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Knowledge spaces and places: From the perspective of a "born-global" start-up in the field of urban technology

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ABSTRACT

The success of cities increasingly relies on its capacity to capitalize on its knowledge base, but also on its potential to anchor external knowledge and the strategies of knowledge-based firms. In this paper we analyze how a "born global" start-up firm is linked to different types of places, and how it explores and exploits different territorial innovation potentials. Our case company—i.e., Living PlanIT—develops, tests and sells smart city software to processes real-time information collected through sensors embedded in a city's buildings and infrastructure towards energy savings and manifold efficiency gains. The paper illustrates how the interaction with different places and knowledge-based cities provides unique resources for the technology development, search, experimentation, market formation and societal legitimation. Beyond focusing on a place's fixed knowledge assets, the paper empirically assesses the innovation functions of different types of knowledge-cities and temporary "non-places" such as international high-level events.

1. Introduction

The economic success of cities depends on its capacity to grow and capitalize on its knowledge base—e.g., to generate and commercialize new knowledge, to attract talent and breed innovative firms. During the last decades, with the emergence and consolidation of a knowledge-based economy, the role of knowledge in urban and regional economic development has been studied extensively (e.g., Carrillo, 2010; Knight, 1995; Kostiainen, 2002; Lever, 2002; Raspe & Van Oort, 2006; Van Winden, Van den Berg, & Pol, 2007; Yigitcanlar & Lönnqvist, 2013).

A key question addressed by the literature on knowledge-based urban development is what explains the performance of cities and regions. Studies in this field seek answers to questions such as which type of knowledge "assets" are particularly valuable, where are they located, and how they can be recombined and managed (e.g., Asheim, Boschma, & Cooke, 2011; Florida, 1995; Gabe, Abel, Ross, & Stolarick, 2012; Lerro & Schiuma, 2011; Lönnqvist, Käpylä, Salonius, & Yigitcanlar, 2014; Sotarauta, 2010; Yigitcanlar, 2009). Performance differences between cities and regions are explained by the variance in their asset mix. Overall, it is contented that large metropolitan areas tend to perform better over time. Their asset mix (i.e., knowledge institutes, economic diversity, thick labor markets, cultural vibrancy, international orientation, consumption value) helps to attract talent, knowledge-intensive investments and makes them breeding places for innovation and entrepreneurship. However, other city types are also well placed, namely those with a strong knowledge base (e.g., a renowned university) and specialized in related knowledge-based industries (Boschma & Frenken, 2011; Van Winden et al., 2007).

An alternative but complementary lens to study the link between the knowledge economy and cities is provided by the (innovation) management literature. Since the pioneering work of Porter (1990), there is a growing literature body on how firms may strategically exploit localized innovation ecosystems and assets to increase their performance and innovation potentials (Howells & Bessant, 2012). Companies strongly rely on external networks and alliances to innovate; even in an age of fast communication and dematerialization, many networks have a strong local orientation. The rise of 'open innovation' strategies (Chesbrough, 2003; Howells, Malik, & Gagliardi, 2008) has evoked studies on extended R&D operations and the co-ordination of knowledge flows

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(Alnuaimi, Singh, & George, 2012; McCann, 2011; Van Winden, Van den Berg, Carvalho, & Van Tuijl, 2011), namely of multinationals scanning the globe to tap into localized knowledge resources (Doz, Santos, & Williamson, 2001). In fact, this strand of literature mainly focuses on multinational companies, as they make the more explicit strategic location decisions. However, much less is known about how smaller firms and start-ups actively exploit territorial differences and unique (yet globally-spread) knowledge assets (e.g., Vale & Carvalho, 2013).

In this paper, we combine these two approaches and focus on the places and spaces mobilized by a "born-global" start-up company—Living PlanIT (hereupon PlanIT)—in their knowledge sourcing strategies. Contrarily to companies that internationalize at later stages of development, a born-global company is a "[n]ew venture that acts to satisfy a global niche from day one" (Tanev, 2012). Frequent characteristics of born-global companies are: (i) their technological drive; (ii) the reliance of large ecosystems of partner organizations; (iii) the limited financial and tangible resources; (iv) the focus on differentiated designs and products and; (v) the high degree of international connectedness of their founding entrepreneurs and managers. A somewhat paradoxical feature of born global companies is that while they tend to advocate that their business strategies are possible because the world is increasingly "flat" (Friedman, 2006), their knowledge sourcing practices reveal the search for very concrete, path dependent and localized resources, often present in knowledge-rich cities.

PlanIT is a company active in the emerging field of "smart city" applications and urban technology (Allwinkle & Cruickshank, 2011; Carvalho & Campos, 2013; Townsend, 2013). Their main product is a proprietary IT system designed to integrate diverse "smart city" innovations and urban "apps" into one single platform: the Urban Operating System (UOS™, hereupon UOS). The UOS processes real-time information collected through sensors embedded in a city's buildings and infrastructure towards energy savings and manifold efficiency gains. In this paper we analyze the "exploitation" of places and spaces of PlanIT in its quest to develop and scale up the UOS. PlanIT "chose" the North of Portugal to settle headquarters and to develop a visionary "city-from-scratch" test-bed (The Economist, 2010) but other carefully selected cities and milieus have been important as well. This makes this case study an interesting arena to explore the role of diverse knowledge-city assets and the drivers behind the nuanced geographies of innovation in a context hyper-mobility and transnational business organization (Mariussen & Virkkala, 2013). Moreover, it also analyses the complex geographies through which emerging "smart city", urban technologies are developed and unfold, which go largely beyond the boundaries of specific knowledge cities.

This case study is based on a large array of secondary sources about PlanIT and the UOS (reports, press-releases, international media coverage, web discussion forums, and personal communications), collected and analyzed during 2011 and early 2012. Moreover, it also draws from 10 in-depth and semi-structured interviews, conducted during the same period with PlanIT founders and executive managers (face-to-face in Portugal and the Netherlands; one conference call to London) as well as four other involved discussion partners in the North of Portugal (regional government representatives and consultant) and Lisbon (partner company).

The paper is organized as follows. Section 2 contextualizes the "born-global" story of PlanIT, its origins, products and business model. Section 3 explores the geographies underlying the development of the UOS and the operations of PlanIT; to do so it uses an innovation system framework under which different knowledge cities and milieus are associated with *functions* that holistically support the innovation under analysis. Section 4 concludes and provides insights on the geographies behind the development of new urban technologies, in particular, and challenges for knowledge cities, in general.

2. The origins and early development of living PlanIT[3]

Living PlanIT was founded in October 2006 in Switzerland by two entrepreneurs (former managers at Microsoft, IBM and other IT companies) with an eye to explore IT-based, platform solutions for the many inefficiencies observed in the construction industry (e.g., long, fragmented and obscure supply chains leading to high costs, waste and very little innovation).

In order to tackle those issues from 2006 to 2008 Living PlanIT invested considerable resources in learning from other industries (e.g., automotive, shipbuilding, aviation, IT) about the roots of their products' life cycle and value chain integration, speaking with many executives and people from multiple technical and commercial backgrounds, most of them former Microsoft relations. This stage paved the ground for the development of the first PlanIT technologies and software solutions for the construction industry. However, despite the achievements, the two founders soon realized that beyond running more efficient value chains, the key breakthrough and "game-changer" ahead was on making buildings able to dynamically change features and interact with users during their lifetime. However, despite piecemeal initiatives (e.g., embedding some sensors in buildings), there was no known integrative platform in the world to run (and interactively "learn" from) that interaction.

Living PlanIT's vision and strategy reached a new critical juncture when one of its founders, out of many contingencies, met three Portuguese individuals (in 2008): the Managing Director for Microsoft Automotive Worldwide (in Germany), a local entrepreneur exploring electric vehicle solutions and prototypes in the city of Paredes (30 km from Porto, Portugal) and its Mayor, who were at the time exploring and electrical mobility project for the city. PlanIT's founder and CEO believed the mobility project of Paredes could be part of a more ambitious initiative to develop and scale up a comprehensive set of environmental-friendly technology solutions. His ultimate vision was to connect buildings, mobility solutions and everyday users through a fully integrated "urban brain", an IT platform in which a potentially infinite number of partners could plug into develop, test and exploit new urban "apps". To develop, test and showcase the possibilities of such a platform, a large Greenfield location was required, freer from the social, infrastructural, legal and regulatory constraints of existing cities. The Mayor agreed to provide a 1670-hectare site at low prices, as well as legal and bureaucratic support with governmental entities. By this time, the two Portuguese entrepreneurs became PlanIT partners and the company's headquarters moved to Portugal.

From this moment onwards, PlanIT's partners started assembling capital and skills through their high-level international networks. A number of new partners joined the venture, leaving their senior positions in leading IT multinationals around the world. Many moved to Portugal, others stayed in their original locations, establishing single-person "antennas", supported by extensive travelling and videoconferencing. The capital acquired (e.g., through equity investments, friends, family and loans) supported the first stages of technology, branding and business model development. In late 2012, PlanIT's staff counted around 100 people (the large majority being also shareholders), including the senior executives, technical, commercial, legal and administrative

[3] Here we present a "nutshell" version of the companýs biography. A much more detailed account of the companýs history and business model can be found in Eccles, Edmondson, Thyne, and Zuzul (2010), on which this section is largely based.

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staff. More than half of the team had former Microsoft experience; others include, among others, former Cisco and IBM staff. Beyond IT engineers, the staff counts with materials engineers, aeronautics engineers, mathematicians and neurobiologists.

2.1. The UOS and the place "apps": the urban technology

Cities are but one type of adaptive social forms of organization, an ever-challenging task in Developed over the last years, the core innovation underlying the vision of Living PlanIT is a complex, trademarked software platform called UOS. The UOS processes real-time information collected through sensors embedded in a city's buildings and infrastructure, unleashing reactions accordingly (e.g., dimming lights, adjusting energy supply according to people's flows in a city) towards energy savings and manifold efficiency gains. Moreover, the collected information and data streams can be used to improve infrastructure's features and performance over time.

Practically speaking, the UOS is composed of a number of algorithms (i.e., the "methods" to deal with data) and pieces of software (i.e., how to get the information and how to process it). UOS analytics (the real-time controller) presently works in a dedicated physical server and routers, to which other potential partners and application developers can plug in[4]. The UOS works in a framework of ubiquitous sensors and cloud computing, which can be compared to a person's brain and nervous system. PlanIT's vice president for corporate development provides a vivid explanation:

> "Think of a room in a café, or a city district, with many bits of things – the lamps, the energy and ventilation system, safety, fire alarms, etc.—everything turning on and off independently, in their own subsystems. The UOS connects all these subsystems together and makes them directly interact with each other."

It is this integrative character of the UOS that distinguishes it from other urban technologies championed by large IT companies, which tend to focus on specific subsystems of a city (e.g., lightning, energy, waste), but which do not consider their interaction with each other. Moreover, just like Microsoft Windows, Facebook or the iPhone Operating System, the purpose of UOS is to be available for an ecosystem of developers that can create "apps" and solutions for citizens, governments, service providers, construction companies, etc. What is also distinctive about the UOS is that the data generated is location-context specific, thus the name "place apps". As the Chartered Institute of Building (2011, p.6) puts it, one of PlanIT's central innovation proposition is to foster

> "...smart buildings and cities impregnated with sensing, communications and remote actuation devices, powered by cloud computing, allowing for unprecedented control of waste and energy. (...) Buildings won't really be buildings anymore; primarily, they will be computing devices, "iBuildings", like iPhones, allowing developers to get more money out of their built assets by facilitating the provision of software applications to building occupants."

The knowledge and competences for developing the UOS came from different sources. The founders brought in competences in IT and the construction industry backgrounds, but an essential part of the knowledge was acquired externally. The key technology pieces involved in the UOS (e.g., the real-time control software) were initially developed in the Formula 1 industry (McLaren), which is known by embeds many sensors in their cars to collect and deal with the enormous amounts of data produced during a race. Through such software, the race data is analyzed and used during the pit stop to assess the car's performance, but also to improve its engines and components for the next race, in a continuous innovation fashion. PlanIT drew inspiration from that solution to the context of buildings and the complexity of the built environment in cities, adjusting the UOS on that basis. As explained by PlanIT's Chief Technology Officer (CTO), there are important basic similarities:

> "...the functioning of a race car is rather complex, it has about 70 switches the pilot may use to alter the car characteristics (e.g., fuel, pressures, engine specificities) following remote instructions from the race pitch, based on real-time information the car produces through sensors. (...) [Moreover] both environments [cars and cities] need high security, since you wouldn't want your competitors snooping around the details of your car (...) [and both environments can] also benefit from continuous improvement and fine-tuning on the basis of user's data".

Such potential triggered the early interest of Living PlanIT for McLaren's technology, resulting in the acquisition of the software's IP in 2010, being licensed back to McLaren afterwards (so that both could work on the solution's continuous improvement). McLaren Electronics is currently one of PlanIT's key technological partners within the company's "ecosystem".

2.2. The business model and partner's "ecosystem"

PlanIT's vision is not to develop technologies in isolation, but to facilitate the integration of the technologies of many providers into a comprehensive solution. Moreover, PlanIT envisages the development of a large technological ecosystem around the UOS, in which companies, organizations and users work together, experimenting and exploring synergies towards the development of building innovations and "place apps". Ultimately, as put by the company's CTO, Living PlanIT's strategy is

> "...to take a bit of a backseat as we get to steady-state and have the partners being the ones driving forward the application of the technology. (...) We will literally just be the suppliers of the platform, the glue that makes it all fit together."

The UOS (and the innovations that run on the platform) are developed through a particular business and technological development model, in which many partners are involved, from all over the world. Partner companies and developers sign an agreement and pay a fee to be part of PlanIT's "innovation ecosystem" developed around the UOS platform. The revenues will come from IP, technology development and other royalties:

> "We don't want their [the partners'] business, we want part of the business we generate them" (Senior Manager of PlanIT).

The creation of such an "ecosystem" is central in the company's vision and strategy. It not only explores technological complementarities but supports: (i) the continuous fine-tuning and scaling up of the UOS, and; (ii) the creation of network advantages, as partners become "ambassadors" not only of their solutions, but of the whole UOS platform around the world. Amongst the PlanIT ecosystem partners are currently leading global companies such as CISCO, IBM, Microsoft, McLaren, Philips, Hitachi Consulting, Buro Happold, Deutsche Telekom, and Alliander. The company's ecosystem also includes a growing number of leading Portuguese companies and organizations, in domains such as IT or sensor technologies. Each partner signs a detailed contract, (typically after

[4] In the future, other brands of hardware might embed the UOS as well, using it with their own routers and software (e.g. like the *Android* platform on smart phones, supplied through many different mobile brands). Moreover, it can also naturally run non-physically in a *cloud*.

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intensive negotiations). PlanIT receives a large amount of partnership requests, but selects only those with credible potential to contribute to the ultimate solution and the company's vision.

2.3. An overview

The company was founded by a handful of well-connected, seasoned and internationally experienced executives in the IT industry, willing to "make a dent in the world", who saw large market opportunities lying ahead for new, more efficient building solutions in the developed and emerging world. The technology underlying the UOS relies on other companies' solutions (sensors, cloud), but mainly on a real-time control software previously developed in the context of Formula 1 races. PlanIT acquired the IP and its staff re-developed or re-adjusted it to the context of buildings and cities. The UOS promises to be a new answer to urban energy and environmental problems by improving efficiency in city's subsystems (e.g., built environment, mobility, safety, energy, lightning, etc.). It can do so, for example, by facilitating distributed energy provision, consumption reduction and more efficient and cleaner transport solutions.

However, the implementation the technology requires substantial organizational and cultural changes. The UOS allows previously unconnected systems such as energy, water, lighting or waste to directly interact with each other, in a "machine-to-machine" fashion. But making this happen requires innovations in the value chains of the construction industry (procedures, communication, integration, accuracy), and new types of public private partnerships.

From its inception, PlanIT has had global ambitions. Its UOS should become a "killer" solution to integrate many other IT-efficiency ("smart") initiatives in cities all over the world. Its founders are not bound or rooted in a single nation (let alone a single city): they are the type of new global Argonauts (Saxenian, 2006), internationally oriented, networked and highly mobile senior executives and technologists. However, this does not mean that specific places and territories are/were irrelevant for the development of UOS and PlanIT propositions, as the "global firm" and "flat world" discourse tends to consider. In the next section it is argued that rather the contrary happens. At a closer look, PlanIT and the UOS development are associated with the selection of very concrete, far-from-random places and with the distinctive resources and assets they provide.

3. Localization strategies and the geography of the innovation

The resources required to develop and scale up the UOS (and associated innovations) are daunting and not strictly financial. In order to access such resources, which geographies have been relevant, and why has that been the case? In other words, are there (implicit or explicit) localization strategies as regards this innovation? What is the spatial dimension of the company's innovation ecosystem, and what is it explained by?

As a born-global, Living PlanIT's staff and operations are located in different cities and regions, for different purposes: developing the technology, experimenting and adjusting early pilots, showcasing, selling, branding, building a partner's and clients' ecosystem, and, ultimately, scale up the UOS as a leading platform for IT-smart city initiatives. For those activities—potentially associated with technological and organizational ruptures—traditional location factors such as government incentives, factor costs or markets are insufficient to explain the company's localization strategies.

In order to shed light on the location strategies of PlanIT and the development of the its main product, the UOS, we consider an "innovation system" framework, under which such locations are understood as composed by distinctive systems of actors, networks and institutions that collectively provide different functions that influence innovation (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008). It considers that innovation systems have important place-based dimensions and change slowly. Their features influence the degrees of freedom for the development of new innovations, supporting (or hampering!) the process. As mentioned, they are composed by:

- *Actors*, such as entrepreneurs, companies, R&D institutes, venture capitalists, governments and supportive organizations;
- Formal and informal *networks*, such as technology consortia, buyer–seller relations, industry-university links, and;
- *Institutions*, e.g., laws, norms and routines, such as procurement and innovation policies, specific business practices, problem-solving culture, and so on.

The interaction between these elements originates a number of specific functions that influence innovation (Bergek et al., 2008):

- *Knowledge development* (e.g., incentives, talent and players to explore new knowledge and applications in a certain field);
- *(Protected) entrepreneurial experimentation*[5] (e.g., provision of physical and regulatory conditions for testing and piloting niche innovations, in spite of associated risks and uncertainty);
- *Resource mobilization* (e.g., accessing to specific labor pools, finance, land);
- *Market formation* (e.g., interaction with larger and/or more sophisticated markets, support the move from inexistent niches to widespread exploitation);
- *Influence of direction of search* (e.g., identification "in-the-field" of risks, dead-ends and latent opportunities associated with the innovation), and;
- *Legitimation* (e.g., showcasing of the innovation's features towards societal acceptance, overcoming cognitive-cultural skepticism).

With this framework in mind, the next sections analyze the function of the most relevant places for PlanIT: (i) The North of Portugal/Paredes; (ii) London; (iii) The US (i.e., Detroit and Boston); (iv) The UOS pilot cities, and; (v) Events and international conferences, as "temporary" yet central places for PlanIT's strategy and the UOS scaling-up. We analyze how different locations complement each other by facilitating one (or more) key function(s) for the UOS development and PlanIT strategy, in a nuanced way. Table 1 synthesizes the following analysis.

3.1. PlanIT Valley: Paredes/North of Portugal

Living PlanIT moved its headquarters from Switzerland to the North of Portugal with the ambition of developing a "new city" (greenfield, planned for a total of 1.670 ha.) in the Municipality of Paredes—PlanIT Valley, the first large scale test-bed of the UOS and all its operative dimensions. The ambition is to host a large number of international companies, R&D units and residents to interactively develop, test and showcase the whole UOS propositions in a newly built urban environment. It should become the

[5] We added the term "protected" to the original "entrepreneurial experimentation" function. This is inspired by the literature on socio-technical sustainability transitions (e.g., Geels, 2002), under which the testing and nurturing of new promising technological niches and ventures require a certain degree of piloting, "incubation" or "protection" from dominant socio-technical regimes (e.g., support of experimentation of new cleaner fuel solutions under the dominance of a fossil fuel regime). For spatial extensions of this literature, see e.g., Truffer and Coenen (2012).

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Table 1
PlanIT and the UOS: locations and main functions.

Location	Main functions	Activities and resources accessed
PlanIT Valley (Paredes/North of Portugal)	• Knowledge development • (Protected) Entrepreneurial experimentation • Resource mobilization • Legitimation	• Developing, testing and adjusting UOS and place apps • Greenfield experimentation • Labor, land, local political support • Showcasing the integration feasibility
Detroit	• Knowledge development	• Automotive software skills
Boston	• Resource mobilization • Market formation	• Venture capital, investors • Sales function
London (Greenwich Peninsula)	• Knowledge development • (Protected) Entrepreneurial experimentation • Resource mobilization • Market formation • Influence of direction of search • Legitimation	• Knowledge partners, app developers, testing • Retrofit experimentation • Science and technology policy, governmental and local political support and funding • Sophisticated users in a global city, IT start-up incubation • First living test-bed feedback • Showcasing
(Other) Pilot cities	• Knowledge development • (Protected) Entrepreneurial experimentation • Resource mobilization • Market formation • Influence of direction of search • Legitimation	• Testing and adjusting technologies • Greenfield/retrofit experimentation • Local political support • Large and advanced cities • Test-bed feedback • Showcasing, regulatory change
International events	• Resource mobilization • Influence direction of search • Legitimation	• New business and technological partners; clients, financers • Feedback and opinions • Showcasing, influencing decision makers

first fully-fledged, real-life application of the manifold urban technology concepts of PlanIT's ecosystem.

Currently, PlanIT's main offices locate close to Paredes (combining working and living in a shared, high-quality villa's resort), permanently hosting a team of about 20–30 staff members, both from the region and abroad, in frequent geographical rotation. Besides administrative and legal services, it concentrates the core of the UOS software development, as well as hardware integration and new solutions to link the UOS with the built environment (e.g., sensor adaptation for sewage and water systems). It is the main development centre of PlanIT.

Why did such a futurist venture, "choose" the North of Portugal as a key location? PlanIT points a number of reasons. First, beyond the circumstantial (yet decisive) meetings with the Portuguese partners, the positive relation early established with the Mayor of Paredes. More than selling a large plot of land at low prices, he facilitated bureaucracy removal and proactively bridged PlanIT to other regional and national partners, as well as to the National Government (e.g., discussing FDI bureaucracy exceptions, staff relocation support, one-stop desks, etc.). Those supports are important for PlanIT, but essentially for potential R&D investments of PlanIT international partners. As PlanIT's executives stress:

> "We never got any type of government funding or direct tax rebate, but we had a very good relation since the beginning [with the Mayor]. He struck me as a different Mayor (...) who understood our ideas very well and was enthusiastic since the first moment. His support has been invaluable. For example, there was a day when we unexpectedly had to deliver a master plan for the area within a tight deadline [to the National Government], and the City's planning department literally slept in the office for days just to support us" (PlanIT's CEO).

> "When we first went to the National Government to explain our ideas, they thought we were a bunch of lunatics and that we would never return [there]. There was a double disbelief: first, which the project existed, and second, that it was in the North of Portugal [and not in Lisbon]. (...) With the Mayor of Paredes, the relation has always been more open, proactive and proximate; he involves us in his municipal initiatives, and we also involve him in ours [e.g., international high-level Microsoft conference on smart cities] (Vice President for corporate development).

A second supportive reason has to do with the presence in the region of a large pool of high-qualified skills (e.g., for first hires of new Plan IT ecosystem partners), with three large universities and engineering schools in a short radius (i.e., Porto, Minho, Aveiro), boasting an increasingly entrepreneurial attitude and very competitive wage rates. Third, PlanIT refers to the "super infrastructure" and international accessibility (i.e., airport), but also the highways and "last mile" infrastructure already existent in Paredes (i.e., basic infrastructure and accesses to the land plot). Fourth, PlanIT mentions "quality of life" factors, such as the many amenities of a metropolitan region, historical city (i.e., Porto) and beach/natural sites and international schools, highly valued by relocated executives and staff. Moreover, these factors endow the location with agglomeration potential, much more than in a strictly "virgin" location.

Another question—associated with a latent criticism—is why to develop the test-bed in an expensive "new city" (i.e., PlanIT Valley) and not in an already existing one. PlanIT also develops and sells the UOS in existing cities[6] (see next sections), but a "blank sheet", privately owned condominium has many advantages for the purposes of the innovation. First, there are technical issues. For example, in existing cities it is presently very difficult, if not impossible, to achieve full integration of all independent subsystems during the testing stages (e.g., energy, waste, lightning, health, safety, etc.), which have always worked independently. A "new city" allows developing the built environment and integrating the urban subsystems from the onset, showcasing its feasibility and advantages (i.e., legitimation). Moreover, in such a fully dedicated test-bed it is possible to jointly learn and adapt the technology features as it develops, such as to turn-on/off all the routers at once and introduce "upgrades" on-the-go, in a flexible and still moldable urban infrastructure.

[6] Urban "retrofitting" is referred as an important target in PlanIT's strategy, together with the development of new cities and districts, in Greenfield locations.

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Second, a "private city" test-bed allows overcoming regulatory issues and legal barriers present in cities, such as the ones related with legal voids and barriers about the integration of such subsystems. On the one hand, in such a test-bed, legal issues related with the ownership and privacy of the collected data belong to a private-sphere; on the other hand, it allows for example, overcoming public procurement, tendering regulations and other legal and bureaucratic procedures unfit for the experimentation and development of more disruptive technologies and "out-of-the-box" solutions.

A large number of firms have already committed to invest and settle R&D units in PlanIT Valley, such as Cisco, GE and IBM (among many others), interested in its "blank sheet" test-bed potential. The first wave of people coming to PlanIT Valley is foreseen to reach 10,000 people, namely workers of transnational corporations and families. Porto's School of Engineering signed an agreement to settle in the area a R&D and education center on smart cities called POLARIS. It should become a living-working environment, where workers, students and residents provide the test-bed for the new urban solutions. However, despite such agreements, the start-up of the building development of PlanIT Valley is at the time of this writing delayed due to the financial difficulties in attracting investors to Portugal, associated with the fragile bonds market, IMF bail-out and current financial situation.

In the meantime, beyond the larger IT houses, PlanIT has been developing a network of partner companies in the country, such as retail companies, architecture firms and technology/IT companies. One example is Critical Software, an indigenous yet world leading company in high-precision software. The company has established formal partnerships with PlanIT and is involved in post-testing the UOS and other solutions, not only in Paredes but also in other global locations where the UOS is being progressively implemented (see next sections). Also, PlanIT has organized joint events with the University of Porto on "smart or knowledge city" issues, prompting the re-organization of some curricula towards more multidisciplinary approaches to offer aligned education and research.

Why not in Silicon Valley? Why not in Asia? A frequent question asked to PlanIT's founders is why not locating the headquarters and test-bed in California or Silicon Valley instead—perhaps the world's most dynamic ecosystem of IT companies and pool of venture capital, incomparable with the IT productive-innovation system in the North of Portugal[7]. Beyond the previous contingencies and the regional assets, Silicon Valley is referred as unfit for the company's emergence and early development stage, namely due to the fast information diffusion of the Valley, easy spin-offing, talent mobility and job poaching, which could do more harm than good to the company. As PlanIT's CTO refers:

> "...at these [early] stages, we wanted to keep some secrecy around our technologies, [the UOS] progress while keeping people in the company, not just seeing our staff switching companies and competitors popping one after another. (...) Moreover, the area [Silicon Valley] offers very expensive and scarce plots of good land, along with extremely inflated local wage rates. (...) I am glad we didn't settle our operations there. Venture capital and talent are abundant, but PlanIT has so far been able to access it through our own international networks and contacts".

Asian locations (e.g., India, China) also have been on the table, namely due to the availability of capital and large on-going urbanization projects. However, the founders recognize that accessibility would be an issue, since all the key partners are Western-based, notwithstanding the cultural and cognitive barriers of establishing such an operation in Asia—especially when relocating and attracting the creative class of knowledge workers (e.g., existing and new staff and their families from the West) is concerned to the new Asian knowledge generation locations.

3.2. United States: Detroit and Boston

Within the US, PlanIT currently has operations in Detroit and Boston, yet for rather different reasons. The Boston antenna is rather small and has a sales function, to be physically present in technological advanced and demanding markets. However, it is also considered important in order to establish contacts with potential US venture capitalists and other investors, as well as to be a connection point for the registry of international IP in the US.

However, relevant parts of the IP development take place in Detroit, PlanIT's "No. 2" R&D center. Together with the staff in Portugal, it has had an important role in the UOS knowledge development. The fact of locating in one of the most well-known yet declining automotive regions is no coincidence. The settling of PlanIT in Detroit happened through the acquisition, in 2009/2010, of a 30-person in-vehicle software company (through share swap), suggested by McLaren and by PlanIT's CTO, a former chief IT architect at Ford Motor Company (headquartered in Detroit) and Microsoft Automotive Vertical. The company was financially struggling (many persons left after PlanIT's acquisition) but had long expertise in automotive real-time control software, a patented "mini-UOS" and sophisticated mobile applications, related sensors and touch screens. Their expertise has been applied to the development of UOS, namely to its real-time control component. At the moment, the in-vehicle platform was redeveloped and will be marketed alongside the UOS.

In contrast with the PlanIT's engineering staff in Portugal, who hold a more "classical", academic-oriented IT background (and less practical experience), Detroit's staff has invaluable practical skills in real-time IT embedded systems (derived from a long expertise in the automotive industry in the region), providing a valuable mix in the development of the UOS solutions. As the CTO puts it:

> "The overall quality and the way we make progress are associated to the right blend of those different approaches, for example a newer technique for the router developed by a more academic team plus the experienced people that has been around long enough that can tell a 90% answer just like that".

Members of Detroit's core engineering team are presently supporting PlanIT's CTO to establish the PlanIT's (growing) development team in London.

3.3. London

PlanIT's "no. 3" R&D location—yet growing fast—is in London, where its CTO lives. More concretely, it locates in East London, in the Greenwich Peninsula. This area hosts important infrastructure (e.g., 02 Arena) and organizations (e.g., Transport for London) as well as large urban regeneration projects. The decision to locate in London relates with a previous link of PlanIT with an ecosystem partner (that is a leading British real-estate developer), involved in the development of PlanIT Valley but with interest in on-going regeneration projects in London. Through them, PlanIT had the opportunity to partner up with London-based development agencies, construction companies and City Councils, namely the Greenwich Council, to explore further and test the implementation of the UOS.

There are important arguments for locating in London, in general, and in Greenwich in particular. As PlanIT's CTO puts it:

[7] Despite the good qualifications, R&D units and a number of leading firms in some IT niches.

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> "There is currently lots of development activity in London, for the Olympics and after the Olympics, and a number of large urban regeneration projects (...) London is kind of red hot right now. Its scene is sort of the next wave of development as the city continues to expand. Also, there is a high-tech corridor emerging in East London, so it makes sense for us to participate on that".

Being present in such a growing and advanced market is naturally important to scale up and exploit the technology. Moreover, at a more local level, Greenwich Council is championing a "digital peninsula" agenda, willing to attract new high-tech investments to the area. Agreements have been signed between the Government, PlanIT and some of their "ecosystem partners" (e.g., Hitachi, GE, Philips, McLaren, the Portuguese IT company Critical Software) to locate and bring staff to refurbished buildings in the area, where the UOS will be tested and demonstrated in a "real" retrofitting urban environment.

The support of the Technology Strategy Board (UK Government) is also relevant for PlanIT. Together with Cisco, PlanIT is involved in the "RAPTOR" project, to support new digital value chains through the incubation of SMEs that build applications on the top of the UOS (e.g., related with retail and transportation). The incubation activities, the governmental support and the partner's ecosystems are turning Greenwich into one of the first effective integration labs for the UOS and place-app development. Besides the commercial staff already in London, new engineers will be recruited in Portugal and expatriated to London to follow the project's development, in articulation with the involved partners.

3.4. Other pilot cities

In addition to the previous locations, Living PlanIT has collaborations with companies and governments around the globe, in cities where the technology can be early tested and commercially exploited. Such locations range from highly developed markets in the Netherlands or Japan (e.g., in reconstructed cities where the 2011's earthquake took place), to global metropolis such as São Paulo and less developed (yet fast growing) cities in Iraq, Middle East or Mozambique.

There are two main types of "pilot" location strategies: PlanIT as leader or as follower. In the former, the pilot initiatives result from PlanIT's own networks (e.g., with local governments who commission the pilot); here PlanIT brings in their own international partner ecosystem to develop the solution, joining forces with local partners (e.g., in São Paulo and the Middle East). In the latter situation, the ecosystem partners pull PlanIT to locations where they are already settled and exploring markets. For example, Hitachi recently asked PlanIT to be involved in on-going construction initiatives in China. A similar situation happened in the Greenwich Peninsula in London (see above).

As some parts of the world economy are still hardly hit by the financial turmoil of 2008–2009 and the development of PlanIT Valley (in Portugal) delayed, developing pilots in different world regions help to diversify PlanIT's business portfolio and cash flows. However, such pilots have broader aims. First, they become knowledge and technology development and experimentation arenas in their own right, complementing PlanIT's permanent locations. Despite the fact that the UOS technology is fairly codified and replicable, there are many relevant contextual differences across the world in the ways it can be implemented. Examples are the sources of environmental problems, the types of construction and urban environment/infrastructure, client's wishes, quality requirements, working methods, culture and manifold regulations. Such variations require the technology and solutions provided to be flexible enough and hence the relevance of the contextual knowledge on different locations. Moreover, globally spread pilots influence the speed of technology development, as well as eventual technology adaptations and search directions. As explained by Plan IT's CEO:

> "The UOSTM "will never be finished (...) multiple platform enhancements are already scheduled for the next three years, spread in releases of various platform versions, evolving also according to the feedback from partners and customers, to the different challenges brought by each location in which we operate, as well as based on data generated during their functioning".

Second, pilots contribute to the expansion of PlanIT's partner network and technology legitimation. PlanIT flies in staff for the pilot locations, but largely relies on a local network of companies and organizations to locally implement the UOS. On the one hand, those may support the development of new knowledge for the UOS, by mobilizing local experts, users and companies to adapt to local and regional specificities. On the other hand, such pilots are expected to enhance the spread of the UOS across those partners' own networks, generating "snowballing" and network economies, and, ultimately, new business opportunities (and royalties) as both new partners and city governments start to act as ambassadors of the technology. The process generates continuous showcasing and potential legitimation of the technology. Moreover, it allows testing the necessary legal and regulation changes associated with the new technology, such as related with privacy or data ownership, wishing to prompt new regulations towards its use in cities.

As PlanIT gets involved and nudges cities to the adoption of the UOS umbrella for their smart city initiatives, it can support local and regional change. For example, in the Netherlands, PlanIT is involved with a number of their key ecosystem partners in the development of a white paper on smart cities. In the case of São Paulo, out of a project for using UOS towards energy savings in buildings, new partnerships and training schemes are being developed between PlanIT, the Municipality and the University of São Paulo.

3.5. International events

Besides the presence in concrete cities and places, PlanIT is since the early beginning present in key high-level international events. Just to mention some, PlanIT has been present in the Rio + 20 Earth Summit and in specialized events organized by the renowned The Economist Intelligence Unit; moreover, Plan has been awarded World Economic Forum Technology Pioneer of 2012, being present in Davos. Hand in hand with the associated media and international attention, the presence in such "temporary places" has been pivotal for PlanIT in many respects.

First, there is a resource mobilization drive. By proactively being present in such events, PlanIT can directly contact and find new partners for their development and scaling-up objectives. For example, it was in one of those events that Deutsch Telekom approached PlanIT for the development of a partnership to develop Place Apps, or that Cisco introduced PlanIT staff to new partners in new cities. It is also in such forums that relevant political contacts are made (e.g., with Mayors), raising interest of potentially new clients and business opportunities. Those contacts and high-level feedback can also influence new directions of technological search, such as by signaling opportunities and latent challenges.

Second, but not less important, international events are key arenas for technology showcasing and legitimation (e.g., the recognition as World Technology Pioneer). Such events are key places where brand and recognition is built, supporting further commercialization and scaling of the UOS, as well as the continuous access to high-level decision-making networks. The opportunity

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to develop a pilot in São Paulo emerged out of the increasing recognition and "buzz" created around PlanIT in the press and international events. In this respect, besides technically oriented forums, PlanIT is selective and attends many conferences with more potential showcasing and legitimation leeway.

4. Conclusions and perspectives

PlanIT is a born-global start-up that develops an "urban operating system", a new type of smart city technology, aimed to integrate a number of urban sub-systems. In this paper we studied the early development of this start-up, with a particular lens on the territorial dimensions of it. It is clear that the origin of this firm is not connected to a specific place. It was developed by a group of internationally mobile "argonauts" with access to wide and deep technology and market knowledge, and able to exploit a variety of spatial options and knowledge-based urban settings.

The case reveals how different knowledge city assets and geographies are important for the firms' development, despite its "born-global" character. The firm has always relied on concrete places and milieus, in different parts of the world, and its founders have had explicit ideas on which places suit its different activities best and how to set up local partnerships. As showed, the firm exploits the advantages of some permanent locations, where it has staff and settled operations (i.e., North of Portugal, Detroit, Boston, London), but it also creates a temporary presence in a number of other places—putting staff in pilot cities, and attending high-level international events.

Our case firm is specific in the sense that operates in the growing market of urban technologies and "smart or knowledge city" solutions. In this market, product development and scaling-up requires substantial testing and experimentation, not only in labs but also in and real-life situations of real cities. Upfront investments and new complex types of partnerships are needed to realize the solutions that new technology offer. The case shows how networks of companies around PlanIT are developing new sustainability solutions and also how cities and tech ventures like PlanIT find each other and enter into new partnerships.

Given its core business, more than other start-ups, the fate of PlanIT depends on its location strategies and the way it engages with the cities in which it works. We have seen how the firm exploits multiple places with distinctive assets and resources (e.g., talents and skills, regulatory features, advanced users, political support, access to decision makers, symbols and brands, and so on). However, those assets are valued by their (intertwined) potential to fulfill a number a *functions* – e.g. knowledge development, entrepreneurial exploration, legitimation, market formation, resource mobilization. This provides a new lens to analyze knowledge-based urban development beyond the assessment of fixed "assets". The conceptualization of the links between knowledge city assets and the concrete functions they provide (for different types of knowledge-based developments) is an important arena or further research.

It is important to note that PlanIT is still young and in a state of emergence and early development. The key locations for its R&D activities are unsettled and in a stage of flux. Its main location close to the city of Porto in the North of Portugal (where it developed the PlanIT valley) dominates, but London has been reinforcing its relevance during the last year. Moreover, in the context of a financially troubled Europe, Asian and Latin American locations might gain relevance as test-beds for the innovation *vis-à-vis* such as the PlanIT Valley project. Furthermore, as PlanIT's core platform technology matures and the competition-associated risk diminishes, places like California or Silicon Valley might start playing a bigger role in the development of place "apps", in partnership with other technology providers. This suggests that a recipe for knowledge-based urban development is not only place-sensitive, but should also take in consideration time dimensions and the life-cycles of different types of knowledge activities.

Companies like PlanIT, due to their distinctive knowledge and global business networks, play a decisive role in connecting territories and bridging knowledge across places, influencing the development of the technology and its relations with the territory. The places where the firm unfolds its innovation (i.e., North of Portugal, Detroit, London and several other pilot sites) have different potentials. For example, while the North of Portugal was able to initially attract talent and related companies, and embed them, to some extent, in the regional innovation milieu, recent difficulties in attracting capital pose challenges to the project. Simultaneously, the role of other cities for the innovation development is increasing (e.g., London), as new resources are mobilized locally.

The study suggests that big, international knowledge-rich cities with high levels of diversity and innovation at large (e.g., London or São Paulo) tend to concentrate an increasing share of the technology development in the smart-city market, even when these places were not the originally planned locations for that purpose. This is largely due to their concentration of industrial players, related organizations, networks and on-going smart-city projects, associated with government initiatives and large-scale urban regeneration projects. Such regions do contain ecosystems that are more capable of formulating and enforcing sustainability projects, and thus support the real-life testing and exploitation of the solution.

Finally, beyond skills and technology, the case study underlines how the performance of different knowledge cities and places increasingly relies on symbolic management: communication both outwardly and towards local actors is based on legitimizing discourses about sustainable development. The pilot projects developed in cities using the UOS become brands in their own right (e.g., "sustainable city", "smart city", "knowledge city"), with high symbolic value. This makes it easier to legitimize the technology, influence decision makers and acquire local and global resources, which ultimately reinforces the assets of a knowledge city over time.

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