LIVING PLANIT AND THE DEVELOPMENT OF THE "PLANIT URBAN OPERATING SYSTEM™": THE GEOGRAPHIES OF AN INNOVATION

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ABSTRACT

This case study explores the development of the PlanIT OS™ and PlanIT Urban Operating System™ (PlanIT UOS or UOS), a complex middleware platform designed to link a city´s sub-systems (e.g. built environment, safety & security, communications, energy, water, waste, mobility), harmonizing resource flows towards manifold efficiency gains thus enabling creation of urban environments that are economically, socially and environmentally sustainable. The chapter explores the spatial and organizational context of the proponent company – the "born global" emerging company Living PlanIT SA, currently headquartered in Switzerland but also based in the North of Portugal, England, the United States and China – paying attention to the

geographies underlying their operations. Despite the codification of the core technology, the chapter illustrates how the interaction with different milieus provided (and keeps providing) unique resources for the technology´s development, commercialization and societal legitimation.

INTRODUCTION

Over the last decades, the emphasis on "green" or "sustainability" has grown in the policy agenda of many cities worldwide (BETSILL and BULKELY, 2007). Beyond the environmental and pollution concerns of the 1980s, the current discourse tends to place a stronger focus on issues such as climate change, energy use, resource waste and the several inefficiencies that could be curbed only if cities used the available resources in a more efficient and integrated way. At a global scale, such concerns proliferated as the world´s urbanization rates increased and urban settlements multiply in fast-growing economies.

Although not a panacea, it has long been recognized that technology solutions can contribute towards more sustainable and resource-efficient cities (CAMAGNI et al., 1998). In line with it, a notion that has gained relevance in policy spheres is the one of "smart city" (e.g. THE ECONOMIST, 2010): places where one or more urban sub-systems (e.g. built environment, safety & security, communications, energy, water, waste, mobility) are coordinated through the use of ICTs, towards better provision and increased efficiency in resource utilization [1]. City administrations – and their "sustainability" agendas – became increasingly interested in the development of such solutions; and so did transnational IT corporations (e.g. Siemens, Cisco, IBM), that have been developing many (yet partial) IT solutions to tackle urban efficiency challenges, both in old urban environments and in newly built cities and districts "from scratch" (CARVALHO, 2011).

[1] Naturally, "smart city" is a very large conceptual container, with highly porous boundaries. Here we are referring to a narrower definition more closely related with its initial "IT" formulation, associated with the use of ICTs to improve and optimize service provision and resource utilization in cities, leaving the conceptual discussion out of the scope of this chapter.

This chapter focuses on a "sustainable innovation", promising to transform the field of urban technology solutions by integrating diverse smart city / Internet of Things innovations into one single platform – the *PlanIT Urban Operating System*™ (hereupon PlanIT UOS™ or UOS). The UOS processes real-time information collected through sensors embedded in a city´s buildings and infrastructure, and additionally data from a myriad of mobile devices and city hardware, then analyzes those data flows, and thereafter actuates reactions accordingly (e.g. adjusting energy supply, distribution and storage according to people 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. It has been developed by a "born-global"[2] emerging company called *Living PlanIT SA* (hereupon PlanIT), whose proponents are a diverse group of highly experienced entrepreneurs, with long professional careers, originating from different parts of the world.

PlanIT chose the North of Portugal to settle numerous team members and to develop a visionary "city-from-scratch" test-bed called PlanIT Valley™, but other world-scattered milieus have also been essential for the development and scaling up of the PlanIT UOS. This makes this case study an interesting arena to explore the geographies of a sustainability-related innovation, as well as the reasons and mechanisms underlying such geographies in a context of hyper-mobility and transnational organization of innovation. By doing so, we contribute to shedding light on the relations between sustainability, innovation and the territorialization of economic activity.

[2] 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 their technological drive, reliance of large ecosystems of partner organizations, limited financial and tangible resources, development of differentiated design and distinctive products (small for large firms), superior quality, highly connected and internationally oriented managers and, naturally, high activity in international markets.

This case study is based on a large array of secondary data about PlanIT and the PlanIT 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 Skype call to London) as well as 4 other involved discussions with partners in the North of Portugal (regional government representatives and consultants) and Lisbon (partner company).

The chapter is organized as follows. Section 2 contextualizes the story of PlanIT, the notion of sustainability associated with the innovation and the company´s business model. Section 3 explores the geographies underlying the development of the PlanIT UOS and the operations of PlanIT; to do so it uses an *innovation system framework* under which different locations and milieus are associated with *functions* that holistically support the innovation under analysis. Section 4 concludes and provides insight on the hypothesis of the overall research project.

CONTEXT OF THE COMPANY AND THE INNOVATION

The origins and early development of Living PlanIT: the company[3]

Living PlanIT was founded in October 2006 by Steve Lewis (former IBM and Microsoft Executive Manager) and Malcolm Hutchinson (IT specialist and former City Manager). In 2005, Lewis had left his Microsoft position in Seattle to work for a retail development and construction project of a client (named DestiNY, in the US) to which he invited Hutchinson, whose Swiss IT company was a Microsoft partner since 2002. The DestiNY project stalled, but Lewis and Hutchinson decided to found Living PlanIT SA, with an eye on further exploring solutions for the many inefficiencies observed in the construction industry such as long, fragmented and obscure supply chains leading to high costs, waste and very little innovation.

In order to tackle such issues (e.g. how can buildings change functions over time? How to build more innovatively and efficiently?), from 2006 to 2008 Living PlanIT invested considerable resources in learning from other sectors (e.g. automotive, shipbuilding, aviation, IT), namely about the roots of their products' life cycle and value chain integration. Lewis and Hutchinson sat down with many company executives and people from multiple industries, with technical and commercial backgrounds, many of them Lewis´ 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, Lewis and Hutchinson soon realized that beyond running efficiently, the key breakthrough would be making buildings able to change features and interact with users to deliver new services during their lifetime. Yet, despite piecemeal initiatives (e.g. embedding some sensors in buildings), there was no

[3] Here we present a "nutshell" version of the company´s biography. A much more detailed account of the company´s history and business model can be found at ECCLES et al. (2010).

known integration platform in the world to run (and learn from) those kinds of interactions and continually improve corresponding digital services.

Living PlanIT´s vision and strategy reached a new critical juncture when Lewis met Celso Ferreira, Mayor of Paredes (30 Km from Porto, Portugal), who was at the time pursuing economic diversification opportunities for the Municipality. In 2008, the Mayor of Paredes envisaged a pilot project for electrical mobility in the city, with niche production and development of an experimentation site ("auto city").

Lewis believed the auto/mobility project of Paredes could be part of a more ambitious initiative to develop and scale up a comprehensive set of environmental-friendly global solutions. Lewis´ ultimate vision was to unify buildings, mobility solutions and everyday users through a fully integrated, urban-"brain" IT platform, in which a potentially infinite number of partners could plug in to develop, test and exploit new urban applications. For such a breakthrough, a large greenfield location was required for a R&D city where innovative building and mobility solutions could be developed, experienced and perfected without the typical physical and legal/regulatory constraints of existing cities. The Mayor showed strong support to this idea and agreed to provide a 1,670-hectare site, as well as legal and bureaucratic support with governmental entities. At this time, the company moved resources to Portugal.

From this moment onwards and with this vision in mind, PlanIT´s partners started assembling capital and new skills, namely through Lewis and the other partners' high-level international networks and relations. A number of new executives joined the venture, leaving their (senior/director) 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 conferencing. The

capital acquired (e.g. through equity investments, friends, family and loans) supported the first stages of technology, branding and business model development.

Presently, PlanIT is classified as a SME (Small-Medium Enterprise) with all staff also being shareholders, including the senior executives and managers, technical, commercial, legal and administrative staff. A large part of the team has former experience with Microsoft and other leading organizations. But not all are IT engineers: to develop PlanIT´s "urban brain" platform, there are also e.g. materials engineers, aeronautics engineers, mathematicians, neurobiologists, biochemists, sociologists, infrastructure planners and financial industry talent, amongst others, including people with broad liberal arts and real estate backgrounds.

The PlanIT UOS™ and PlaceApps™ : the "sustainable innovation"

Developed during the last years, the core innovation underlying the vision of Living PlanIT is a complex, software platform called the PlanIT Urban Operating System™ (PlanIT UOS or UOS). The UOS processes real-time information collected through sensors embedded in a city´s buildings and infrastructure, and additionally data from a myriad of mobile devices and city hardware, then analyzes those data flows, and thereafter actuates reactions accordingly (e.g. adjusting energy supply, distribution and storage according to people 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 PlanIT 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 or RTC™) works in a Cisco

environment and other equivalent hardware (physical server and routers), to which other potential partners and application developers can plug in[4] to develop new "PlaceApp" digital services. 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 PlanIT UOS connects all these subsystems together and allows them to directly interact with each other."

It is this integrative character of the PlanIT 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 application developers that can create "apps" and solutions for citizens, governments, service providers, construction companies, building owners and tenants etc. However, what is distinctive about the PlanIT UOS is that the applications that leverage city data are location- and context-aware, thus the name "PlaceApps™". As the CHARTERED INSTITUTE OF BUILDING (2011, 6) puts it, one of PlanIT´s central innovation propositions is to foster

[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*.

> "...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."

PlanIT licenses and deploys the PlanIT Urban Operating System solution for both existing urban environments (retrofit) and newly built cities (greenfield). But where did the UOS come from? Naturally, it stems from the combination between the IT and the construction industry backgrounds of its proponents; however, one key knowledge and technology piece of the PlanIT UOS (e.g. the real-time control software or RTC™) was initially developed in the Formula 1 industry, namely by McLaren, whom since 2001, embed many sensors on their cars to collect and deal with the enormous amounts of data produced during a race. Through such software, the race data is collected and analyzed to assess the car´s performance, but also to improve its engines and components for the current as well as future races, in a continuous innovation cycle.

PlanIT drew inspiration from that solution applying it 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 close collaboration between the companies and some creative IP licensing models, so that both can work on the solution´s continuous improvement. McLaren Electronics is currently one of PlanIT's key technological partners, within the company´s "ecosystem".

The business model and partner "ecosystem"

As McLaren´s example illustrates, PlanIT´s vision is not to develop technologies in isolation, but to integrate the technologies of many providers towards a comprehensive solution. Key partners initially involved in the core solution are Cisco (routers, blades and switches) and Microsoft (cloud computing), although, the PlanIT UOS is hardware agnostic so other equivalent technology can be used. Moreover, PlanIT is continually developing and growing a stakeholder ecosystem around the UOS, in which companies, organizations and users work together, experimenting and exploring synergies towards the development of building innovations and PlaceApps™. 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 side-innovations are developed through a particular business and technological development model, involving diverse worldwide partners, under which companies and developers sign an agreement to be part of PlanIT´s "innovation ecosystem" (centered around the UOS platform). Although the business of PlanIT has to do with buildings and the built environment of cities, real estate development is estimated to represent in the future less than 5% of the company´s profits. The key driver and income source of PlanIT will have to do with income from IP licensing, 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 continuous development of such a growing partner "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 increased market competitiveness for the partner network, as partners become "ambassadors" not only of their solutions, but of the underlying UOS platform, around the world. Among PlanIT ecosystem partners are leading global companies such as Alliander, Amazon Web Services, Autodesk, Buro Happold, Cisco, Critical Software, Hitachi, Deutsche Telekom, IBM, McLaren, Microsoft, Milligan Retail, Moura Dubeux, Philips, among others. The company´s ecosystem increasingly includes leading Portuguese companies and organizations as well, in domains such as IT and sensor technologies. Each partner and ecosystem member signs a detailed contract; PlanIT receives many requests, but selects partners on the basis of their potential to contribute to the ultimate solution and the company´s vision.

Summing up: The meaning of sustainability and the context of the innovation

The development of the PlanIT UOS emerged out of the personal awareness of its proponents, international IT executives, a diverse group of entrepreneurs, and local government, willing to "make a dent in the world" (PlanIT´s CEO) but also driven by the perception of large market opportunities lying ahead for new, more efficient building solutions and digital services in the developed and emerging world. The UOS exploits other companies´ solutions and various IP assets including e.g. sensors, cloud, and a real-time control software previously developed by McLaren, for the context of F1 races. PlanIT established creative IP and product licensing models in order to use these technologies in the context of buildings and cities.

The UOS is a technological innovation – a new software platform that integrates sensor, cloud computing and other technologies – to curb environmental problems in cities while maintaining or improving people´s economic and social wellbeing. The prime sustainability objective for the UOS is tackling urban energy and environmental problems in an integrated way, improving efficiency in city´s subsystems (e.g. built environment, communications, mobility, safety, energy, lightning, etc). It can do so, for example, by facilitating distributed energy provisioning, consumption, reduction and more efficient and cleaner transport solutions.

However, such technology implies substantial organizational and cultural changes in the functioning of cities and in the built environment. For example, UOS allows previously unconnected systems such as communications, energy, water, lightning or waste to directly interact with each other, in a "machine-to-machine" fashion. Hence, the diffusion of UOS implies a more articulated functioning of the construction industry

value chains (procedures, communication, integration, accuracy), thus prompting more innovation. Moreover, the UOS stimulates – and has its value enhanced by–the development of associated innovations and new services, such as "place-apps".

The UOS ambitions are clearly global – it intends to become a “killer” solution to integrate many other IT-efficiency (“smart”) initiatives in cities; since the early beginning, its development was associated with internationally-oriented, networked and highly mobile senior executives and technologists. However, this doesn’t mean that specific places and territories are/were irrelevant for the development of UOS and PlanIT offerings, 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 they provide.

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* company, 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, marketing, selling, branding, building a partner and client ecosystem, and, ultimately, scaling up the PlanIT UOS™ as a leading platform for IT-smart city and Internet of Things (IoT) initiatives. For those activities traditional location factors such as government incentives, factor costs or markets seem insufficient to explain the company´s localization strategies.

In order to shed light on the location strategies of PlanIT and the development of the UOS – the "sustainable innovation" under study here – we consider an "innovation system" framework, under which such locations are understood as composed by distinctive systems of actors, networks and institutions built over time, that collectively provide different *functions* that influence innovation[5].

Innovation systems have important place-based dimensions and change slowly. Their features influence the degrees of freedom for the development of new innovations,

[5] We used here the framework synthesized by BERGEK et al. (2008) and recently applied at the regional level by HENNING et al. (2010). A similar framework has been applied in the realm of socio-technical studies of sustainability transitions (e.g. MARKARD and TRUFFER, 2008), also at more nuanced spatial levels (CARVALHO et al., 2012).

supporting (or hampering!) the process. As mentioned, they are composed by a) *actors*, such as entrepreneurs, companies, R&D institutes, venture capitalists, governments and supportive organizations, b) formal and informal *networks*, such as technology consortia, buyer-seller relations, industry-university links, and c) institutions, e.g. laws, norms and routines, e.g. procurement and innovation policies, specific business practices, problem-solving culture, etc. The interaction between these elements originates a number of specific *functions* that influence innovation (Bergek et al, 2008; Henning et al, 2010):

- *Knowledge development* (e.g. incentives, talent and players to explore new knowledge and applications in a certain field),
- *(Protected) entrepreneurial experimentation*[6] (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 labour 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),
- *Legitimation* (e.g. showcasing of the innovation´s features towards societal acceptance, overcoming cognitive-cultural skepticism).

[6] We added the term "protected" to the original "entrepreneurial experimentation" function. This is inspired by the literature on socio-technical sustainability transitions (ROTMANS, 2005), 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).

With this framework in mind, the next sections analyze the geographies of the UOS development and scaling-up, in particular: i) North of Portugal/Paredes, ii) London, iii) US (Detroit and Boston), iv) the pilot cities, and v) events and international conferences, as "temporary" yet central places for PlanIT´s strategy and the UOS scale-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.

Table 1: PlanIT and the UOS: Locations and main functions

Location	Main Functions
PlanIT Valley (Paredes/North of Portugal)	• *Knowledge development* - creating, testing and adjusting • *(Protected) Entrepreneurial experimentation* - greenfield • *Resource mobilization* - labor, land, local political support • *Legitimation* - showcasing the integration feasibility
Detroit	• *Knowledge development* - software skills
Boston	• *Resource mobilization* - venture capital, investors • *Market formation* - sales function
London (Greenwich Peninsula)	• *Knowledge development* - knowledge partners • *(Protected) Entrepreneurial experimentation* - retrofit • *Resource mobilization* - science and technology policy, governmental and local political support and funding • *Market formation* - sophisticated users in a global city, IT start-up incubation • *Influence of direction of search* – 1st living test-bed feedback • *Legitimation* – showcasing
(Other) Pilot cities	• *Knowledge development* - testing and adjusting technologies • *(Protected) Entrepreneurial experimentation* – greenfield/retrofit • *Resource mobilization* - local political support • *Market formation* - large and advanced cities • *Influence of direction of search* • *Legitimation* – showcasing, regulatory change
International events	• *Resource mobilization* - new business and technological partners; clients, financers • *Influence direction of search* - feedback and opinions • *Legitimation* - showcasing, influencing decision makers

PlanIT Valley – Paredes/North of Portugal

Living PlanIT moved resources 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 platform and mixed-use R&D city[7]. The ambition is to host a large number of international companies, R&D centers and residents to interactively develop, test and showcase holistic UOS propositions in a newly built urban environment. It should become the first fully fledged, real-life application of the manifold urban technology concepts, and one of the facilities that form the backbone of PlanIT´s research and innovation network and contribute to the mutual acceleration and demonstration of robust solutions and concepts to be exported to local and global markets.

Currently, PlanIT´s main offices are located close to Porto and Paredes (combining working and living in a shared space), permanently hosting a team of PlanIT staff members and serving as additional accommodation for staff visiting from other geographies in frequent geographical rotation. Besides administrative and legal services, it concentrates PlanIT´s solution development and advanced research resources for the PlanIT UOS. It is one of the main development centers of PlanIT.

Why did such a futurist venture "choose" the North of Portugal as a key location? PlanIT points to a number of reasons. First, beyond the circumstantial (yet decisive) meetings with the Portuguese partners, the positive relation early established with Celso Ferreira, the Mayor of Paredes. More than reserving a large plot of land, he facilitated bureaucracy removal and proactively bridged PlanIT to other regional and national

[7] Despite the move of the headquarters and operations to Portugal, PlanIT is still registered as a holding in Switzerland, for legal and administrative reasons.

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 also essential for potential R&D investments of PlanIT international partners. As PlanIT´s executives stress:

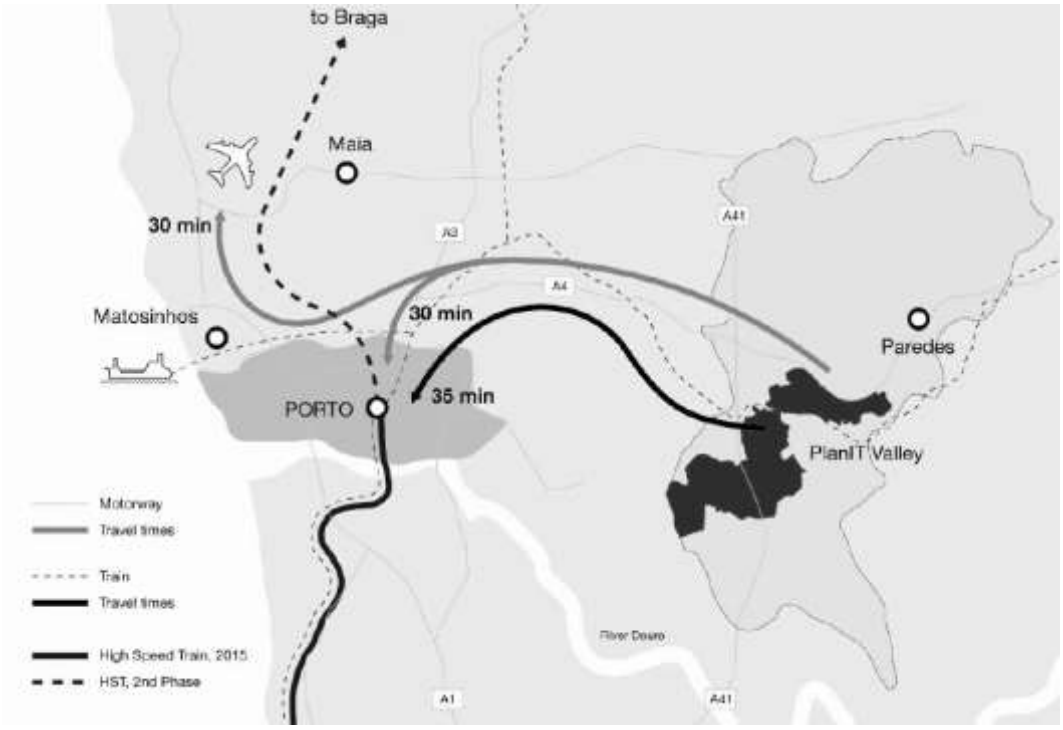
> "We never got any type of government funding or direct tax rebate, but we [Lewis and the Mayor] had a very good relationship since the beginning. He struck me as a different Mayor (...) who understood our ideas very well and was enthusiastic since the first moment. His support has been invaluable. 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, that the project existed, and second, that it was in the North of Portugal [and not in Lisbon]. (…) With Celso, the relationship 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 supporting reason has to do with the presence in the region of a large pool of high-qualified skills (e.g. for hiring staff and recruiting new PlanIT ecosystem partners), with three large Universities and engineering schools in a short radius (Porto, Minho, Aveiro), boasting an increasingly entrepreneurial attitude and very competitive wage

rates. Third, PlanIT refers to the "super infrastructure" and international accessibility (airport), but also the highways and "last mile" infrastructure already existent in Paredes (basic infrastructure and accesses to the land plots). Fourth, PlanIT mentions "quality of life" factors, such as the many amenities of a metropolitan region, historical city (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.

Figure 1: PlanIT Valley: Location and accessibility



Source: PlanIT Valley Master Plan (ECCLES et al., 2010)

Another question – associated with a latent criticism – is why to develop the test-bed in an expensive "new city" (*PlanIT Valley*™) and not in an already existing one. PlanIT also develops and sells the PlanIT Urban Operating System in existing cities[8] (see next

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

sections), but a "blank sheet", privately owned condominium complex 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 (such as 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 (legitimation). Moreover, in such a fully dedicated test-bed it is possible to jointly learn and adapt the technology features as it develops, e.g. to introduce "upgrades" on-the-go, in a flexible and still moldable urban infrastructure.

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 e.g. 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, interested in its "blank sheet" test-bed potential. However, despite such agreements, the physical construction 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 support and the past financial situation that has now started improving.

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 and world leading company in high-precision and critical-systems software. The company has established formal partnerships with PlanIT and is involved in the PlanIT UOS™ and other solutions, not only in Paredes but in other world locations where the UOS is being progressively implemented (see next sections). Also, PlanIT has organized joint events with the University of Porto on "smart 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 resources 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 [9]. 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 PlanIT UOS] progress while keeping people in the company,

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

> 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 (Japan, China) have also 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 (e.g. relocation of staff and their families), since most key partners are western-based, notwithstanding the cultural and cognitive barriers of establishing such an operation in Asia.

United States: Boston and Detroit

Within the US, PlanIT currently has operations in Boston and Detroit, yet for rather different reasons. The *Boston* antenna is rather small and has a sales and administrative function, to be physically present in technologically advanced and demanding markets. 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.

Parts of the IP development take place in *Detroit*, PlanIT´s "no. 2" R&D center. Together with the staff in the UK, China and 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 2010, of a SME of in-vehicle software, identified

by McLaren and by PlanIT´s CTO, a former chief IT architect at Ford Motor Company (headquartered in Detroit) and Microsoft´s automotive vertical. The company was financially struggling (several 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 PlanIT UOS, namely to its real-time control component.

In addition to PlanIT´s engineering staff in Portugal, who hold a more "classical", academic-oriented IT background, 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 PlanIT´s growing development team in London.

London

PlanIT´s "no. 3" R&D location is in London, where its CTO lives. More specifically, it is located 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 (a leading British real-estate developer), involved in the development of PlanIT Valley and additional 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 an 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:

> "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. It´s seen as 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. Commitments have been made between the Government, PlanIT and some of their "ecosystem partners" to locate and bring staff to the newly refurbished buildings in the area where the UOS is being used in a retrofit 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 PlanIT UOS™ (e.g. related with retail and transportation initially). The

incubation activities, the governmental support and the partner ecosystem are turning Greenwich into one of the first integration labs for PlanIT UOS and PlaceApp™ 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 close collaboration with the involved partners.

(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 tested early and commercially exploited. Such locations range from highly developed markets in the Netherlands or Japan (e.g. Almere Grote Markt retail and community center), to a global metropolis such as São Paulo and less developed (yet fast growing) cities elsewhere.

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 or partner companies 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). 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 recovering from the financial turmoil of 2008-09 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 as “design wins”. 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 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, world-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 PanIT UOS “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, world-spread 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 legitimation of the technology. Moreover, it allows testing the necessary legal and regulatory changes associated with the new technology, e.g. related with privacy or data ownership, with the intent of influencing new regulations towards easing UOS implementations in cities.

As PlanIT gets involved and nudges cities to the adoption of the PlanIT 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 could be developed between PlanIT, the Municipality and the University of São Paulo.

International events

Besides the presence in specific 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 Economist Intelligence Unit; moreover, PlanIT has been awarded World Economic Forum Technology Pioneer of 2012, being present in Davos and the 2013 Frost & Sullivan Best Practices Award for Smart Cities. Hand in hand with the associated media and international attention[10], the presence in such "temporary places" has been pivotal for PlanIT in many respects.

[10] Despite its early growth stage, the experience of PlanIT has been already analyzed as a case study of Harvard Business School (ECCLES et al., 2010).

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 Deutsche Telekom approached PlanIT for the development of a partnership to develop place-apps, and 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 research, e.g. 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 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.

CONCLUSION

According to PlanIT´s founders and PlanIT UOS proponents, the idea for the development of the UOS lies in the vision that humanity, while improving social and economic opportunities and quality of life for people, must have a smaller impact on the natural environment of the planet, and that technology can play a role on that. This idea does not propose a radical transformation of society and socio-economic regimes, but a

way to mitigate the negative impacts of urban agglomeration towards more efficient resource uses in cities. The origins of the idea for the UOS as an urban technology can hardly be connected to a concrete milieu but rather to the many experiences and visions of its world-spread proponents; moreover, the vision for UOS is to become a "killer" solution for the built environments of cities, and additionally a solution for some challenges of the broader region.

However, as illustrated in the previous sections, this is not to say that different geographies and milieus are unimportant for the UOS development, quite the opposite. Despite the "born-global" character of PlanIT, their operations and the PlanIT UOS development have ever since looked for and relied on concrete places and milieus, in different parts of the world. As shown, the localization strategies involved in the innovation ranged from permanent locations with staff and settled operations (e.g. North of Portugal, Boston, Detroit, London) to temporary and intense co-location of staff in pilot cities, to attendance in international events, as a "temporary place" in its own right.

The development and scaling-up of the PlanIT UOS requires substantial testing and experimentation, change in city´s infrastructure, new regulations and socio-cultural legitimation, resembling what has been called a *sustainability transition* (e.g. MARKARD and TRUFFER, 2008; ROTMANS, 2005). The UOS case suggests and illustrates that these features are associated with the need for diversified localization strategies. More than a-spatial notions, the role of specific milieus is of utmost importance, but the geographies of such innovations are better understood under a multi-scalar framework, with multiple places with distinctive resources (talents and skills, regulatory features, advanced users, political support, access to decision makers, symbols and brands, etc).

The locations analyzed here correspond to the stages of emergence and early development of PlanIT and of the PlanIT Urban Operating System. At this stage, there is significant diversity, and the key locations for the innovation are still in a stage of flux (e.g. London has been reinforcing its relevance during the last year). 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 e.g. the PlanIT Valley™ project, despite its present centrality in the whole company´s strategy; moreover, as the core UOS technology is further hardened and the competition risk diminishes, places like Silicon Valley might play a bigger role in the development of PlaceApps™.

The extent to which different milieus can anchor the knowledge embedded in this innovation in their own productive systems is still to be seen. Naturally, the features and production-innovation dynamics of some milieus seem fitter than others (e.g. London), and many pilot cities will be primarily users of the innovation with limited contributions for its development. Other locations raise more questions as the UOS develops and scales up. Beyond the development of PlanIT Valley™ – which will be critical in its own right – it will be interesting to analyze how and to which extent the North of Portugal – a key region in emergence and early development of PlanIT – will manage to anchor and recombine the associated knowledge, and, with that, promote the consolidation of its related productive-innovation system.

HYPOTHESES

1. *The increased mobility (of workers, of capital, of customers...): Sustainability is related to "rich", "multidimensional" forms of anchoring, with a focus to "gate keepers" or "anchors" or "anchoring milieus".*

Confirmed. The innovation under analysis requires multidisciplinary knowledge and highly qualified staff to be mobilized from all over the world. Despite its codification (software), the technological development, testing, branding, showcasing and scaling-up of the innovation largely relies on and benefits from the (complementary) characteristics of different milieus. Hence the clearly noted emergence of global-local intermediation and gate-keeping phenomena in such locations, frequently played by transnational entrepreneurs, local administration (mayors) and industrial and technological partners. The milieus where the innovation unfolds (e.g. North of Portugal, Boston, Detroit, London and several other pilots) have different, although not static, anchoring potentials. For example, while the North of Portugal was able to initially attract talent and the innovation´s proponents, recombining them (to some extent) with the milieu, difficulties in attracting capital pose challenges to the project. Simultaneously, the role of other milieus for the innovation development is increasing (e.g. London), as new resources are mobilized locally.

The observed needs for exploration and commercialization of the technology in different pilot cities in the world is also consistent with the idea that anchoring has social, environmental and economic dimensions: the innovation under analysis will only thrive and scale-up if it can find anchorage along these dimensions in different milieus, namely in urban retrofitting projects. Only the development of "from-scratch" city pilots may seem to challenge this assumption, since the early testing and exploration of a disruptive technology (like the PlanIT UOS) might require some level of "protection" and early juxtaposition with existing urban models. This is due to the initial physical and institutional mismatch that would otherwise prevent the innovation to have chances of proving itself and scaling-up towards a more complete sustainability transition.

2. *More local resources for a narrower specialization: Faced with a deepening division of labor, places mobilize local multifunctionality and local extra-economic dimensions (particularly cultural and natural resources). The question of positive or negative environmental final impacts remains open.*

Partially confirmed. By focusing on an innovation whose development cuts across different milieus from the early beginning, this hypothesis cannot be easily tested here. The innovation under analysis and its emergence is not directly associated with one place. Moreover, the challenges it wishes to tackle are only marginally related with the places where its initial technological development took place, namely the North of Portugal or Detroit. The UOS vision is to become a world "killer" solution for integrating "smart-city" initiatives and a city´s subsystems (communications, energy, water, mobility, safety, etc), in urban areas ranging from historical western cities to fast growing metropolis of the emergent world.

However, as the development of the innovation unfolds, we do find that the places of experimentation – city pilots – mobilize narrower sets of extra-economic resources that support the innovation´s development. Examples are sets of knowledge on local environmental challenges, types of construction, mobility behaviors, specific regeneration/greenfield building challenges, etc, that support the development of a more fit solution to different urban contexts. In this case, parts of the locally mobilized "resources" are actually more related with intrinsic urban and regional *challenges*, as well as with the local expertise to deal with them (networks of experts and local industrial and knowledge partners), that can be mobilized to other similar locations in the future.

3. *Competitiveness of a place relies on symbolic management: Communication both outwardly and towards local actors is based on legitimizing discourses about sustainable development. It plays a key role, especially when conciliating local authenticity and its increasing commodification.*

Confirmed. The pilot projects developed in cities using the PlanIT UOS become brands in their own right (e.g. “sustainable city", “smart city”), whose symbolic value is exported to other locations as efficient and "sustainable". This makes it easier to legitimise the technology, influence decision makers and acquire local and global resources for the pilot. In contrast, the innovation under analysis makes it hard to speak about "authenticity", since it is a largely codified solution whose algorithms work out everywhere; yet, sustaining the development of such innovative pilots does require the legitimization of discourse at the local level. Overall, the creation and legitimization of discourses and symbolism are multi-scalar, the reason why PlanIT is actively leading global lobbying platforms for environment and "smart cities", whose efforts have repercussions at the various scales.

4. *The emergence of a new level of organization: Innovation processes have become multi-local and multi-scalar. At that level, local milieus able to manage their long-range interactions (dynamic metropolitan milieus, milieus who keep their “authenticity”, etc.) manage their sustainability. Other places are subordinate or excluded.*

Confirmed. Our case study clearly shows the emergence of multi-scalar modes of organization for the development of the UOS as a sustainable innovation. Local territories, for instance dynamic metropolitan milieus, and local authorities are pivotal players in this process, namely the ones that, due to their scale, specificity or influence

are active in manifold "urban sustainability" and "smart city" international networks (such as London or São Paulo, in our case).

Yet, the multi-scalability involved in the UOS is better understood through the interaction between territories and transnational companies, in this case, both well-established corporations (Microsoft, Cisco, McLaren, etc) and highly connected *born-global* emerging companies such as PlanIT. Such companies, due to their distinctive knowledge and world-spread business networks, play a decisive role connecting territories and bridging knowledge across sites, influencing the development of the technology and its relations with the territory. The authenticity of a place also plays a role in this relation (developing technologies that fit the authenticity of a place), but the main direction of this innovation is towards "commoditization" and massification of a solution. For the territory and the cities involved, the quest is for increasing efficiency and reducing waste while nurturing economic opportunities and related high-tech innovations locally.

5. *Strong sustainability only with strong milieus: Sustainability that takes into account local, multi-local and multi-scalar effects can only develop from regions containing strong milieus. Others risk concentrating the negative effects originating from other spaces ("weak" sustainability).*

Confirmed. The on-going evolution of the UOS development and its exploration in different city pilots seems to confirm this hypothesis. Places with more diverse and stronger milieus (e.g. London or São Paulo) tend to concentrate an increasing share of the technology development, even though those were not the originally planned locations for that purpose. This is largely due to the 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 milieus that are more capable of formulating and enforcing sustainability projects, and thus support the real-life testing and exploitation of the solution.

This does not mean that other places of the UOS development cannot reinforce their roles as distinctive milieus (e.g. the test-bed and further concentration of companies and related networks in the North of Portugal), but their role in this respect is still moderated at this stage, despite the promising evolutions and potential anchoring conditions.

6. *More complex, coordination oriented, public policies: The effectiveness of public policies dedicated to build agreements about sustainability depends more and more on the management of complex (multi-local and multi-scalar) territorial interdependencies.*

Confirmed. Linking and anchoring innovations like the UOS (and not only its exploitation) in place require policies that look way beyond the administrative boundaries and the policy silo. In the case of the North of Portugal/Paredes, local policy makers (not policies) played a key role in bringing the venture and the development of the technology to the region. Moreover, they brokered new contacts of decision makers and technological partners. Subsequently, the mayor of Paredes became involved in global conferences and networks of smart cities, in close connection with transnational corporations like Microsoft.

Moreover, local actions to steer such developments required extensive coordination among city departments (planning land, energy, transport, etc.). Moreover, the disruptive character and the novelty involved in some innovations require an “out-of-the-box” mindset not frequently found in industry and city administrations.

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