Smart mobility providing smart cities

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Chapter 7
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Abstract
By 2050, 70% of the world's population will live in or around a city. Cities already generate 70% of energy-related greenhouse gas emissions. The future of urbanisation will be smart, in which land use is optimised and the transport system is more efficient and environmentally friendly, providing affordable mobility services to ensure the well-being of people in the city.

In a smart city, urban and transport planning should be co-conducted harmoniously in order to create a new transit-supportive city. After defining our vision of smart mobility, we will present and analyse the links between the transport system, disruptive innovation, and the role of public policies in change management. In this chapter 6, we focus on the way to organise the co-conception of smart mobility, defined as a disruptive eco-innovation, in a local territory. The development and diffusion of innovations within the mobility ecosystem significantly disrupt usages and modify market boundaries. Implementation conditions to achieve a widespread adoption of smart mobility are discussed and the role and decision-making methods of territorial actors are considered.

Keywords: smart mobility, smart city, disruptive innovation, eco-innovation, territory, public policy, governance.

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1 Introduction: The lack of transport systems in the least dense territories

In order to work or study, to consume and to build relationships, people have a fundamental need to travel. The mobility of people and goods strengthens exchanges and enables access to much larger territories (Didier and Prud'homme 2007, Le Boennec 2013). People move in space: within cities, from the suburbs to the city, to the country, between two cities, two regions or two countries. What mobility has in common in these heterogeneous spaces is that it provides people with better accessibility to jobs, goods and services. Accessibility is thus defined as the number of travel opportunities for a given distance (Pouyanne 2005) or for a given travel time (Deymier 2007). Accessibility gains occur when a new transport infrastructure enables the individual to reach the same destinations in a shorter time, or destinations further away with no increase in time, thus offering new travel opportunities.

Accessibility has extremely different characteristics depending on the territory considered, influencing the modal decisions of households. In 2013 in Paris, France, 100% of inhabitants were served by a structuring transport accessible at less than one kilometre from their home (Marks 2016). This privileged situation is correlated with a high population density coupled with a public transport network that is historically well connected (particularly the metropolitan network). If one considers the inner circle of Paris (the three departments around the city centre), then the outer Parisian circle (composed of the remaining territories of the Ile-de-France Region), this level of cover of inhabitants by structuring transport falls dramatically to 66%, then only 13%, respectively.

This heterogeneous accessibility to a public transport network within the same urban area[1] constitutes a direct manifestation of the rapidly decreasing density gradients from the city centre. It is much easier to connect a territory effectively where the housing density, and thus the population, is high (generally, the central municipality of an urban unit). Conversely, in less dense zones, a transport network, especially structuring (underground, tram, train or bus rapid transit), necessarily favours certain zones, with some irreversibility due to the size of the infrastructure deployed. This less favourable situation usually corresponds to municipalities that are peripheral to the urban unit, or to municipalities of the urban area around the urban unit (commonly called the peri-urban space). Regarding rural municipalities, they are rarely served other than by a bus network of varying size and frequency.

Such a heterogeneity in public transport provision can be seen in most European conurbations, where the collective housing is largely concentrated in the urban unit; individual housing is more often located in the peripheral municipalities, on building plots whose size is positively correlated with their distance from the centre, consistent with the urban economics theory (Alonso 1964, Fujita 1989, Le Boennec 2014). In emerging countries, very rapid urbanisation, often poorly controlled, does not always allow a sufficiently thought out coordination between urban planning and transport systems (Marks 2016).

[1] An urban area in France is a group of contiguous municipalities, with no pockets of clear land, constituted by an urban centre (or urban unit) providing more than 10,000 jobs, and by rural municipalities or urban units (urban periphery) in which at least 40% of the employed resident population works in the centre or in the municipalities attracted by it (French national statistics institute *INSEE* definition).

It is thus the urban sprawl that is at the origin of the contrasting accessibility to the public transport network. This sprawl has only one consequence: in the less dense housing areas, peripheral municipalities of urban areas and rural municipalities, the private car is often the only solution for daily journeys (Brownstone and Golob 2009)[2]. Thus, the car is used daily by 10% of Paris inhabitants, 26% of those in the inner circle, but 56% of the outer circle inhabitants (source: Chronos/L'ObSoCo study, *"L'Observatoire des mobilités émergentes"*, The Observatory of Emergent Mobilities, September 2016). Similar travel patterns are found in the rest of France; while 54% of city centre inhabitants think that they can do without their (owned) car completely, this can be envisaged by only 27% of people in conurbations of 2 to 20,000 inhabitants. As a result, in all territories taken together, 85% of journeys in 2016 were still undertaken in private cars.

This contrasting accessibility, and the heterogeneity of opportunities that it offers, is often, in an urban environment, the legacy of functionalist urban planning of the 1950s to 1970s, at least in France. Ways of living, working and consuming often concern separate spaces, which may be far from each other even within the same urban unit. Moreover, the aspiration to own an individual house for a large number of households, coupled with easier home ownership, has increased land use and urban sprawl beyond the urban unit. In these peri-urban territories, accessibility is limited, including by private car in rural municipalities, with access times to major services (leisure, studies, health) systematically longer than the average (source: Insee Première n° 1579, January 2016).

In these patterns of development in which the private car dominates, the negative externalities associated with an exclusive use of the automobile are reinforced. These external effects are known: traffic noise, greenhouse gas (GHG) emissions, and air pollution (Verhoef 1996). Although most are suffered relatively little by the inhabitants of less dense zones, GHG emissions at least, due to their worldwide dimension, constitute a universal problem that public policies must take into account in their mobility and urban development plans.

We will begin by considering the difficulty of changing local planning policies for a better coordination with local mobility policies (Section 2). We will then see how, in a *smart city*, innovation enables such limitations to be, at least partly, overcome (Section 3). Nevertheless, deploying a disruptive innovation in a territory demands the concordance of a number of conditions, the nature of which we shall consider in Section 4. In the context of emerging offers and more difficult decisions for public actors, we will discuss in Section 5 the different techniques for assessing mobility policies before concluding. Section 6 concludes the sixth chapter of this book.

2 Reducing inappropriate urban forms: expensive and long-term public policies

There are many territorial scales required to correct the negative externalities of road transport; in fact, they are complementary. In its White Paper on Transport (2011), the European Commission drew up the "roadmap for a single European transport area – Towards a competitive and resource-efficient transport system". The states developed the European

[2] The *INSEE* typology uses the following travel motives: home to work or studies, purchasing, personal business, accompaniment, leisure or visits.

objectives into national policies (bonus-penalty systems for the purchase of vehicles, regulatory framework for trying out restricted traffic zones). On a local scale, the municipality authorities often seem relevant for the development, implementation and evaluation of local policies, whose objectives are often quite similar from one document to another[3], but whose range of operational measures is supposed to take into account the special features of territories in connection with other planning documents concerning transportation and land-use.

In France, the constitution of metropoles on 1 January 2016 aimed to resolve some governance problems that had been observed. The non-simultaneous implementation of multiple planning documents may have resulted in an insufficiently consistent vision of the development of a territory to the relevant boundaries (the city centre and its suburbs constituting the urban unit). The legislators have sought to change these historic practices by recently encouraging the adoption of urban plans at this scale. In 2016, the majority of the ex-urban communities that had become metropoles intended to adopt such a document. Urban planning at this scale should ensure a better visibility in favour of a concerted development of housing, employment and service areas. In parallel, the mobility policies were themselves strengthened at the municipality level by the NOTRe law of August 2015. For example, since 1 January 2016, the new conurbations reaching the threshold of 50,000 inhabitants have jurisdiction over transport in their territory by becoming *Autorités Organisatrices de Mobilité* (AOM) (Mobility Organising Authorities). This scheme is further facilitated by the legislators who encourage the existing municipalities to come together in order to reach higher population thresholds. Thus, with some exceptions, on 1 January 2017 those new (inter-)municipalities should cover at least 15,000 inhabitants.

This rationalisation, of an unprecedented size and speed in France4, originating from greatly constrained budgets since 2009, has led to a reinforced integration of the governance of development and mobility policies at the local level. Moreover, the territorial projects, often pre-existing and contractualised with the higher authorities, have increased the financial means as well as the expertise available to the conurbations on the question of mobility. Thus, Transit Oriented Development contracts (TOD) have been decided jointly to serve territories of average density. The fundamental principle of such a contractualisation envisages specific subsidies from the higher authorities5 for the deployment of a public transport network with a high level of service, through a commitment from the local authorities to increase the housing density in the town centres served. In addition, multimodal exchanges, park-and-ride car parks, bike lanes and footpaths conceived jointly can also be supported. As well as financial aspects, the role of the higher authorities may include sharing and disseminating experiences of the same type, which have already been implemented in its territory or elsewhere.

The traditional cooperative modes mostly concern public transport and intermodality. However, while the developments for active modes are fairly expensive for local authorities, which may contractually agree to share the financing, the deployment of a public transport

[3] In France, Agendas 21.

[4] The number of inter-municipalities on 1 January 2017 was thus 1263 against 2062 previously, i.e. a fall of 39%.

[5] "Départements" and "Régions" in France

network with a high level of service in territories less dense than a metropole raises the question of available funding sources, especially as the share likely to be covered by the user is substantially less than it could be in a densely urbanised environment.6 Moreover, the timescales needed for such projects are long: while a TOD project might be on a 5-year scale, the deployment of an urban planning zone on the future site often takes from 15 to 20 years. As a result, the very gradual arrival of housing, employment and services in these zones compromises even more the profitability of the transport provided during its first years of operation.

For both these reasons (financing and long timescales), many local authorities now prefer to consider the alternative, or complementary, opportunity of introducing light mobility offers. Moreover, the idea of a Mobility Organising Authority, which has replaced that of the Transport Organising Authority in France, aims to take into account these sometimes rapid changes. The advent of Mobility Organising Authorities thus envisages "extended authority in the fields of the shared use of the automobile (car-sharing, car-pooling), active modes and urban logistics".

This promotion of the shared use of the car and multimodality offers a renewed regulatory framework for multimodal information platforms, which are part of the smart city, one of whose goals is to encourage these new mobility practices.

3 Innovation as a support of the ecomobility market within the smart city

From an innovation perspective, the transport sector, based on a combination of new energy systems and the spread of internet (typical of the third industrial revolution of Rifkin (2011)) turns today toward clean vehicles and connected mobility solutions. We thus refer to sustainable mobility for all the available offers – individual or collective, public or private – that contribute to responding positively to economic and ecological issues in terms of reducing GHG emissions (Pillot 2011).

This trend toward a new technological paradigm applied to local territorial development is expressed in the idea of "smart mobility", as a component of a "smart city".

Since the 1990s, the smart city concept has become increasingly popular in international scientific studies and national public policies have adopted this type of territorial development. There are many definitions of the smart city and we propose the following typology of its analytical models (for more details about the many evolutions of the concept, see the works of Caragliu et al. (2015)).

The first approach defines the smart city as a model based on the data needed to manage and plan the city:

"Smart Cities initiatives try to improve urban performance by using data, information and information technologies (IT) to provide more efficient services to citizens, to monitor and optimise existing infrastructure, to increase collaboration among different economic actors, and to encourage innovative business models in both the private and public sectors." (Marsal-Llacuna et al. 2014).

[6] In 2010, the contribution of users to financing the public transport network in the Paris region was only 29.7%.

Consequently, the objective of a smart city is to organise its activities in order to implement and interconnect technologies, devices and services as efficiently as possible using information technologies (Hancke et al. 2013).

In this model, the smart city is conceived as an information system, which instrumentalises and interconnects its assets such as buildings, the energy or water network, and transport. According to Harrison et al. (2010), "instrumented" refers to the capability of capturing and integrating live real-world data through the use of sensors, meters, appliances, personal devices, and other similar sensors. "Interconnected" means the integration of these data into a computing platform, which enables the communication of such information between the various city services.

Gradually, this very technological approach has been replaced by more open definitions of the smart city that take into account the social capital dimension and its relationships with urban development. Thus, in the second model, we have a definition of the smart city through its governance and its ability to be resilient. The idea of the model is to move from a "connected" city to a "smart" city. "Smart" refers to the inclusion of complex analytical, modelling, optimisation, and visualisation services in order to make better operational decisions. The model emphasises the role of human capital/education, social and relational capital, and environmental interests as important drivers of urban growth (Leydesdorff et al. 2010, Komninos 2002).

A smart city in this perspective is one that organises the conditions for the commitment of all the stakeholders of its ecosystem in the decision process. Resilience is thus reflected by the quality of people and communities, to be connected, to manage, and to be informed (Albino 2015, Repko 2012). Resilience is a factor of governance, risk assessment, knowledge and education, risk management, vulnerability reduction, and disaster preparedness and response (Baron 2012, Twigg 2009).

However, in a more operational logic with a territorial application of the smart city, it seemed necessary to propose a third model, which defines how to produce smart city strategies (Ben Leitafa 2015). To meet these objectives, we propose, in line with the studies of R. Giffinger, to consider the following levers to make cities smart:

- develop new efficient services in the transport-mobility sectors; responsible housing and urbanisation; smart materials and energy networks,
- manage information systems in real and multiple time to help in decision-making (citizens, administrations, organisations),
- promote renewed governance and the financing of new services.

Based on this operational logic, we can propose a third so-called architectural approach, which breaks down the systems and dimensions of the smart city in an organic way. The literature, particularly the studies of Giffinger et al. (2007) and Dirks et al. (2009), proposes six components of the smart city that correspond to six dimensions of urban life that must be made efficient: industry, education, democracy/governance, logistics and infrastructures, efficiency and sustainability, safety and quality. These six components can be represented as follows:

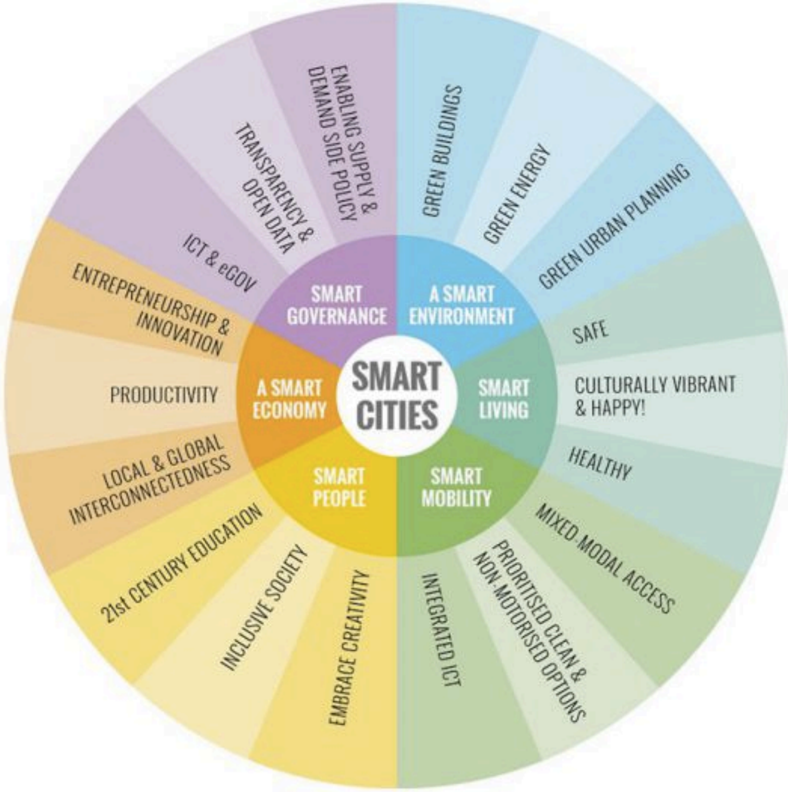

Figure 7.1. The Smart Cities Mandala (EU & Giffinger et al.).

In this context, we use the definition proposed by Caragliu et al. (2011): "We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through a participated governance".

In each sector, there is a supply of and a demand for connected and smart systems with specific characteristics to be analysed in various approaches related to eco-innovation[7] (Rennings 2000; Cecere and alii 2014).

In the eco-innovative mobility system, there are many evolutions that impact the most typical drivers of eco-innovation classified as "market pull", "technology push" and "institutional factors and policy measures" (Horbach and alii, 2012; Nemet 2009):

- Changing travel habits and the demand for services to increase convenience, multimodality and predictability will require mobility solutions as well as business model transformation.
- Concerning the supply, one observes, in an expanded automobile ecosystem, the integration of companies specialising in other sectors such as telecoms (Faucheux and Nicolaï 2015). Similarly, the vehicle has an evolving role beyond that of a means of

[7] We adopt the consensual definition of eco-innovation proposed initially by Kemp and Pearson (2007) : "Eco-innovation is the production, application or exploitation of a good, service, production process, organizational structure,or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction ofenvironmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives". See Horbach (2016) for an overview of the eco-innovation literature.

travel toward a means of energy storage and production. Thus, a transport fleet of rechargeable electric vehicles enables electricity to be bought or sold on a smart grid.

- A system-level approach is critical: sustainable improvements in a city's mobility performance require simultaneous improvements in urban sustainable systems, smart infrastructures, new urban services and associated business models.

In the management of a "smart mobility" system, there are additional constraints to take into account. When analysing the demand for "smart mobility", we can identify the following specific features of the services proposed:

i. user-focused service with an analysis of user preferences depending on the specific temporal and geographic contexts
ii. a service available at every point in the territory and from all the facilities
iii. an integrated service with data coming from and supplying different applications according to the principle of collaborative participation of the actors.

From the point of view of the supply of "smart mobility", the actors, such as local authorities and companies that have to be taken into account in the eco-innovation eco-system (Ghisetti and alii 2015), must offer services:

i. inter-connected within a platform that is open to heterogeneous facilities, ensuring connectivity at every point in the territory
ii. with great efficiency: the organisation of such a network must be as cost-efficient as possible
iii. with satisfactory energy efficiency to valorise sustainable applications
iv. reliable in terms of a guaranteed connectivity in all situations, even exceptional ones.

In order to examine how the literature can transcribe the special features of a "smart mobility" system, we will deal with the quality of its eco-innovation to present how the new mobility solutions can be considered disruptive innovations (as defined by Christensen 1997).

4 A systemic disruptive eco-innovation

4.1 A disruptive innovation

Ecomobility or "smart mobility" as an eco-innovation consists of both responding to the needs of consumers and encouraging their support ("demand-pull innovation"), while questioning which business ecosystem is most likely to provide effective solutions to these needs ("technology-push innovation") in an evolving institutional context.

In this perspective, the characterisation of smart mobility according to different types of innovation is important because it will determine the conditions of its implementation.

In an ecomobility system, new needs appear and user behaviour changes in a complex co-evolution with regulatory frameworks (Dantan et al. 2015). In order to characterise the dynamics of ecomobility innovations, we will use the typology of eco-innovation proposed by Faucheux et al. (2011) in association with the different trends in the innovation economy (Uterback and Abernathy 1975, and Rennings 2000, Hellström 2007, Carrillo-Hermosilla et al. 2009).

The analysis of industrial regimes leads us to consider first the dynamics of innovation through technological trajectories as defined by Dosi (1982). In this perspective, according to Utterback (1994) innovation is identified as “dominant design”. In the context of smart mobility, this means, for the automotive industry, imagining technologies that meet the needs identified, such as those of the ownership and use of vehicles with increasing constraints or opportunities: reduction in environmental impacts, innovative economic models with, for example, the electric vehicle, taking into account recent legislation, and acceptance of the economy of functionality, which provides a mobility service instead of the acquisition of a vehicle.

We observe that over time these innovations result from a creative process that occurs in a market and production context (technology push) as well as from an adaptive response to a new demand expressed by the market (demand pull).

However, these changes go beyond the issue of a technological trajectory to promote new paradigms of smart mobility (as defined by Dosi (1982)). Thus, radical innovations (as defined by Dewar and Dutton (1986)) support technological disruptions and changes in user behaviour. This destabilisation, which was dealt with in terms of internal disruptive techniques for the overall product structure by Henderson and Clark (1990, with modular/architectural innovations), challenges the current skills of companies. The production of autonomous vehicles, as well as the development and sale of new mobility services (NMS) requires different skills for the automotive industry. However, if, like Markides (2006), we focus on the “technological” innovation, which aims to attack new segments in an existing market[8] (a different business model in a current market), we observe that a “strategic” innovation must also be envisaged in smart mobility, which involves a different value distribution in the value chain of the automotive industry. For example, car-pooling proposes a collective use of an individual mode of transport while, conversely, car-sharing describes the individual use of a collective mode of transport. These technological innovations are applied to different uses of a traditional transport mode and transform the economic model. How can companies now promote a systemic vision of technological change, characterised by a complex structure of interactions between the socio-economic environment (markets, governments), the skills of the firm linked to technological changes, and the modifications of uses? How can they promote these systemic eco-innovations (as defined by Chesbrough and Teece (2002)) which require new internal skills and solicit new markets with few customers, sometimes in competition with their own existing market?

Smart mobility as an eco-innovation that simultaneously destabilises the supply system and the demand system (needs of users) is considered a disruptive innovation according to the definition of Mackay and Meltcafe (2002): “A disruptive innovation represents new technologies with characteristics that are initially unfamiliar to producers and consumers, which may also require a major evolution of institutions and infrastructures, and which have the potential to disrupt market structures and lead to changes in behaviours”.

As well as in smart mobility, we observe the following evolutions:

[8] The company redefines its technologies, goods and services and does not find a new market: for example Amazon, easyJet, etc.

1. The emergence of a new technology such as electromobility (or previous automobile technologies and ICT assembled differently), which underperforms compared to the "dominant design" (individual combustion vehicle) and the expectations of consumers. However, this new technology follows a faster technological evolution than the established one. The new mobility services (NMS) are also disruptive compared to the current use of individual and owned vehicles.
2. The technology of NMS is provided by actors at the competitive fringe, or even outside the market[9]. For example, Bolloré, a competitor outside the automobile sector, has been one of the pioneers in car-sharing practices. The success of this innovation will move the strategic value of the old paradigm toward the new, which will significantly change the industrial structure, with the constitution of a new ecosystem.
3. The new technology requires new skills and a learning process by the providers to gain them. It also introduces new uses and/or considerably modifies the initial use of the technology. New practices in the economy of services related to the acquisition or maintenance of the car and the spread of connected objects in the vehicle are transformations in the uses, and thus in the supply, of products.
4. The innovations linked to ecomobility are addressed at new users. For example, the autonomous vehicle will target the visionary "early adopters" who are sensitive to the new technology required for its own sake. The diffusion of this innovation will follow the classic sinusoidal curve of innovation, which associates each phase of technological development with a particular category of consumers.
5. Consumers are categorised according to the time they choose to acquire the innovation in question: "early adopter" and "early majority". The success or failure of the "ecomobility" innovation will be judged when the early majority (who prefigure the transition from a niche to a mass market) adopt ecomobility with a greater importance accorded to the traditional economic determinants (price, reliability, flexibility of choice, interoperability). A new business will thus arise if the management of the transition between consumer categories is assured.

Whether the innovations in ecomobility are "demand-pull" or "technology-push", they can dramatically disrupt usages and change market boundaries. They thus involve new reflexions about the business model[10] that companies in the automotive industry need to develop and the evolution of the structure of the automobile ecosystem. In this sense, Christensen (1997) speaks about a disruptive innovation.

Many conditions need to be fulfilled to implement these disruptive eco-innovations:

- have a design-user approach, i.e. identify and deal with what could be the uses of tomorrow in order to design technologies and products according to those needs (what are the different autonomous car models proposed by Tesla on one hand, and by existing manufacturers on the other hand?).

[9] Christensen (1997) speaks of the dilemma of the innovator for whom the disruptive innovations are rarely introduced by the dominant companies in the market.

[10] In the meaning of Christensen and Rigby (2002) for whom innovation corresponds to "the creation of totally new markets and economic models" (p. 22).

- agree to costly investments to explain to future users what innovation is and the value it will bring them. Given that most people are rather resistant to change and prefer to keep their habits, convincing them to adopt a new product or service that requires them to change their practices will not be a simple and rapid process. It is up to the innovative companies to identify both the facilitating and the obstructing factors to ensure a wider and faster adoption of the innovation.
- invest heavily in R&D (facilities, expertise, patents) in order to stay ahead in terms of skills in the new market identified. The company must also equip itself with the new skills indispensable for developing this innovation.
- becoming the leader in a new market also involves rapid growth, i.e. continuing to invest heavily once the innovation is launched.
- lastly, the sales cycles of a disruptive innovation can be very long, certainly longer than classic innovative products. This is an additional risk factor.

The disruptive nature of smart mobility imposes a methodology of putting the user at the heart of the strategic reflexion and choosing the business model most likely to provide effective solutions to their needs in a perspective of co-conception and co-innovation. The implementation conditions are thus crucial in both the diffusion of these innovations and the success of the new business model.

4.2 Implementation conditions

Different variables will impact whether or not the disruptive eco-innovation is successfully adopted. The first concerns the choice of developing new skills internally or not. Chesbrough and Teece (2002) envisage two organisational models to implement the innovation process: a decentralised (or virtual) approach for "autonomous"[11] innovations and an internal development of skills for "systemic" innovations. This "organisational design" is one of the accompanying variables of disruptive eco-innovations. In an institutionalist approach, it consists of identifying the most suitable institutional determinants and socio-economic organisation modes for decision-making: how do collaborative practices, known as "open innovation", promote disruptive innovation? What are the main obstacles to overcome for the public and private actors?

The second variable affects the institutional level. How can we ensure the conditions for disruptive innovations to be accepted? For example, should we preserve the acquired positions of the organisation of mobility with new actors such as *Uber*? How can we choose between the protection of private life and big data? In fact, the major pitfall for a new mobility solution is achieving the required critical mass of users; many of these solutions emerge and then just as frequently decline only one or two years after their launch. For example, this is the case of the solution *Djump* launched in 2013 but abandoned in 2015, which came close to a dynamic car-pooling. This critical mass, i.e. the transition from the adoption of the solution by the early adopters toward the early majority, is often easier to reach in dense housing areas, but this is not usually enough.

[11] The authors speak of autonomous innovations when they can be carried out independently of each other.

The third and last variable for a successful adoption of the offer concerns the support of public policies, with a focus on financing and territorial questions. What are the favourable and unfavourable factors for the birth and development of the disruptive innovation? Is the financing from private and public funds sufficient and well adapted to the specific needs of the disruptive innovation, in the territories concerned? How does the territorial dimension affect the disruptive innovation? Are there “best practices” that can be transposed from one territory to another?

Most new mobility solutions are deployed primarily in central Paris, and sometimes in the Parisian inner circle and the city centres of large conurbations. This is demonstrated by the use of different private hire services *(Uber, le Cab,* etc.), whose attractiveness decreases rapidly further from the very centre of cities. Thus, while 42% of Parisian households used a private hire service at least once in 2016, only 11% did in the urban centres of more than 100,000 inhabitants outside the Ile-de-France, and only 4% in the rural municipalities (source: *Chronos/ L'ObSoCo* study 2016).

This extremely contrasting situation makes support for the development of the solution by the local authority indispensable. Even solutions that are relatively inexpensive to implement for the territories and whose success seems guaranteed, like bike-sharing schemes, remain dependent on characteristics linked to the population density, amongst others. The recent failures of this type of service in several provincial cities, some of which have more than 100,000 inhabitants (Perpignan, Angers, and Dijon), are due to various factors: too high an operational cost for the local authority compared to the revenue recovered, and under-utilisation of the system. In both cases, the lack of infrastructure or development dedicated to cyclists is highlighted; in other words, although there was sufficient public and private financing, it was not adapted to the territory.

Car-pooling is another example of a solution that may succeed or fail. While the long-distance car-pooling represented by *BlaBlaCar* has proved to be a success over the whole national territory (and internationally), the same group of solutions applied to shorter distances, like *WayzUp*, is difficult to deploy in less dense areas, despite this solution's position in the market since 2013. For a car-pooling solution to operate in more extensive territories, it often needs to be part of a local experiment: for example, the dynamic car-pooling of *Covivo* in Isère in 2010, or *RézoPouce* in the Montauban region (France). However, this experimental nature makes it difficult to identify the reproducibility of the solution, including in territories with similar socio-demographic characteristics. The local “best practices” cannot always be transposed.

To try out innovative offers, there is regular cooperation between start-ups and historic actors of mobility (car manufacturers and associated services, public transport operators). Nevertheless, these partnerships remain limited over time and are generally subject to cautious investment, thus restricted. For example, the *RATP* (Parisian public transport provider) and the start-up *Sharette* set up a partnership in summer 2015 during works on Line A of the Express Regional Network. Despite its success announced at the time, the partnership was not renewed during a new series of works in summer 2016, due to the bankruptcy of *Sharette* in the intervening period.

Promoting the socio-economic conditions for the birth and development of disruptive innovations remains insufficient. In the presence of negative externalities associated with transport, public regulatory actions are indispensable to restore the well-being of the population suffering from the negative effects to its original state. Individual mobility (solo driving) presents many advantages for the user: in a car, there are often more opportunities for travel. One can travel to destinations further away and generally in a shorter time than on public transport. The car provides "seamless mobility", door-to-door and without a break, especially in less dense areas. It is practical, offering the possibility of transporting heavy objects. Solo driving remains synonymous with independence and flexibility: the user depends on no one to make his/her journey. Lastly, it provides the driver with a space completely isolated from the outside world, if he/she wants it.

On the other hand, the use of the car leads to many negative externalities. It causes noise, air pollution, greenhouse gas emissions, traffic congestion, road accidents, etc. The role of public actors is to limit all these externalities and preserve an acceptable quality of life for the inhabitants. However, public mobility policies are often expensive to implement, even though they provide significant and long-term effects (Quinet 2010). Converting a city thoroughfare into an urban boulevard with more space dedicated to public transport, pedestrians and bicycles represents an ambitious development for a local authority, with a certain irreversibility of choice.

In this respect, mobility policies must be assessed as thoroughly and robustly as possible, before or in progress (Rousval and Bouyssou 2009). The implementation of a policy represents a number of potential projects or actions between which the decision-maker must choose with regard to various considerations. Will the project envisaged meet its objectives of correcting the negative externalities? Will it be too expensive? Is it assessed using the correct criteria? Is it preferable to another project? In other words, the cost of the opportunity of a project must be assessed.

5 Assessment methods

In the last fifteen years, less structuring mobility policies have increasingly entered the evaluation field; for example, a car-pooling centre facilitated by an average-sized conurbation (source: *Ministère de l'Ecologie, du Développement sustainable et de l'Energie*, 2015).

There are many economic methods to estimate the effects of a public policy. These aim to calculate the individual's willingness to pay, "that is, how much the individuals would be prepared to pay to benefit from an increase in the supply of a non-market commodity" (Meunier and Marsden 2009, p. 6). Two groups of methods are traditionally contrasted: the stated preference and the revealed preference methods (Mahieu et al. 2015). In these two groups, there are applications specific to transport projects, or to transport externalities for the local authority.

Stated preference methods are often applied to transport projects (Bristow et al. 2015). Among these, contingent valuation "estimates by survey techniques how much individuals would be ready to pay to enjoy the benefits of a project" (Meunier and Marsden 2009, p. 7). The assessment of transport projects by contingent valuation has been the subject of many applications: reduction of noise and air pollution in Navarre (Lera-Lopez et al. 2012), estimation of parking charges in Greece (Anastasiadou et al. 2009), improvement in the provision of public transport in Dubai (Worku 2013), and rail services in Korea (Chang 2010).

In terms of revealed preferences, the best known method applied to transport projects is that of hedonic pricing. This approach is based mainly on the estimation of property prices, which depend partly on the proximity to transport networks and to sources of amenities and nuisances. Thus, the property market indirectly provides a monetary value of these attributes through the difference observed between the values of two identical properties, with the exception of one of the characteristics studied. This difference in value is explained by the gain or loss of well-being attributed by the buyers to these proximities (Rosen 1974, Le Boennec and Sari 2015). Besides the property's own characteristics and the socio-demographic variables of the neighbourhood, the variables of accessibility (to a public or road transport network) constitute another group of accommodation attributes considered in a local market. Many applications of the hedonic pricing method continue to characterise the sub-markets: in Paris (Bureau and Glachant 2010), Ireland (Mayor et al. 2012), and the United States (Duncan 2011, Bajari et al. 2012).

In these approaches, the calculation of willingness to pay may provide a basis to fuel decision-making methods of the cost-benefits analysis (CBA) type. The CBA enables the public decision-maker to choose a transport project in a context in which the decision criteria can be valued in monetary terms. In this way, even if recent evolutions have expanded the perspectives of the cost-benefits analysis, "the quantified economic assessment constitutes the core of the evaluation", as Quinet (2010) points out.

The CBA first clarifies the different elements to take into account in the analysis and provides a structured framework for the public debate (Meunier and Marsden 2009). However, several limitations of the method are generally highlighted. Some impacts are not taken into account in the assessment of projects, which risks biasing the selection; this situation arises because it is sometimes difficult to choose between an inaccurate costing of an impact, an essential condition for monetary evaluation, and no costing at all, in which case the impact will not be taken into account (Forum International des Transports 2011, Bueno et al. 2015).

Finally, although a cost-benefits analysis undeniably improves the transparency and reliability of the analysis by objectifying it, a better appreciation of the diverse effects of a mobility project may be sought by using alternative or complementary tools, in all those situations in which the analytical criteria may not easily be valued in monetary terms (Joubert et al. 1997, Tudela et al. 2006). Moreover, in practice, the CBA described above continues to favour large infrastructure projects (Beria et al. 2012, Hüging et al. 2014). For a mobility project without a very heavy infrastructure (such as bike-sharing or car-sharing), a multi-criteria analysis may be preferred by the decision-maker. Finally, it is generally agreed that a multi-criteria analysis "takes more impacts into account (…), responds more directly to the concerns of decision-makers and is open to different assessments of the weight given to different impacts" (Forum International des Transports 2011, p. 13). In many cases, this greater flexibility can make the multi-criteria analysis preferable to a cost-benefits analysis in the eyes of decision-makers (Bueno et al. 2015).

A multi-criteria analysis is implemented in several phases (Beria et al. 2012). The project or the actions to be assessed must first be specified. It is then indispensable to draw up a list of criteria that will guide the researcher in evaluating the predefined actions. The foreseeable impacts of actions should be envisaged; they must be assessed with regard to each criterion, according to a weighting system. Lastly, the aggregation of the assessments, criterion by criterion, should inform the decision-making.

The different stakeholders in the project or action, public or private, may help the researcher in the construction of the process (Beria et al. 2012). However, as described, the simple multi-criteria analysis does not explicitly take into account this diversity of stakeholders, who are not involved in the implementation stages presented above. Yet, there is a wide range of actors potentially concerned by the possible impacts of a mobility project (Macharis et al. 2009). They are primarily the users, but also the suppliers, as well as the financers (who may be partly the same but also include the public actors). This is why it may be relevant to integrate, explicitly and as soon as possible in the method, all the stakeholders in the decision-making process. Such a strategy makes the group of techniques revolving around multi-actor multi-criteria analyses (MAMCA) particularly timely (Macharis and Bernardini 2015, Le Boennec et al. 2017).

6 Conclusion

There are many challenges facing national and local mobility policies. From an environmental point of view, the fight against climate warming is a priority of local policies, which should not, however, reduce the ability of individuals to travel. From a social point of view, it is therefore a question of offering mobility solutions that meet the demands of actors to travel, specific demands that depend on the territorial contexts.

The deployment of an innovative “smart mobility” ecosystem is envisaged as an opportunity to promote a better coordination of all public transport and alternative mobility services to the private car, associated with a development of car-sharing according to different modalities.

The generalisation of ICT in ecomobility facilitates the complementarity, or even the competition or substitution, of new kinds of transport. Nevertheless, these new transport modes, developed by both public and private actors, must be coordinated to meet the new needs expressed by the demand.

What could be the role of public policies in this management of disruptive eco-innovations? Moreover, the ability to invest in and exploit infrastructures is important in the implementation of a local transport policy. In the context of a rapid evolution in mobility options and systems of governance, how could a local policy on these smart mobility issues be more effectively structured than it is today? The following chapter provides an illustration of these new responsibilities.

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