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van Winden, W.

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Willem van Winden
Amsterdam University of Applied Sciences/Centre for Applied Research on Education

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Smart city pilot projects, scaling up of fading out? Experiences from Amsterdam

Author:

Willem van Winden[1]
Amsterdam University of Applied Sciences
PO box 1025, Room 07A08
1000 DB Amsterdam
The Netherlands
Email w.van.winden@hva.nl

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Abstract
In many cities, pilot projects are set up to test or develop new technologies that improve sustainability, urban quality of life or urban services (often labelled as "smart city" projects). Typically, these projects are supported by the municipality, funded by subsidies, and run in partnerships. Many projects however die after the pilot stage, and never scale up. Policymakers on all levels consider this as a challenge and search for solutions. In this paper, we analyse the process of upscaling, focusing on smart city projects in which several partners –with different missions, agenda's and incentives- join up. First, we review the extant literature on upscaling from development studies, business studies, and the transition management literature. Based on insights from these literatures, we identify three types of upscaling: roll-out, expansion and replication, each with their own dynamics, context sensitivity and scaling barriers. We illustrate the typology with recent smart city projects in Amsterdam. Based on desk research and in-depth interviews with a number of project stakeholders and partners of the Amsterdam Smart City platform, we analyse three projects in depth, in order to illustrate the challenges of different upscaling types. i) Energy Atlas, an EU-funded open data project in which the grid company, utilities and local government set up a detailed online platform showing real-time energy use on the level of the building block; ii) Climate Street, a project that intended to make an entire urban high street sustainable, involving a large number of stakeholders, and iii) Ikringloop, an application that helps to recycle or to re-use waste. Each of the projects faced great complexities in the upscaling process, albeit to a varying degree. The paper ends with conclusions and recommendations on pilot projects and partnership governance, and adds new reflections to the debates on upscaling.

Keywords: Smart cities, governance, technology management, urban technology, upscaling

1. Introduction

In many cities, pilot projects are set up to test or develop new technologies that are meant to improve urban quality of life and/or the efficiency of urban services. Typically, these projects are supported by the municipality, funded with subsidies, and run in partnerships with businesses and other stakeholders. In pilot projects, partners invest resources to explore a new technology, concept or solution on a small scale or in an experimental setting.

In recent years, city governments across the world have been actively initiating, promoting and supporting smart city technology projects, reflecting the belief of urban policymakers and other stakeholders that technology might help to make the city more liveable, sustainable, competitive and inclusive, and improve public services (Townsend, 2014; Hollands, 2008). A wide array of funding opportunities have become available, from the local, national and EU level. In Europe, EU-backed funding for smart city technology projects is large and growing. In a special report, EC (2013) provides an overview of the generous EU smart city funding options for the 2014-2020 period (EC 2013). The Horizon 2020 programme provides for 18,5b euro subsidies for clean energy, green transport and climate actions, implying significant funding opportunities for smart-city related research (most of it to be conducted in collaboration with local authorities and companies). The ELENA scheme (funded by EC and EIB) offers technical support to make cities' and regions' sustainable energy projects ready for funding and implementation. The ERDF regulation requires that a minimum of 5% of the funds is allocated to sustainable urban development. This amounts to minimum of EUR 16 billion over that period. To tap from these funds, cities and regions across Europe set their priorities in line with the development of smart regions and smart cities. Moreover, the EU provides for debt and equity facilities that ease access to capital for smart city type of innovation projects.

The smart city equally appeals to large businesses. Tech multinationals like IBM, Cisco, Schneider, Google or Philips have discovered the potential of smart city technology as significant business opportunity, and offer all sorts of solutions ranging from smart grids, energy-saving street lighting concepts, optimization systems for waste collection, big data analysis to improve decision making, camera systems to enhance safety, traffic flows, urban dashboards etc. Deloitte (2015) expects the global smart cities market to grow from US$400 billion and US$1.5 trillion by 2020. To explore and exploit new business opportunities, many multinationals (including Accenture, Cisco, IBM, Schneider and Philips) have set up city-centric business units (Cisco's "smart &connected communities", IBM's "smarter Cities"). Moreover, these companies engage in local smart city pilot projects and partnerships with a number of urban stakeholders including housing corporations, local authorities, grid owners, energy companies etc. to test or demonstrate innovations in real-life contexts.

The wealth of funding opportunities, in combination with growing interests from businesses, research institutes and all kind of urban stakeholders has led to a proliferation of smart city technology projects in recent years. City administrations have set up institutional arrangements (platforms, specialised agencies) to promote experimentation, partnership formation, and knowledge sharing. Smart city platforms and projects are fascinating new arenas where different urban stakeholders, public, private and civic, engage in coalitions and innovate together. Amsterdam Smart City alone reports 75 projects on its website (http://amsterdamsmartcity.com/projects?lang=en).

Projects are proliferating, but many of them stay very small and experimental, do not scale up to make a wider impact, cease to exist after a (subsidized) demonstration phase, and fade out after initial funding ends. There are obvious cases where scaling does not happen. Some pilots are merely set up to offer inspiration, demonstrating a future possibility or solution without claiming immediate business sustainability. Such projects are run in a protected/shielded situation with regards to funding and/or regulation. Other pilot projects end because they fail in terms of technology, feasibility, a lack of demand/interest or otherwise, and scaling in whatever form makes no sense.

Despite this, the lack of scaling is widely perceived a major problem that needs to be addressed. In its global smart city monitor, Deloitte (2015) strongly puts that “the ability to transition from pilot tests to larger scale is distinctly absent globally” (Deloitte 2015, p. 8), and suggests that projects tend to be built specifically to fit local demand and don’t maintain their logic on a larger scale.

Policymakers on all levels recognize the lack of scaling and replication as a key problem. The challenge of upscaling has reached the top of the agenda at smart city conferences: Amsterdam’s smart city event 2016 has scaling as its central theme, and the title of the EC’s DG for Mobility and Transport conference is 'Transport for smart cities 2016: scaling innovation in Europe'. In response to the poor record of upscaling, the EC’s smart specialisation platform includes the notion of upscaling in its very definition of smart cities: “Smart cities aims at improving liveability and sustainability of cities, by ensuring scaling up and replicating smart city solutions, which will help reaching the 20/20/20 energy and climate goals in cities.” (http://s3platform.jrc.ec.europa.eu/smart-cities)

Several initiatives are being taken to enhance upscaling. The EU’s Smart Cities and Communities Innovation Partnership (EIP SCC) was developed to promote the rollout of smart city solutions in the EU. Launched in July 2012, it was set up by three Directorates of the European Commission (DG MOVE, DG ENERGY and DG CONNECT), in partnership with many cities and other stakeholders in Europe. Among other things, it focusses on the development and sharing of viable business models, financial tools and procurement instruments in order to make smart city projects economically sustainable instead of dependent on temporary subsidies or grants, in order to help scaling up and replication across cities. On the supply side, the EIP is implementing a limited number of large scale projects (the Lighthouse projects), at the intersection of transport, energy and ICT, targeting large-scale demonstration of SCC concepts in city contexts, where existing or very near-to-market technologies will be integrated in innovative ways.

Addressing the lack of scaling is the central concern of the Open & Agile Smart Cities (OASC) initiative, in which 75 cities join forces to develop common standards and data platforms for smart city solutions. In their background document, they state that "standard ways of accessing and exchanging data have the potential to take smart city innovation beyond the limits of the current chicken-and-egg situation where no systems can scale and spread because there are no standards, and there are no standards because there is no widespread deployment". http://www.oascities.org/wp-content/uploads/2015/03/Open-and-Agile-Smart-Cities-Background-Document-3rd-Wave.pdf, p. 1)

The lack of scaling is widely recognized and addressed, but the concept often remains undefined and undifferentiated. In the remainder of this paper, we intend to look more closely at the dynamics of scaling processes in urban technology projects, and bring more clarity into the somewhat fuzzy concept. First, we explore what the literature has to say about the problem at hand. Second, and based on that, we unfold a more refined conceptualisation of scaling up in complex projects, making the distinction between three types of upscaling: roll-out, expansion and replication.

2. From pilot to scaling

The problem of upscaling is treated in several literatures. Without claiming to even approach completeness, below we discuss insights on upscaling from three strands of literature: transition management, business studies, and development studies.

The literature on transition management studies the dynamics of system innovations over long periods of time. Many studies in this strand focus on sustainability-related transitions – e.g. shifts from centralized to distributed energy generation regimes and from fossile-based to greener energy sources, an important domain of smart city projects. System innovation is broadly framed as a non-linear and co-evolutionary process between technological, social, political and economic domains, taking place (Geels, 2002; Elzen et al., 2004; Smith et al., 2005). *Niches* are defined as experimental settings in which innovations are tested by new constellations of actors, with the ambition to present alternatives to the current regime (Rip and Kemp, 1998). The actions unfolding in niches contribute to add variety and pressure to the current socio-technical configurations or "regimes". Strategic niche management (Kemp et al., 1998; Hoogma et al., 2002) catalyses the transition: it involves the creation and development of "protected spaces created by specific actors – companies, policymakers or citizen groups – with the strategic aim to test and develop a technology and to prepare it for further diffusion" (Truffer et al., 2002, p.113). Niche development occurs through experiments in concrete places (e.g. though pilot projects in cities). At the same time, local experiments tend to add up to a "global niche" through the exchange and sharing of lessons and insights across locales (Geels and Raven, 2006; Raven and Geels, 2010). This leads to the articulation of common/shared problem agendas, expectations, theories, and success narratives, articulated and circulated by intermediary actors such as industrial lobbies, policy networks, user groups, not-for-profit organizations, etc. –, influencing new experiments and funding programmes for research and innovation (Carvalho, 2015). Niche developments do not lead to the radical replacement of established regimes, but challenge and influence them more subtly: "niches may branch, pile up, and contribute to changes in the behaviour, practices and routines of existing regime actors". (Schot and Geels, 2008, p.547). Some authors note that niches often fail to influence the mainstream due to an overprotection from real life contexts, e.g. by generous subsidies and regulatory exceptions that last for too long. From this perspective, Hommels et al. (2007) signal the need to gradually remove niche protection early on in the process.

Thus, the transition management literature hints at the function of pilot projects as playing out in protected "niches", in which alternative solutions are being tested by deliberate and coordinated action of several actors; Upscaling refers to subtle mechanisms by which such niche developments affect the "regime". It is a gradual process, facilitated by local-global learning mechanisms that play out in communities, but often withheld by legal or financial overprotection.

In business studies, there is a large literature dealing with the broad challenge of upscaling from experiments/pilots/R&D to larger scale production and market roll-out on the firm level. A central debate concerns the balance between exploration (developing new knowledge and competences associated with research& development and innovation) and exploitation (exploiting existing competences associates with implementation, production, refinement) (March, 1991 and many others). A balanced approach of pursuing both activities, i.e., ambidexterity, is essential for performance. Organisations that focus on exploration to the exclusion of exploitation bear the costs of experimentation but gain little of its benefits, whereas an overfocus on exploitation will hollow out a firm's competitive performance on the longer run. Scholars have discussed how firms can achieve balance (Lavie, Stettner, and Tushman, 2010). Most call for some form of separating exploration from exploitation, which can take three forms (Stettner and Lavie, 2014): 1) temporal separation, where a firm manages transitions between exploration and exploitation over time (Eisenhardt and Brown, 1997), 2) organizational separation (Benner and Tushman, 2003), enabling a firm to maintain distinct activities while engaging in internally consistent tasks within separate organizational units dedicated to either exploration or exploitation (O'Reilly and Tushman, 2008; Smith and Tushman, 2005), and 3) separating exploration from exploitation across distinct domains, e.g., engaging in upstream activities of the value chain via partnerships and alliances with the same partners, thus combining structural exploitation with functional exploration (Lavie and Rosenkopf, 2006). Smart city pilot projects involve exploratory activities, set up to test new technologies or concepts. If we follow the analogy and frame the process of scaling as the transition to the exploitation stage, the literature suggests performance will be enhanced by separating the two stages; scaling up requires different competencies and this must be accounted for. At the same time, the relevance of this literature for the upscaling challenge of smart city projects is limited, as it deals with for-profit private sector organisations, where R&D and innovation efforts are made with an explicit commercial motive in mind, whereas many smart city projects aim at social benefits such as emission reduction, energy savings etc.

A third and highly relevant literature strand on upscaling finds its origin in development studies, often carried out or funded by organisations like the UN, Worldbank or other donor organisations. Here, the typical question is under what conditions local health or development pilot projects might be scaled up, and how their scaling potential can be maximized from the onset. Worldbank (2005) defines scaling up as "expanding, adapting and sustaining successful policies, programs or projects in different places and over time to reach a greater number of people". Cooley and Kohl (2005) make a useful distinction between expansion, replication and spontaneous diffusion. *Expansion* involves scaling up a pilot to scale within the organization(s) that developed it; *Replication* means scaling up by others than the organization that originally developed the initial pilot or model intervention (for example through franchising as one model). *Spontaneous diffusion* involves the spread of good ideas or practices largely of their own accord. Many authors find that one of the keys to upscaling lies in the design of the pilot stage: a pilot must be set up with a vision on the ensuing scaling (in any form). "Pilots should be designed in such a way that they could be scaled up, if successful, and so that key factors which will be necessary for a scaling up decision—with what dimensions, with which approach, along which paths, etc.—are already explored during the pilot phase." (Hartman & Linn 2008, p. 16). Simmons and Shiffman (2006) find that scaling requires a personal champion: "A champion believes in the potential of an idea, model or intervention, is committed to promote its scaling up, sticks with the agenda and can convince others to follow her or his lead. A common feature of effective champions is that they are persistent, well connected, have coalition-building skills, articulate a clear vision amidst complexity and have credibility that facilitates the mobilization of resources. It is also desirable for them to know how to generate commitment by appealing to social values, to identify the critical challenges in their environments, and to have the relevant technical competence, management skills and capacity to motivate and train others. Most successfully scaled up programs have been led by outstanding personalities" (cited from Hartman & Linn 2008, p. 17)

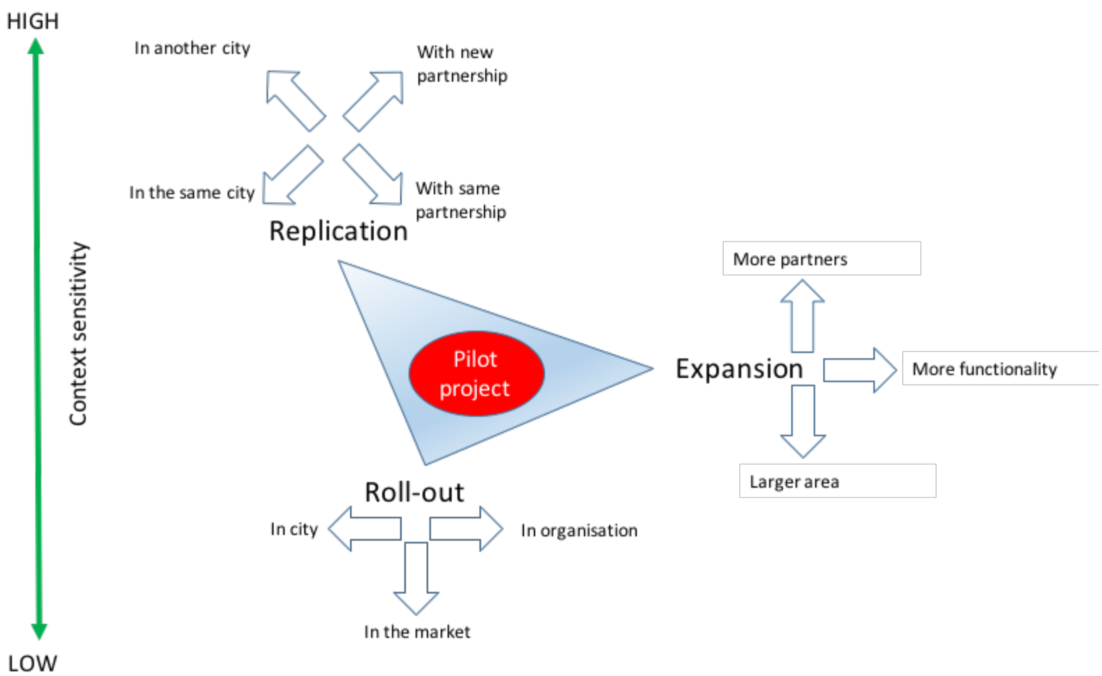
Where commercial firms have a market incentive for upscaling, public and not-for-profit organisations have a tendency "to move from one new idea to the next, from one project to another". To avoid this, scaling up should be a key dimension of performance feedback. The monitoring and evaluation of projects and programs should include conditions for effective scaling up of successful interventions.

Scaling up faces different types of challenges. It requires appropriate funding, but funders/donors often prefer to fund promising new ideas. Replication is particularly difficult when the pilot relies on expensive technology and other resources (Hartman and Linn, 2008). Upscaling is hampered when vested interests accept a small pilot but perceive scaling it as a threat, or when regulatory, legal and policy frameworks are not supportive. The implementing bureaucracy often resists change or smothers it (Samoff and Molapi Sebatane 2001). The scaling process can be stalled by a lack of capacity (manpower, skills, systems) in the organisations that carry it; Replicating a project in another cultural context requires an adequate accommodation to cultural values and social-interaction patterns, and often implies a re-configuration of the partnership. The simpler the institutional framework and the less complex the relationships between actors, the swifter and more successful the initiative is likely to be (Binswanger and Aiyar 2003).

3. Upscaling in smart city partnerships

In this section, we analyse upscaling in smart city technology pilots in more detail. Inspired by Cooley and Kohl (2005), we propose a distinction between three types of upscaling: Roll out, expansion, and replication, and apply the concepts from transition management and the literature on ambidexterity for a further anatomy of upscaling. The three types are different but not mutually excluding: a project may scale in various directions simultaneously.

Figure 1 Three types of upscaling



Type 1 Roll-out

In the case of roll-out, a technology or solution that was successfully tested and developed in the pilot project is commercialised/brought to the market (market roll-out), widely applied in an organisation (organisational roll out) or rolled out in the entire city (city rollout). Roll out is associated with technologies, products or solutions that don't fundamentally challenge the current state-of-the-art and are easily adoptable. Spreading does not require new partnerships, mayor behavioral or organizational changes, and does not challenge big vested interests or organizational cultures. The transition from the pilot to the scaling stage can be achieved without major modifications of the product/solution. The roll-out process is typically managed by one organisation –the one that initiated the pilot-, based on a profitable business model, including appropriate funding and a value proposition. This organisation has a high level of control over the upscaling process, reducing transaction and coordination costs. Regulatory and legal barriers to upscaling will be limited, especially when upscaling take place in the national market.

The roll-out type of upscaling might bring specific friction between the pilot stage and the upscaling stage: Organisations need to be ambidextrous to make a transition from exploration to exploitation. Roll-out requires operational competences, internally or through partnerships, and training of staff that was not included in the pilot. When the public sector is the main client, European public procurement rules apply, and the city government cannot purchase the successfully tested solution on a large scale from the company that co-developed it, but is requited to tender it. When the pilot was heavily subsidised, alternative funding has to be found for the roll-out. Roll-out will be complicated in case of excessive regulatory protection during the pilot stage; also, it is questionable whether the test context is a good proxy for (inter)national roll-out.

Type 2 Expansion
Some smart city pilot projects generate concepts that cannot be rolled out but can be "expanded" by a) adding partners, b) enlarging the geographical area covered by the solution, or c) add functionality. This type of upscaling applies to platform projects in which collaborating partners create added value, such as smart cards for tourists, where the value of the solution grows with the number of participating organisations. It is also relevant for local circular economy projects (where the waste of company x is reused as input for company y), or in cases where organisations share data to create a joint new application (elaborated below in the case of Energy Atlas). This type of upscaling applies when the innovation is not a single product controlled by one organisation, but a coproduction that depends on a close alignment of more partners. Upscaling in this case involves high transaction and coordination costs as new partners enter (implying negotiations) or new geographical conditions are to be met. This type of upscaling is more complicated due to the nature of the solution that was developed and the partnership relations. There cannot be a straightforward "rolled out" because there is limited control over the process and several independent organisations are involved; transaction and communication costs are high.

Type 3 Replication
Replication is the third and most problematic type of upscaling. With replication, the solution that was developed in the pilot project is replicated in another context (another organisation, another part of the city, or another city). Replication can be done by the original pilot partnership but also by others, and the replication can be exact or by proxy. Replicating a project always involves the complexity of the new context (legal, organisational or partner context), that never is the exact copy of the original. The solution developed in the pilot must be re-designed by the new partners in the new context. A typical barrier to the replication of smart city projects in other cities (especially data-based solutions) is the lack of standards, open data formats and protocols. Replication is further complicated because of poor knowledge transfer mechanisms. The knowledge developed in successful project often remains tacit and is thus difficult to access for outsiders. Communications about a project, if existing, tend to focus on the successful outcomes, rather than the design process and the difficulties that were tackled along the way. Moreover, replication is hampered by the "not invented here" syndrome.

4. Illustrating the typology: an analysis of projects from Amsterdam Smart City platform

In this section we illustrate the complications of upscaling with three case studies of smart city pilot projects in Amsterdam. The first project is Klimaatstraat. Led by the city administration, this project was launched in 2009 to turn a busy urban street, the Utrechtsestraat, into a living lab and showcase for sustainable technology. The second project is Energy Atlas. Here, public and private players in the local energy system decided to share their data and create an online interactive energy atlas that reveals real data on energy, water and sewage use on the (detailed) level of the building block, for the entire city of Amsterdam. The Atlas is a tool to reveal how energy use correlates with land use and building types, and also helps to identify the locations in the city with the highest potential to adopt sustainable energy solutions. The third case is the development of the i-kringloop (recycling) app. An independent app developer received a subsidy from the city to develop an app that helped to connect citizens that want to get rid of their bulky waste to charities that might reuse or resell it.

The cases were chosen on the basis of theoretical sampling, and they are interesting for the analysis because they represent different types and mixes of upscaling processes. Although all three projects relied to some extent on subsidies in their pilot stage, they are not excessively “shielded” by legal or regulatory protection, which would have reduced the chance of upscaling from the outset.

As a context, we briefly describe the history, rationale and development of each project, and the partnership. For each case, we explore how the upscaling process played out in each case, and what barriers were faced. Evidence was collected through semistructured face-to-face interviews with projectleaders and stakeholders of each project, and staff from Amsterdam Smart City platform, as part of an evaluation study on the effectiveness of Amsterdam Smart City projects. Interviews lasted between one hour and two hours. Interviews were transcribed into detailed interview reports, and this information was triangulated with secondary sources such as evaluation documents, press releases, personal communications, etc. We opted for a narrative approach to present our findings to do justice to the context specificity and to preserve most of the richness of each case.

Case 1: Climate street

The Climate Street project was launched in 2009, to turn a busy urban street, the Utrechtsestraat, into a living lab and showcase of how to make a high street more sustainable in all respects. Retailers in this street were invited to apply a broad range of technologies and concepts that would reduce energy use or waste. Also, experiments were set up in the fields of waste collection, logistics, and innovative street lighting. For technology companies and utilities, the project leadership positioned the street as an interesting urban lab where they could test new products and services that could later be rolled out. In some cases, the project management team actively approached companies they knew had something to offer; in other cases, companies approached the project leader asking if they could test their product in Climate Street.

The partners had different roles and interests. The various city departments saw the pilot as a unique lab to learn how to work with local retailers, have them adopt clean technologies, and so contribute to the cities' ambitions regarding emission reduction. The city was the main funder of the programme, and helped to set conditions for realising urban innovations: permits, solving legal issues, access to civil officers with the right skills and competences. The retailers (40 of them were involved) hoped that applying new technologies would help them save on energy costs, and/or increase the sustainability of their businesses. The technology companies and services providers considered the climate street as a unique lab to test their new products and concepts in a real-life setting.

The initial enthusiasm of the retailers waned in the course of the project, because the benefits proved often marginal – just a slight decrease of the energy bill, for example. And in some cases, the benefits accrued to the real estate owners, not the retailers (most of them not owning of the building). At the same time, many of them were very annoyed by delayed streetworks and renovations – with substantial revenues foregone - and the trust in the municipality eroded. In 2010 the project almost collapsed due to the lack of commitment and a lack of clarity as to who was in charge of the project.

Upscaling the Climate Street project was envisioned in two respects: roll-out (by companies that tested new products) and replication (creating sustainable retail streets elsewhere in the city and in other cities). Both turned out to be problematic. The only rollout success that the project leader could remember was realised by Quby, a start-up firm that tested a smart energy display in the Climate Street project and sold it to Eneco (a major electric utility in the Netherlands) that sold over 100,000 energy displays to date. Note that in this case, exploration and exploitation were explicitly separated and performed by different organisations.

Replication was another explicit objective of the Climate Street project. To enable other cities to set up a similar project, a consultancy agency was hired to write a "blueprint for sustainable shopping streets", based on the experiences in the Utrechtsestraat, as a handbook and source of inspiration for other highstreets. It is unclear to what extent this blueprint has been used and whether the Climate Street has been replicated, but the project had an impact: due to the effective communication of the Amsterdam Smart City platform, Climate Street attracted wide attention from professional media and local governments, nationally and internationally, and many delegations made study visits to see how things were running. It is beyond the scope of this study to assess whether these visits have played a role in replication but at least some degree of knowledge transfer took place.

The Climate Street was not envisioned as a pilot project but as rather as a permanent beta lab, a platform for all sorts of experiments that would enhance sustainability. The municipality kick-started it with initial funding and hoped that other stakeholders would take over. At the projects' inception, the partners were excited, but it turned out very hard to keep the spirit. After 2 years the city (municipality and borough) proved not prepared to extend its funding. The municipality organised a closing event for all the stakeholders, to "celebrate the successes", but also sent the clear message to the local retailers and the other project partners that the project should be able to run on its own, without active government support. There was no partner willing to take over the active lead beyond the project phase, and so it slowly faded out.

Case 2 Energy atlas
In this project, key public and private players in the local energy system decided to share their data and create an online interactive energy atlas that reveals data on real energy, water and sewage use on the level of the building block for Amsterdam. The Atlas helps to identify the geographic locations in the city with the highest potential to adopt sustainable energy solutions. In its initial stage, the project was supported by European funding from the TRANSFORM project (executed between January 2012 and August 2015), in which six European cities collaborated to lower carbon emissions (Van Warmerdam and Brinkman, 2015). One of the action lines was to design and build tools to support energy transition of cities, and in this context the Energy Atlas was developed in Amsterdam. The Amsterdam city administration led the project, organized the process and developed the technology platform. The participating utilities and housing corporations agreed to provide their data for free, provided that the platform would be open and would not reveal energy use on the level of individual clients. It was a key challenge for the partners to cluster information on clients in such a way that it would be impossible to trace back individual use. Despite many technical, legal and data problems, the partners backed the project and realised the value could create. The project partners but also experts in the energy sector that we interviewed consider the Atlas a great success. It is internationally unrivalled, especially because it gives up-to-date and real (rather than projected or estimated) data on a wide variety of energy consumption and production in the entire city. The Atlas has survived the pilot stage and floats without European subsidies: the local partners have committed to continue to feed the platform with data and keep it technically up to date.

In this case, the upscaling process had two dimensions. First, from the outset, replication was central ambition the six city partners of the EU-funded TRANSFORM project. The partnership developed a "Replication & Exploitation Campaign" to transfer the tools and lessons learned about energy transition to other cities. Handbooks and masterclasses were developed to transfer the lessons on energy transition that were developed in the project. Also, three companies (Accenture, Macomi and AIT) developed an online integrated urban energy planning tool (http://urbantransform.eu/decisionsupportenvironment/), that enables cities to simulate energy scenarios, and helps to design interventions in the energy system, assess their impact, and also might help to facilitating the dialogue with stakeholders. The value of tool critically depends on detailed geo-spatial and energy data inputs that must come from a variety of sources (different utilities, housing corporates, a number of municipal departments, etc.). So far, the tool is not actively used by other cities, mainly because of data issues. The developers of the tool recognize the "limited success in getting the right data at the right level of granularity", arguing that data owners often face technical difficulties and do not perceive the value behind opening of their data. They identified a set of legal, economic and data quality challenges (http://urbantransform.eu/wp-content/uploads/sites/2/2013/02/Transform-open-data-booklet.pdf, p. 17).

Amsterdam has this far been the only city in the consortium to develop a full-fledged energy atlas.

This brings us to the second dimension of replication: Many Dutch municipalities and utilities expressed the ambition to somehow replicate the Energy Atlas. Inspired by the Amsterdam example, the association of Dutch municipalities is developing a national Energy Atlas. It is supported by the national government , the Amsterdam team acts as advisor. At the same time, similar atlases are being developed independently by larger municipalities and provinces.
This upscaling process illustrates some typical challenges replication. First, as the context-specificity is high, replication requires the formation of local coalitions, involving high communication and transaction costs. Second, replication would benefit from a knowledge transfer. However, there are no strong governance mechanisms or incentives to transfer lessons and experiences from the Amsterdam project to other municipalities. This slows down the process and makes it more expensive: the Amsterdam project leader estimates that applying the lessons could reduce the costs of replication potentially by half. Third, many cities –especially smaller ones- lack the sophistication and expertise of GIS systems; The Energy Atlas could draw from many existing databases and maps.

Case 3 iKringloop
An independent app developer noted that the system of bulky waste collection in Amsterdam was unsustainable: upon request of citizens, the waste company collects larger pieces of waste to have it burned, with negative repercussions regarding CO2 emissions, foregoing opportunities for barter or reuse, and creating a bad image in the streets. To tackle this, the developer had the idea to design an app that would link citizens who want to throw stuff away with charities that would collect, reuse or sell it. He convinced the city officials that if only 5% of people would use the app, the cost savings for the city would already be substantial, the waste in the street reduced and CO2 emissions would be lower. The city administration provided him a subsidy to develop the app, and used the cities' marketing channels to promote it (e.g. in billboards, waste collection trucks, etc.). The app started with a successful pilot, but after that, scaling turned out to be complicated. Each of Amsterdam's relatively independent boroughs had their own bureau responsible for solid waste collection, with specific rules, regulations and routines. The system would have to work for all the bureaus. Expansion of the app's coverage in Amsterdam required time consuming negotiations with operational waste managers in each borough, many of who considered the solution as an unwanted change in their routines. To get things done, the developer moved up in the hierarchy and engaged in talks with the bosses and politicians that understood it better (convinced through issues of city image, safety issues, CO2, saving money, etc.). Replication in other cities would have taken a similar effort. In an effort to increase the take-up of the app, the developers

made it less context specific and eliminated the complexity of dealing with local municipal waste companies. In a new version, the app merely intermediates between supply and demand of 2nd hand items, regardless of their location. Users can submit photos of their waste, and other users (including thrift stores) can see the offer and contact the owner. The app also contains an overview map of waste collection points in The Netherlands and Belgium. Although the app claims coverage in Netherlands and Belgium (it maps 300 thriftstores across these countries), all the the offered items on the map from the last month originate from the Amsterdam region. Volumes are limited: the platform has 596 items on offer.

5. Discussion and conclusions

Smart city technologies hold the promise of more liveable and sustainable cities and improved urban services. European cities set up a growing number of smart city pilot projects, in which various stakeholders apply new technologies to address urban challenges or improve service provision. In the last decade or so, European, national and local public funding for such initiatives has grown, and also the private sector is increasingly interested to invest in smart city projects. Recently, there is a growing concern among policy makers and funders about the impact of these pilot schemes, mainly because of the low rate of upscaling: most projects die after the pilot projects ends and/or when the project subsidy dries up, and fail to make a substantial impact. In this paper, we have made an attempt to analyse the process of upscaling (including its hick-ups and barriers) more in detail. We started out by exploring insights on upscaling from three strands of literature: transition management, business studies, and development studies. We proposed a more refined view on different types of upscaling, making a distinction between three upscaling types: Roll-out, expansion, and replication, each with their own specificities and context sensitivity. We illustrated our point by describing the upscaling process in three rather different smart city projects from Amsterdam, one of the most active cities in this field.

Before drawing conclusions on upscaling as such, some of our findings challenge the emerging policy orthodoxy about scaling as the holy grail of project success. Even in the absence of upscaling, pilots generate lessons and insights that might benefit ensuing projects –if captured, documented and shared appropriately. On a higher level of abstraction, the transition management literature highlights the value of sequences of experiments, including failed ones, as part of the process of newly emerging narratives and agendas, influencing established regimes. Our interviews with local project leaders and other stakeholders revealed significant project-to-project learning processes, where tacit knowledge from former projects is infused into new ones. Moreover, a project can be successful without upscaling in other respects as well: Energy Atlas is seen by its local stakeholders as a success, the local initiators maintain and fund it without intending to expand or replicate it elsewhere. It evolved from a pilot project to a useful shared instrument. These findings suggest that a single-sided focus on scalability could reduce or impede more fundamental experiments that may not scale immediately but function as small building blocks in a process of systemic and more fundamental changes, and entail important learning processes. Policymakers need to be aware that the changes they are pursuing in society with their funding will take time and require the accumulation of many projects. By far the most smart city technology projects are not purely technical but involve social, cultural, political, institutional and behavioral changes that are very context sensitive.

The Energy Atlas case demonstrates how replication is complicated by high levels of context specificity. In such cases, the dissemination/replication activities (producing handbooks, toolkits or online tools) so typical in European projects are ineffective, because a project's success is highly contingent on local coalitions and conditions. There are often no robust mechanisms and incentives to transfer lessons learned from place A to B, and data-dependent tools are not widely applicable because of data format problems and legal issues. (Inter)national consultants or tech multinationals play an important intermediating role in replication and knowledge transfer between locales. Consultants develop and exploit valuable process knowledge from their involvement in multiple projects: they codify the lessons learned, enabling them to translate and mediate between contexts, helping new local coalitions not to reinvent the wheel. The consulting company Accenture played an important role in the development of Energy Atlas and uses its experience to advice other cities. Technology multinationals such as IBM or Cisco are able to replicate solutions in a different way, namely by combining their multi-local presence with firm-internal knowledge transfer and ambidexterity. They manage to transfer solutions from one place to another and capitalise on their investments. Startups (such as Ikringloop) and SMEs lack such networks and competences, and have much more difficulty to effectively scale up smart city solutions. This explains why so many applications and solutions never outgrow the local or even parochial level, unless adopted and scaled up by a larger player. The case of Climate Street is illustrative: the successful roll-out of the energy display only happened after the start-up company was taken over by a larger player that managed to sell the displays in the national market.

Our study demonstrates that upscaling is multi-layered, and different types of scaling might follow from a single pilot project. The Climate Street project offers an example where the ambitions of replication and rollout coincided: the aim of the project was to create a more environmentally sustainable retail street, to be replicated elsewhere in Amsterdam and beyond. Besides, the project created a living lab environment where companies could test new products and services, as a first step to further rollout.

Understanding the scaling process of smart city solutions requires insights into the subtle interplay between the project level and the individual organisational/firm level. Many smart city projects are collective ventures of different organisations, each with different rationales, ambitions and perspectives regarding upscaling. Partners may enter a project for a variety of reasons: to test how consumers react to new products (as did the tech companies in Climate street), to demonstrate the technical feasibility of solution on a small scale, to conduct research/development that might be commercialised later on, or to create customer value (i.e. cost savings or improved service for clients or citizens, as was the case in the Energy Atlas case), or to reach sustainability ambitions (lower CO2 emissions, energy use etc). Private partners may also join a project to (re)establish close relations to the local government (especially relevant for companies that have the local government is an important client), or from a corporate social responsibility perspective and/or to improve its image. More research is needed to study the dynamics in this arena of upscaling where different interests meet and collide. For a start, our cases suggest that project participants rarely openly discuss each other's upscaling perspective and ambitions during the pilot projects formation stage, nor do they build in mechanisms that ease the transition to the upscaling phase. When the pilot ends, this puts a strain on the upgrading stage which become a project of its own. This finding resonates with insights from the business literature that longer-term competitiveness relates with ambidexterity: a firm's ability to find a good balance between exploration (developing new knowledge and competences associated with research& development and innovation) and exploitation (implementation, scale production, refinement). Pilot projects, after all, are designed for the exploration stage.

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