Fostering urban-centered innovation

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INTERNATIONAL DESIGN CONFERENCE - DESIGN 2016
Dubrovnik - Croatia, May 16 - 19, 2016.

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Keywords: design process, urban stakeholder, real life experimentation, networking, open innovation, startups

1. Introduction

Innovation matters to cities and cities matter to innovation. This relation is however not easy to apprehend given the complexity of both concepts of "innovation" and "city". The urban space of a city can be characterized as a "complex socio-technical structure consisting of physical components such as building, streets, roads, infrastructure and citizens as well as softer aspects such as the behaviour patterns of its citizens"[Hillier 2012].A city is thus, above all, a geographical perimeter,which can form a hive of entrepreneurs swarming around locations like incubators or living labs.

Cities capture, generate and spread innovative ideas and businesses energized by mobile and multidisciplinary populations. Today, large and metropolitan cities become international innovation hubs, in particular given their proximity to globally connected airports. They provide an ad hoc meeting platform for innovators to encounter end users, entrepreneurs, venture capitalists as well as other public and private stakeholders. This network of stakeholders aims at exceling innovation, economic growth, creativity and learning processes.

Innovations and more accurately innovation processes are somehow tied to cities and to the network of public and private stakeholdersvia research laboratories, livinglabs, fast prototyping labs, production sites, market places, communication and distribution channels. Moreover, some innovations aim at directly addressing the city's and urbanites' challenges, such as urban mobility, public places development, basic infrastructure and services as well as health and wellness[NCF 2015]. It is thus possible to broach a new concept that we call here, Urban-Centered Innovation (UrCI), which may include the two following categories of innovative products, services and business models:

A) Those developed by city-based companies, which do not necessarily address city's challenges (for instance startups developing innovative products for rural environmentwith the support of public and private urban stakeholders).
B) Urban innovations or those innovations that directly addresschallenges of city and urbanites and provide solutions to the city issues(for instance, intelligent urban furniture, smartphone applications for smart mobility that contribute to reducing city's Co2 emissions).

In the design literature, User-centered or Human-centered innovative design is defined as a standard process that begins with identifying users' needs and usage contexts. It involves specifying requirements, designing solutions, prototyping and test of designed solutions[ISO 2015]. Urban-centered Innovation (UrCI),unlike User-centered ones,does not claim to be a design process. Nevertheless, it can help forging a framework of innovative products, services and business models

mainly designed by “startups”, given their agility to scale and adapt a product to the urban context. We believe that this framework is relevant to provide guidelines in order to optimize the design process of UrCIs and to design value-creating products that address urban challenges pertinently. In other words,if one seeks to design a relevant product or service by taking advantage of city’s resources and infrastructures and/or in order to address urban challenges, the urban ecosystem of stakeholders and their characteristics must also be taken into account into the different phases of the design process. An urban ecosystem of stakeholders includes obviously users but also public purchasers, purchasing advisors, founders etc.

The main attributes of UrCIscan be described as following:

- Urbanspace and/or urban stakeholders are involved at a given stage of their design processes (for instance the product is co-designed with citizens or is prototyped in city’s fab labs).
- Value beneficiaries are the city services and/or citizens (e.g. innovative software for urban waste management).
- They promote local economic and social value creation by creating jobs and attempting to provide a better quality of life for city’s residents(e.g. urban logistic products and services to optimize city’s parking places).
- The city’s administration can play a key role by either facilitating the deployment of the UrCI innovations (for instance the City allows real life experimentations of products and services on its public spaces) or by potentially purchasing them (for instance the City buys and deploys the innovative products and services following a Pre-Commercial Procurement (PCP) approach).

Cities take important actions to foster their economic development through purchasing, advising and financing innovative products and services developed in cities and/or for urban spaces. However, given the wide diversity of city challenges as well as the important number of stakeholders involved in urban-centered innovations, it has proven difficult to characterize and categorize them. Added to this, these innovations must be experimented *in vivo in situ* in order to validate and verify their capacity to match city challenges and needs. It is thus not trivial to scrutinize urban-centered innovativeproducts and services (or, design solutions developed by city-based startups and/or dealing with city issues).

This paper aims at investigating, through several examples of innovative startups, different categories of UrCI design solutions as well as the necessity to conductreal life experimentationssupported by public and private stakeholders.This research will also shed light on the reasons why some urban-centered innovations are not efficient, and provides as well decision-making elements intended for startups and public administrations in order to improve the efficiency of UrCIs.

2. Literature review on innovation and cities

The design literature directly related to urban innovations is limited. Most of the research works studying the link between cities and innovations derive from sociology, economics and public policy fields. Hence, in the following and for the sake of briefness, we will particularly focus on innovationsdesigned by startups in metropolitan cities by responding to three major questions:Why are cities interested in innovation? Why are innovation processes tied to cities? And how does innovation happen in cities?

2.1. Why are cities interested in innovation?

Innovation dynamism in cities enables them to improve their image by creating a buzz [Shearmur 2012] and attracting more ideas, businesses and capital. Moreover,urban innovation is becoming a key driver of national economies. For instance, in the United-States the most glaring example is the American Small Business Act and its integration into public procurement since 1982, mainly by the establishment of the SBIR (Small Business Innovation Research) act. These acts spur companies to design innovative products intended for governmental organizations such as cities. In this respect, American centres for urban innovation have been launched (for instance Centre for urban innovation

of the Arizona State University and Urban Innovation Centre at Georgia Tech) with the purpose of helping urban innovators; strengthening collaboration opportunities between people creating inclusive urban innovation ecosystems in different cities and also improving public policy to further stimulate urban innovation.In European cities,urban organizations are created to promote and accelerate urban ideas to market. For instance, Future Cities Catapult in London[Walt *et al.* 2014]or smart city missions at the City of Amsterdam and the City of Paris to boost local innovation ecosystems.The framework of an urban innovation ecosystem is indeed characterized by the crossing between economic, physical and networking assets[Mulas *et al.* 2015].

2.2.Why is innovation tied to cities?

Shearmur [Shearmur 2012] enumerates two main reasonsexplaining the link between cities and innovation. First of all, cities provide better networking possibilities to innovators. Innovations should indeed happen in cities because they require face-to-face encounters. Second of all, dense urban areas encompass workforce, infrastructure, connectivity, actors and market accessesthat are obviously far more important than in suburb areas and small towns. Ehrenhalt argues[Ehrenhalt 2013] that there has been in the last decades a large movement of talents, jobs and ideas from suburbs toward largecities. When it becomes to common factors of innovation success in these metropolitan cities, Markatou et al. analyse the notion of Urban System of Innovation and the factors influencing this system[Markatou and Alexandrou 2015]. Among these factors,the following can be mentioned: residents forming the city (mainly young and dynamic populations), prestigious universities, urban attractive environment, strategic location of the city and city government business policies stimulating local investments[Markatou and Alexandrou 2015].

2.3.How does innovation happen in cities?

Successful territorial innovation happens more often as a result of geographical proximity and local environment development, which facilitate knowledge transfer and innovation processes.Cities still remain an adequate platform for innovation processes, even though the spread of ICT in the last decades has made novel ideas available almost everywhere. Recent studies[Packalen and Bhattacharya 2015]demonstrated that large cities have gradually lost their advantage in new ideas generation.The role of cities is more crucial in innovative ideas maturation and problem solving following a more collaborative approach. They provide the possibility of local random encounters with people. This is called the "collision"theory, which stands for bringing new ideas, perspectives and value through random encounters[Kaplan 2012]. Satell describes [Satell 2013] that individuals become more creative when collisions are multipliedbetween people with new ideas (see Figure 1). An interesting report published by the World Bank emphasizes the importance of networking assets (e.g. meetups, co-working spaces, network of mentors of accelerators and incubators) to multiply the number of collisions[Mulas *et al.* 2015].

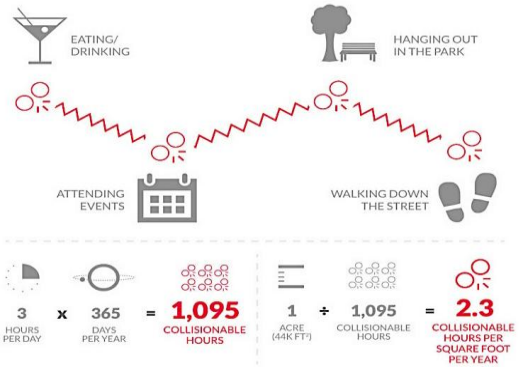

Figure 1. Collisionable Activities [Mulas et al. 2015]

The open innovation paradigm, which assumes that innovative companies must collaborate with external stakeholders to meet their target market, can be thus observed in an urban environment where

multiple stakeholders interact in a rather sporadic way to create and capture value. Shearmur affirms "the greater a firm's potential for local interaction, the more it is likely to innovate"[Shearmur 2012].

The recent examples of disruptive innovations in large cities (such as Airbnb, Uber and Kickstarter)confirm the importance of innovation-enhancing exchanges between multiple stakeholders to respond to the challenges of a large city. However, these radical innovations are generally akin to high levels of uncertainty where experimentationsare necessarily performed in real situations. Cities can support the creation of experimentation or urban innovation labs, in which new concepts are tested and validated, with the objective ofinvolving citizens in the early stages of design process[Koutsomarkou *et al.* 2015].

In spite of extensive literature in socio-economic and public policy fields, the characteristics of urban-centered innovations and stakeholders is to be explored following a holistic vision of urban stakeholders, innovative products and services as well as the needsof experimenting these products and services.

3. Research method

A literature review is carried out to identify a set of criteria of analysis of innovative solutions as well as stakeholders'characteristics. To validate the lists of criteria and stakeholders' characteristics, we first reviewedtheexisting reportson the real life experimentation projects' carried out by Parisian startups.In parallel, field investigations among Parisian innovative startups have been carried out through semi-directiveinterviews with 60 innovative startups. This sample of 60 startups has been selected among an approximate number of 250 startups that currently test or have already tested their innovative design solutions. In addition, this sample of startupshas been selected according to their potential to cover a large spectrum of key city challenges,as well as their willingnessand capacity to communicate their intermediate or final results of real life experimentations.Subsequently, experimentation and incubation experts, such as City of Paris agents specialized in real life experimentations, and incubation coaches, validated the qualitative and quantitative collected data.

The collected quantitative data include useful information related to the expectations and obtained results of real life experimentations performed by Parisian startups. This data is then analysed to provide quantitative proofs that will allow a better understandingof UrCIs design practices in order to improve and robustify them.

4. Context of Urban-Centered Innovations

This section seeks to identify urban stakeholders as well as urban-centered innovations types, natures and families of products and services. The case of innovative solutions experimentedin the city of Paris isalso explored in the following.

4.1. Urban related stakeholders

Freeman defines a stakeholder as "any group or individual who can affect or is affected by the achievement of the organization's objectives"[Freeman 1984].Given the complexity of interactions between stakeholders of an innovation ecosystem at the scale of a large city, we must first consider a *network* of stakeholders aiming at creating and capturing value. Feng [Feng 2013] introduces the concept of stakeholders value network as a multi-relational network where tangible and intangible value exchanges happen between stakeholders and a focal organization, and also between stakeholders themselves. Several qualitative and quantitative models and tools are developed to provide decision-making supports to public and private stakeholders. For instance, Feng [Feng 2013] quantified the value flows of stakeholder value networks with the help of Dependency Structure Matrices (DSM). Godet developedalso stakeholder network models with associated quantitative combinatory matrix tools, called MACTOR and MICMAC [Godet 2000]. All of the above-mentioned models start with a qualitative identification of stakeholders and their value-exchanging flows.

In the following, key stakeholders of the innovation ecosystem of the city of Paris are identified after the analyses of 60 innovative solutions developed by startups. This representation of stakeholders is thus limited to the Paris innovation ecosystem and is a result of the investigations carried out among a sample of 60 startups. First, amatrix of 14stakeholders (see Table 1) is created. This matrixprovides their key roles in the Parisian innovation ecosystem as well as their average relative influence on the improvement of Maturity Level (ML) of UrCIs for instance from a prototype to an industrialized solution.

Table 1. Key urban related stakeholders of Paris innovation ecosystem

No.	Stakeholder	Key role in the ecosystem	**Influence on ML improvement** *(low, medium, high)*
1	End user	Using ultimately a product or service	High
2	Experimentation facilitator	Linking the company with the test fields	High
3	Experimentation field	Test field, which can be public, semi-public, private or simulated. It can also be a living lab	Medium
4	Fab lab	Prototyping laboratory, where a product, service or software can be prototyped thanks to the existing tools in the lab	High
5	Incubator	Hosting, supporting and assisting startups in their development	High
6	Larger companies	Larger companies who potentially incubate or purchase an UrCI	Medium
7	Observation and evaluation expert	Conducting field observations and evaluating design solutions	Medium
8	Private investor	Private company or venture capital investing in UrCI	High
9	Public authority	Public administrative actors who support the deployment of the UrCI	High
10	Public funder	Funding the innovative project	High
11	Public purchaser	Public stakeholder who buys the UrCI	High
12	Purchasing advisor	Public or private actors who prescribe the purchase of a given UrCI	Low
13	Startup	Designing and commercializingurban-centered products and/or services	High
14	Supplier	Providing supplies needed in a given time frame	High

Second, dependency matrices are built in order to be able to represent the innovation-enhancing exchanges of value between stakeholders. These value exchanges are the flows of: financial support, product or service, material and networking support, improvementinsights of the design solution, contract as well as policy influences (for instance in terms of influencing the purchase of a solution).Figure 2 depicts stakeholders network and their interactions. Here, the prototyping laboratories or fab labs are not modelled because of their emerging nature and their still unstable economic models.

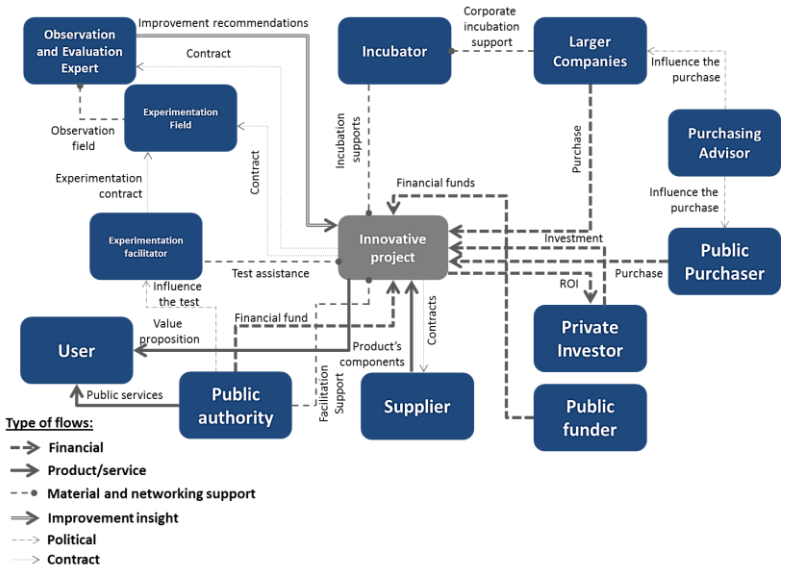

Figure 2. Stakeholders network of Paris innovation ecosystem

In this network, public local authorities not only provide financial funds to the innovative projects but they also form a “honeypot” around which are gathered entrepreneurs and other stakeholders in order to develop together urban-centered innovative solutions.

4.2. Urban-Centered Innovative (UrCI) solutions

It is necessary to characterize these solutions (i.e. products, services and business models) that are related to urban space and/or urban stakeholders.An urban-centered innovative design solution can thus be characterized as a combination of criteria of analysis.These solutionsparticularly intend to respond to city’ssocio-economic and environmental challenges.

Four main criteria of analysis are identified thanks to our observations and also to the related literature in innovation marketing [Forbes and Ahmed 2010, Shelly 2011]. These criteria help to characterize UrCI solutions:

- Type of the design solution (product, service, software tool or business model);
- Commercial transaction model (B2B, B2C, B2C2C, B2B2C, B2A (or Administration));
- Maturity level (e.g. idea, basic development, prototype…);
- Involved urban relatedstakeholders in their design process (cf. 14identified stakeholders in previous sub-section).

The topic to which a design solution can be associated (for instance healthcare or cleantech) is not analysed here because of the complexity of classifying task and multi-topic design solutions.For instance, a smartphone application can generate incentives for citizens to pay more attention to their and at the same time to their ecological environment as well.

The type of design solution can either be a physical and/or functional product (such as an innovative urban furniture), or a service (e.g. better Internet access in public libraries), or a software tool (e.g. a

smartphone application to help urban managers in their decision-making process), or an innovative business model.

The commercial transaction model can be for instanceBusiness-to-Business (B2B) (e.g. a solution developed by a private company helping local businesses to better promote their products and services) or Business-to-Administration (B2A)[Forbes and Ahmed 2010]. In the case of B2A, the solutioncan be purchased by a public stakeholder, where the buying process is not the same as B2B solutions. An example of B2A solution is the case of innovative software tools developed for urban agents to better manage their administrative files. An extension of this model is B2A2C (B2A to Citizens). For instance, the public local authority purchases innovative urban displays for making the life of its citizens easier. In this case, citizens (or end users) do not pay a direct fee to use this urban new service. The interest of identifying commercial transaction modelsis that UrCI developers can better identify usage segments and the needs of end users, intermediates, innovation advisors and purchasers.

The solution's maturity level must be characterized in order to better keep track of the solution and to better monitor its evolution. These Maturity Levels (ML) (see Table 2), that we have already exposed in[Bekhradi *et al.* 2015], are inspired by the Technology Readiness Level (TRL) developed by NASA[ASD(R&E) 2011].

Table 2. Maturity Level of UrCI solutions

Maturity Level	Description
ML_1: Concept	Research project, basic sketches of the product, service or software aiming at responding to city's challenges
ML_2: Development	CAD designs, computation modules
ML_3: Basic prototype	Basic mock-up to be tested inside the labs
ML_4: Semi-advanced prototype	Tested and pre-validated prototype, industrial use cases and generated data
ML_5: Pre-production	Trustable, validated and verified solution to be industrialized
ML_6: Industrialized but not commercialized	Proved solution
ML_7: Commercialized	Existing on the market and widely used by customers

The last criterion of analysis is related to the involved urban stakeholders. This dimension depends on the solution's business model and design process. For instance, prototyping laboratories are involved intothe design process from ML2 to ML5 and can also play an important role in terms of collisions or face-to-face encounters between innovators.The evolution of this criterioncan be observedthrough real life experimentations performed by innovative startups in Paris.Besides, the facilitation role of the city can be better detailed through experimentation projects.

5. Real life experimentations of UrCI

A primary question to be addressed here is why some UrCIs must be tested on an urban space in real usage situations?

An innovation needs to be tested in order to reduce uncertainties and risks before its launch. Real life experimentations enable innovators to expose UrCIsto their users and also to public services, in orderto accustom public purchasers to forthcoming innovative solutions for the city (thus the importance of incubator showrooms for public purchaser/funder/investor). These experimentations help also to improve the design solution and to validate a given design process step. Therefore, some UrCIs must be tested,out of the context of the startup in order to design an efficient urban stakeholder-centered solution.

For instance, what are the needs and expectations of citizens in the case of B2A2C solutions? Are these needs and expectationsappropriately integrated into the design of the solution?

In the following, three examples of innovative startups will be exposed following a set of five measuring and monitoring criteria applied to the case of real life experimentations of UrCIs. These criteria are the Usefulness, Newness, Profitability, Concept and Stakeholders network (UNPCS) proofs, inspired by the works of[Zimmer *et al.* 2012, Bekhradi *et al.* 2015, Yannou *et al.* 2015, Yannou *et al.* 2016]. The usefulness represents the coverage of usage and needs situations of users/stakeholders for which important needs are covered. The proof of newness integrates bothperceived newness, by urban value beneficiaries and also usage newness, where urban stakeholders are not educated or sensitive to this innovation. The proof of profitability embeds expected profitability for the company as well as for customers or users. The proof of concept is related to the ability of the UrCI solutions to work effectively and efficiently in expected situations.Now, if the UNPC robustness is validated but urban stakeholders are not acquainted with the solution, the risks of failure are higher in spite of a robust UNPC proofs. Therefore, another proof to be robustified from the perspective of solution designers (e.g. startups) is the stakeholders network proof with the purpose of: raising financial funds by convincing public and private investors; building partnership to foster the product's industrial and commercial development and also communicating easy-to-share information to users in media, social networks and forums (based on for instance word of mouth, buzz creation, user communities (fan clubs, user groups) technics).

The UNPCS proofs are studied before (expected) and after (obtained) experimentations for the three examples as follows.The first example is pre-recruitment software to facilitate the recruitment process of young candidates.The solution helps recruiters in an urban area to save more time and be more efficient in their hiring process of hundreds of candidates. This solution has been tested in collaboration with local employment missionsand was applied to the case of hotel industry.

The expectations in this experimentation, in order of importance, based on startup's claims were: stakeholders network proof bycreating partnership links with local employment missions; the proof of profitability (testing the willingness to pay of industrial stakeholders); and the proof of concept (software is working in expected usage situations as well as in extreme usage contexts such as simultaneous connections of important number of candidates). However, even though the startup have not identified any expectations in terms of solution's usefulness and newness proofs in advance, the end of experimentation project showed that these proofs could have been quantified during the test process.

The second example is a waste management software tool helping field managers to better manage their waste collection and sorting (seeFigure 3).

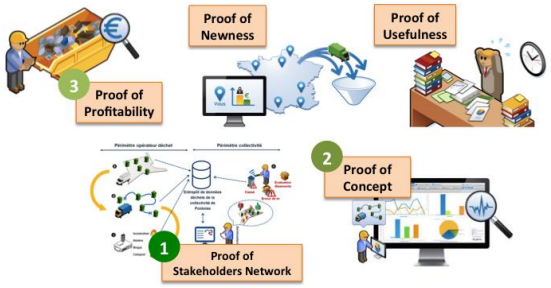

Figure 3. Waste management software to optimize the waste collection and sorting

In this case, the expectations were also focused, on stakeholders network, proof of concept and profitability(listed in order of importance). The startup did not however express systematically the importance of usefulness and newness proofs to be experimented and improved.

The third example is about a Wifi service on pre-configured PCsat public libraries to provide a better Internet access to the library users. Here, the only expectation of the company was to meet urban stakeholders in order to create a buzz around startup's activity and other solutions. In this case, no claim has been expressed in terms of proofs of usefulness, newness, profitability andconcept.

Quantitative analyses over expectations and results of 60 urban-centered real life experimentations at the city of Paris showed that the most important objective of startups is to robustify their knowledge of urban stakeholders without systematically measuringUrCI robustness(see[Bekhradi *et al.* 2015]). Indeed, the real life experimentation is an opportunity to test and validate UNPCS proofs and it mobilizes important human, financial and time resources.However, startups devote an important part oftheir efforts to networking and lobbying. Therefore, there is a general misconception of experimentation and its importance to improve UNPCS proofs among startups. They generally perform unorganized trial and errors experimentations, without following a methodologyallowing to systematically enouncing hypotheses, performing field observations and operatingdata collections.

Based on open innovation funnel representation [Chesbrough 2003] crossed with design maturity level (i.e. from concept to a commercialized product), the current general attitude among observed startups can be depicted inFigure 4. In this figure, an innovative initial idea or concept is entered into a process of maturation in order to meet its potential market towards the end of the funnel. A given idea is then matured following a collaborative approach with the stakeholders of an urban innovation ecosystem. However, the current observed attitude of Parisian startups consists in closing their boundaries at the beginning of the design process i.e. very few questioningsare formulated on the legitimacy of the design problem. In practice, the integration of urban stakeholders' needs and pains is generally done, unfortunately, in very late stages of the design process, after an advancedprototypeis ready to be experimented in real life situations. Therefore, the degree of liberty in terms of design solution improvement is limited and it is too late at this stage, in terms of resources and time,to reflect on itspossible improvements.The success of the UrCIs is thus questionable following this attitude.

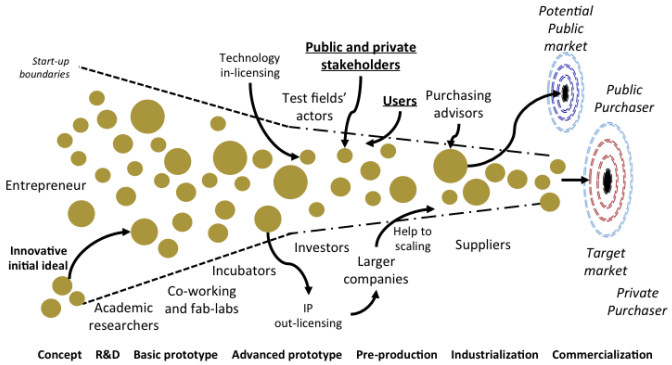

Figure 4. Current attitude of innovative startups observed through real life experimentation projects

To robustify UrCIs,startup boundaries that are more porous are recommended from front end of innovation by identifying needs and pains of urban stakeholders (i.e. users as well as other public and private stakeholders). The latter necessitates more collaborative UrCI developments from early design stages(see Figure 5).

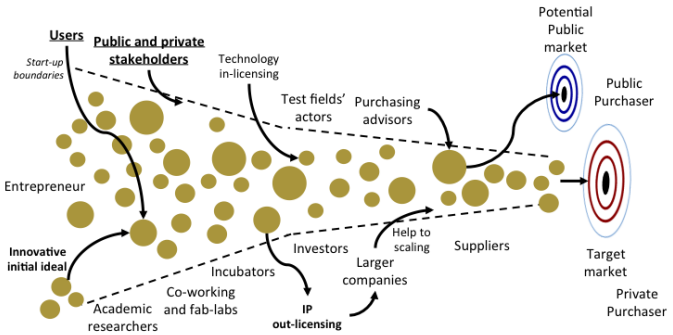

Figure 5. Robustifying the development of UrCIs through more collaborative designs from front end of innovation

It is thus recommended to adopt a more collaborative approach following a relevant open-innovation attitude, by reinforcing the interactions between public and private stakeholders on the one hand and startups on the other in front end of innovation. The next section describes, through some examples, the new trend of co-designing innovative solutions by citieswith their users or with startups.

6. Examples of Urban-Centered Open Innovations: a new way of integrating urban stakeholders into early design stages

Cities utilize open innovation strategies that broadly engage organizations, industry and individual citizens to define problems and to co-designinnovative solutions. Collaboration and partnership matter to local governments: as they try to build strongernetworks with residents, the potentialto share ideas grows. However, the value lies not only in sharing innovations and know-how, but also in helping cities to identify problems that they may not have previously been aware of.

Strategically using the media to extend the dialogue with end users increases awareness of the city challenges, and provides more opportunity for transferringideas. It also gives citizens the chance to provide feedbacks to their city. The crowdsourcing platforms developed by the Cities of New Yorkand Paris("*Madame la Maire, j'ai une idée*"[Paris 2014]) to collect feedbacks of citizens represent famous examples of city crowdsourcing.

A recent example of an urban-centered open innovation project in the city of Paris is the use of shared electrical transportation cars for local and small businesses[Paris 2015].The services of the City of Paris have developed a multi-partnership innovative project by involving several public and private stakeholders,mainly advised by a public transport R&D competitiveness cluster. The idea behind this project is to test an innovative solution, which responds to the needs ofcity stakeholders (i.e.for small and local businesses: the use of a less-expensive car-sharing solution and for the city services: reducing pollutions in the heart of the city).

The urban collaborative models of innovation (also called co-creation and co-design) are currently experimented and used in metropolitan cities. Among others, quadruple helix[Arnkil *et al.* 2010](governmental organization, industrial stakeholder, academia and users) open innovation model is generally used in the context of urban projects.

7. Conclusion

A conventional User-centered innovative design process does not systematically cover the importance of taking into accountthe needs of multiple urban stakeholders. Besides, an UrCI embraces also the process of public purchasing and facilitation of real life experimentations. Analyses over 60 UrCIs experimented in real life situationsin the city of Paris showed two results: first of all, startups dedicate a lot of their effort to networking and lobbying instead of improving their design solution; second of

all, urban stakeholders and their needs and pains are not systematically integrated into the design process from early design stages. Therefore, the quality and efficiency of UrCIs remain questionable.

Indeed, urban related stakeholders are multiple and their needs, pains and expected performances must be integrated in early design stages. It is thus essential to raise the question of how to promote a need-seeker innovation strategy at the scale of cities and in the case of urban-centred innovations? A possible answer could be the implementation of urban living labs to accelerate UrCIs following a design-by-urban-experimentation methodological framework, which aims at identifying a useful design problem in frontend of innovation.The development of such methodological framework and the testing of its relevance represent the perspectives of our current research at the City of Paris.

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