World Academy of Science, Engineering and Technology
International Journal of Mechanical and Industrial Engineering
Vol:11, No:10, 2017

Analysis of the Diffusion Behavior of an Information and Communication Technology Platform for City Logistics

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***Abstract*—**The concept of City Logistics (CL) has emerged to improve the impacts of last mile freight distribution in urban areas. In this paper, a System Dynamics (SD) model exploring the dynamics of the diffusion of a ICT platform for CL management across different populations is proposed. For the development of the model two sources have been used. On the one hand, the major diffusion variables and feedback loops are derived from a literature review of existing diffusion models. On the other hand, the parameters are represented by the value propositions delivered by the platform as a response to some of the users' needs. To extract the most important value propositions the Business Model Canvas approach has been used. Such approach in fact focuses on understanding how a company can create value for her target customers. These variables and parameters are thus translated into a SD diffusion model with three different populations namely municipalities, logistics service providers, and own account carriers. Results show that, the three populations under analysis fully adopt the platform within the simulation time frame, highlighting a strong demand by different stakeholders for CL projects aiming at carrying out more efficient urban logistics operations.**

***Keywords*—**City logistics, simulation, system dynamics, business model.

I. Introduction

In recent years, problems caused by the increasing urban freight transportation, such as congestion and pollution, have led both researchers and public administrations to concentrate their efforts on CL programs and projects. CL fosters the development of integrated logistics systems, wherein all the stakeholders involved are coordinated in order to decrease the negative impacts on citizens. In this context, freight carriers play an important role, since they carry out the core tasks of the CL process meaning delivering goods [1]. The daily activities of freight carriers are strongly influenced by initiatives aimed at reducing the negative impacts of urban logistics operations.

This study presents an SD model that is aimed at evaluating the potential diffusion of an ICT platform for supporting the logistics activities in urban areas in Italian territory by taking into account the main three different populations of potential adopters that can be involved in the adoption. The results of the simulation allow to identify some factors that might drive the adoption. The present work is part of the Urban Electronic and Logistics (URBeLOG) national research project carried out by a consortium of academic and industrial partners including a main ICT operator, a commercial vehicle manufacturer, a logistics service provider, and companies in the automotive, mechanics, electronics, information technology, automation, and energy sectors. The project's ultimate goal is developing an innovative platform acting as a middleware connecting on-board units and road sensors to manage the access of commercial vehicles to the Restricted Traffic Areas in the city centers of the two test beds (Torino and Milano). Moreover, it will monitor the state of filling loading/unloading areas, providing valuable routing improvement and planning to freight carriers.

The aim of the project is to create and validate a virtuous system that would make the service of last-mile distribution in urban areas more cost-effective, efficient, economically advantageous and ecologically sustainable.

The SD methodology [2] has been used given its proven ability to represent and simulate the behavior of complex systems like CL ones that involve a lot of factors and stakeholders, such as governments, companies, citizens, and carriers that interact with each other. The model was developed based on the interviews with the main stakeholders involved by the projects by carrying out two different participatory sessions of the Business Model Canvas in order two identify the main potential levers of diffusion. This approach can be considered new and innovative, and it has proved its effectiveness since during the two Business Model Canvas sessions the all partners involved had the opportunity to highlight their own needs and requirements that are crucial for making the platform interesting and feasible from a commercial point of view.

The paper is structured as follows. An overview of the pertinent literature is presented in Section II. Section III describes the methodology, while the development of the model is presented in Section IV and its calibration is shown in Section V. The results of the simulations together with their interpretation are discussed in Section VI. Finally, the study implications, future research, and conclusions are given in Section VII.

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II. Literature Review

A. CL Context

CL is defined by scholars and practitioners as the effort of "totally optimizing the urban freight distribution activities by considering economic, social and environmental outcomes of such activities [3].

The CL concept has been explored and substantiated in many different ways in recent years, as a result of both private and public undertakings. Several projects have been tested and implemented, such as urban consolidation centers [4], [5], delivery with alternative vehicles [6]-[8], satellite terminals inside the city center where goods are being transshipped from vans to small delivery vehicles [9], [10], or off-hour deliveries to retailers [11], [12]. The implementation of these projects has always included a careful and thorough assessment of the response of CL stakeholders to the introduction of new CL systems.

Among the methods used to assess the feasibility of CL project, modeling techniques can be used to perform ex-ante evaluation of the potential outcomes of the introduction of CL private and public policies [13], [14]. Models investigate different scenarios and aim at modeling the behavior of the system considering social, economic and sustainability aspects [15]. Most of these models take into account the freight flows and aim to optimize them to achieve both operational efficiency and reduction of emissions [16], [17]. Such models describe the city topology and traffic regulation, in addition to representing the logistic chains and the main vehicles used. A SD model with similar objectives has been proposed by [18]. The authors propose a ground work for introducing SD as a tool to model freight transportation for urban areas. The main model components are freight demand from the population, freight transport demand, road mileage and fuel consumption, and finally transport lead time and costs. To the best of our knowledge, this is the most comprehensive SD model for CL systems developed so far. However, the complexity of the system can be overseen by urban freight flows models. In fact, CL systems are complex systems where a multitude of stakeholders pursue different objectives [19]. Hence, the implementation of successful CL projects require in-depth analysis of the potential success factors and the dynamics of the complex interrelations among stakeholders [20]. Only recently there has been a surge in evaluation methods and modeling techniques that would include the perspectives of different stakeholders [21], [22]. It is therefore challenging to meet the potentially conflicting interests in order to find a shared solution. The most significant conflict arises between private operators, such as retailers and transport operators, and public administrations. In fact, while public administration implement policies to cope with the negative externalities of urban freight distribution activities, transport operators are challenged with bearing the additional costs deriving from such public regulations. Moreover, it is becoming more and more difficult for them to charge their final customers with such additional costs because of a wider convergence and increasing competition among global delivery operators [23], [24]. As a consequence, public policies settled by local authorities might negatively impact CL systems in terms of cost and efficiency. To understand the interrelations between CL stakeholders and include them in the SD model, it is necessary to understand their behaviors and objectives.

B. CL Stakeholders

The key stakeholders of the urban movement of goods are shippers, freight carriers, local retailers, residents and local authorities [21]. Each stakeholder presents distinct points of view as a consequence of the different roles they play in the system and their objectives, which can be overlapping and contrasting at times.

Residents would like to have a good living environment with low level of pollution, traffic congestion and nuisances generated by freight transportation activities such as noise and road accidents [16], [25]. However, citizens do not have a direct impact on CL systems decisions, and their objectives are usually shared by the local administration. Local authorities aim at fostering urban economic development and they should coordinate the efforts for the improvement of CL systems' efficiency. In fact, in some of the most important best practices of CL, local administration have played a major role in resolving conflicting issues and implementing the projects [26].

Shippers outsource the delivery process to transport operators, and thus, seek to achieve at the same time low cost deliveries and a high quality of service in terms of reliability [27]. Moreover, they may benefit from reliable and timely information on the state of the delivery (e.g. through tracking and tracing systems) [28]. Finally, security and safety of the delivery are major requirements for a logistics service [29].

Transport operators offer logistics service to shippers, and hence, are keen on maximizing shippers' objectives. In addition, they seek to maximize profits by increasing revenues and decreasing the cost of pick-up and delivery. In fact, last mile distribution in urban areas account for a significant share of delivery costs, that can range from 20% to 40% [30], [31]. This relatively large share of cost is due to the congested roads, higher number of vehicles used (i.e. only smaller vans are allowed in most of the cities) high number of delivery points, traffic congestion and other issues such as the first delivery attempt failure when the receiver cannot attend the delivery [32]. Couriers and express delivery services compose probably one of the most efficient group of transport operators in urban areas. They provide pick-up and delivery services to large shippers, small businesses and local customers. To this end, they have invested a large amount of money in warehousing infrastructures, vehicle technology and ICT systems to reduce operative costs and improve network and operations planning in urban areas. As previously mentioned however, local regulations such as limited time windows of access to city centers urban areas affect their profitability by putting an additional time pressure on their daily operations. Moreover, local regulations differ significantly from city to city, and these global players find it difficult to cope with this dispersion of policies. A second major group of transport operators includes smaller actors who want to sell their goods, own few freight vehicles and organize their own transportation. These operators do not consider transportation activities as their core business, have fewer points of delivery in urban areas and their operations are usually less efficient.

In conclusion, the introduction of a new CL ICT platform should take into account the diverse and sometimes conflicting objectives of the major private and public stakeholders. Furthermore, it should seek to improve the operative conditions of transport operators while reducing the negative externalities generated by their activities. To model the diffusion of such an initiative therefore requires a clear understanding of the most important factors that could leverage the attractiveness of such an initiative for transport operators and local administrations, as well as the interconnections that are embedded in the CL system.

C. Modeling the Diffusion of Innovation

The diffusion of a new technology is usually described by an S-shaped curve, with slower diffusion rate at the beginning and increasing growth rate after the system reaches the "tipping point" [33]. Several models were proposed to explore the patterns of diffusion of a product or service by a community of users, such as the Gompertz model [34], the logistic model [35], the Fisher-Pry model [36], and the Bass diffusion model [37].

Diffusion models are either homogeneous or heterogeneous in nature. Homogeneous diffusion models are depicted by the two-step flow theory, by which the innovation spreads initially within a small group of individuals as result of advertising effect, and then it is transmitted to other potential users by means of word-of-mouth influence [37]. However, potential users can present different purposes and needs that induce them to adopt a new product in separate times and under different circumstances or factors. Heterogeneous diffusion models thus include such aspects in the model development [38].

Technological platforms connect different type of potential users, generating other kind of social influences such as network externalities and social signals. When network externalities have a positive effect on product diffusion they can be called "positive demand externalities" [39], [40], and they occur when the purchase of a product by a consumer is a function of the number of consumers that have already purchased that product [41]. As a matter of fact, direct network externalities ensue when the willingness to purchase a product is a function of the installed base, and this in turn leads to an interdependency of users [42]. Indirect network externalities take place instead when the willingness to adopt one innovation increases as the number of adopters of a complementary product increases – an example is the increasing adoption of DVD players as the option of movies in DVD exponentially grows [43].

The dynamics of diffusion of new products and technologies pose a great challenge to researchers, in particular, where such products benefit from network externalities originated by different users' behaviors and perspectives, as in the case of a CL ICT platform. To this end, SD modeling approach can help in simulating and evaluating the effectiveness of implementing ICT tools for urban freight distribution management [44].

SD has proved to be an appropriate approach to explore the process of innovation and technology adoption by communities of users. Reference [45] proposes an organic view of innovation diffusion literature to single out the core elements common in seemingly separate research works. The author identifies some founding linkages among variables related to innovation diffusion. For instance, committing to an innovation has a positive effect on the effort dedicated to using that innovation; other users then observe this reinforcing loop taking place and contribute to the diffusion. References [46] and [47] introduce the notion that managers can actually leverage on certain factors to increase the likelihood of a successful diffusion, and that other non-structural factors (e.g. the market structure) intervene on the diffusion process. The most important leverage factors are considered to be pricing, advertising, product quality, production capacity and investment, or successive substitute products.

D. Modeling Diffusion with SD

SD has been applied in various domains to observe and explore the dynamics of an innovation diffusion. For instance, it was used in the energy sector to model the diffusion process of energy efficiency lighting in households [48], or the introduction of alternative fuel vehicles [49]. Diffusion models for the ICT and telecommunications sector were also developed with a SD approach [50], [51]. In particular, Ryan and Tucker investigate how heterogeneity among users in terms of adoption cost, network effects, or technology usage, can affect network evolution and the product diffusion. In a CL context, a SD diffusion model with focus on the diffusion of electric vehicle within an urban freight transportation system has been proposed by [52]. The major components of this model are the number of freight delivery vehicles, the economic and environmental savings, and the cost for installing the charging stations. The model compares the existing system with the proposed one, and calculates the resulting savings. A third sub-model is built to study the adoption process, following a consolidated Bass [37] diffusion model.

III. Case Study

The case study involves the introduction of URBeLOG, an ICT platform for managing last-mile services and coordinating CL stakeholders [53]. The platform oversees the process of granting green certificates to give entry access to the city center, as well as providing real-time data on parking spot availability and local regulations to transport operators. The authors have been directly involved in the development process of the platform, and have had the chance to investigate the stakeholders' needs and the platform' specification by means of subsequent focus groups and group sessions. These sessions have enabled the authors to include the attributes of the provided service and the stakeholders' requirements.

These attributes have been evaluated and extracted using the Business Model Canvas approach [54], which focuses on understanding how a company can create values for customers and organize assets and resources to the task. A Business Model is the rationale of how an organization creates, deliver and captures value [54]. In particular, three aspects are crucial. First, how key components and functions or parts are integrated and deliver value to the customer. Second, how those parts are interconnected within the organization and throughout its supply chain and stakeholder network. Finally, how the organization generates value or creates profit, through those interconnections [55]. An organization's business model can provide insight into the alignment of high level strategies and underlying actions that can support strategic competitiveness [56]. This approach proves to be effective and exhaustive: all the partners of the projects, together with a public authority have taken parts to the plenary so that all the aspects that can foster the adoption of the platform can come up. These features are then translated into diffusion factors that make up the diffusion model together with state variables and feedback loops, adopting the Bass [37] diffusion model approach with three different population of users. Coherently the populations analyzed contribute to the development of the Business Model Canvas sessions. Then, the calibration of the model is performed by defining the parameters of the system from multiple internal and external sources.

Finally, different scenarios are simulated and the resulting implications are drawn.

IV. The SD Model

The proposed SD model has been inspired by previous contributions such as [57]-[60], as well as by the SD representations of the Bass model by Stermann [61], [52]. It is structured into three interconnected populations:

- "Municipalities": represents the dynamics of the diffusion of the URBeLOG platform among the Italian municipalities;
- "LSP": describes the behavior of diffusion for the main logistics service providers operating in Italy;
- "OAC": refers to the adoption of the ICT platform by the own account carriers.

As previously mentioned, the Business Model Canvas is used to frame the diffusion leverages of URBeLOG. The business model Canvas divides an organization's business into nine interconnected components: Value Proposition, Customer Segment, Customer Relationships, Channels, Key Resources, Key Activities, Partnerships, Costs Structure and Revenues Stream.

The Value Proposition identifies the way a firm deals with the customer's problems and the way the customer's needs are met. It represents the bundle of products and services that create value for a specific customer segment. The first value proposition is a better management of the access restrictions. Thanks to the data gathered, URBeLOG can be an interface for dealing with the green credits that are given to logistics service providers and own account carriers, from carrying out their activities. Green credits are fiches that are acquired or lost according the adoption of green strategies such as the use of low impact vehicles or optimized routings policies. When the amount of credits is out, they can be purchased back through URBeLOG. The platform also supports the development of dynamic policies such as the management of reserved lanes. Another service of URBeLOG is the real time monitoring of lay-by areas and the vehicle fleet, which allows for an enhanced scheduling of the routings. URBeLOG will then enable the planning of national logistics policies in order to standardize the different local regulations. The purpose of URBeLOG is to present herself as a unique interface among the different stakeholders involved in the CL processes, optimize the logistics processes and reduce the delivery times. Thus, the identification of the Value Propositions has allowed to define the main potential levers of diffusion for the populations under study.

A. Municipalities Sub-Model

Fig. 1 represents the diffusion of the URBeLOG platform among the Italian Municipalities that deal with a Restricted Limited Area. The choice of taking into account just this subgroup of municipalities coaches on the idea that they are the ones more focused on congestion, logistics and mobility issues, and in turn more interested about the services that URBeLOG can offer.

Municipalities could adopt URBeLOG as a service for better defining their CL strategies and for better dealing with the mobility green credits. These drivers, together with the negative element of the cost of the platform, identify the first lever of diffusion defined as "Adoption Rate from Green Image and Advertising Municipalities". The other lever is made up of two different word of mouth (WOM); the WOM among Municipalities depending on the Contact Rate that is the frequency of contact between a Municipality that has already adopted and a potential adopter and the Adoption Fraction, expressing the amount of contacts the becomes a real adoption. The other WOM takes into account the Municipalities and the LSPs. It depends on the contact between two different populations (Contact Rate Municipalities and LSP) and on the Adoption Fraction Municipalities cross side that represents the number of municipalities that after a contact with an LSP decides to adopt URBeLOG.

The adoption of the nine LSPs operating in the Italian market is associated with the green image and with environmental friendly management for carrying out the logistics activities, together with the commercial campaigns. In this context the enhancement of the routings, the improvement of the foot print and effective communication strategies are crucial. On the contrary, the cost of the platform is considered as a negative factor for the diffusion. The two WOMs taken into account are the WOM among LSP and the WOM between Municipalities and the LSPs.

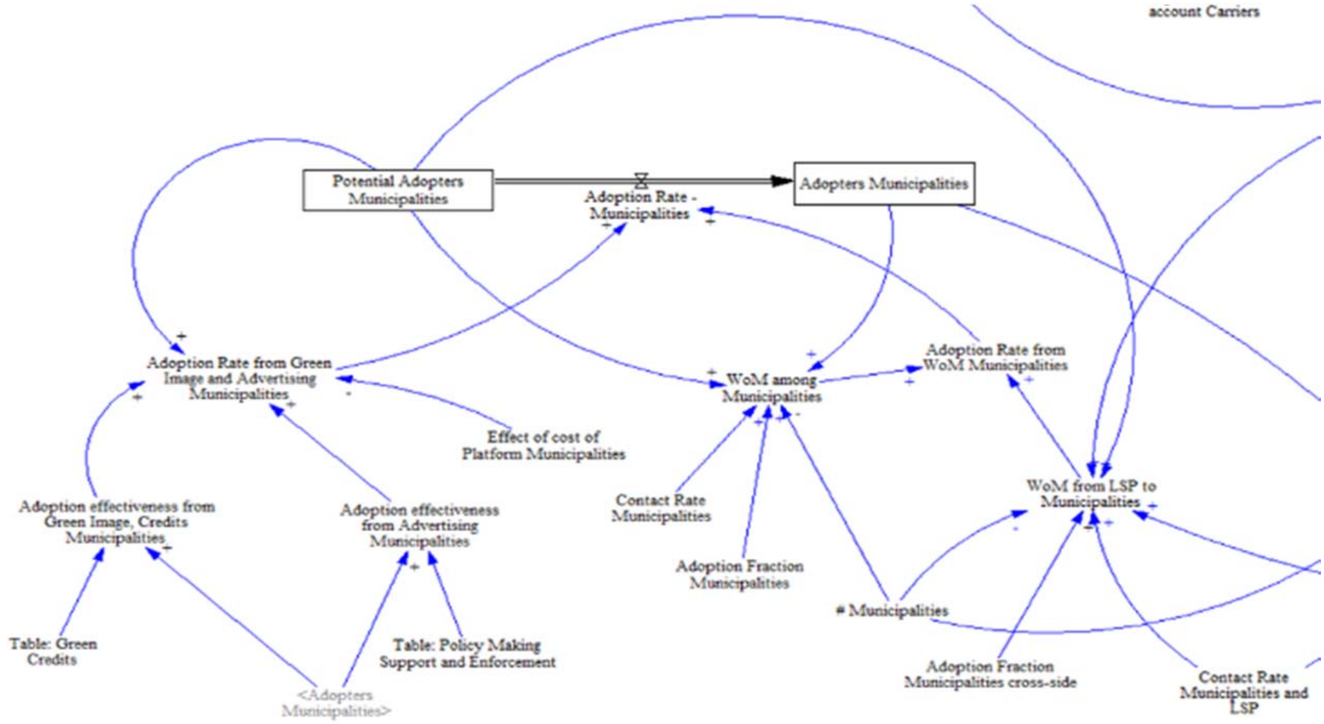

Fig. 1 Municipalities Sub-Model

B. Logistics Service Providers Sub-Model

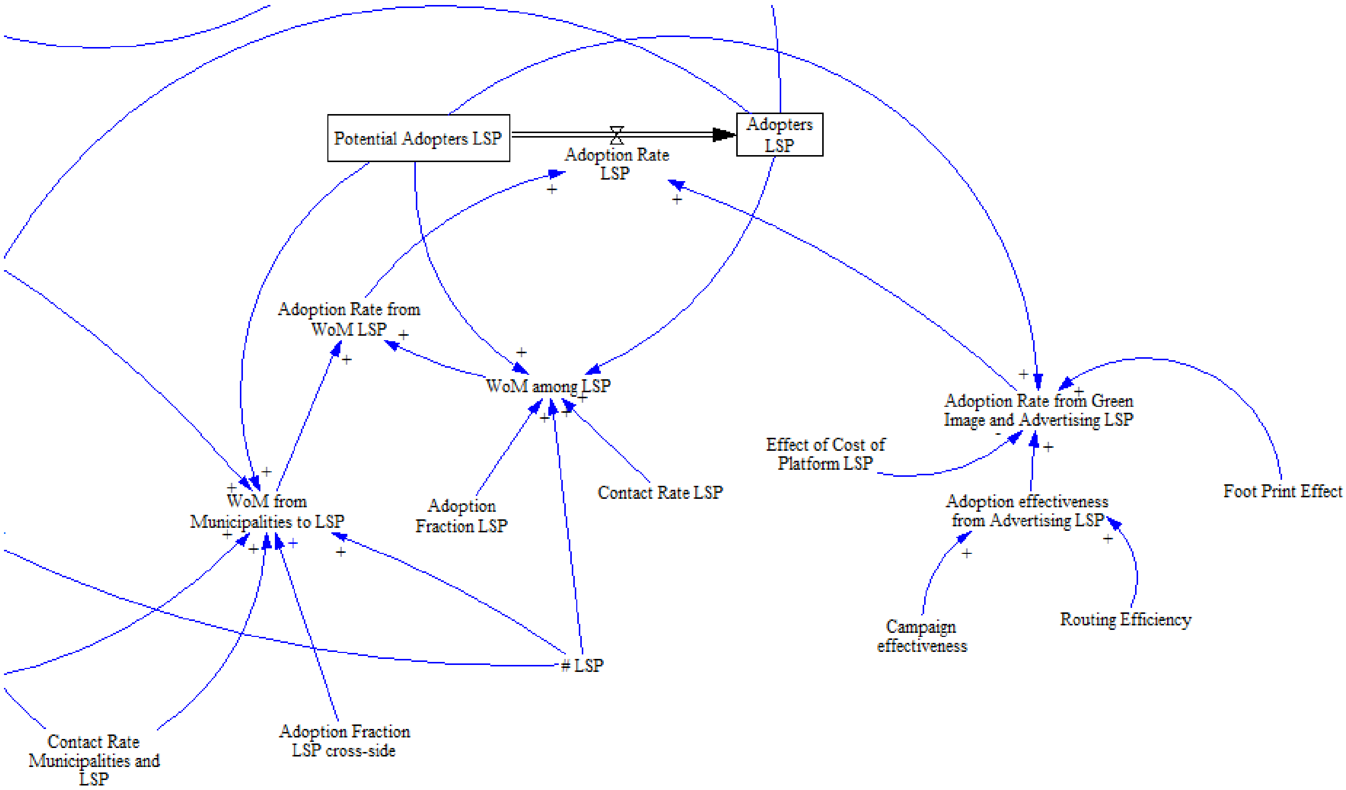

Fig. 2 Logistics Service Providers Sub-Model

C. Own Account Carriers Sub-Model

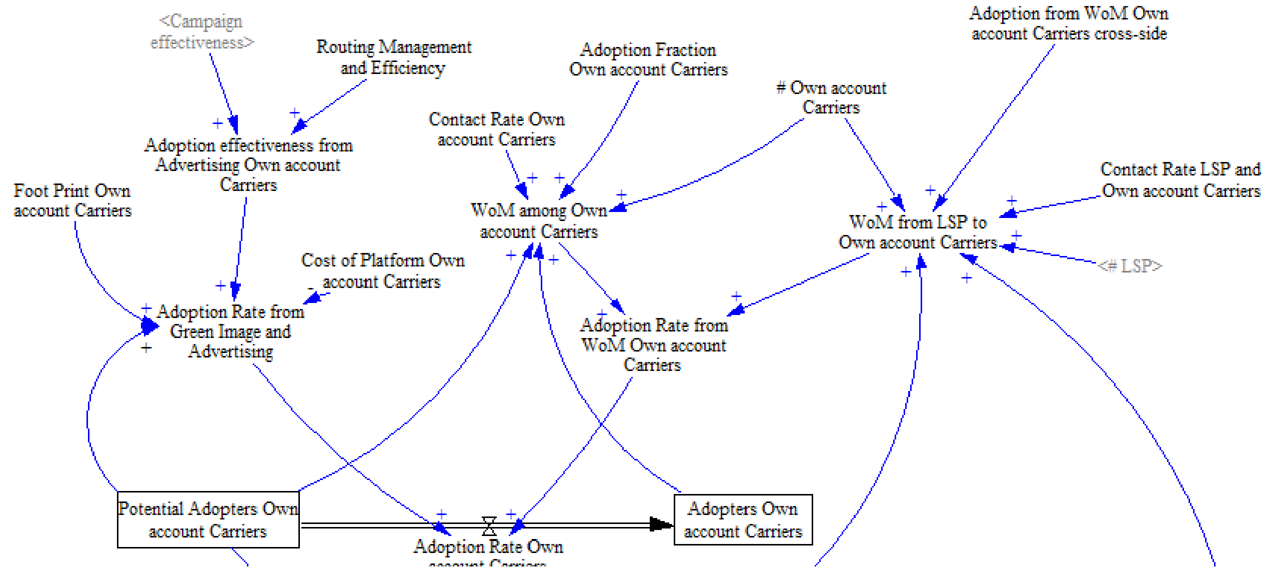

Fig. 3 Own Account Carriers Sub-Model

The 2688 Own Account Carriers (OFC) operating in the sample of Municipalities of the analysis is the third population studied. The diffusion levers considered are the same ones analyzed into the LSP sub-model. On the one hand, the adoption is fostered by commercial campaigns and the green image, and on the other, through the effect of WOM.

V. Model Calibration

The numerical values of the input variables to carry out simulations have been gathered from a variety of sources as follows. The values of the following parameters have been set together with partners of the project based on interviews and previous market studies.

Municipalities Sub-Model

- “Effect of cost of Platform Municipalities”: 0.5 [1/month] range 0-1
- “Contact Rate Municipalities”: 0.01 [1/month] range 0-1
- “Adoption Fraction Municipalities”:0.002 [dmnl] range 0-1
- “Adoption Fraction Municipalities cross-side”: 0.001 [dmnl] range 0-1
- “Contact Rate Municipalities and LSP”: 0.005 [1/month] range 0-1
- “# Municipalities”: 224 [users]

Logistics Service Providers Sub-Model

- “Contact Rate Municipalities and LSP”: 0.005 [1/month] range 0-1
- “Adoption Fraction LSP cross-side”: 0.0005 [dmnl] range 0-1
- “#LSP”: 9 [users]
- “Adoption Fraction LSP”: 0.0005 [dmnl] range 0-1
- “Contact Rate LSP”: 0.008 [1/month] range 0-1
- “Effect of Cost of Platform LSP”: 0.5 [1/month] range 0-1
- “Campaign Effectiveness”: 0.01 [1/month] range 0-1
- “Routing Efficiency”: 0.05 [1/month] range 0-1
- “Foot print effect”: 0.02 [1/month] range 0-1

Own Account Carriers Sub-Model

- “Contact Rate LSP and Own Account Carriers”: 0.003 [1/month] range 0-1
- “Adoption from WOM Own Account Carriers cross- side: 0.01 [dmnl] range 0-1
- “# Own Account Carriers”: 2688 [users]
- “Adoption Fraction Own Account Carriers”: 0.005 [dmnl] range 0-1
- “Contact Rate Own Account Carriers”: 0.005 [1/month] range 0-1
- “Routing Management and Efficiency”: 0.05 [1/month] range 0-1
- “Campaign Effectiveness”: 0.01 [1/month] range 0-1
- “Foot Print Own Account Carriers”: 0.2 [1/month] range 0-1

VI. Simulation Results

In a simulation period equal to 100 months, the 224 Municipalities of the sample adopt the URBeLOG platform. As shown in Fig. 4, during the first 18 months the adoption is very low, then it skyrockets and the market is completely saturated after month 54. The graph highlights that there is concrete interest in the solutions proposed by URBeLOG, but a certain period of time is required for a robust diffusion.

The behavior of diffusion for the LSPs and the OFCs is actually the same, as shown in Figs. 5 and 6.

Fig. 5 shows that the nine LSPs saturate the market in just 36 months. This is likely due to the fact that the big players are very keen on technological innovations that might bring an improved efficiency of the processes. On the contrary, 2643 out of 2688 OACs adopt URBeLOG within 100 months.

However, given the increasing trend of the adoption curve it could plausible to think that the market would be saturated after 100 months of simulation.

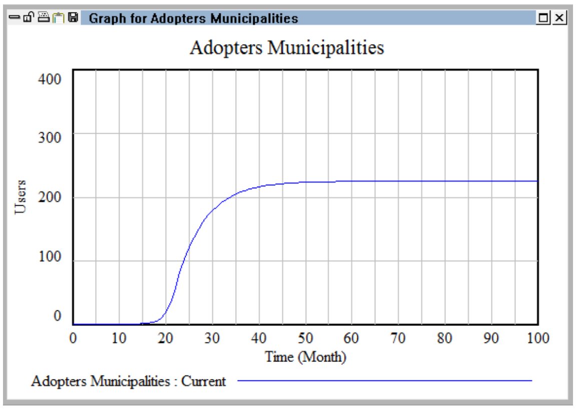

Fig. 4 Adoption by Municipalities

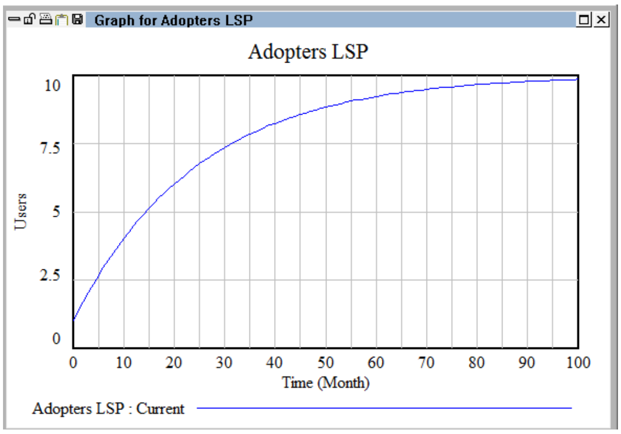

Fig. 5 Adoption by LSPs

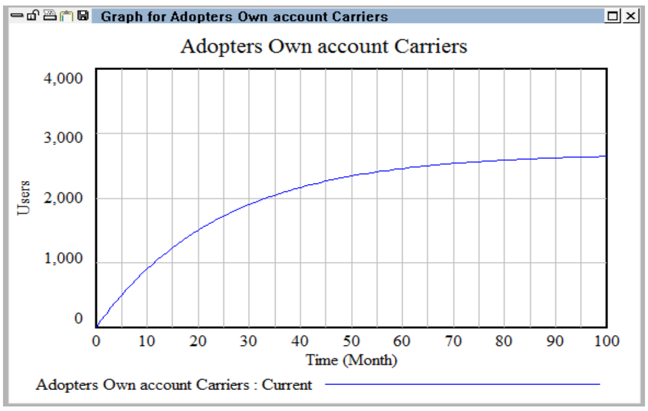

Fig. 6 Adoption by LSPs

The presented study demonstrates that ICT services supporting the urban logistics activities can be jointly used by different stakeholders that can fully exploit their associated benefits. This is a very important result, since the three populations analyzed do not have a shared standard for dealing with the urban logistics issues. For this reason there are often problems of communication and information flows with consequent a more complex process in the definition of the strategies. URBeLOG allows to overtake these issues because both members of a population and members of different population can share, exchange and manage information through a unique interface. All Municipalities in the sample adopt URBeLOG within the 100 months' time span. This result points out that the environmental awareness based on the exploitation of green credits and the action of supporting for developing new strategies, combined with the WOM can be considered valid levers of diffusion. Similarly, all LSPs and most of OACs of the sample adopt the proposed platform. The identified levers of diffusion related to the environmental attention, the increased efficiency of the routings and the WOM can effectively stimulate the diffusion.

A. Scenario Analysis

A scenario analysis is performed to highlight the behavior of the system under different parameter configuration.

Different scenarios are designed and simulated to explore the combined effects of the diffusion enhancing factors. To design the scenarios, it has to be noted that the platform provides several value propositions to the users, such as calculation of foot print effect or increased routing efficiency among them. However, these value propositions come with a cost of installation, which affects the number of potential users that adopts the platform as a consequence of the advertising and the green image effect. Therefore, one scenario investigates the effect of an increase in the value of the enhancing factors at the expense of a higher installation cost. Conversely, another scenario involves a lower installation cost and a lower efficiency. In Table I all parameters for the two scenarios are shown (all units of measure is 1/month)

TABLE I
INPUT VALUES FOR SCENARIO ANALYSIS

Parameter	Baseline	Scenario 1	Scenario 2
Effect of Cost of Platform LSP	0.5	0.4	0.6
Campaign Effectiveness	0.01	0.02	0.005
Routing Efficiency	0.05	0.06	0.04
Foot print effect	0.02	0.03	0.01

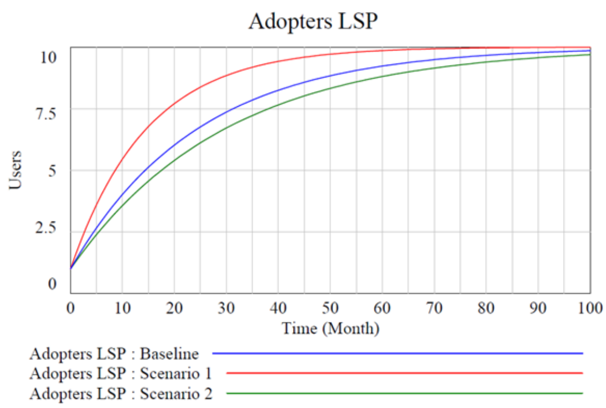

Fig. 7 Adoption by LSPs under different platform efficiency and cost scenarios

From the simulation, a slight difference in the outcomes of the diffusion process of the two scenarios is noticeable. In fact, LSPs adopt more easily in the high efficiency, high cost scenario. The same results can be noticed also from the OAC population.

Interestingly, an indirect effect is also visible in the adoption by own account carriers, mostly due to the cross side word of mouth effect.

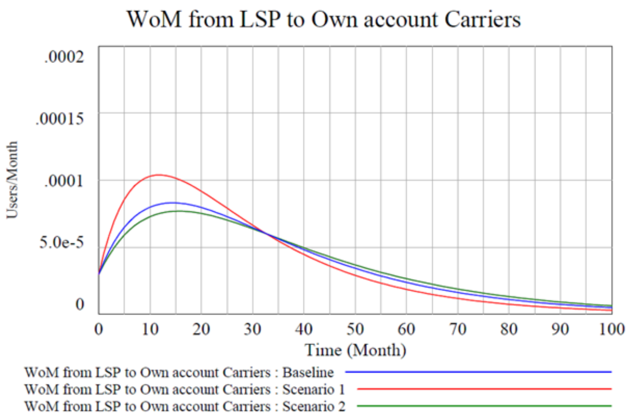

Fig. 8 Different effects of WOM

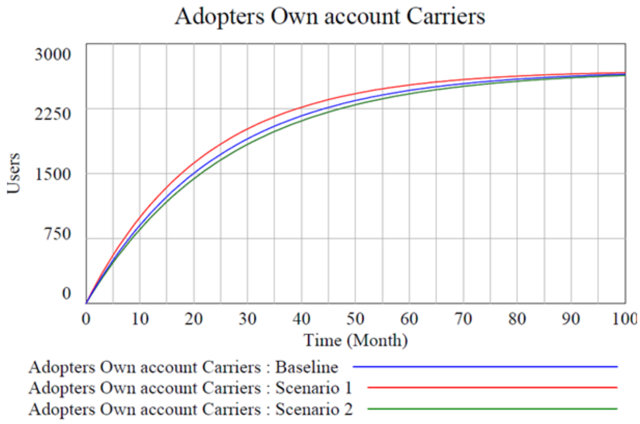

Fig. 9 Adoption by OAC as an effect of cross-side WOM

VII. Implications

Some implications can be drawn from the proposed study.

From a theoretical point of view, this work contributes to the modeling approaches for ex-ante evaluation of CL projects, by proposing an innovation diffusion model of a new CL technology. Moreover, it introduces aspects to the diffusion of innovation modeling of the CL arena, such as the effects of WOM across different populations. This is particularly important since in CL, the relationships among stakeholders are crucial for the success of CL initiatives. Another addition to the existing modeling efforts in both CL projects evaluation and diffusion of innovation comes from using the Business Model Canvas to identify and explore the levers of diffusion from the actors' perspective by means of focus group and participatory sessions. This appears to be very important, since different populations of potential adopters with different requirements have taken part together in the Business Model sessions. In this way all the potential levers of diffusion have been taken into account, and consequently, their global effects on the diffusion of the URBeLOG platform have been considered in the analysis.

From a practical point of view, this work aims to highlight the most important levers of diffusion for a more proper uptake of CL initiatives, in the light of the different requirements by the CL stakeholders. Identifying the correct levers of diffusion might drive the strategies of the stakeholders proposing the CL initiative, in terms of resource allocation, marketing efforts, and value proposition.

As a matter of fact, the model shows that a correct integration among stakeholders' requirements can foster an effective implementation of innovative CL projects. Finally, the proposed study can be exploited by public authorities for exploring the feasibility of new public policies related to new technologies, such as the green credit proposed in the case study.

VIII. Conclusion

The proposed analysis investigates the diffusion dynamics of an innovative ICT platform for CL systems. This study extends the literature on the modeling of diffusion of innovation, which typically takes into account the diffusion of new technologies within one population, by exploring the cross-side effects across three populations of potential users. The structure of the model, together with the potential levers of diffusion, has come up by both in a literature review analysis and in two focus group sessions conducted with the stakeholders. In particular, the focus group sessions have been based on the Business Model Canvas framework, which allows to identify the value proposition of the project, the target customers, and in turn, the levers of diffusion. These diffusion levers were translated into state variables and feedback loops, exploiting the Bass [37] diffusion model approach, studying three different populations of users. In fact, the SD proves to be an effective approach given its ability to carry out precise and structured investigation of complex environments, such as CL systems, by taking into account every single interaction among the variables involved.

Results show that, with the proposed parameter configuration, the three populations under analysis actually fully adopt the platform within the simulation time frame, highlighting a concrete demand by different stakeholders for projects aiming at carrying out more efficient urban logistics operations. However, this work suffers from some limitations. The cost of the platform is still not taken into account, since at this level of the study, the market price has not been setup yet. Moreover, aspects related to the utility that could be generated by the adoption of the URBeLOG platform are not considered in the model. For this reason, future research will be addressed towards the introduction of more precise cost parameters and more accurate depiction of the utility aspects related to the adoption of the platform. Such improvement could provide more detailed insights on the diffusion dynamics of innovative CL projects.

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