Special Contribution

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STP Development in the Context of Smart City

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Abstract

Cities will soon host two third of the population worldwide, and already today 80% of the world energy is used in the 20 largest cities. Urban areas create 80% of the greenhouse gas emission, so we should take care that urban areas are smart and sustainable as implementations have especially here the greatest impact. Smart Cities (SC) or Smart Sustainable Cities (SSC) are the actual concepts that describe methodologies how cities can handle the high density of citizens, efficiency of energy use, better quality of life indicators, high attractiveness for foreign investments, high attractiveness for people from abroad and many other critical improvements in a shifting environment. But if we talk about Entrepreneurship Ecosystem and Innovation, we do not see a lot of literature covering this topic within those SC/SSC concepts. It seems that 'Smart' implies that all is embedded, or isn't it properly covered as brick stone of SC/SSC concepts, as they are handled in another 'responsibility silo', meaning that the policy implementation of a Science and Technology Park (STP) is handled in another governing body than SC/SSC developments. If this is true, we will obviously miss a lot of synergy effects and economies of scale effects. Effects that we could have in case we stop the siloed approaches of STPs by following a more holistic concept of a Smart Sustainable City, covering also a continuous flow of innovation into the city, without necessarily always depend on large corporate SSC solutions. We try to argue that every SSC should integrate SP/STP concepts or better their features and services into their methodology. The very limited interconnectivity between these concepts within the governance models limits opportunities and performance in both systems. Redesigning the architecture of the governance models and accepting that we have to design a system-of-systems would support the possible technology flow for smart city technologies, it could support testbed functionalities and the public-private partnership approach with embedded business models. The challenge is of course in complex governance and integration, as we often face siloed approaches. But real SSC are smart as they are connecting all those unconnected siloes of stakeholders and technologies that are not yet interoperable. We should not necessarily follow anymore old greenfield approaches neither in SSCs nor in SP and STP concepts from the '80s that don't fit anymore, being replaced by holistic sustainability concepts that we have to implement in any new or revised SSC concepts. There are new demands for each SP/STP being in or close to an SC/SCC as they have a continuous demand for feeding the technology base and the application layer and should also act as testbeds. In our understanding, a big part of STP inputs and outputs are still needed, but in a revised and extended format. We know that most of the SC/STP studies claim the impact is still far from understood and often debated, therefore we must transform the concepts where SC/STPs are not own 'cities', but where they act as technology source and testbed for industry and new SSC business models, being part of the SC/STP concept and governance from the beginning.

Keywords

Science and Technology Parks (STP); Smart Cities (SC); Smart Sustainable Cities (SCC); Smart City Solutions; Digital Innovation Hubs (DIH)

1. INTRODUCTION

Cities have always faced challenges and opportunities, but nowadays, cities are urban spaces which face a never seen complexity of the challenges, but also very promising opportunities (Acuto and Steele, 2013). To create the solution, we need to go beyond known city governance models, subsystem architectures

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and break down a lot of siloes. The transformation requests new governance models with changing roles and responsibilities, much higher level of interoperability not only on IT level but also between all those siloed solutions and services that have been created before. Our focus in this article will be mainly to pinpoint some crucial interoperability challenges that we see, and they are not 'just' technically; a big part of the changes has to be addressed on a policy level, technical level, service level, stakeholder engagement level, authority and funding level. Science Parks (SP) or Science and Technology Parks (STP), for example, are still an appreciated policy instrument created on regional state level or state level and therefore specific 'city-level' needs, 'customization' of services requests, or provision of city-level testbeds cannot be addressed as city governance has limited administrative power in this projects and sometimes they are not even involved as stakeholder of STPs. Connected to this misfit, the technology orientation of the STPs and engagement in topics that are of core interest of the Smart Sustainable City (SSC) are not fitting at all to the orientation of the STP connected to the city. According to the MGI Smart Cities Full Report (McKinsey Global Institute, 2018), such key domains that affect multiple aspects of the quality of life but also sustainability are mobility, security, healthcare, energy, water, waste, economic development and housing as well as engagement and community.

2. STP AND SMART SUSTAINABLE CITY GOVERNANCE: IS THERE A NEED TO BETTER CONNECT SO FAR SILOED SOLUTION?

Amazingly enough, the literature offers a lot of new articles and studies covering SPs or STPs as well as a lot of literature about SSCs. We see SCCs as a necessary evolution of the Smart City (SC) concept, putting more emphasis on the citizens and quality of life aspects than purely on technology and resource efficiency. The same is true for SPs and STPs, STPs are also an evolution of the former pure SP concept taking Open Innovation and Exploitation tasks into account, but not all authors share this view and so we will always talk about SP/STPs. Despite the fact that there is a lot of literature available we couldn't find many articles where typical tasks and goals of SP/STPs are described as a core ingredient in the new SSC concept, except Carvalho (2017) who analyses the entrepreneurial development and innovation within SC and Zouain and Plonski (2015) who asks what makes STPs contribute to improving the quality of urban development analyzing STPs and their role in Brazil as case study. Our article would like to lobby for an approach to have STP governance much more localized and being under or part of SSC governance. The technological competence can still be wider than the SSC demand but must cover at least the SSC demands fully. The funding can still come from the regional state or national level, but in order to be much more interconnected regionally and being much more efficient, SSCs have to be the key player and client of technological input coming from STPs. This is also important in order to create more innovation besides the offers of the large corporates, that already dominate this market with big vendor log-in risk of their solutions. Just to make it clear, we do not want to replace Ministry level program ownership and governance to the Major level, as we stick on the fact that the private sector plays also a key role in proper SCC governance models like citizens; Ministries and Majors act as enablers. Technology is only as effective as the entity that puts it to work (Genta and Riberi, 2019). A split in public policies will occur because public authorities must be capable of thinking "city" and developing new abilities in system architecture, which implies a profound evolution of the administrative organization, which must operate transversally as it is impossible to think in terms of complex systems with an administration compartmentalized into silos (Rochet, 2018). A very good example and maybe benchmark is Singapore. Singapore found an articulation between the central role of the government and initiative of actors; a city is an archetype of the strategist state. In Singapore, the atmosphere is favorable to pilot and innovative field projects that are quickly integrated into the system of systems (Rochet, 2017). The exercise to be done in all those STPs and SSCs is to take the existing subsystem architectures and concepts and make them in a way interoperable as system of systems, that they function properly together, reusing as much as possible from what exists (measured according to KPIs) from all those services, functions and features in order to capitalize on already made investments, but carefully break all siloes that hinder interaction between stakeholders and business models. We believe STPs (or at least the aim of any SC/STP to foster entrepreneurial development and innovation) must be better integrated in the Smart Sustainable City concept and business model, as STPs are not only investments, they can heavily increase the impact when fully being integrated within the SCC concept by taking over key features of the innovation front-end. A best fit of such approach can be

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seen in the Barcelona Urban Lab (BUL)[1] , which is a tool to facilitate the use of public spaces in the city of Barcelona to carry out tests and pilot programs on products and services with an urban impact, which are in the pre-market stage and in line with the Barcelona City Council's aims, priorities, and lines of action. Through this BUL project, the city is made available to companies with innovative projects to test their infrastructures and services for the future in a real environment. This concept fits very well in the European Program of Digital Innovation Hubs (DIH)[2]. DIH are one-stop-shops that help companies to become more competitive with regards to their business/production processes, products or services using digital technologies. Being an evolution of the Smart Specialization activities in Europe, the DIH concept is a very good approach for how STPs could reinvent themselves and finetune themselves for being SSC interoperable.

We need especially for developing countries a smart, lean, agile and sustainable concept that is not anymore copying the 1980s phenomenon of the North American Research Park model and follow only the newest models that are properly adapted to the local context. Those former mostly greenfield models don't fit anymore in modern sustainability concepts, STPs must be integrated service providers within SSC concepts, being close to cities, avoiding wholesale access by private car. There is a clear trend in all healthy start-up-friendly cities where incubators move from the periphery to areas close or into the vibrant city life and cultural activities; not only to be more attractive for talents in a global competition. Incubators often use old industrial or harbor areas to offer their services. These areas are becoming very attractive parts of the changing cities. Attracting startups and SMEs within STPs which are greenfield located is becoming more challenging, because of its very low service density, precludes the emergence of support facilities, and further reliance on the private car is engendered, particularly during the lunch period (Why, 2001). Having successful STP and successful SSC implementation is an integration problem, as it breaks silos of responsibilities and it asks for interoperability of partly already existing IT and IoT infrastructure; only a governance model that goes beyond an existing group of stakeholders can manage this. Rochet (2018) defines a Smart City as 'system of systems' and proposes a concept with an integrative line of thinking which avoids the pitfall of reducing a set to its sub-set: a city is not just its economy, its culture, traffic, energy, housing, etc., but it is the integration of all of these elements. To the entrepreneur, it offers a perspective on their activity that likens it to a rock in an edifice which is bigger than him or her, a great creation that inspires and draws them in and gives them meaning. To the citizen, it offers a path to reconstruct the link between the common good and an individual one which was the basis for the prosperity of medieval towns and cities (Rochet, 2018). Parry (2018) also referring to Brookings Institution (Katz and Wagner, 2014) describe several of those components like Economic Asset, Physical Asset and Network Asset that must be connected for a full functioning SP ecosystem, many of those provisions fall under urban governance. All those successful cities with hundreds of years of experience have already faced those evolutions many times and this is how we should tackle the problem as well; it is very close to the problem that manufacturing is facing when reaching Industry4.0. The pure new technology aspects are still important, but only as one of many aspects that have to be taken into account. The key aspect is nowadays interoperability between technology solutions, services, but also within the governance layers, where we still see too many islands and siloed solution approaches. This approach addressing the key issue of 'How to Break Down Silos to create a better Smart City' was tackled by several cities (SmartCityBrand, 2017) like Oslo, Amsterdam, Ljubljana, Medellin, Vienna, Trieste and for sure by other, each of them focuses on another area.

3. STP AND SMART SUSTAINABLE CITY CONCEPTS AND DEVELOPMENT: HOW CAN THEY BENEFIT FROM EACH OTHER?

STPs have become a very popular policy tool to enhance knowledge-based regional development since the early 1980s. STPs can be found all over the globe based on different models of stakeholder involvement and mission (Geenhuizen and Soetanto, 2008). First Science Parks emerged in the U.S. in the 1950s at Stanford Research Park and Research

[1] http://www.22barcelona.com/content/view/698/897/lang,en/

[2] https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs

Triangle Park, first Science Park in Europe was established in Edinburgh 1965. In 1970 there were only 21 Science Parks throughout the world (Haxton, 1998) and this number increased to 473 science and research parks in 1998 (McQueen and Haxton, 1998), and in 2014 Europe counted already about 400 Science Parks (Rowe, 2014). This amazing increase of Science Parks and STPs can only be explained by a kind of common policy understanding where STPs are the Number 1 tool to encourage the formation of knowledge-based businesses and the other organisations that are normally residents on-site (Ylinenpää, 2001). Despite the fact of such growth rates where Science Parks and STPs become common practice, the impact is still far from understood and often debated (Lecluyse et al., 2019). Geenhuizen and Soetanto (2008) even state: 'Despite the rather poor proof of success, Science Parks, paradoxically, have remained extremely popular as a policy tool'. In times of Open Innovation, full digitalization of communication from telcos, meetings to social media, digitalization of industry, globalization, are SPs with localized tenants still the right instrument? Does close mean these days a distance or does it more mean frequency of interaction that doesn't care about distance? But in case - being close to the end clients- is an important element we need to fully capitalize on it and use the testbed functionality much more for Smart Sustainable City solutions. Did SPs and STPs miss to digitalize their services, missed the STP4.0 evolution and did they miss to detect a core client of their services and functionalities, the SSCs? Is this one of the reasons why we do get a very diversified picture of the performance when analyzing SP/STPs? As already reflected by A. D. Nararasimhalu (2013) STPs are key partners within the Open Innovation Ecosystem and we suggest to add SSCs as a key partner in the presented valorization model. Valorisation of high-quality infrastructure and services of many intermediaries doesn't properly function as we often miss the high-level orchestration of the national, regional and city-level policy development and therefore we see missing interoperability within the support services. Innovation infrastructures and digitalization services are boxed in silos and miss interoperability of infrastructure, services as well as on technical level, whereas the impact could be increased with better coordination and meta-level governance of those instruments.

SPs or STPs are part of policy tools that serve to enhance the knowledge-based economic growth of regions. Important policy tools that are used in combination are intermediary organisations for knowledge and technology transfer, networking and cluster programs and finally investment support schemes. Since the 1980s and depending very much on the stakeholders and regional context there are attributes that all SPs and STPs have in common (Gower and Harrris, 1994):

- a property-based initiative close to a place of learning (university or research institute),
- the supply of high-quality premises or units to businesses,
- a policy context of mixed public/private stakeholders with expectations on the knowledge-based economic results of the parks.

In order to find commonalities between SPs/STPs and Smart and Sustainable Cities, we should compare the contributors for each of them. According to (Lecluyse et al., 2019) the contributors could be categorized in Inputs (regional level, SP/STP-level, firm-level), Mediators (networking for SP/STP and firm-level) and Outputs (regional level outcomes, firm-level outcomes).

SCs or SSCs both don't have yet a normalized definition. So, we mainly have kind of prototypes that we take in order to define them. Some of them are showcases for technologies endorsed by our largest tech companies (Cisco, IBM, Siemens, Microsoft, etc.), such as Songdo (Korea), Masdar (Abu Dhabi) and Plan IT Valley (Portugal), but which are not cities made to be lived in by real people (Rochet, 2018). After a decade of trial and error, municipal leaders are realizing that smart city strategies start with people, not technology. "Smartness" is not just installing digital interfaces in traditional infrastructure or streamlining city operations. It is about using technology and data purposefully to make better decisions and deliver a better quality of life (McKinsey Global Institute, 2018). But looking at the expansion of Singapore (Rochet, 2017) we can see that absorbing hard technologies is actually relatively easy, and as soon as a country has understood that the keys to success are in the intellectual investment of soft technologies and social capital, the student overtakes the master in only a matter of decades.

As mentioned before, the key aspect is to master the hard technologies and the soft technologies. Whoever masters the ecosystem of the city will de facto master the underlying technologies, and will define the demand, supply also define standards (Rochet, 2018). This is a promising role to have, not only because SC/SSC market is forecasted in 2020 having a valuation in studies of $1.5 billion with 70% in infrastruc

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Fig. 1. The Chinese approach to urban integration.

Source: Quangbin Wang, in: Rochet (2018); see also for a larger version of this figure: www.iste.co.uk/rochet/cities.zip

ture and about 30% in services. Chinese planners have not wasted any time integrating such a system approach as visualized in Figure 1.

The advantage of this Chinese strategy is in looking at a city as a whole (system of systems approach) rather than a mere sum of its parts, accentuating the ability to integrate technologies which, for the time being, come from the Western world. Their approach understands that what controls the system controls the underlying technologies and not the other way around.

4. SMART SUSTAINABLE CITIES SUPPORTING ENTREPRENEURSHIP AND INNOVATION, THE INTEGRATION CHALLENGE

Like mentioned already, the biggest cities worldwide will be the most important testbeds for new sustainability approaches, but also testbeds for better transactions of communication, processes, business models, inter-governmental collaboration and the destruction of former siloed approaches with very low interoperability and this is meant technically, process- and communication-wise. Most of these cities are having hundreds of years' experience in reinventing themselves and saw already three industrial revolutions. The next challenge is the secured full digitalization combined with a much more participative collaboration with the citizens.

Those changes are disruptive changes, changes that are not done as greenfield approaches on a drawing table. The changes must be implemented within a running and existing system like a customization approach because of new requirements. The process is for sure a loop process which is in a way never-ending permanent learning; the Moebius strip. Integrating STPs fully into SSC concepts mean an extension of the already know value propositions that with new stakeholders and new governance are different to what is practiced so far. Comparing this with Parry's governance models (Parry, 2018),

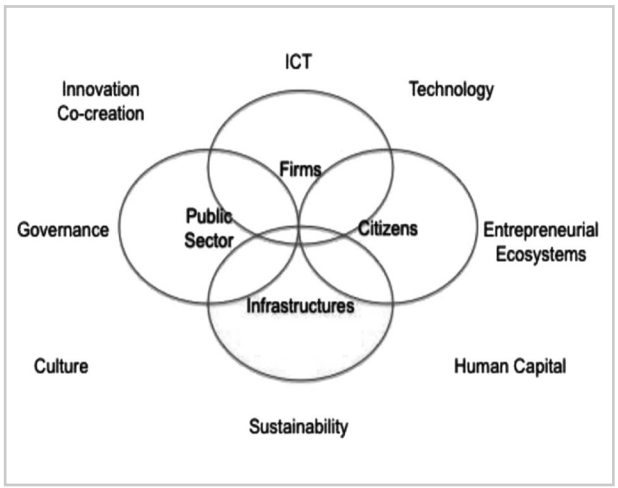

Fig. 2. Smart City environment

Source: Carvalho (2017)

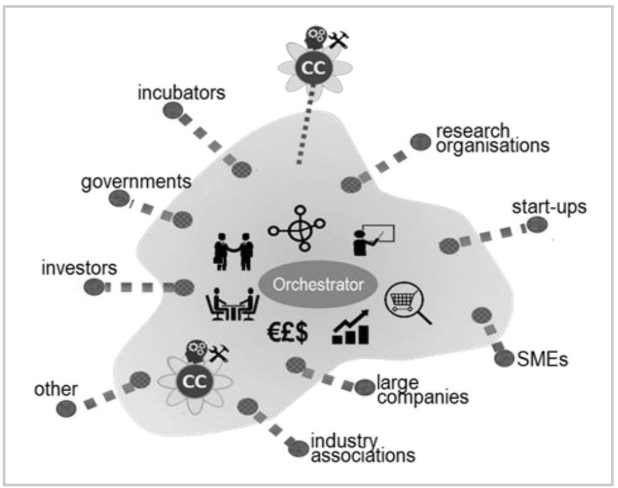

Fig. 3. Digital Innovation Hub Ecosystem

Source: Roundtable on Digitising European Industry: Working Group 1 – Digital Innovation Hubs)[3] (2017)

the approach could follow a 'Startup/Entrepreneur led cluster approach that is also described in SSC methodologies where the integration is Public-Private Partnership driven and Governments are just preparing and facilitate the environment for proper integration. Carvalho (2017) defines a Smart City according to the mandatory environment where typical core elements of SP/STPs are integrated (Figure 2).

Normally an SP/STP contributes to three (out of eight) areas shown in Figure 2, Innovation and Co-creation, Technology and Entrepreneurial Ecosystems. As most of the Cities already exist and not set up on a greenfield the right model and strategy have to be selected, depending on the objectives, motivation, governance model, partners, funding, etc. This means SC/SSCs can be planned and projected or originated from retrofitting projects. Of course, the actual maturity level (disperse, integrated or connected) is important as well and depends on the local and required specificities.

In our point of view, SP/STPs must undergo a two-stage transformation in order to be ready to be part of a system of system approach. The first stage is transforming the SP/STP in a Digital Innovation Hub (DIH) ecosystem. The second stage is the full integration of the newly created DIH into a holistic concept of SC/SSCs, overcoming former bottlenecks and inconsistencies of siloed policy solutions that separated the concepts, solutions, and services without any interoperability between them.

Digital Innovation Hubs as a first transformation step are one-stop-shops that help companies to become more competitive with regards to their business/production processes, products or services using digital technologies. They are based upon technology infrastructure (Competence Centre – CC) and provide access to the latest knowledge, expertise, and technology to support their customers with piloting, testing and experimenting with digital innovations. DIHs also provide business and financing support to implement these innovations, if needed across the value chain. As proximity is considered crucial, they act as a first regional point of contact, a doorway, and strengthen the innovation ecosystem. A DIH is regional multi-partner cooperation (including organizations like RTOs, universities, industry associations, chambers of commerce, incubator/accelerators, regional development agencies and even governments) and can also have strong linkages with service providers outside of their region supporting companies with access to their services. The model is visualized in Figure 3. This approach also takes into account the former challenge mentioned that SP/STPs are normally policy tool that is created on federal-state level or even country-level in small countries.

DIH create with their embedded design and architecture an entrepreneurial ecosystem and this links also to the former mentioned second integration step. Entrepreneurial Ecosystem is a recent concept without a clear consensus about its

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definition. Isenberg (2010) proposed nine 'prescriptions' for creating an entrepreneurial ecosystem:

1. **Stop Emulating Silicon Valley:** While Silicon Valley is a successful entrepreneurial ecosystem it is unique for its region and unlikely to be replicated in other areas.
2. **Shape the Ecosystem around Local Conditions:** Look for locally based industries with growth potential and existing capacity and build upon these foundations.
3. **Engage the Private Sector from the Start:** Entrepreneurial ecosystems must be led by the private sector and the role of government is to facilitate not try to lead or control.
4. **Favour the 'High Potentials':** While there must be room for all types of business attention should be given to fostering the growth of firms with the capacity for innovation and global market engagement.
5. **Get a Big Win on Board:** Success stimulates and motivates others to have a go and where there are successful firms they should be showcased and used as case examples for others.
6. **Tackle Challenges Head-On:** Entrepreneurial activity in some areas may be stifled by an entrenched culture that is risk-averse or conservative, this should be challenged by active communication and education programs.
7. **Stress the Roots:** Entrepreneurial growth-oriented firms should not be flooded with 'easy money' through grants or venture capital flows. Firms must be profitable and sustainable with good financial management.
8. **Don't over Engineer Clusters;** Help Them Grow Organically: Government enthusiasm for building industry clusters needs to be tempered by a realization that they emerge organically from existing industries and not from attempts to 'pick winners' or building green fields science parks.
9. **Reform Legal, Bureaucratic, and Regulatory Frameworks:** A key role for government is to address legal, bureaucratic and regulatory issues such as taxation, licensing and compliance so that there are no unnecessary impediments to entrepreneurship and small business growth.

SP/STPs is a policy instrument and very often they don't respect those prescriptions. In those government-driven approaches, SP/STPs are often building on promising new technology areas without having the locally based industries with growth potential and existing capacity to build upon these foundations. Large exogenous firms also play a major role in developing regional ecosystems, especially in peripheral regions, developing the ecosystem's managerial talent pool and providing commercial opportunities for local businesses. Additionally, large companies can also give several other contributions, including the provision of space and resources for local startups, the creation of programs to support start-ups and the development of companies that improve their own eco-systems.

5. CONCLUSION

This article lobbies for having the traditional features and services of Science Parks (SPs) and Science and Technology Parks (STPs) being revised. SP/STP have optimized their features and services up to the limit the governance model has given them. But this is exactly the problem, the limited interoperability to connect as a sub-system to the system of system. On the other side, we have the Smart Cities (SCs) and Smart and Sustainable Cities (SSCs), their governance system should allow the orchestration of the system of systems and instead of reinventing the wheel we should connect SPs/STPs as innovation front end; being part of the Innovation Ecosystem. We should be very careful that we put our focus on a sustainable integration of optimized subsystems. As the investments are massive, we should be very careful to integrate sustainable business models into this system of systems that are not only generating revenues just and only for large corporates and their solutions. SSCs are reinventing themselves every day according to new demands, a vendor lock-in system is dangerous because of missing flexibility and missing integration of business models and solutions provided by players that are part of the ecosystem. There are open source solutions available that would support revenue creation for all players in the system like the FIWARE Smart City solutions (FIWARE Foundation, 2019). We need two-sided markets for SSCs and STPs that transformed into modern DIHs that support the Innovation Ecosystem and allow financial sustainability as well.

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