solutions to treat patients. Further the community planned to invest 8.3 million Euro in the transformation of the hospital with the objective to acquire surgery robots and foster training in robotic surgery.

In a different field, the Spanish capital became a very attractive destination for tourists. Nowadays, tourism is a big part of urban life. In 2019, the city welcomed between 717'871 and 970'288 tourists every month (Monthly number of tourists in Madrid 2019-2020 | Statista, 2020). People from across the world visit Madrid for different reasons such as the architecture, the culture, sport events, and shopping offers. It is essential for the community to keep the high attractiveness for visitors in order to keep the tourism industry alive. One initiative reinforcing smart tourism in urban areas is "Arquitectura Madrid", a mobile application developed by the COAM with the support of the city council (COAM lanza la App "Arquitectura Madrid" con casi 300 edificios emblemáticos y rutas para conocer la ciudad - ESMARTCITY, 2018). This system registers almost 300 emblematic buildings in Madrid from which interesting information can be found such as the author, year of construction and a description. Moreover, thanks to the geolocation and augmented reality technology users can find through their smartphone camera the closest buildings around them and see at what distance the building is (COAM lanza la App "Arquitectura Madrid" con casi 300 edificios emblemáticos y rutas para conocer la ciudad - ESMARTCITY, 2018). As previously observed, Madrid recently developed a smart quality of life mostly based on initiatives coming from private companies and citizens.

3. Conclusions

Madrid made several efforts to improve its competitiveness over the last decade. Thanks to local government works, Madrid became one of the most ambitious smart cities in Europe. The Spanish capital aims to offer a comfortable economic environment for entrepreneurs, local firms, and multinationals. Madrid city council succeeds in introducing new technologies in the urban area. Furthermore, the city seems to provide modern lifestyle for its citizens and encourages them to participate in the development of the city. The government's initiatives target mostly one of the 6 dimensions related to a smart city and succeed in improving each dimension distinctively. However, weaknesses and instabilities in the smart city of Madrid could be observed in specific dimension. Indeed, Madrid lack in having a global smart city vision and connecting each smart initiative to multiple dimensions of the smart city. Today it seems crucial that Madrid develop a global smart city strategy that include every characteristics of the smart city concept. The strengths and weaknesses noticed in different city ranking can be observed in the exhibit 1 below.

Despite the weaknesses observed and the lack of a global smart city strategy, Madrid remains among the most promising smart cities in the world. The case of Madrid might provide interesting insight for the development of future smart cities elsewhere in Europe. Madrid movement toward a smarter urban center shows the importance for regional areas and cities to remain attractive and competitive. In this sense, today, it seems crucial for urban centers to develop a smart city plan with concrete objectives and strategies.

Exhibit 1: Summary of the Rankings Extremity Results

City-Level Rankings			
Positive		Negative	
¹World Happiness Global Ranking of Cities 2020			
Current Life Evaluation	48 th	Future Life Evaluation	99 th
²The Sustainable Cities Index 2018 (21st overall/100)			
People	10 th	Profit	49 th
Planet	15 th		
³Local Online Services Index (1st overall/100)			
Content Provision	1 st		
Services Provision	1 st		
Participation & Engagement	1 st		
Technology	2 nd		
⁴The IMD Smart City Index 2019 (21st overall/102) A/M: Above Mean - U/M: Under Mean			
Car Sharing have reduced congestion	A/M	Traffic congestion	U/M
An online platform where residents can propose ideas has improved city life	A/M	Air pollution	U/M
Online voting has increased participation	A/M	Corruption of the city officials	U/M
Green space are satisfactory	A/M	Online public access to city finances has reduced corruption	U/M
Online reporting of city maintenance provides speedy solution	A/M	Businesses create jobs	U/M
Public safety	A/M	IT skills are taught in schools	U/M
⁵The IESE Cities in Motion Index 2019 (24th overall/174)			
Mobility and Transportation	9 th	Environment	58 th
International Outreach	17 th	Governance	46 th
		Human Capital	41 st

Source: own elaboration from ¹Helliwell *et al.*, 2020; ²Arcadis, 2018, pp. 11-17; ³United Nations, 2020, p. 101; ⁴The IMD World Competitiveness Center, 2019, pp. 118-119; ⁵Berrone and Ricart, 2019, p. 29.

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