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The Future of Smart Cities and Their Economic Impact

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Abstract

This research paper deals with the link between new technological paradigms and the shape of urban life, that is smart cities. Understood as cities that are not merely equipped with a sophisticated ICT infrastructure but are in fact using the Available Network Technologies (ANT) as a driver for more sustainable, greener, open and just forms of economic growth. A general point is made on the novelty of smart cities, their multidisciplinary nature (IT Governance, Urban Economics, Policy Evaluation), and the theoretical and methodological challenges they raise. At an analytical level, attention is paid to the effects of smart cities on urban change, and the emergence of a new urban structure. Cities are hubs of economic activity, innovation, cultural life and law-making, their fertility depends on their ability to smoothen the aggregation, production and distribution of tacit and codified knowledge. Urban productivity growth is robustly associated with higher quality of life. Furthermore, the issue of urban sustainability has gained much attention, being cities the source of most carbon emissions the world over. This links to the traditional urban economy literature. The aggregate ecological footprint of many cities is much larger than the biocapacity of their local natural environment. As such, a sustainable management of their natural resources is necessary for their long run economic success. At another level, the depletion of these natural resources can affect the availability of production factors for future generations. These points have been captured by a rich literature dealing with the impact of urban form (compact vs. sprawl) on economic performance and social sustainability. These issues are especially pressing given the expected, and much feared, population trajectory of the world's largest urban areas

in the coming decades, a funnelling of an ever growing (and increasingly less educated) number of new urbanites into what in turn will be mostly informal, low-productive, over-polluted and crime-ridden economic enclaves.

Keywords smart cities, economic impact, urban sustainability, technology infrastructure, urban economics, innovation, quality of life, resource management

1.1. Introduction to Smart Cities and Economic Impact

Today more than half of the world's population lives in urban areas and, inevitably, will continue to do so (Caragliu & Del Bo, 2018). This trend has raised a number of new challenges in terms of sustainability, inclusiveness and productivity for urban areas. In the past decades, the concept of 'smart cities' has emerged as a promising response to these new challenges. Originally introduced as a planning concept only, it has recently evolved into a 'market' (or rather a race) for services delivering urban security, well-being, efficiency and sustainability by means of new digital technologies. In this context, technology is increasingly integrated within everyday life and environmental complexes, in a way that was inconceivable before. Indeed, as (B. Anand & Navio-Marco, 2018) argue, the convergence of the Information and Communication Technologies (ICT) revolution in urban planning and management marks a potentially epochal development in the way cities are designed, opened and – or – controlled.

As the integrated approach of the 'smart' concept implies and as Smart City strategies are designed to cover a wide number of requirements, urban typologies and contexts as small cities, metropolitan areas, insular territories and so forth a wide array of research has been undertaken on the governance, economic and political feasibility and impacts of this new approach. As in parallel wide array of research is also ongoing focusing on how the whole policy cycle of the 'new' urban agendas of city partnership, integrated planning, healthy cities, smart cities, inclusive cities, sustainable urban development and so on are reshaping the traditional and emerging new planning practice and whose benefit these do generate. While urban planning

literature has considered the 'successful' Smart City strategies as a new development paradigm stressing the convergence of urban and information planning, this paper investigates the actual performances of a number of Smart City practices focusing on the economic growth of territories and on the efficiency and the transparency of urban management.

1.2. Technological Innovations Driving Smart Cities

There is an array of technological advancements shared around the world that are consistent with the development of smart cities society. First and foremost, the Internet of Things (IoT) enables any electronic device as a potential medium of connectivity for intelligent devices to check specific health conditions or detect danger, among other characteristics, thus maintaining and enhancing urban infrastructure & environment. Recently, South Korea succeeded in connecting X-band maritime surveillance radar and ultra-small lighthouses to combat illegal fisheries and protect marine lives (Min Kim, 2021). Furthermore, through artificial intelligence and big data, number of smart sageun buses have increased to maintain efficient operation in Seoul through traffic prediction and operation optimization by analyzing traffic data and data of sageun bus operation information on a real-time basis. Also, its LED lamps act as IoT terminals by turning on and off according to triggers and sending reports of statuses. In addition, air quality sensors that can measure ultrafine particles, fine dust, and CO_2 in particular were deployed throughout the city. All data is available in real-time so that it can organically and diversely turn on or off IoT devices according to triggers (times, values, conditions) such as particular air quality monitor values, car accidents, fire reports, and emergency response facilities.

There are other technological innovations, such as blockchain, drones, and mobile applications that can transfer relevant information more easily shared among urban systems that also presents potential for smart cities and local communities. A blockchain-based service that shares real-time traffic data stored in existing closed

circuits individual devices (mobile application) used deploying intelligent traffic systems and trying to create a real-time bus transits information one place regardless bus companies. Traffic data is shared in real-time between devices (IoT and non-IoT) installed and store data in blockchain in Paris. Public agencies analyze and use this data to optimize traffic lights and make further traffic policies concerning low-emission zones. In this regard, interconnected urban systems (traffic, environment, energy, weather, etc.) in smart city environments are opened and shared with others. Whether the policy/goal is related to bicycle sharing, energy saving, monitoring social inequalities in access to public equipment, the reuse of data generated and collected by urban systems strengthens the proposed analysis and results. By integrating real-time data in its own platforms and innovation in relation to real citizen challenges, the potential solution to societal issues is explored. Yet its adequacy and limitations for a local administration context also opposes the so-called big/multi-scale data as a new challenge.

1.3. Benefits and Challenges of Smart Cities

There is a growing global trend towards urbanization, with the majority of the world's population now residing in urban areas. This trend can result in significant benefits to countries; however, it also presents challenges. Given the socio-economic and spatial diversity that characterizes many countries, policy makers often need alternatives and adaptive measures to better accommodate and manage urban growth. These trends raise the importance of smart and sustainable solutions in the management of cities (Abdalla et al., 2019). This shift towards a digital economy is expected to have significant impacts on a city's capacity to create economic growth and job creation, enable resource optimization and improved public service delivery, and build sustainable urban environments. Smart city technologies and initiatives have the potential to redistribute many benefits to citizens, business, stakeholders, and governments in general and to act proactively in the development of proposals concerning the creation of a smart city strategy.

Although smart city solutions can foster the transition towards clean and efficient systems, cities can also lead to new emissions and environmental impacts. Smart city approaches can enable a more efficient management of resources and assets by augmenting human experience and responding to challenges. Examples of this includes transport systems in South Korea or Taiwan. In both cases there has been an increase in the average city wealth and attractiveness towards physical investments, enhancing the environment and an increase in the asset stock affecting the overall economic dynamics. Given the increased global interest in smart cities and the potential economic and environmental benefits to developing countries, this research provides a comprehensive analysis of specific city state and the implications smart cities have for economic growth, energy security, urbanization, and technological diffusion. Given the wide range of positive impacts, developing countries such as Somalia would benefit from policies aimed at expanding and promoting smart city technologies and strategies to address growing energy consumption, urban development, and economic growth. Additionally, understanding and assimilating the lessons from developed countries' policy implementation and technology diffusion of the smart city initiatives can facilitate the economic and environmental sustainability of these cities. Despite the potential positive benefits of smart cities, there are a number of challenges and limiters to such initiatives.

1.4. Economic Impact of Smart Cities

The economic impact of smart cities has been widely discussed in the academic literature. On one hand, a broad series of arguments underline the direct and local effects of technological innovation as drivers of urban economies. Among the most notable, and often reminded, there is the potential creation of high-tech sector jobs, or the establishment of businesses or start-ups in the city-centre (B. Anand & Navio-Marco, 2018). Multiplier effects are also mentioned as long as small businesses benefit from the increased attractiveness of the urban environment for costumers or

investors. On the other hand, it is also argued that, and despite the business-oriented approach to this field, an increased productivity and efficiency derived from the smartness of cities is essential for their competitiveness in a global context, since it allows establishing, attracting or favouring mobile, advanced corporate activities (Caragliu & Del Bo, 2018). This cascade effect could also eventually enhance the overall standard of living of urban populations, therefore reducing regional inequalities. Besides, substantial attention has been paid to those effects of infrastructure quality improvement in urban economies, attracting private investments and promoting urban tourism due to their growth-enhancing impact. However opportune those predictions may sound at first sight, it is not less true that a number of negative side-effects of such a trendy assembly of findings have been recently fostered by the academia. For instance, it has been stressed that not only job displacement effects can considerably offset the potential high-skilled job creation envisaged, but also that a tailored (re)qualification of the labour force is needed in order to facilitate (re)insertion in this dynamic job market segment, which will likely account for strong entry barriers for unqualified workers, DS and others included. Advances in knowledge economy can also foment a rise in real estate values, therefore triggering gentrification processes in historically poor areas, or else leading to the increase of informal settlement concentration in urban outlying districts. Notwithstanding, it is stressed that, e.g., in Europe, in order to tackle the challenge posed by the "smart" discourse on cities, a coherent and inclusive development strategy should be carefully designed by policymakers, turning potential negative economic spill-overs into a set of guidelines to be followed by local authorities and stakeholders. SMART or "innovative" pilot-scheme projects like this should be consequently envisaged.

1.5. Policy Implications and Future Directions

Governance has become an important area of research when analyzing the development of smart cities, but what is less clear is how governance systems are

changing and how these changes can shape different urban futures with different configurations of smart technologies and data uses (B. Anand & Navio-Marco, 2018). On the one hand, the development of smart urban technologies is leading to the emergence of new modes of regulation, in the form of complex networked environments between new and traditional urban actors. These new environments are governed through novel technology-dependent processes that are challenging the formal, instrumental, and vertical characteristics of traditional bureaucratic governance (Caragliu & Del Bo, 2018). On the other, the prospects of smart urban development are shaping and being shaped by new horizontal interconnections and dependencies between governments, the private sectors, and communities, which are fundamentally challenging the old models of single-sector in cities' policy-making processes. All of these issues suggest that, due to this far-reaching transformation in the ways in which cities are governed, it is a complex and evolving task to understand how governance is, and can, govern differently the development of urban technological innovation.

Governance systems are evolving, most seemingly, towards models of innovative multi-level governance, to accurately govern smart urban development, policy and regulatory frameworks are considered as well. One of the most visible and important implications of multi-level is that the historically closed systems of urban governance are becoming more open, amplifying the number and variety of actors able to participate in their design, consent, and oversight. Successful smart urban development, their policies and regulatory frameworks, rely on a web of formal agreements of shared responsibilities and resources between 'processors' of different scales – supranational, national, urban and district. Beyond years of abiding history, the success of multi-level governance is seen to be contingent on the ability to harmonize diverging interests not only of different tiers of governments but also of the private sectors and other civil society organizations. An important role in this respect is attributed to community and business networks, that are seen to generate

a pressure toward more integrated and effective solutions on particular smart city-risks, offering a voice for private and civil interest in the context of traditional, closed bureaucratic negotiations. Successful collaboration between different actors at the local level can reduce the cost and enhance the efficiency of smart urban development. And yet, the literature also brings out the possible side effects of the devolution of power and the promotion of cooperation between multi-level actors. This include the risk that the local governments are being 'swamped by the weight of the supranational governance', that the top-down legislative measures shared by supra-urban actors can be inadequate to achieve desired goals, and that strengthened urban players are irreversibly committed to distributing 'sub-optimal deals' in which reactionary power is channeled through smart city agendas in ways that respond to the stronger coalition insider city's local governments. In general, this underlying literature suggests that the governance of smart cities is an issue of growing importance, with far-reaching implications for and to be analyzed in markets in more detail. In terms of economic development, the spatial outcomes of smart city actions are not predetermined. Smart city actions can have a variety of economic outcomes, some of which may reinforce existing conditions that could favour the already smart and rich. At the heart of an economically smart city, it is necessary to move beyond analyses of city segment and flagship achievements and to evaluate how a comprehensive smart governance framework could reduce the possible negative consequences of smart city actions and maximize potential pay-offs for all places within and between cities.

2.1. Smart Cities

Smart cities is a contemporary term that refers to urbanized areas which involve a wide range of information and communication technologies for enhancing the overall quality and performance of infrastructure service (Ismagilova et al., 2019). The concept of a smart city is a conglomerate approach supported by the central and local governments and driven by the involvement of various departments and

ministries. The key elements of smart cities are smart governance and policies including the investment and incentive schemes, integrated urban infrastructure, smart transportation, smart technologies, and smart solutions to determine urban development and improvement.

Smart cities incorporate innovative technological applications, particularly in urban infrastructure and governance, to address various environmental, social, and economic issues within city systems. The essence of smart cities lies in their potential across multiple sectors related to urban life. One of the most fundamental aspects of smart cities is their approach to urban problems and the solutions offered by top industries for the development of high-tech cities. Smart cities are expected and demanded for providing sustainable and efficient systems across energy, mobility, ICT, and multiple aspects of life such as aged care and public safety. However, the smart city domain has been criticized over the risk-assessment of technologies applied and the source of cities becoming new inequalities (Agbali et al., 2019). It is essential to have a holistic approach towards smart cities with a broad understanding beyond technology to address the broader context of a smart city and its economic reflection.

Smart technologies offer highly advanced network applications and instruments across the city, giving citizens a communicative and interactive platform to stay well-informed and connected. It is assumed that smart cities perform connected technology integration through the governing and managing urban environment, improve the way of living style, and demonstrate efficiency to the city services. It is predominantly driven by the intelligent connection and embedding of the information technology infrastructures and the surrounding, in extensive places of the urban environments. Smart cities have a profound capacity to focus on essential areas of urban living, such as energy, transportation, healthcare, and education, which offer the opportunity to transform and optimize cities, towns, and communities.

2.2. Economic Impact

Smart city dynamics have a variety of economic impacts. When driven by innovations, city's shape, morphology, and structure change in a way that influences urban productivity growth. In general, a productivity increase in cities is associated with a rise in the quality of life. In turn, the better quality of life, the more attractive the city. Also, the issue of the urban sustainability of cities has been increased during recent decades. The sustainability of cities is an important asset as, in the current post-industrial society, a sustainable management of urban resources became necessary for a long-run success of urban economies (Caragliu & Del Bo, 2018). Cities, which since World War II have absorbed most of the world population, are, at the same time, the largest consumer of natural resources due to the high concentration of population and activities. Consequently, the depletion of natural resources can affect the availability of production factors for future generations. These points are captured by a plethora of the literature dealing with the impact of the urban form on economic performance and social sustainability. In this sense, smart cities can be considered as the last evolution in the urban structure. However, a production model that better explains the growth of services in advanced economies refers to the modern sector as the output of high qualifications and skills labor and knowledge. In this scenario, cities are the best place where services can grow more easily due to higher market opportunities. Economic growth is expected to come from the implementation of endogenous innovation. Here, market characteristics such as the agglomeration of industries and specialized services, create an environment capable of enhancing the knowledge spillover effect. If correctly designed, smart city policies could also benefit from these conditions (B. Anand & Navio-Marco, 2018).

2.3. Technological Innovations

Fueled by innovative advancements, the establishment of smart cities is penetrating cities worldwide. With urban policies directed firmly toward technological applications, a stream of investment is being funneled into "smart" initiatives with

economic interests continually at the fore. More than merely introducing sensing technologies into urban management, the smart city development blocks transformations to new economic sectors (Min Kim, 2021). With new forms of device-based production and consumption constantly demanding new infrastructure, digital and material, urban space incarnates this continuous upgrading in installations and services most visible in the gradual installment of giga-capacity, fifth-generation mobile networks.

Among various economic reconversions embedded in smart cities, technological applications birthed through sensing devices are of crucial importance. Individual objects like streetlights, roads, and public transport are made addressable via the coding of radio-frequency identification or quick response tags. With motors such as electric vehicles equipped with sensors recording 'what or where and how much' electricity is being spent, logistics between vendors and warehouses or homes are entirely optimized with detailed data recording delivery. Major expansion of information-communication technology or transportation infrastructure builds the fundamental material conditions for such procedures to take place. Major cities worldwide support the paradigm of infinitely increasing technological application within urban environments with significant implications.

However there is a crucial lack of debate on what the actual consequences of smart city development are. Economic interests in technological applications are addressed as tools holding the capacity to mitigate infrastructure limits. Streets and roads, public transport, and building infrastructure, the basic elements shaping daily life in cities, increase far slower than the demand they have for providing services. Without fundamental adaptation, the growing adoption of new, more demanding infrastructures is assumed to exacerbate the performance of what becomes a clear-cut bottleneck between the lower and the middle classes facing the economically 'desirable' areas and those suffering from unreliable service provisions, effectively walled outside of what is made attractive to a growing section of the population.

2.4. Urban Development

Cities are constantly evolving through cycles of renewal or regeneration and over the past twenty years, there has been an increasing movement towards sustainable development practices (Baucells Aletà et al., 2017). Nowadays, the concept of smart urban development is more heavily discussed in developed countries compared to cities in the developing or less-developed world, which may also be an outcome of past real-world experiences. Common urban development ideologies are based on ideas of economic growth and efficiency, often negatively affecting the social and environmental aspects of sustainable urban development. Smart urban planning, on the other hand, focuses on efficiency, social inclusion, and sustainability. There is a perception that economic growth in a traditional sense is a necessity and desired outcome of urban development, whereas smart growth considers social and environmental consequences as well (Agbali et al., 2019). Traditional development models are criticised as being too focused on growth and economic efficiency and neglecting social or environmental aspects. Thus, stakeholder involvement should be sought from the beginning to understand the local context and needs. Through early and thorough engagement it is more likely to reduce fear of the unknown and avoid premature judgements which often lead to opposition jeopardising the entire project. Furthermore, as cities and its population expand faster than ever before, cities need to address challenges like poverty, mobility, energy, infrastructure development, climate change, land allocation, public health and air pollution. However, barriers to urban development can include financial constraints, cultural, historical or demographic factors, or inadequate governance. Financing is a major hurdle for urban development projects, especially in the developing world. Moreover, there might be internal and external regulatory hurdles slowing or stopping the implementation of urban projects, such as incompatibility with existing regulations or strict land-use plan restrictions. Major challenges relate to such development in addition to the readiness of entities to scale up pilot projects. Social aspects such as

cultural heritage and equality will also suffer if a smart and sustainable development policy is not introduced. The environment is neglected by urban policy makers in the face of economic benefits resulting from smart technology implementations. However, urban development policies that do not factor in all aspects while planning future investments of land will suffer from the quality of large city life, and if not addressed, all potential advantages of city living will be negated. All the above facts result in congestion and environmental pollution, and might get even worse. Few city governments have been able to effectively apply smart city models or have an integrated smart city approach for urban development policies. Major reasons include lack of expertise, funding, partnerships, and available technological assets.

2.5. Sustainability

Sustainability is generally defined as the capability of systems or activities to maintain or improve the quality of life within environmental limits. This is often further broken down into three main pillars: the environment, social equity, and the economy (Min Kim et al., 2021). Smart technologies contribute to sustainability by decreasing the carbon footprint of cities or improving resource management in a more efficient equitable way. In recent years, the use of smart technologies such as IoT devices, smart sensors, and big data analytics has also extended to urban infrastructure and services, reinforcing the smart city concept.

To understand the sustainability of urban ecosystems, this concept is here broken down into green, blue, white, gray, and red components. Green, blue, and white factors are related to the amount, type, and quality of green and blue infrastructure, meaning vegetation, forests, green rooftops, and aquifers, among others. Gray and red factors are related to the structure and age of the infrastructure, such as streets, buildings, or civil protection measures. A resilient urban ecosystem is capable of adapting to extreme events, moments of stress, and other unpredictable hurdles. In an approach inspired by ecology, the resilience and adaptability of an urban ecosystem are taken into account when assessing the damage and recovery rate of a

set of different components. One possible interpretation of this threefold measure of sustainability is to consider these aspects to be related to a global sustainable development (SD), comprising a sum of economic, social, and environmental axis. This interpretation aligns with the adopted approach, basing the discussion on the cities' compliance with the Sustainable Development Goals (SDGs) of the United Nations (UN) 2030 Agenda (Baucells Aletà et al., 2017).

In recent years, education campaigns and community-based initiatives have shown to have a positive impact on the sustainable development of local ecosystems. This is because those engaged at a local level are closer to the problem, and so their ideas can be more effective, creative, and better integrated. There is also evidence that local-based solutions are accepted (or imposed) more easily. This, coupled with the assertion that the proximity of the local scale spreads a more significant awareness of the problems, explains why local communities tend to be key actors in the sustainable development of a local area. Moreover, the proximity to those solutions and the immediate revenge of the results often result in a more solid ongoing commitment compared to centralized power branches. However, the success of community-based programs in urban areas is strictly dependent on local community engagement and a clear local vision.

2.6. IoT

The great numbers of urban population growth and development of vertical and horizontal urban spaces frequently are occurred due to rapid urbanization and industrialization in last couple of years. The Web of Things (WoT) is a group of computing technologies for constructing systems connecting the World Wide Web with the actual "things." It was motivated by the thought that Web technologies can ideally be adapted to meet the requirements of the emerging state-of-the-art technology (Park et al., 2018). The main ambition of WoT is to reinforce the basic idea of seamless interactions among everyday objects without the intervention of human beings. In a smart city context, "things" refer to the real-world entities being

monitored or controlled using IP-connected devices. The underlying principle of WoT is similar to that of a possible Internet of Things, as perceived by numerous scholars, where objects are labeled and located using metadata.

The Internet of Things (IoT) is a technological revolution reigning over the info society, allowing a varied selection of objects, intended for everyday use, to be networked. It brings the inference of linking the study of real-world things to the Internet. In concordance with this definition, objects supposed to be signify are embedded with RFID tags and computers declaring their identity, state, and other rudimentary data to other devices, functioning the same way. The introduction of IoT technologies in a city context, often referred to as a smart city. The IoT can be thought of infrastructural assignments used to enable devices to share and impart data in order to reduce the power consumption, and escalation of the livability of the city.

2.7. Policy

A wide array of previous research on IT initiatives has highlighted a number of important success factors or major challenges. While some smart city concepts are focused on highly technical aspects of the Internet of Things (IoT) and associated data analytics, there is a risk of overlooking how technology fits into a broader human-centric environment. Both local and central governments have promoted a blend of socio-technical innovations that enable citizens and social enterprises to collaborate in the beautiful nation - Amazon of Peru. Internet access is common in many district capitals, but mobile Internet access has only recently been rolled out in the Amazon.

Smart cities enable the interaction of individuals with urban services and also facilitate material inputs to these services. Using mobile Internet access, an urban waste collection service was designed that allowed rural consumers to notify a social enterprise when waste bins were full. Citizens were able to view in real time what part of their waste had been marketed, the price obtained, the date and time of the

transaction, and the amount earner. Social enterprises are able to view a map of transactions of all their competitors. In return for granting market access, the social enterprise collects the waste in front of the rural vendor and splits the profits from commercialization in the urban market. This design experiment was shown to increase the frequency of commercialization by 268% and waste arisings by sorting 62%. Of 43 social enterprises formed; 37 are still active 18 months after conclusion of the initiative (B. Anand & Navio-Marco, 2018).

2.8. Future Directions

Future directions for smart cities are presented concerning the extent to which these urban areas are responding to current emerging technological, social, and environmental trends, as well as how they are perceived by the wider public. Cities worldwide are evolving in their conception of what makes a city 'smart' and what technological innovations will best shape urban environments. In wonkier jurisdictions, smart cities encompass complex systems of technology and infrastructure where automation and artificial intelligence dominate. In their practice, smart cities are built through sustainable infrastructure and community engagement, with cycling and walking infrastructure spread throughout. Environmental considerations are central to the creation of smart cities. In all these respects, smart cities are inevitably malleable and ever-evolving concepts for urban development; however, it is the degree of citizen involvement and transparency concerning changes to the urban environment that marks a significant change from what has been seen historically in city development (Agbali et al., 2019). Moreover, public acceptance of large-scale smart technology in towns and cities has made limited headway. Much of this has to do with the emergent field of data ethics and privacy, which are seen as potentially undermining the vast penetrative promises of smart technology in urban areas. Furthermore, this paper considers the degree to which smart cities are perceived to be hospitable for the public, regardless of their personal

idea of what cities should look like, and whether the distribution of smart technologies in particular cities can be shown to be uneven or unfairly distributed.

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