

Three drivers for cities development: a focus on start-up contribution

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Abstract. This research considers the interplay among new technologies – mostly digital –, new ventures, and the new emerging city contexts leading to support the urban transformation to improve quality of life. The need to provide public services in an efficient and more performative way led to consider such a challenge as a business opportunity for new ventures, thus inspiring the infusion of new technologies in start-ups and spinoffs created to offer public services. City governments lack the right knowledge and resources to do that, thus stimulating and partnering new ventures is a way to achieve a successful city transformation. Several case studies show this new dynamic and the potential improvements to be further achieved, thus mirroring the business opportunity caught by new ventures and the support new technologies can offer to citizens and other city's stakeholders.

1 Introduction

The improvement of quality of life and well-being in cities is a key issue for both local governments and central ones; the World Economic Forum in November 2022 stressed how complicated the challenge for life in cities is, due to the combination of climate change, pollution, ageing and unemployment among others.

The debate on cities' transformation is hot even among academicians from various fields of study; indeed, cities' structure as well as the services offered are drivers of quality of life [1]. The debate also led to many conceptualizations, therefore many years after the conceptualization of digital cities [2] scientific contributions witness more recent advances such as smart sustainable cities [3] and resilient cities [4].

This stratified discussion led to consider a great variety of topics – as technology, environment, citizens' participation, business opportunities, performance measurement, among others – and the interplay among them, shaping a context made of multiple perspectives [5] and opportunities for further advances, both theoretical and practical. New business initiatives are meant as one of the opportunities for such advances [6], since it is evident that public entities cannot afford cities transformation on their own, due to the need to consider technological issues, as well as because of budget constraints and lack of technical resources.

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Additionally, the implementation of novel technologies is particularly challenging for city managers, since they miss the suitable competence for designing new solutions [7], thus the need for support from private entities is even stronger than in the past.

Therefore, this study observes new business opportunities emerged in cities' transformation to implement new technologies, to understand how the interplay between public and private entities occurs and which goals are pursued; moreover, the novel element of this investigation is the description of the expected contribution of novel technologies, thus shading light on a recent issue. Thus, a theoretical background showing cities in transformation, new ventures in public services, and new technologies opportunities will be presented, leading to highlight the research gap. The analysis of multiple cases would offer insights from the empirical context leading to both theoretical and practical implications for future implementation of novel technologies in public-private partnerships for the improvement of life in cities.

2 Theoretical background

This section describes the theoretical background of this study, shaped by three topics, namely cities in transformation leading to consider new urban contexts, then the rise of new ventures set around solutions for offering services to cities' residents and firms, and the contribution of new technologies to shaping new solutions for public services.

2.1 New city contexts

New city contexts are featured by the infusion of new technologies, the emerging of specific needs, and the efforts to make people participating in decision-making, as well as in proposing and setting new services.

Scholars shaped a long-lasting debate on new cities' contexts, including the emerging of different classifications of cities. Indeed, one of the first concepts shaping such an evolution of cities was digital city, dating back 1999, when Ishida [8] highlighted the advantages of digitalization in the processes of cities' transformation, namely the support to communication services, the improvement of system architectures, and the achievement of higher efficiency. Moreover, the author stressed that digital advances would have led cities' development in the future and this is mirrored in what is currently happening.

The contribution of technologies was not thought to be enough in leading cities to better conditions, since citizens' participation is a feature that cannot be unconsidered [9, 10]; indeed, the infusion of technologies might mislead some soft features, leading not to properly transform governance, too. This is the main reason why scholars switched their attention from digital city to smart city is the need to consider people participation in cities' transformation, since this supports an increasing understanding of public needs, as well as the awareness of citizens in appreciating the technological improvements [11]. Moreover, a view involving citizens and technologies throughout all the features of a city is in line with one of the most adopted postures on smart city, namely the model that ranked the medium-sized cities [12], proposing the key characteristics of a smart city project.

More recently, the relevance of issues as pollution, climate change, unemployment, and other social issues led to reframe the debate of cities in transformation with reference to sustainability, thus leading to the 'sustainable city', as the city that undergoes changes to favour the achievement of sustainable goals from multiple perspectives [13, 3]. Parker et al. [14] approached cities' development underlining the need for tools to manage, practically, cities' regeneration going beyond the simple theoretical perspective. Literature and research are relevant but, in some cases, like the city high streets improvement projects, it is necessary to use theory to set tools to get practical results. First of all, to plan and act with

urban regeneration it is necessary to study new and multiple techniques to stimulate the city stakeholders' participation in the majority of the projects and each of them should have a practical side able to be tested. The call for further studies refers to city stakeholders' involvement, thus understanding the relevance of cooperation and the fundamental role of sharing of data and information.

2.2 New businesses for public services

The relevant growth of new ventures (i.e., start-ups and spin-offs) in cities undergoing a smart transformation attracted the interest of scholars, since this phenomenon offers interesting insights. Indeed, the model that ranked smart cities [12] also referred to the push towards entrepreneurship as a feature for smart cities; additionally, cities would benefit from technology-based solutions offered from start-ups to further local innovation [15].

The interplay between cities and start-ups is seen as reciprocally beneficial, since – on a side – city authorities offer a supportive environment to set new start-ups and represent a customer of specialized services offered by new ventures [16]. This is also in line with the posture of cities to favour innovation through the creation of a context offering opportunities to new firms to cooperate and launch new initiatives. This also happens through incubators [17], thus mirroring the interest city authorities have in favouring entrepreneurship for local growth, as well as in achieving scalable results. On the other side, cities can benefit from technology infusion through start-ups [18], thus reducing the risks depending from low competence and the limited chance to invest, as well as contrasting the impossibility to focus on multiple solutions, while leveraging on new ventures as partners would widen the set of opportunities available.

The increasing need for specialized skills in implementing new technologies led to create a fertile ground for new ventures. This happened globally and in multiple services domain; indeed, scholars reported that start-ups supported the launch and deployment of peer-to-peer initiatives in public service domains as transport and energy [19], as well as new ventures show wider capabilities in managing complex infrastructures – as platforms – in new urban contexts [20]. A two-way perspective also emerged from research on collaboration [21], showing that the need for collaborative pathways in implementing new technologies in smart cities; indeed, cities lack of the critical knowledge to implement technology-based initiatives, while start-ups need both the empirical context for testing and legitimacy to test and market their advanced services.

Some recent studies in the economics domain highlighted the new entrepreneurial efforts embedded in cities' transformation [22]. Anyway, scholars called for further investigation in order to test with various methods and in multiple geographical context to increase validity and highlight new issues, due to the continuously ongoing novelties brought by creativity and new technologies.

2.3 New technologies in cities' transformation

The contribution of new digital technologies in smart cities is well-established, as it was also in previous theoretical views of this debate, since cities' transformation depends on several issues, but most and foremost on technology and citizens' participation. The advances in new technologies – especially with the tools proposed in the framework of the so-called Industry 4.0 – might be very supportive for cities [23]. One of the first contributions on the infusion of Industry 4.0 technologies in smart cities [24] highlighted the quickness in responding to citizens' needs, due to the interactions mediated by ICTs and thanks to the information brought by data and the related analyses. A mutual symbiosis emerges as users interact with a city's platform touchpoints generating information that

would feed the service platform, thus favouring a continuous increase in what local governing entities know about citizens. Data might be conveyed to platforms either voluntarily or automatically, since apps would favour both ways of transferring data from users to providers, namely to the collaboration teams shaped by public entities and private businesses.

Recent studies on new technologies implemented in smart cities showed the general changes in society brought by new technologies setting the ground for new businesses and citizens participation [25]. With reference to specific technologies, scholars identified some impacts of recently successful initiatives; big data for security and privacy through analysis leading to a more customized and effective service provision as well as to higher levels of efficiency [26], artificial intelligence to improve transport network and its effectiveness in city mobility services [27], digital twins to optimize the testing of new strategies and services [28] and data dissemination for the feeding of predictive models of public services, first and foremost transport [29].

The considerations on technologies are related to the previous debate on new businesses, since the interplay between new ventures and new digital technologies is still under investigated, besides supranational institutions stressed this chance. Indeed, the Digital Strategy of European Union challenged citizens and firms in favouring the digital transition via new technologies and infrastructures in the main framework of the European Green Deal [30]. Recent studies on digital technologies in smart cities showed their key role in favouring urban entrepreneurship and in grasping benefits from it [31]; anyway, due to the newness of this topic and the deriving debate, the authors called for additional studies to identify the impacts on sustainability in cities, the mechanisms affecting e-government, and – in a general vein – a more accurate knowledge on the impacts of Industry 4.0 on urban contexts.

3 Research gap and research process

This research addresses the gap in investigating how new digital technologies are favouring new business initiatives in cities' transformation; the interplay among these three topics is yet to be fully investigated due to the being new of several new ventures, as well as due to the continuous emerging of new technologies supporting both new business initiatives and new ways to provide public services in cities.

In order to deal with the interplay among new cities' contexts, new start-ups, and new technologies, this research addresses the priorities for cities viability as recalled by Parker et al. [14] and the framework provided by Dana et al. [31] describing the role of digital technologies in smart cities and urban entrepreneurship. Moreover, scholars also called for additional investigations [22] to further test what recently set businesses might offer to the improvement of cities' conditions in terms of quality of life, sustainability, and viability of public investments.

The combination of the two conceptual perspectives recalled would lead the analysis of several projects of cities transformation either planned or performed by recently set start-ups. A multiple case studies approach would guide the general understanding of the phenomenon and set research perspectives aimed at investigating various topics, including born global start-ups, intra- and cross-industrial alliances, engagement mechanisms for citizens, new business dynamics in cities transformation, and societal implications. This methodological choice is in line with previous studies in this domain, including recent ones (e.g., [32]). Moreover, such a choice mirrors the need to adopt a qualitative approach when dealing with new topics, not yet developed to carry out other typologies of study [33].

Finally, 27 case studies have been chosen from online sources to widen the range of observations and to consider successful initiatives on an objective basis, instead of having

the authors selecting them. Multiple sources were used to contrast the elements shaping each case and to highlight issues evolving over time, if any. Authors collected data together, then individually analysed the evidences to finally compare the considerations and further limit subjectivity bias.

Some case studies are summarized in the table below, mirroring the variety of technologies, services, and background areas of start-ups and testbed locations:

Table 1. Key characteristics of main case studies

Start-up / Spin-off	Location	Technology(-ies)	Service	Testbed area
Automa	Brazil	Digital twins	Energy	Curitiba
FuVeX	Spain	Drones	Energy	Spain
Xmart-Sense	Spain	Sensors	Air quality	Spain
SafeUp	Israel	App	Street safety	Israel
Neer	US	Machine learning	Water control	Missouri
Urban Sky	US	Remote sensing	Air quality	Rocky Mountains
Urbio	Switzerland	Data analysis	Energy design	Switzerland
Wisear	Italy	Sensors & Data	Air quality	Italy
MCS	US	Artificial intelligence	Traffic control	Serbia
Blackshark	US & Austria	Artificial intelligence	Urban planning	US
Angoka	Ireland	Machine-to-machine interaction	Mobility	Ireland and The Netherlands
Mobito	Greece	Data analysis	Mobility	Greece & UK

4 Findings

The new ventures analysed present a variety of backgrounds, technologies used, and services provided to cities and small communities. Therefore, this variety mirrors the key mission of cities in transformation, namely offer new solutions to the city, thus combining the needs and goals of the various characteristics of cities. The findings are presented with reference to the city services undergoing a transformation, to show the multiplicity of goals and the intricacies among them.

4.1 An overview on new solutions

A general overview of such evidence shows that energy and air quality control are the most frequently recalled areas of intervention, but also transport, safety – intended in multiple ways –, water control, and urban planning are significantly considered. This overview describes a dynamic business environment shaped by new ventures offering solutions designed for cities and the start-ups and spinoffs had been founded because of a business opportunity was foreseen in public services. Due to this, in several cases firms report their being funded via international competitive projects, acceleration programs, and banks with programs aiming at improving cities.

Additionally, the cases show a multitude of national backgrounds, but in most cases the testbed areas were just local; anyway, there are cases with these new ventures testing solutions abroad and this is due to partners (e.g., Mobito signed a partnership in the UK to design a solution for traffic congestion) or founders' background (e.g., MCS had most of the co-founders moving from Serbia to US, so they suggested to test their traffic control system in an area they had more information about).

4.2 New solutions for energy

About the energy, FuVeX sets drones capable of flying on long distances tracking the electric energy network; The tracking method save energy and improve the quality of control if it is compared with the same work using helicopters. Further the drones can make a further service collecting data about air quality.

Automa simulates new digital models about energy provision in big companies and cities creating twins of energy consumption systems. The models are useful in decision-making. It is possible to use the system in testing and monitoring traffic, public lighting and security.

Urbio is focused on data collection through machine learning and it is a start-up based on a project able to be applied to neighbourhoods and cities in order to measure energy consumption in terms of electricity and heating and, consequently, assess the system potentialities in terms of resources.

4.3 New solutions for air quality

In terms of air quality, some case studies follow.

XmartSense, a company supported by Iberdrola, measures air quality, CO2 emissions, air pressure with sensors and combines data, working both optimizing the wind-turbine parks efficiency and at the same time, measuring air quality in cities.

Urban Sky uses a system of microballoons and remote sensing taking high resolution images for cities for public, technical, agricultural and commercial use. The images can be used analysing the cities areas, parkings, roads and vast areas.

Wiseair works on air quality through several systems and sensors useful to realize constantly and real time updated platforms that generate dashboard to constantly analyse information about air quality. Results can be spread to city government or directly to citizens.

4.4 New solutions for mobility and traffic control

Considering the traffic, some solutions are intended to reduce the use of own cars, others to stimulate the use of public transport. For example, MCS uses artificial intelligence to forecast the movement of vehicles on roads and the occupation of parking lots. The use of these systems increases the possibility of finding parking and reduces road congestion with direct benefits for citizens in terms of time saved and pollution reduction.

Angoka is a company projected looking at the intelligent mobility. The services have been designed for self-driving vehicles but they can, in general, favour the automatic and digital communication between cars to increase safety. Mobito is a technological solution for optimizing mobility through the use and management of data acquired through an advanced driving behavior monitoring system. Collection, systematization and

transformation of data into information allows Mobito to sell data and information to cities. The latter, through the data obtained, can plan traffic management more accurately

4.5 New solutions for other domains

Looking at safety, health and water management integrated into city planning, other start-ups have provided solutions that can be immediately used by citizens and businesses to improve their level of quality of life in cities.

Safeup allows to increase the level of safety on the streets by building a network of people who somehow find themselves walking alone at night. The application helps with references and contacts of people who, in the vicinity, share the same application. A system like this creates a community which, by sharing a problem, reduces its impact on the individual.

Neer allows to efficiently manage the flow of water distributed in the houses of the cities in a sustainable way, allowing a reduction of the impact of water scarcity and losses in the aqueducts. It is based on machine learning and the application of sensors on existing infrastructures.

Blackshark allows to create 2D or 3D models of specific urban areas and integrates simulation with modelling. For this reason, the application, subject to authorisation, acquires images of the area to be analyzed and, using an artificial intelligence system, can replicate the structure of an area, such as a city or even a forest. The acquired images can be used for participatory planning, for simulations, for any urban/area planning activities.

5 Research implications and further research avenues

The result stimulates some research implications about the role of stakeholders in the city, their interactions and the role of technology in connecting city stakeholders that share the same vision for the development. Technologies are not only a mean to increase opportunities for start-ups to get revenues or a solution to satisfy city stakeholders needs. Technology emerges like a driver for city development and viability and at the same time it stimulates the knowledge diffusion among city stakeholders. This confirms the relevance of citizens' involvement – as theorized by Benli [9] and shows the potentialities of new technologies in furthering an active participation. The key evidence is related to start-ups, since they caught the opportunity offered by an increasing need in the market of public services; such a chance for new ventures [6] depends on the role played by technology in solving complex issues and in combining multiple results. This latter is related to the trend of cities offering multiple services through platforms, thus technology-based services can be easily combined both with extant ones based on technologies as well as with the ones that would emerge in future. Therefore, integration is a key reason to lever on such a business chance for new ventures in proposing innovative solutions to cities.

These implications suggest further efforts in several research areas from engineering to urban planning, from sociology to economics and management of businesses and cities. This is due to the multi-side effects of new technologies implementation, in line with what scholars observed about innovation in cities (e.g., [3]), but also because of the multiple effects technologies might offer to cities' transformation. These effects were considered in the general idea of bringing efficiency to cities' management [26], but the evidence shows the empirical side of such effects.

The consideration of multiple effects also offers insights on the complexity of cities issues, as it represents the reason why new technologies are the fitting match with local

domains because they allow to manage complex flows of inputs (needs) and outputs (services) to a variety of stakeholders. Therefore, new ventures are needed in public service domains [19] and their capability to infuse new technologies offers potentialities to improve quality of life in cities.

Focusing on a managerial perspective, some research considerations and needs emerge. Future research might be useful on the following domains:

- relations among city government, citizens, and city entrepreneurship to combine creativity, knowledge, and efforts;
- the role of open data in creating new technology for cities can be instrumental for a proper combination of efforts from multiple city's stakeholders;
- citizens involvement in city vision development is needed to get insights from the users, thus grasping citizens' needs is a not-to-be-missed element;
- new ventures dynamism and capabilities in interpreting city and citizens needs played a crucial role, thus cities' transformation is a new business domain stimulating new investments;
- spreading innovations and technology to other cities not directly interested by the first application of technology can favour the viability of some interventions;
- how to favour the upgrade of Technology Readiness Level (TRL) of innovative technologies for cities is still puzzling, besides some new ventures managed to achieve beneficial results in a limited amount of time.

6 Conclusions

This work observes technology start-ups engaged in their value proposition towards cities and citizens with the aim to study the interaction between public and private business and among multiple stakeholders in the dynamics of city transformation. The results explain that technology start-ups identify and interpret the city stakeholders emerging needs with particular reference to citizens. These latter express directly or indirectly their needs, requirements and difficulties in living the city and, in some cases, those needs are noted by international organisations. Start-ups rarely propose solutions from direct inputs or city government strategies. In contrast, technology-based companies seek to respond to the direct needs of the people living in cities; they seek to first improve the life within the cities, for example, by improving air quality, proposing traffic control and reduction systems, and smart solutions to improve the quality of life of city dwellers.

The findings coming up from this research show some key points about the contribution of new digital technologies in favouring new business initiatives in cities' transformation; at the same time, the findings suggest to focus the attention on the multiple relations among new ventures, their technologies, places and citizens and the other addressees of new solutions – including local government. Each component interact in a structure where technology can be the bridging element to stimulate the emersion of the city like a system.

Anyhow, for this first analysis, from the findings a prevailing focus on 'users' (citizens) emerges. The start-ups provide solutions directly or indirectly addressed to satisfy citizens needs through direct solutions from the energy and water management to the air quality and traffic regulation. Products and services that can solve, quickly, citizens' needs in a city independently by the main vision of the city government. So, new ventures' offering are mediated by governments, but the focus of new ideas is on users.

The technologies infused in new services by start-ups are immediately useful to satisfy the everyday needs with a double effect: they represent solutions for the short term and, at

the same time, they are incremental improvement for the medium and long run if the technology will be integrated with other technologies and in a city strategy.

New ventures interpret cities as places where citizens can firstly live their lives with their loved ones in a better way than before. These places are first meant as vital and, only in a second moment, as workplaces and production environments for products and services. For these reasons, new ventures do not have as their first objective the improvement of the productive capacity and efficiency of the city's services but the improvement of viability, relations, and quality of life.

From this analysis perhaps a predefined role for city government and politicians emerges: if new ventures and urban entrepreneurship intend to interpret the needs of users and improve their quality of life through the provision of technological systems and citizen-oriented services, city governments on the one hand should provide strategic directions for the city – for example, attempting structural and infrastructural renovation – and, on the other hand, should take care of fostering the inter-collaboration between citizens and new ventures in a value co-creation logic.

For the future new needs grow up and 3 main city stakeholders should work together supported by technology evolution.

The first stakeholder group consists of citizens. They should be confident in expressing their needs with or without the city government support. They should have the will and the knowledge to be involved. Every stakeholders considered can cooperate to let the right space to citizens expression.

The second group is characterized by technology start-ups interested in working with and for cities. They should got right capabilities to interact with citizens and with every open data structure to get data, information and citizens' needs, identifying opportunities to deliver to citizens with their value propositions.

Last but not the least, the city government, meant as a city stakeholder. City government should have a vision for the city creating structural and infrastructural conditions for city development even favouring relationships between citizens and new ventures.

The technology is the link among the three stakeholders' groups and their activities, also because of service platforms in urban contexts. Every part involved should be able to manage technologies and every technology adopter and provider should be able to spread the knowledge about adoption and management of the technology. The triple N of cities is based on knowledge diffusion and on the dynamicy of stakeholders involved in the shared vision of the city development.

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