# The value propositions of Smart City Mobility projects



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# The value propositions of Smart City Mobility projects

Adriano Tanda[1]*, Alberto De Marco[1]

[1] Department of Management and Production Engineering, Politecnico di Torino, Corso Duca degli Abuzzi 24, Torino, Italy

*Corresponding author contacts:

Corso Duca degli Abruzzi 24, 10129, Torino, Italy

Office Phone: +390110907206

## Abstract

To improve city livability and economic competitiveness is a critical objective for public administrators who have been seeking to tackle these problems via increasingly investing in promising Smart City Mobility solutions. However, despite a growing interest and booming market of solutions and technologies, there is still the need to unlock the value that Smart City Mobility projects can bring to their stakeholders.

To fill this gap, this study presents an empirical analysis of 300 mobility projects implemented internationally. Projects are scrutinized according to a business model framework and the variety of projects characteristics are analyzed to identify general concepts and discarding redundant information. A classification of characteristics of Smart City Mobility projects is given, illustrating the main benefits and objectives of smart mobility projects and how such value is generated and distributed among stakeholders.

The resulting implications help scholars to design Smart City Mobility projects and support the decision-making processes.




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# Introduction

The world's population exceeded 7.5 billion people in 2017 and by 2050 the United Nations (2017) estimate it will surpass 9.8 billion. Cities and urban areas are at the forefront of these tremendous growth. Indeed, between 1990 and 2014 the urban population rose from 43 to 54%, and it is estimated that by 2050 it will reach 66% (United Nations, 2014). These trends pose a multitude of threats and problems to both the environment and the citizen's wellbeing, from physical risks, such as pollution and weather anomalies, to social and economic risks, such as unemployment and inequality (Toppeta, 2010; Nam and Pardo, 2011).

In the context of urban mobility, the increasing traffic congestion (TOMTOM, 2017) and pollution due to the ever-growing number of vehicles (UNEP, 2012) are becoming increasingly problematic issues for modern cities (Tanda and De Marco, 2018b). Hence, mobility problems must be addressed by cities' administrators and policymakers (Lee, 2014) while, at the same time trying to exploit the opportunities that the city creates by providing better services and creating a stronger economic environment (Nam, 2011; Anthopoulos, 2017; Dameri, 2013).

It is in this complex environment that the paradigm of the Smart City (SC) has been emerging. SC as a concept aims to foster urban economic and social growth, assure the city's global competitiveness, improve its environmental sustainability and the quality of life of its citizens (Komninos et al., 2011; Caragliu et al., 2011; Schaffers et al., 2011; Komninos et al., 2013; Monfaredzadeh and Bernardi, 2015; Stratigea et al., 2015; Dameri, 2013). While a common definition is elusive (Dameri, 2013), the vast majority of authors agree that the objectives of a SC can be achieved when a city finds a balance between its efforts in fostering its human capital resources and its investments in innovative technologies (Michelucci et al., 2016; Caragliu et al., 2011: Meijer and Bolivar 2016; Mosannenzadeh and Vettorato, 2014; Scuotto et al., 2016; Neirotti et al., 2014; Walravens, 2015). In particular, within the SC concept, the mobility domain and smart mobility solutions are one of its most important topics (Benevolo, 2016) as mobility solutions and infrastructures are the most important facility to support the urban environment (Staricco, 2013). Indeed, while trying to define and classify the SC concept and its application domains, several authors underline the key role of mobility solutions in developing a smarter and more sustainable city (Neirotti et al., 2014; Giffinger and Pichler-Milanović, 2007; Albino et al., 2015).

Several tools have been developed in order to evaluate SCs and SC technologies. That is the case for example of the Smart City Wheel presented by Cohen (2014), who proposes an exhaustive set of indicators to evaluate the maturity of a SC's plan, or the Technology Analysis Matrix (Branchi et al., 2014), developed for the qualitative evaluation and comparison of urban technological solutions, later expanded in Branchi et al. (2017) to include the city's strategic objectives in the analysis and better evaluate and compare SC technologies. Nevertheless, just a few studies focus on how SCs and SC Mobility initiatives create and deliver value. As it is the best tool to describe how an organization creates, captures, and delivers value (Osterwalder and Pigneur, 2010), most of these works study these topics with a business modelling approach. Indeed, business models allow to understand the value and benefits proposed by a SC Mobility projects and how this value is created and distributed between all the stakeholders. This approach is taken by several studies developing classifications and taxonomies of SC business models. For example, in Anthopoulos et al. (2016), the authors present a classification of SC business models, validated with 11 case studies and with the contribution of SC experts. Other authors focus their work on developing taxonomic classifications of SC projects business model characteristics. Perboli et al. (2014) develop a taxonomy of SC projects' business model characteristics based on 28 European SC projects. However, while quite informative, this taxonomy does not focus on how SC projects generate and distribute value among their stakeholders.


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Also, few studies approach these topics with a specific focus on smart urban mobility. Benevolo et al. (2016) develop a taxonomy that analyzes the role of ICT and the main benefits of mobility projects taken from literature contributions while Cledou et al. (2018) classify the characteristics of 42 SC mobility services on a business model taxonomic framework describing how these projects are designed and developed. In particular, this taxonomy focus on value creation and how this value is delivered, overcoming some of the limitation of Perboli et al. (2014). However, it still ignores the relationships between the other projects' stakeholders.

Indeed, the literature on SC and SC Mobility business modelling is quite limited, and heterogeneous and it appears that none of these contributions present a comprehensive approach, addressing both value creation and stakeholder relationships while also not focusing on the mobility domain. As a contribution to filling these literature gaps this study aims to address the following research question: how do SC projects define and deliver value?

To answer this question, the goal of this work is to study the value creation processes of SC Mobility projects and services and develop a classification of their business model characteristics able to describe which value SC Mobility projects aim to deliver and how the intended value is created and distributed in relationship with projects' stakeholders.

This classification will explain the objectives of SC Mobility projects, how these objectives are created and how these are delivered to the right targets, and how they are able to generate revenue to cover their costs.

To this end, the author collected 300 SC Mobility projects worldwide with a focus on small scale projects. Each project has been analyzed in order to understand and categorize the projects' goals, value proposed by its implementation, main characteristics, and the relationships between its stakeholders.

For each of the 300 smart mobility projects, these elements have been subsumed on a framework based on the business model canvas (Osterwalder and Pigneur 2010), chosen due to its ability of describing the value generated by a project and how this value is captured and distributed between the different project's stakeholders and its prominence in SC literature (Schiavone et al., 2019). This classification provides a tool to assist academics for their studies on SC Mobility projects and support public managers and private organizations in their decision-making processes.

To this end, this study is structured as follows. First, an overview of the literature about the general conceptualization of the SC is given, followed by a deeper focus on literature contributions on mobility solutions. Second, the methodology is explained. Then, the results are presented and discussed. Finally, the author underlines the implications and limitations of the study and draw takeaways and conclusions.

# Literature Overview

Throughout the years, what a SC is and how it should be implemented sparked strong debates (Tanda and De Marco., 2018a). Several authors and trade literature support the idea that the SC must be designed and executed with a top-down approach, and that a strategic centralized plan is needed.(Hall, 2000; Singer, 2012; Sennet, 2013) These arguments are often criticized by other authors who conceptualize the SC more as a bottom-up, community-driven chaotic development where the SC is more than just about "smart" technology but about "smart" people (Breuer, 2014; Toppeta, 2010; Kraus et al., 2015; Townsend, 2013). Finally, several authors argue that a city's SC strategy needs to mediate between these two opposites approaches and develop a top-down vision to enable, focus, and direct the chaotic forces of bottom-up citizen-driven urban development (Walravens 2015; Breuer et al., 2014; Dameri and Benevolo, 2016).

Regardless of the approach taken in conceptualizing the SC, smart mobility appears to be one of the most important dimensions in a SC (Benevolo, 2016) and mobility and transportation infrastructures are


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fundamental for development of the modern urban environment (Staricco, 2013). In their seminal work on the ranking of European cities, Giffinger and Pichler-Milanović (2007) define a widely used taxonomy of SC initiative where mobility is identified as one of the six main SC application domain: “smart economy”, “smart people”, “smart governance”, “smart mobility”, “smart environment”, and “smart living. A similar approach can be found in Anthopoulos (2015) who includes smart mobility and transportation in its description of the seven main dimensions composing the SC concept: “resource”, “transportation”, “urban infrastructure”, “living”, “government”, “economy”, and “coherency”. Similarly, Neirotti et al. (2014) highlights the key role of the mobility and transportation domain by including it in its taxonomic classification of the main SC application domains: “natural resources and energy”, “transport and mobility”, “buildings”, “living”, “government”, and “economy and people”.

Indeed, the wise use of natural resources is becoming a priority for modern cities who are facing ever-growing economic and environmental pressures, and one of the key issues faced by modern cities is traffic. In 2017 the Dutch company TOMTOM (2017) has released its yearly report where it analyzes the traffic conditions of 390 cities worldwide. Between 2008 and 2017 citizens have increased the time spent in traffic by 23% and in extremely congested cities such as Mexico City (Mexico) or Jakarta (Indonesia), citizens may spend in traffic twice the time that would be needed with a normal traffic flow. Traffic has an important impact on the economy due to the loss of productivity and the wasted fuel: congestion in the USA costs 0.7% of the GDP, 0.75% in the European Union and 2.6% of Mexico City’s GDP. Emissions and pollutions are also important concerns for city administrators: in 2005 transport accounted for 13% of the global GHG emission and road transport accounted for 89% of the total transportation energy used, 60% of which in North America and Western Europe. Meanwhile 80% of all the emissions generated in the developing countries are due to transportation (UNEP, 2012).

From this premise should come to no surprise the vast amount of efforts in the last few years in finding technological solutions to tackle mobility issues. Cities are starting to invest in software platforms for the integration of traffic data in order to either implement smart traffic modelling (Dobre and Xhafa, 2014) or to provide mobility information to citizens such as traffic, weather conditions and accidents (Ganti et al., 2011) (Yatskiv, 2017). These platforms can also be designed to aggregate data and give travelers information about different mean of transportations, from bike and car sharing to times and routes of public transportation (Anastasi et al., 2013). Moreover, they can support and help city administrators design intelligent and reactive traffic systems (Suzumura et al., 2012) that, for example, can dynamically manage traffic lights to improve traffic flows and allow faster transit for emergency services (Horng, et al., 2013; De Marco et al., 2016). Sensors inside vehicles can help designing emergency systems that alerts authorities in the event of an accident (Tarapiah, et al., 2014) or integrate public transportation vehicle-data in the city’s administration (Zhu, 2018) and traffic management system (Seredynski, et al., 2014) or even allowing the creation of smart parking systems that can guide the driver to the nearest open parking spot or inform the city of illegal parking (Polycarpou, 2013). The pervasiveness of mobile technologies and on-board sensors is also one of the main enablers of new mobility-sharing business models. The more traditional docked bike sharing schemes (Midgley, 2009) have been able to evolve to dock-less free-floating bike sharing systems (e.g. Didi Chuxing Technology or Beijing Mobike Technology’s MoBike services) that allow users to seamlessly rent and leave a bike inside the service’s operating limits (Pal and Zhang, 2017; Castillo-Manzano, Sánchez-Braza, 2012; Chen et al., 2018). Similar technologies also enabled similar business model for car and van sharing (e.g. Daimler’s Car2go or BMW’s Drive Now services) (Firnkorn and Müller, 2011), and ride-hailing (eg.g Uber, or Lyft) (Henao and Marshall, 2018). Technologies can also help in improving the efficiency and environmental footprint of transportation logistic (Lin et al., 2005; Zenezini and De Marco, 2016). City logistics technologies can enable new business models (De Marco et al, 2017) thank to the introduction of electric-powered delivery vehicles (Cagliano et al., 2017b) and the reduction of the number of vehicles by the


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consolidation of shipments (Wanke, 2013). Furthermore, city logistics software systems can help in the management and optimization of transportation fleets and delivery routes (Koç et al., 2016; Cagliano et al., 2017a). These kinds of technologies are generating new markets opportunities, as much as market research firm Infoholic Research (2017) estimates that between 2017 and 2023 the market for smart mobility solution will grow on average 20% per year.

Considering the large number of technological solutions providing a plethora of value propositions in a varied and nuanced field, the authors decided to follow the taxonomic definitions given by Neirotti et al. (2014) who presents a taxonomic definition of the SC domain "transport and mobility" by decomposing it in three sub-domains, namely: City Logistics (CL), which includes technologies involved in integrating and improving the logistic flows in the city's traffic system; People Mobility (PM), which comprises technologies aimed to provide innovative ways for people to move around the urban environment; and Info-Mobility (IM) which includes technologies and services for the gathering and distribution of multi-modal information.

# Methodology

This study uses a case study-based methodology for it is the most suitable one when researching the "why" and "how" of a contemporary issue or set of events (Johnson, 2008). The case study-based methodology is a robust and reliable method (Baxter and Jack, 2008) that allows to study a "specific object, event or activity, such as a particular business unit or organization" (Sekaran and Bougie, 2013, pp. 103) and it "deploys a wide range of interconnected methods, hoping always to get a better fix on the subject matter at hand" (Denzin and Lincoln, 1994, pp. 2). The author develops a qualitative data analysis approach (Corbin and Strauss, 1990; Glaser and Strauss, 2017) with the objective of using data in order to extract theory (Turner, 1981). The steps of this approach are as follows: 1) Case study collection, 2) Framework design, 3) Business modelling characteristics synthesis and classification, and 4) Descriptive analysis.

## Data gathering

The case study collection process was based on the taxonomic definition presented earlier. To avoid lack of statistical significance and selection biases (Yin. 2013; Scuotto et al., 2016), the authors based the gathering methodology on theory building (Eisenhardt, 1989). For each of the three sub-domains, 100 projects were collected and analyzed, for a total of 300. This number was found sufficient in saturating the sample. Indeed, during the case study gathering, the authors always experienced the point where no more surprises or patterns emerged from additional data, which highlighted an adequate level of thematic data saturation (Gaskell, 2000; O'Reilley and Parker, 2012). The research process was conducted on the Google search engine with queries as "name of the subdomain" AND "case study". This gave the possibility to gather case studies from multiple sources such as project reports by funding bodies, company websites and press releases, or white papers. This multitude of sources strengthens the validity of the process (Yin, 2013; Tellis, 1997) and enhances the credibility of the study (Baxter and Jack, 2008).

The projects were selected following the definition of "project" provided by the Project Management Institute (2000): "A project is a temporary endeavor undertaken to create a unique product or service". Furthermore, project selected needed to be small-scaled and self-contained (i.e. not spanning multiple unrelated SC domains), implemented or in progress, and with enough information available in order to evaluate their business model characteristics.

Figure 1 shows the geographical distribution of the sample by international region, while Figure 2 shows their year of implementation.



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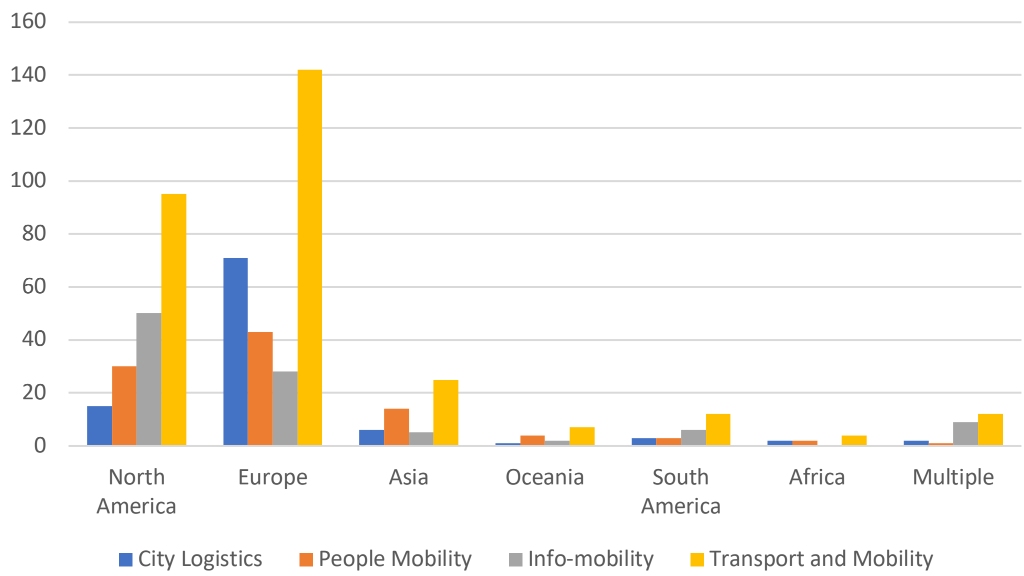
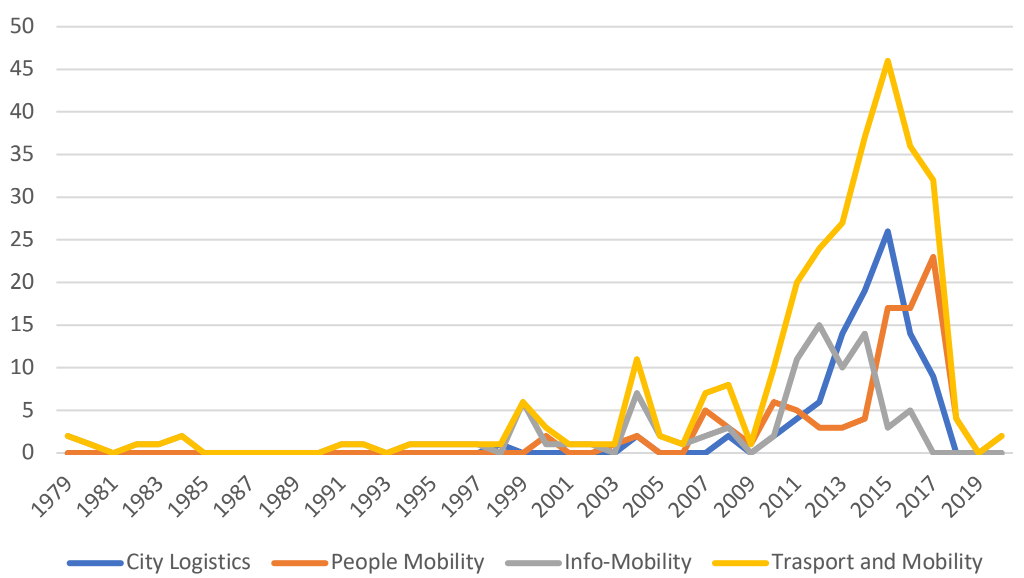
Figure 1: Geographical distribution of Transport and Mobility SC projects




From Figure 1 it is possible to notice that the majority of projects can be found either in Europe or North America, with the other continents accounting for a much lower project count. The vast majority of the projects is developed and implemented in one nation only. However, it is possible to observe that a small portion of projects extend outside national borders and can be found in multiple nations.

Figure 2 shows the implementation year distribution for the projects sampled. Despite the data gathering process not being limited to a specific timeframe to avoid potential recency biases, it is possible to observe that the overwhelming majority of projects have been implemented in the last ten years, between 2008/2009 and 2019/2020, highlighting the dramatic impact that recent technological advancements had on the development of innovative SC Mobility solutions. However, a minority of projects have been implemented during the 1980's and 1990's. This highlights the fact that, while the smart mobility concept is relatively recent as for it is enabled by modern technologies, the opportunities and treads created by the urban environment have been matter of study and innovation for several decades.

Figure 2: Implementation year of Transport and Mobility SC projects



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## Framework design

A framework of main business modelling elements is necessary in order to analyze and confront the projects' characteristics. Such framework needs to be able to describe how a SC Mobility project defines its value and how it delivers is to its stakeholders. Indeed, business models are valuable tools for analysis and using them as a classifying device gives stakeholder a better understanding of business phenomena and practices by creating idea types and generic categories (Braden-Fuller and Morgan, 2010). As discussed earlier, the literature presents several tools for the study of SC value creating process and their business modelling characteristics. It is the case, for example, of Perboli et al. (2014) who presents a framework composed by 10 business modeling categories: "objectives", "tools", "initiator", "stakeholders", "management", "infrastructure financing", "financial resources", "client", "product", and "geographical target". A similar approach can be found in Cledou et al. (2018) who present a framework of 8 main business modelling elements: "type of service", "level of maturity", "type of user", "technology", "delivery channels", "beneficiary", "benefits", and "common functionality". The business model matrix (Walravens 2012; Walravens 2015), while presented in the contest of evaluation and not classification of SC projects' business models, could also be used as reference framework for this study. Nevertheless, given its prominence in the literature on SC projects business modelling (Schiavone et al, 2019), the author decided to use the business model canvas by Osterwalder and Pigneur (2010) as the reference framework for this study.

However, the business model canvas does not map two additional important elements that are needed to better describe how projects are developed: the project's ownership and the project financing source, as it is reasonable to assume that depending on who finances and owns the project, its value and how this value is created and distributed change accordingly. To overcome this problem the business model canvas is integrated with the classification model presented by Perboli et al. (2014). In their taxonomy, Perboli et al. (2014) map the "project initiator" of a SC project as either a public entity, a private organization or their mix, while the "financial resources" of a SC can come from either public or private sources of financing.

The reference framework for the following analysis is presented in Table 1.

Table 1: Reference business model framework for the analysis of smart mobility projects

<table>
<tr><td colspan="2" rowspan="2">Key Partners</td><td colspan="2">Key Activities</td><td colspan="2" rowspan="2">Value Proposition</td><td colspan="2">Customer Relationships</td><td colspan="2" rowspan="2">Customer Segments</td></tr>
<tr><td colspan="2">Key Resources</td><td colspan="2">Channels</td></tr>
<tr><td colspan="5">Cost Structure</td><td colspan="5">Revenue Streams</td></tr>
<tr><td colspan="5">Ownership</td><td colspan="5">Financing</td></tr>
</table>



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## Analysis

After the data collection and framework design, several analyses are performed. First, each project is studied individually, and its characteristics are synthesized on the framework. The project's owner and its financing sources are identified following the classification in Perboli et al. (2014): project ownership is classified as either public, private, or public-private. Financing sources follow the same classification, as SC Mobility projects can either be financed with public funds and grants, private sources of financing, or their combination.

After this first step, each project the remaining nine building blocks of the business model framework are filled so as to identify the value and benefits provided by the project, its customers, its main activities and partners, and its sources of revenue and cost items. Finally, an iterative process of refinement allows for the identification of the main similarities between different projects and the general concepts capturing their essence while discarding redundant and meaningless information. This iterative process allows to reduce and manage the variability in the projects' characteristics while preserving their meaningful differences. The result has been a classification of business model characteristics on a reference framework for each of the three SC Mobility sub-domains. This classification allows to identify the main objectives and value propositions of smart mobility projects, how these are created and transferred between the different project stakeholders, with different sources of revenues and sustaining different kind of costs. This classification explains how SC Mobility projects define and deliver value while the use of a common framework allows to identify similarities and differences between projects characteristics the different domains.

Once the classification efforts are completed, some analysis on the dataset are performed to evaluate whether the emerging business modelling characteristics are dependent from a set of external exogenous variables. In particular, the goal is to understand whether the economic and geographical dimensions of a nation can impact on the implementation of smart mobility projects in terms of ownership structures and financing sources as it is reasonable to imagine that such variables may have an impact on the projects' ownership and financing distribution between the public sector and private organizations. To this end, to represent the economic and geographical dimensions of the analysis, a subset of the variables used by Neirotti et al. (2014) in their study are used, namely: GPD per capita, expressed in $ per person; R&D expenditure in terms of percentage of GDP; Population, expressed in number of people; and Population Density, measured as people per kilometers squared.

These variables are collected from the International Monetary Fund (IMF, 2016) and World Bank databases (World Bank, 2016) using the 2016 as the base year.

Table 2 illustrates the descriptive statistics of the GDP, Population, and Population Density variables.

Table 2: descriptive statistics of GDP, Population and Population Density variables

| Variables | Average | St. Dev. | Minimum | Maximum | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|---|---|---|---|
| GDP ($) | 23703,5 | 21990,8 | 979,0 | 101790,0 | 5679,2 | 16274,7 | 40978,5 | 101790,0 |
| R&D spending in GDP % (% of GDP) | 1.3 | 1.03 | 0.04 | 4.25 | 0,5 | 0,99 | 2 | 4,25 |
| Population (millions) | 78,5 | 227,8 | 0,09 | 1388,3 | 5,3565 | 14,3 | 55,6 | 1388,3 |
| Density (people/km2) | 341,4 | 1249,7 | 3,2 | 8155,5 | 37,6 | 103,3 | 205,4 | 8155,5 |

For each subdomain, the percentage of either publicly- of privately-funded and owned projects in each quartile of the three chosen variables is evaluated. Projects implemented in multiple nations are considered separately.



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Through this analysis the authors aim to better understand whether the ownership structures and financing schemes are affected by such variables. Furthermore, the potential impacts of the ownership and funding on the benefits created by projects is evaluated, as one can assume that publicly or privately-owned or partnered projects may have different objectives and may provide different benefits.

In order to test the statistical significance of such relationships, the Fisher's exact test is used, preferred to the more commonly used Chi Squared test as it is not possible to guarantee frequencies higher than 5 in each relationship. The relationships are deemed significant when present a value of the Fisher's test lower than 0.05 (Sprent, 2011).

# Results

The reference business models for each of the three SC Mobility domains are presented and argued in the following sections. The complete dataset can be found in the online supplemental materials. First, the objectives and values proposed by the projects are discussed and commented, also by referring to the related literature, highlighting the value proposed by the implementation of these projects. After that, the projects' main customers and targets, activities and technologies, partnerships, revenue streams and cost items are discussed, followed by the projects' ownership and financing structures. Through this discussion it is possible to have a clear picture on how projects' plan to deliver value. Finally, the impact of the independent geographical variables presented in Table 2 is given and commented.

## City Logistics

The CL projects collected for this study develop technologies and solutions aimed at integrating and improving the logistic flows in the city's traffic system. It is the case, for example, of Ponyzero, an Italian last mile city logistics service provider who uses cargo bikes for parcel and groceries delivery. Another example is the company Starship, based in the USA, who also provides last mile parcel delivery services, but through the use of semi-autonomous small robots. The service offered by Shopopop, based in France, on the other hand, is innovative in its business model more than its enabling technologies, by developing a platform for facilitating and coordinating peer to peer delivery.

Table 2 present the classification of business modelling characteristics of CL projects, identifying value propositions, enabling technologies, targets and partners.

Table 2: Classification of business modelling characteristics for CL projects

| *Key Partners* | *Key Activities* | *Value Proposition* | *Customer Relationships* | *Customer Segments* |
|---|---|---|---|---|
| Technology providers (84%);<br>Commercial partners (67%);<br>Logistic firms (34%);<br>Universities / research centers (21%);<br>Public entities (19%); | Delivery Management (90%);<br>Bike-based delivery (34%)<br>Shipment operations (28%);<br>Autonomous vehicle-based delivery (22%);<br>Delivery optimization (20%);<br>Electric vehicle-based delivery (18%);<br>Sharing and peer to peer delivery (15%);<br>Manufacturing (14%);<br>Delivery lockers (11%); | Operation cost savings (99%);<br>Pollution reduction (92%);<br>Urban traffic congestion reduction (80%); | Automated services (77%);<br>Dedicated custom solutions (48%); | Public entities (71%);<br>Private organizations (71%);<br>Private citizens (69%);<br>Logistic firms (39%); |



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<table>
<tr><td colspan="2"></td><td colspan="2">Key Resources<br><br>Hardware & Software (100%);<br>Commercial relationships (73%);<br>Research and intellectual property (70%);</td><td colspan="2"></td><td colspan="2">Channels<br><br>Web portals / applications (81%);<br>Sales force (61%);</td><td colspan="2"></td></tr>
<tr><td colspan="5">Cost Structure<br><br>SG&A (100%);<br>Research & Development (91%);</td><td colspan="5">Revenue Streams<br><br>Usage fee (83%);<br>Software licensing (63%);<br>Sales (11%);<br>Leasing\lending\renting (6%);<br>Advertising (2%);</td></tr>
<tr><td colspan="5">Ownership<br><br>Private (75%);<br>Mixed Public Private (14%);<br>Public (11%);</td><td colspan="5">Financing<br><br>Private (57%);<br>Mixed Public Private (35%);<br>Public (8%);</td></tr>
</table>

Reducing operations costs is a benefit created by 99% of CL projects. Moreover, environmental protection is of paramount importance: 92% of projects are undertaken to reduce pollution and 80% to minimize urban traffic congestion. These findings are consistent with most literature contributions: De Marco et al. (2018), while proposing a classification of CL measures, state that their objectives are to either improve the logistic operator's productivity, and therefore decreasing operations costs, or to reduce pollution, emissions and traffic congestion. Similarly, Cledou et al. (2018) present a list of benefits of SC Mobility projects in which reducing costs, pollution, and traffic congestion are presented as primary objectives.

CL projects aim at achieving these goals by deploying a multitude of technologies. 34% of projects implement bike-base delivery solutions, 22% implement autonomous vehicle-based deliveries, while electric vehicle-based delivery solutions are implemented in 18% of the sample projects. 20% of projects propose to provide solutions aimed at optimizing the delivery operations, while 11% are implementing urban delivery lockers. Finally, 15% of projects deploy sharing logistic and peer-to-peer logistic solutions.

The main targets of CL projects are public entities, private organizations, and citizens. Around 70% of projects have these three main customer targets. From these data, it is reasonable to infer that most CL services are designed to serve multiple customer segments. Logistics providers are the target clients for 39% of the sample projects. However, for a CL project to successfully deliver these benefits, partnerships are key. The most important partners appear to be, unsurprisingly, technology vendors, who are key partners in 84% of the projects, followed by commercial partners, and logistic firms, which are present in, respectively, 67% and 34% of projects. The public sector, on the other hand, is relatively unimportant.

Regarding revenue generation, usage fees (pay per use) appear to be the most common (83% of projects), followed by software licensing fees in 63% of the sample projects. This underlines a propensity to offer services through both servitization mechanisms and through more direct forms of monetization. 11% of projects generate revenues directly from traditional asset sales and 6% from leasing, lending and renting and just 2% generate revenue from advertising. Research and development represent an important cost item, which highlights the innovative nature of these projects.

The vast majority of CL projects are privately owned (75%), which suggests that cities and public organizations tend to avoid developing these kinds of tools by themselves and prefer to directly buy logistics services from the market. This is consistent with the previous findings and it is also suggested by the relatively unimportance of the public sector as key partner. However, while only 25% of CL projects are owned, fully or in part, by public entities, when it comes to financing the public plays a more significant role as a large number of projects



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(43%) are developed through public sources of funding. This suggests that the implementation of these projects is beneficial for both private organizations and public entities and that, thanks to their multi-purpose nature, private organizations can rely on public funding such as energy efficiency and pollution prevention subsidies as an important source of capital for the implementation of CL projects.

Given that private entities own and fund the majority of CL projects, it comes as no surprise the weak impact of the exogenous variables on the ownership and financing distributions of CL projects. From results given in Table 4, the population is the only one likely to have a significant impact on the ownership and financing structures of CL projects. While the majority of privately-owned projects are developed in largely populated countries, a number of publicly-owned and publicly-financed projects can be found in less populous nations (first, second, and third quartiles). These less populated countries are also those where a large fraction of mixed owned and financed projects is implemented.

Given the initial consideration, it is also unsurprising that the ownership and financing distribution of CL projects has a relatively weak impact on different value propositions. From the second part of Table 3, the majority of projects aimed at reducing traffic congestion are privately owned. It is reasonable to imagine that private organizations may be interested in solutions aimed at reducing traffic congestion, given the waste of time and money due to traffic congestion as reported by TOMTOM (2017) and the UNEP (2012). Finally, a large fraction of projects aimed at reducing pollution are likely to be financed by public-private mixed sources of funding. This is consistent with earlier considerations discussing about how private organizations, benefitting from public financing and grants, are able to develop both economically-beneficial and environmentally-friendly projects.

Table 3: Impacts on CL project's ownership structure, financing sources, and Value Propositions

| | | Project ownership | | | | Project financing | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quartile | Public | Private | Mixed | Fisher Exact | Public | Private | Mixed | Fisher Exact |
| GDP per capita | 1 | 0% | 7% | 0% | 0,815 | 0% | 8% | 3% | 0,859 |
| | 2 | 11% | 9% | 0% | | 14% | 8% | 6% | |
| | 3 | 22% | 27% | 17% | | 14% | 23% | 31% | |
| | 4 | 67% | 57% | 83% | | 71% | 62% | 59% | |
| R&D expenditure | 1 | 0% | 6% | 0% | 0,591 | 0% | 4% | 6% | 0,281 |
| | 2 | 11% | 6% | 0% | | 14% | 6% | 3% | |
| | 3 | 33% | 36% | 17% | | 14% | 27% | 47% | |
| | 4 | 56% | 53% | 83% | | 71% | 63% | 44% | |
| Population | 1 | 22% | 1% | 0% | 0,002* | 29% | 2% | 0% | 0,000* |
| | 2 | 44% | 13% | 25% | | 57% | 13% | 16% | |
| | 3 | 22% | 14% | 25% | | 0% | 10% | 31% | |
| | 4 | 11% | 71% | 50% | | 14% | 75% | 53% | |
| Population density | 1 | 44% | 27% | 17% | 0,244 | 43% | 31% | 19% | 0,561 |
| | 2 | 11% | 10% | 0% | | 14% | 10% | 6% | |
| | 3 | 22% | 26% | 8% | | 14% | 25% | 22% | |
| | 4 | 22% | 37% | 75% | | 29% | 35% | 53% | |
| Value Proposition | | Project ownership | | | | Project financing | | | |
| | | Public | Private | Mixed | Fisher Exact | Public | Private | Mixed | Fisher Exact |
| Operation cost savings | | 11% | 75% | 14% | 1 | 8% | 57% | 35% | 1 |
| Pollution reductions | | 12% | 73% | 15% | 0,375 | 9% | 53% | 38% | 0,040* |
| Urban traffic congestion reductions | | 9% | 81% | 10% | 0,012* | 8% | 61% | 31% | 0,189 |


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## People Mobility

PM projects develop solutions and technologies aimed to provide innovative ways for people to move around the urban environment. That is the case of Bluetorino, based in Turin, Italy, who provides shared electric cars or the similar service Emmy, based in Denmark, who provides shared free-floating electric scooters. On the other hand, many cities around the world are developing bike-sharing services, such as Divvy, based in Chicago, USA, a popular fixed-station bike sharing program sponsored by the city's transportation department.

Table 4: Classification of business modelling characteristics for PM projects

<table>
<tr>
<td rowspan="2">Key Partners<br><br>Technology providers (79%);<br>Commercial partners (54%);<br>Public entities (31%);<br>Universities / research centers (8%);</td>
<td>Key Activities<br><br>Car sharing (41%);<br>Energy consumption optimization (35%);<br>Shuttle and bus services (28%);<br>Bike sharing (26%);<br>Manufacturing (14%);<br>Ride sharing (6%);</td>
<td rowspan="2" colspan="2">Value Proposition<br><br>Operation cost savings (100%);<br>Pollution reduction (76%);<br>Access traffic-restricted areas (76%);<br>Mobility during traffic bans (76%);<br>Travel comfort (76%);<br>Travel safety (58%);<br>Fewer parked vehicles (44%)<br>Urban traffic congestion reduction (16%);</td>
<td>Customer Relationships<br><br>Automated services (96%);<br>Dedicated custom solutions (11%);</td>
<td rowspan="2">Customer Segments<br><br>Private citizens (99%);<br>Private organizations (13%);</td>
</tr>
<tr>
<td>Key Resources<br><br>Hardware & Software (99%);<br>Research and intellectual property (94%);<br>Commercial relationships (47%);</td>
<td>Channels<br><br>Web portals / applications (95%);<br>Sales force (16%);</td>
</tr>
<tr>
<td colspan="3">Cost Structure<br><br>SG&A (100%);<br>Research & Development (100%);</td>
<td colspan="3">Revenue Streams<br><br>Usage fee (100%);<br>Advertising (44%);<br>Software licensing (12%);</td>
</tr>
<tr>
<td colspan="3">Ownership<br><br>Private (42%);<br>Mixed Public Private (31%);<br>Public (27%);</td>
<td colspan="3">Financing<br><br>Private (49%);<br>Mixed Public Private (32%);<br>Public (19%);</td>
</tr>
</table>

Table 4 shows the classification of business modelling characteristics for PM projects. Travel cost and pollution reductions are the most pursued objectives (100% and 76% or the projects), however PM projects propose to achieve several other goals. 76% of PM projects aim to implement solutions for guaranteeing mobility in limited situations, such as restricted traffic areas or during traffic bans. Travel comfort and safety are also of great importance, with 76% and 58% of projects focusing on improving these two dimensions, respectively. Solving the problem of parking on congested cities by lowering the number of parked vehicles is the objective of several projects (44%), while improving traffic flows is the goal of 16% of projects. These findings are largely consistent with the literature on SC Mobility projects. Indeed, in Benevolo et al. (2017) reducing cost, pollution, and traffic congestion, while increasing people safety and transfer time are the most important objectives of SC Mobility projects.

However, another key aspect is the focus on travel comfort. A comfortable and convenient travel experience, bypass traffic bans, low traffic or easy parking are all important benefits provided by PM projects. Travel safety is also of paramount importance with 58% of PM projects focusing on improving the safety of passengers and travelers. This is consistent with Cledou et al. (2018) as in their study, next to cost savings and pollution reduction, they identify comfort and safety as the main goals of PM projects.


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Most PM projects aim to achieve these objectives via implementing different forms of sharing mobility, from rather traditional car-sharing and bike-sharing solutions (41% and 26% respectively) to more innovative technologies related to on-demand shuttle services (28%) and ride sharing solutions (6%).

The main customer segments of PM projects are private users, with 99% of projects targeted to private citizens, while 13% address private businesses. Interestingly, public entities are not target customers. This may be due to the fact that the development of a large number of projects is done directly in collaboration with the public sector, hence it is possible to infer that public entities find it easier and more convenient being involved directly in the development of PM projects instead of purchasing them from a third-party. Technology providers and commercial companies are the most important key partners.

The main sources of revenue are servitization-based monetization through pay-per-use and/or periodic subscription schemes (100%), however a consistent part of PM projects (44%) has advertising as its main source of revenue. The presence of research and development as a main project's cost item in 100% of the sampled projects suggests the innovative nature of PM projects.

Finally, the presence of the public sector as both owner and financing source in more than 50% of projects confirms the considerations made earlier: the public sector prefers to directly develops PM projects and services rather than buying them from third party developers.

Given this more balanced distribution of ownership and financing, with more than half of the projects owned and financed exclusively, or in part, by the public sector, from Table 5 it is possible to observe a stronger impact of exogenous variables, in particular with regard to project's ownership structures. The vast majority of privately-owned projects are developed in the wealthiest countries (fourth percentile), while fully publicly-owned projects have a balanced distribution. Population has similar impact. This suggests that PM problems affect countries regardless of their GDP or population. Finally, it is possible to observe that the majority of both publicly and privately-financed projects are developed in populous countries while, however, publicly-financed projects have a more even distribution through all the quartiles.

Ownership and financing structures have significant impact on the projects' value propositions. The majority of projects aimed at providing PM services without vehicle ownership are developed and implemented by private organizations. Similarly, projects aimed at reducing the number of parked vehicles and avoiding parking fees are often implemented by private organizations. On the contrary, projects aimed at reducing pollution, or whose goal is to provide easy regulated access to traffic restricted areas and during traffic bans, have a strong public component. This may suggest environmental friendliness is the main focus of the public sector when developing PM solutions. Finally, travel comfort is a goal for the greatest part of publicly-participated projects. However, the presence of privately-owned projects with this goal cannot be neglected.

Table 5: Impacts on PM project's ownership structure, financing sources, and Value Propositions

| | | Project ownership | | | | Project financing | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quartile | Public | Private | Mixed | Fisher Exact | Public | Private | Mixed | Fisher Exact |
| GDP per capita | 1 | 20% | 3% | 0% | 0,005* | 16% | 5% | 3% | 0,174 |
| | 2 | 24% | 9% | 3% | | 26% | 7% | 7% | |
| | 3 | 8% | 21% | 33% | | 11% | 24% | 24% | |
| | 4 | 48% | 68% | 63% | | 47% | 63% | 66% | |
| R&D expenditure | 1 | 4% | 0% | 0% | 0,281 | 5% | 0% | 0% | 0,146 |
| | 2 | 12% | 6% | 0% | | 16% | 5% | 0% | |
| | 3 | 36% | 32% | 30% | | 32% | 29% | 38% | |
| | 4 | 48% | 62% | 70% | | 47% | 66% | 62% | |


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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Population | 1 | 12% | 0% | 0% | 0,011* | 11% | 0% | 3% | 0,039* |
| | 2 | 20% | 0% | 10% | | 16% | 2% | 14% | |
| | 3 | 16% | 15% | 17% | | 11% | 12% | 24% | |
| | 4 | 52% | 85% | 73% | | 63% | 85% | 59% | |
| Population density | 1 | 28% | 59% | 43% | 0,062 | 26% | 54% | 45% | 0,303 |
| | 2 | 16% | 6% | 3% | | 11% | 5% | 10% | |
| | 3 | 12% | 21% | 27% | | 16% | 22% | 21% | |
| | 4 | 44% | 15% | 27% | | 47% | 20% | 24% | |
| Value Proposition | | Project ownership | | | | Project financing | | | |
| | | Public | Private | Mixed | Fisher Exact | Public | Private | Mixed | Fisher Exact |
| Cost savings | | 27% | 42% | 31% | - | 19% | 49% | 32% | - |
| Pollution reduction | | 36% | 24% | 41% | 0,000* | 25% | 33% | 42% | 0,000* |
| Access traffic-restricted areas | | 36% | 24% | 41% | 0,000* | 25% | 33% | 42% | 0,000* |
| Mobility without vehicle ownership | | 3% | 58% | 39% | 0,000* | 3% | 67% | 30% | 0,005* |
| Travel comfort | | 34% | 37% | 29% | 0,007* | 24% | 45% | 32% | 0,076 |
| Travel safety | | 28% | 31% | 41% | 0,001* | 28% | 36% | 36% | 0,004* |
| Fewer parked vehicles | | 2% | 70% | 27% | 0,000* | 2% | 75% | 23% | 0,000* |
| Mobility during traffic bans | | 36% | 24% | 41% | 0,000* | 25% | 33% | 42% | 0,000* |
| Parking fees avoidance | | 3% | 58% | 39% | 0,000* | 3% | 67% | 30% | 0,005* |
| Urban traffic congestion reduction | | 38% | 38% | 25% | 0,613 | 19% | 56% | 25% | 0,879 |

## Info-Mobility

IM projects include technologies and services for the gathering and distribution of multi-modal transport information. That is the case of NeTEx, an Italian project whose goal is to allow public transport users to receive proper and timely information, such as arrivals stop, rates, and directions. With similar goals, but more limited in scope, is the Bus Time application from the Metropolitan Transportation Authority, US.A. On the other hand, IM services can also provide solutions aimed at business and professionals such as Grey Routes, an Indian based, but worldwide reaching, integrated route and fleet management system. In Table 6 it is possible to observe the classification of business modelling characteristics for IM projects.

Table 6: Classification of business modelling characteristics for IM projects

<table>
<tr>
<td rowspan="2">Key Partners<br><br>Public entities (38%);<br>Technology providers (11%);<br>Commercial partners (14%);<br>University / research centers (2%);</td>
<td>Key Activities<br><br>Route management (89%);<br>Operation optimization (28%);<br>Public transportation monitoring (25%);<br>Shifts management (13%);<br>Maintenance, monitoring management (11%);<br>Parking monitoring (5%);</td>
<td rowspan="2">Value Proposition<br><br>Delays reduction (96%);<br>Easier city navigation (88%);<br>Travel safety (75%);<br>Operation cost savings (71%);<br>Easier city navigation (with Public transport) (23%);<br>Access traffic-restricted areas (20%);<br>Pollution Reduction (10%);</td>
<td>Customer Relationships<br><br>Dedicated custom solutions (75%);<br>Automated services (32%);</td>
<td rowspan="2">Customer Segments<br><br>Logistic firms (45%);<br>Private citizens (25%);<br>Public transport firms (23%);<br>Public entities (26%);</td>
</tr>
<tr>
<td>Key Resources<br><br>Research and intellectual property (100%);<br>Hardware & Software (100%);<br>Commercial relationships (13%);</td>
<td>Channels<br><br>Web portals / applications (100%);<br>Sales force (82%);</td>
</tr>
</table>



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| Cost Structure | Revenue Streams |
|---|---|
| SG&A (100%);<br>Research & Development (100%); | Software licensing (75%);<br>Information reselling (26%);<br>Advertising (23%); |
| *Ownership* | *Financing* |
| Private (89%);<br>Public (10%);<br>Mixed Public Private (1%); | Private (69%);<br>Mixed Public Private (16%);<br>Public (15%); |

IM projects are about improving travel speed and reducing trip delays (96%) and improve travel safety (75%). Improving the user's overall travel experience is also of paramount importance for many projects that propose solutions aimed at aiding citizens navigate the city, providing status on traffic, weather, and points of interest (88%), and informing users on public transport routes and hours (23%). Nevertheless, IM technologies are implemented also in more professional environments where they can help fleet management operations with the goal of reducing cost and improving productivity (71%) and manage the access to traffic restricted areas (20%).

These objectives are mostly pursued by implementing some forms of route management systems (89%). Other projects develop solutions for monitoring and optimizing transport operations, personnel shifts, and vehicle maintenance (28%, 13%, and 11%, respectively). 25% of the projects develops technologies to monitor public transportation routes and passage times.

Target customers are consistent with the considerations done on projects' value propositions and main activities. 44% of the projects target logistic firms, while private users, public transport firms and the public sector are the target of around 25% of projects each. This suggest that IM projects have narrow scope and are primarily designed with a single customer in mind. Key partnerships appear to be, in general, relatively uncommon, suggesting that IM projects are developed without much external help. However, the public sector appears to be a relatively important key partner (25% of IM projects), which may be explained by the reliance of IM projects on data provided by public entities.

Licensing and/or periodic subscription-based monetization is the source of revenues for 75% of projects with advertising also being an important source of revenue (23% of projects). IM projects also introduce a new form of monetization in the sale of user data to third parties (26%), either for market research or advertising purposes. Finally, research and development represent a key cost item for IM projects: this again implies that IM projects have a high degree of technological innovation.

Most of IM projects are owned by the private sector (89%) suggesting that public entities (e.g. cities or public transport firms) prefer to outsource IM innovative solutions and directly buy these services from the market instead of developing them in house, hence the small number of publicly owned projects in this domain. However, the public sector covers an important role in financing these IM suggesting that the implementation of IM projects is beneficial for both private organizations and private entities and, therefore, private organizations can rely on public funding to finance, at least partially, the implementation of IM projects.

Due to these considerations, it comes to no surprise that from the data presented in Table 7, it is possible to observe that neither the ownership nor the financing structure of IM projects is impacted by the considered exogenous variables.

However, ownership and financing distributions have several statistically significant impacts on the projects' value proposition. The most notable is that projects aimed at reducing transportation related operation costs are mostly owned and financed by private organizations, which is unsurprising as it is reasonable to assume that cost reduction and productivity improvements solutions are a priority for the private sector. Private


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organizations are also the main developers and financiers of solutions aimed at improving city navigation by informing the user on public transport routes and timetables. This strengthens the idea that the public sector, and in particular public transportation firms, prefer to outsource these kinds of services to private developers and vendors. This allows public transportation firms to avoid the financial burden of developing these kinds of solutions in house, but still give an important service by only having to provide private vendors with access to their raw data.

Table 7: Impacts on IM project's ownership structure, financing sources, and Value Propositions

| | | Project ownership | | | | Project financing | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quartile | Public | Private | Mixed | Fisher Exact | Public | Private | Mixed | Fisher Exact |
| GDP per capita | 1 | 0% | 8% | 0% | 0,116 | 0% | 9% | 7% | 0,081 |
| | 2 | 0% | 9% | 0% | | 0% | 11% | 7% | |
| | 3 | 33% | 4% | 0% | | 23% | 2% | 14% | |
| | 4 | 67% | 78% | 100% | | 77% | 79% | 71% | |
| R&D expenditure | 1 | 0% | 9% | 0% | 0,091 | 0% | 11% | 7% | 0,495 |
| | 2 | 0% | 5% | 0% | | 0% | 7% | 0% | |
| | 3 | 78% | 30% | 100% | | 62% | 30% | 36% | |
| | 4 | 22% | 55% | 0% | | 38% | 53% | 57% | |
| Population | 1 | 11% | 4% | 0% | 0,438 | 8% | 5% | 0% | 0,808 |
| | 2 | 0% | 7% | 0% | | 0% | 5% | 14% | |
| | 3 | 22% | 22% | 100% | | 23% | 23% | 21% | |
| | 4 | 67% | 68% | 0% | | 69% | 67% | 64% | |
| Population density | 1 | 44% | 64% | 100% | 0,115 | 54% | 63% | 64% | 0,120 |
| | 2 | 11% | 4% | 0% | | 8% | 5% | 0% | |
| | 3 | 33% | 7% | 0% | | 23% | 4% | 21% | |
| | 4 | 11% | 26% | 0% | | 15% | 28% | 14% | |
| Value Proposition | | Project ownership | | | | Project financing | | | |
| | | Public | Private | Mixed | Fisher Exact | Public | Private | Mixed | Fisher Exact |
| Delays reduction | | 8% | 91% | 1% | 0,088 | 14% | 71% | 16% | 0,055 |
| Easier city navigation | | 10% | 90% | 0% | 0,136 | 13% | 76% | 11% | 0,000* |
| Travel safety | | 5% | 93% | 1% | 0,014* | 12% | 68% | 20% | 0,079 |
| Operation cost savings | | 1% | 97% | 1% | 0,000* | 8% | 72% | 20% | 0,014* |
| Easier city navigation (with public transport) | | 35% | 65% | 0% | 0,000* | 35% | 57% | 9% | 0,013* |
| Access traffic-restricted areas | | 20% | 80% | 0% | 0,29 | 20% | 50% | 30% | 0,95 |
| Pollution reduction | | 10% | 90% | 0% | 1 | 40% | 20% | 40% | 0,002* |

## Summary of Results

Table 8 presents a summary of the Classification of business modelling characteristics for SC Mobility projects. From this overview it is possible to draw some additional considerations and highlight both common trends and differences between projects. Regarding the goals and benefits of SC Mobility projects, by far the main one is to provide cost saving solutions to logistics and mobility operations. In addition, pollution reduction is the most pursued objectives for these projects. This is not surprising as emissions and pollutions are important concerns for city administrators: in 2005 transport accounted for 13% of the global GHG emission (UNEP, 2012). However, while pollution control is a key objective of both CL and PM projects, it is



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of relatively lower priority in IM projects. Travel safety and, to a lesser extent, travel comfort are also important benefits of mobility projects, in particular in projects developed in the PM and IM sub-domains with a wider and more varied field of application. Considering the economic impact of traffic congestion on the economy (UNEP, 2012) it comes to no surprise finding that the reduction of traffic congestion and, in general, the number of vehicles on the road is also a key objective of SC Mobility projects. Hence, from the framework presented in Table 9, it is possible to further synthesize that the main goals of smart mobility projects are the reduction of logistic and transport operations costs and environmental impacts, the improvements of transport safety and comfort, and the reduction of urban traffic congestion.

Table 8: Classification of business modelling characteristics for Transport and Mobility SC projects

| *Key Partners* | *Key Activities* | *Value Proposition* | *Customer Relationships* | *Customer Segments* |
|---|---|---|---|---|
| Technology Providers (58%);<br>Commercial partners (45%);<br>Public Entity (29%);<br>Logistic Firms (11%);<br>University / research center (10%); | Delivery management (30%);<br>Travel directions (30%);<br>Car sharing (14%);<br>Energy consumption optimization (12%);<br>Bike-based delivery (11%);<br>Manufacturing (9%);<br>Shipment operations (9%);<br>Shuttle and bus services (9%);<br>Implementation of decision support systems (9%);<br>Bike sharing (9%);<br>Public transportation monitoring (8%);<br>Autonomous vehicle-based delivery (7%);<br>Delivery optimization (7%);<br>Electric vehicle-based delivery (6%);<br>Sharing and peer 2 peer delivery (5%);<br>Shifts management (4%);<br>Delivery lockers (4%);<br>Maintenance, monitoring, and scheduling (4%);<br>Ride sharing (2%);<br>Parking monitoring (2%); | Operation cost savings (90%);<br>Pollution reduction (59%);<br>Travel safety (44%);<br>Traffic flow improvements (32%);<br>Access traffic-restricted areas (32%);<br>Delays reduction (32%);<br>Easier city navigation (29%);<br>Mobility during traffic bans (25%);<br>Travel Comfort (25%);<br>Fewer parked vehicles (15%);<br>Easier city navigation (with Public transport) (8%); | Automated services (68%);<br>Dedicated custom solutions (45%); | Private citizens (64%);<br>Public entities (32%);<br>Logistic firms (28%);<br>Private organizations (28%);<br>Public transport firms (8%); |
| | *Key Resources*<br><br>Hardware & Software (100%);<br>Research and intellectual property (88%);<br>Commercial relationships (45%); | | *Channels*<br><br>Web portals / applications (92%);<br>Sales force (53%); | |



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| Cost Structure | Revenue Streams |
|---|---|
| *Cost Structure*<br><br>SG&A (100%);<br>Research & Development (97%); | *Revenue Streams*<br><br>Usage fee (61%);<br>Software licensing (50%);<br>Advertising (23%);<br>Information reselling (9%);<br>Sales of goods and services (4%);<br>Lending/Renting/Leasing (2%); |
| *Ownership*<br><br>Private (69%);<br>Public (16%);<br>Mixed Public Private (15%); | *Financing*<br><br>Private (58%);<br>Mixed Public Private (28%);<br>Public (14%); |

Following this discussion, it is also possible to draw some additional considerations on how these projects are able to create and deliver their intended value. A multitude of technological solutions are implemented in order to achieve these goals. A large number of projects implements solutions and technologies able to improve the operations of city logistics operators, while several other projects are more focused in improving traffic by providing up to date travel directions. Finally, several projects implement some form of sharing mobility. Outside the more commonly-shared technical solution just discussed, SC Mobility projects are implemented through a number of sector-specific technologies and innovative solutions suggesting that while projects in the different mobility domains may share benefits and goals between each other, they pursue value with entirely different enabling technologies and innovative solutions.

Private users are by far the main customers of these projects, thus making mobility projects more geared toward delivering their value and benefits directly to end consumers. Following private consumers, public entities, private organizations and, specifically, logistics firms are the other main targets of these projects. Interestingly, however, there are differences in the target distribution between different sub-domains. Indeed, while both CL and PM projects have a wider audience and target several customer segments at once, IM projects appear more focused and generally targets only one customer segment. Furthermore, both CL and IM projects have in public entities an important customer segment, while PM target directly private citizens and private organizations, suggesting that public entities in this subdomain prefer to actively participate in the development of these projects rather than buying them from third party developers. Mobility services are, for the most part, accessed through web portals and other digital application (92%), while 53% of the projects under are also distributed through more classical sales channels. This is also reflected by the relationships created between service providers and customers. More than half of the projects (68%) are automated and do not present any particular specific relationship between provider and user. On the other hand, 45% are developed and implemented following more closely the requirements of the customer. That is the case especially for IM projects.

Some partnerships are key in creating and delivery the projects benefits. Main partners of these projects are technology providers and commercial partners such as distributors and retailers. Universities and research centers are a key partner in a smaller but sizable share of projects, for the most part concentrated in the CL domain, highlighting the innovative nature of many of these projects. Public entities, on the other hand, appear to be an important key partner only in IM projects, for the most part due to their reliance on the data provided by the public administrations. Regarding monetization strategies, more traditional software licensing is an important source of revenues, however the main monetization for these projects are usage fees or pay-per-use. Advertising is also an important source of revenues, in particular in PM and IM projects. IM projects also introduce a more peculiar monetization strategy: customer's information profiling and re-selling for marketing and advertisement purposes. Research and development being a major cost item in the vast majority of smart mobility projects once again highlights the innovativeness and cutting-edge nature of these projects. Cost structure, on the other hand, are not particularly varied or innovative. Interestingly, almost all projects in all


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three sub-domains have research and development as a key cost item, once again underlining the innovative and cutting-edge nature of these projects.

Finally, the vast majority of SC mobility projects are owned by private organizations, with the exception of PM projects that present a more balanced ownership distribution between private and public organizations. On the other hand, the public sector has an important role as a financing source for projects in all three SC Mobility domains, suggesting that thanks to their ability to provide both economically-beneficial objectives and achieving socially- and environmentally-conscious goals, private organizations are able to use grants, subsidies, and public funding to reduce their costs and improve their own operations.

# Discussion of Results

As discussed in the previous sections, it can be observed that while SC Mobility projects present several common elements in the distribution channels, relationships, and cost structure, they also have heterogeneous value propositions and objectives, key enabling partners and technologies, customers, and revenue stream. Nevertheless, a main trend appears to emerge: pollution reduction and costs savings are SC Mobility projects' most common goals. More in general, SC Mobility projects pursue two main types of objectives. The first one is private and business-oriented, providing solutions for cost reduction and business operations improvements. The second, on the other hand, focus on the public sphere and generates environmentally and socially-conscious objectives for the city, communities, and citizens (Emerson, 2003).

This trend is confirmed by the literature on SC, both from a mobility-specific perspective, for example in Cledou et al. (2018) and Benevolo et al. (2016), and also by the main literature trends on the SC concept, where safety, comfort, and environmental protection emerge as key objectives of SC policies (Dameri, 2013; Dameri, 2017; Caragliu et al., 2011), followed by improving efficiency and reducing pollution (Janssen and Estevez, 2013; Pollio, 2016; Shelton et al., 2014; Caragliu et al., 2011). This suggests that considerations made earlier on the goals, objectives, and value propositions of SC Mobility projects can at least partly be generalized, and are not related to local variables. This is also reaffirmed by Dameri et al. (2019) who argue that several key elements of SC projects can be generalizable and present a more global dimension, which is the case for the key role of ICT and technologies, the application domains, and the objectives pursued by their implementation.

Finally, the prevalence of private organizations in the development of SC Mobility projects confirms the bottom-up nature of the SC concept (Townsend, 2013; De la Peña, 2013), for the most of the development and implementation efforts come from the private sector with a bottom-up approach. However, the key role played by the public as guide and driver of this bottom-up efforts toward the pursuit of socially-conscious objectives and the generation of public value, confirms that by implementing a top down policy framework, public administrations and city managers are able to drive and guide these bottom-up effort toward the creation of public value (Walravens, 2015; Breuer et al., 2014; Fontana, 2014; Dameri and Benevolo, 2016).

Unfortunately, the analysis of the impacts of economic and geographical variables does not highlight any major trend or pattern, while the authors expected that the local variables would play a more meaningful role in the strategies for the implementation of SC projects. Arguably, however, this lacks of meaningful impacts, strengthens the consideration made earlier that the key elements presented in this study, that is the classification of business modelling characteristics of SC projects, can be, for the most part, generalized outside the local level.


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## Implications, limitations and future research

This paper presents a classification of business modelling characteristics of SC Mobility projects. As a theoretical contribution, this classification addresses the shortcomings of the academic literature and gives scholars a clearer picture of the state of the art of SC Mobility projects. This work helps the theoretical understanding and classification of the objectives and values driving the development of smart mobility projects, and how practitioners and professionals are able to achieve them. Furthermore, it allows the identification of differences and commonalities between projects in different sub-domains of the mobility field, highlighting common trends and major differences. This work is based on an analysis of smart mobility project case studies from a multitude of sources, each using its own format and dictionary, and without a common indexation. Hence, this extensive research and synthesis efforts allow this tool to be also used as a database of SC Mobility projects, overcoming the lack of common repositories. In conclusion, scholars can use this work as a reference canvas for the analysis of SC Mobility projects for a better understanding of the why and how they are developed and for predicting the strategies and decisions required for their implementation.

As a practical implication, this study supports both public administrations and private vendors in their decision-making processes for designing, developing and implementing smart mobility projects. Public administrators can use this classification to support the development of their own SC Mobility projects. Given the goals and objectives they plan to achieve, they can use this work to identify the best activities and technologies, targets, partners, and revenue streams for an effective and efficient implementation. Furthermore, public practitioners can use this study as a reference guide to identify the best commercial solutions for achieving their goals. Private vendors can use this classification to understand the benefits expected by their clients, their objectives, and how to effectively deliver them. This will guide private companies in designing and developing SC Mobility projects better suited to create and deliver the right value to the right people.

This study has some limitations. First, by design this study limits the projects' collection to the given taxonomic definitions. Hence, any SC project outside the scope of those taxonomic definition is not included in the analysis. Furthermore, while the large number of case studies helps reducing the impact of selection bias (Baxter and Jack, 2008; Yin, 2013), from Figure 1 it is possible to observe that the majority of the projects has been implemented either in Europe or North America. However, this does not and cannot suggest a hegemony of these two regions in the implementation of SC projects, but it reflects the limitations of the data gathering process due to the author's geographical and language constraints. Future research should address this limitation and collect and analyze additional case studies from under-represented regions in order to improve the results and further analyze possible differences between projects' characteristics.

The objective of this study is the development of a classification of business modelling characteristics that allows to understand the objectives pursued by smart mobility projects and the value they deliver. However, the analysis of the extent to which smart mobility projects achieve their objectives and fulfill their promises is far from over. While all the projects in this study were in the process of being implemented, and therefore they indeed succeeded to reach the objectives reported in this study, how much they were able to be beneficial, satisfy their users and fulfill their promises, requires further examination. Future research will need to more directly investigate SC Mobility projects, sub-domain by sub-domain, in order to quantitatively assess their impacts on the urban environment with regard to control measures such as pollutant emissions or entrepreneurship development so as to evaluate their success rate and investigate the degree of which these projects will be able to fulfill their promises. To this end, tools such as the Technology Assessment Matrix (Branchi et al., 2017) could be used.



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# Conclusions

This paper develops a classification of business modelling characteristics for SC Mobility projects based on a collection of 300 internationally distributed case studies to answer the following research question: how do SC projects define and deliver value?

This classification provides a clear understanding of the value generated and the objectives pursued by SC Mobility projects, a deeper evaluation of the enabling technologies and partnerships needed to achieve these goals, and their main targets. Finally, it gives an insight on the project's revenue, cost items, ownership and financing structures. Furthermore, differences and similarities between projects in various sub-domains are observed and discussed.

From these discussions it is possible to draw some interesting takeaways. SC Mobility projects present a large number of heterogeneous objectives and value propositions pursued through an even larger and more heterogeneous number of technologies and innovative solutions. Nevertheless, a trend emerges. On the one hand Smart Mobility projects are able to deliver business-oriented value and assure a monetary return on investment. On the other hand, these projects develop technologies and solutions able to create public value (Emerson, 2003) and deliver socially and environmentally-conscious objectives. It is possible to argue that these results find confirmation in a large body of related literature (Dameri, 2017; Caragliu et al., 2011; Cledou et al., 2018; Benevolo et al., 2016), suggesting a certain degree of global generalization.

Finally, the heterogeneity of value propositions, enabling technologies and implementation strategies, and the prevalence of privately-owned projects, confirms the conceptualization of SC as a mainly bottom-up process (Townsend, 2013; De la Peña, 2013). However, the presence of the public sector as key enabler of many of these projects, focused on the creation of public value, suggests that the public sector plays the role of guide and director, driving these bottom efforts through a top-down approach (Walravens, 2015; Breuer et al., 2014).

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# Glossary

**Automated services**: services that can be accessed automatically by the user without further customization or support. It's the main type of customer relationships in the majority of SC Mobility projects.

**Commercial partners**: partners required for the commercial success of the project, such as installation technicians, retailers or distributors. They are key partners in a large number of SC Mobility projects.

**Commercial relationships**: relationships with third party companies fostered for the commercial success of the project. They are key relationships in a large number of SC Mobility projects.

**Dedicate custom relationships**: services that require dedicates support and customization to be enjoyed by the user. It's the main type of customer relationships in a large number of SC Mobility projects.

**Logistic firm**: companies whose core business is the management and supply of logistic services and operations. They are key partners in a large number of SC Mobility projects.

**SG&A**: selling, general and administrative expenses. They are key cost items in all SC Mobility projects.

**Technology providers**: hardware supplier or software contractor. They are key partners in the majority of SC Mobility projects.



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## Author's Contributions

Adriano Tanda: data gathering and manuscript writing.

Alberto De Marco: manuscript writing and editing.

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