Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 46 (2020) 133–140

Transportation Research Procedia

www.elsevier.com/locate/procedia

City Logistics 2019

E-groceries and urban freight: Investigating purchasing habits, peer influence and behaviour change via a discrete choice/agent-based modelling approach

Valerio Gatta[a], Edoardo Marcucci[a,b], Michela Le Pira[c]*, Giuseppe Inturri[c], Matteo Ignaccolo[c], Alessandro Pluchino[c,d]

[a]*University of Roma Tre, Via Gabriello Chiabrera 199, 00145 Rome, Italy*
[b]*Molde University College, Britvegen 2, 6410 Molde, Norway*
[c]*University of Catania, Via Santa Sofia 64, 95125 Catania, Italy*
[d]*INFN Section of Catania, Via Santa Sofia 64, 95125 Catania, Italy*

Abstract

This paper presents a modelling framework to investigate the potential acceptability of digitalized services connected to groceries, i.e. e-grocery, via a discrete choice agent-based approach. A preliminary investigation of consumers' preferences for buying groceries on-line has been performed via a stated preference survey. Besides, a new agent-based model is presented with the aim to test different e-grocery scenarios and the potential spreading of this solution, characterizing agents with the results of the survey. This will allow evaluating stakeholders' acceptability and making a first assessment of the potential of e-grocery to improve the efficiency of urban freight transport.

Keywords: e-grocery; stated preferences; agent-based model; behavioural analysis

1. Introduction

Advances in technology and digitalization have the potential to change how people interact with one another, work, travel and shop. Transport is one of the sectors that is likely to be most affected by changes brought by new technologies. In particular, urban freight transport (UFT) has to constantly evolve both to take into account new

* Corresponding author. Tel.: +39-095-738-2220.
E-mail address: mlepira@dica.unict.it

10.1016/j.trpro.2020.03.173

shopping habits and to fulfil requirements to reduce its impact on the environment (Visser et al., 2014). It is estimated that in the future people will not only buy online or in stores, but will use any channel according to their needs (Nielsen, 2015). A sector still in its infancy is that of "e-grocery", i.e. ordering groceries from home in an electronic way and either having it delivered to the house or collecting it at pick-up points (Cagliano et al., 2014). According to a survey performed by Nielsen about the future of the grocery sector, one-quarter of the 30,000 online respondents say they order grocery products online, and more than half (55%) are willing to do so in the future (Nielsen, 2015). However, this percentage varies a lot between countries. As an example, in Italy the rate of revenue from e-groceries compared to the other sectors was only 2.7% in 2017, but with a percentage growth of 23% with respect to 2016 and a predicted growth of 43% in 2018 (Casaleggio Associati, 2018).

More transport efficient distribution of groceries to the final consumer appears to have significant potential for reducing the carbon footprint (Wygonik and Goodchild, 2012). However, few European retailers have given consumers a compelling reason to switch to e-grocery (Galante et al., 2013). The development of e-grocery is likely to be influenced both by the organization of the grocery industry, as well as by consumer preferences for online purchases. In fact, these two elements are strongly interlinked. The share of people buying their groceries on-line will depend on the characteristics of the services offered which, in turn, depend on the size of the market. Thus, it becomes fundamental to evaluate ex-ante the acceptability and potential for e-grocery models.

This paper presents a modelling framework for evaluating the potential acceptability and adoption of e-grocery. The approach relies on an analysis of consumer stated preferences, and of the influence of their social networks using a discrete choice/agent-based model. In this respect, a new agent-based model (ABM) is implemented to test different e-grocery scenarios and the potential spreading of this solution, taking into account the microinteraction between individual agents characterized by utility functions derived from discrete choice models (DCM). The integration of ABM and DCM has proven to be useful and effective to evaluate stakeholders' policy acceptability taking into account their heterogeneous preferences and their interactive behaviour (Le Pira et al., 2017b; Marcucci et al., 2017).

A preliminary investigation of consumers' preferences for buying groceries on-line has been performed in Rome, where University students have been interviewed as early adopters of such innovative concepts. Results of the survey will be presented as the starting point for a wider in-depth behavioural analysis in future research investigating the social and economic acceptability of e-grocery via agent-based simulations.

The remainder of the paper is organized as follows: the research framework is presented based on the description of stated preference (SP) experiments and DCM to characterize agents' preference structures, ABM for scenario simulations, and the integration of ABM and DCM. Then, the methodology is presented, together with the survey performed and a description of the ABM's features. DCM results will be presented, together with the ABM that will be used for a wider behavioural analysis. Finally, conclusions of the work will be presented.

2. Research framework

2.1. Stated preference experiments and discrete choice modelling

SP experiments are used in numerous research fields (e.g. transport, marketing, environmental evaluation and economics). A SP experiment consists of several choice sets, each involving two or more alternatives, described by several attributes with two or more levels. Each respondent is asked to choose one of the options presented in the choice set according to their preferences. The core part is characterized by the statistical design to construct the choice sets. The idea is to study the relative influence of independent variables (attributes) on a given observed phenomenon (choice) (Gatta et al., 2018).

DCM use random utility theory to model SP respondents' decision-making (Ben-Akiva and Lerman, 1985). Microeconomics assumes rational agents maximize utility, which is composed of a deterministic and a stochastic term. Different assumptions about the distribution of the stochastic term lie at the basis of different DCM specifications.

The simplest model is the multinomial logit (MNL), which has been traditionally used in transport studies (Ben-Akiva and Lerman, 1985). The renowned restrictions characterizing the MNL severely limit the capability to account for likely random variations in stakeholders' preferences. More articulated variance-covariance matrix of the random terms characterizes the Mixed Logit (ML) model that allows handling of individual heterogeneity supposing a continuous mixed distribution to describe the individual deviations of preferences from the mean. The model can be further refined allowing for a systematic heterogeneous component of the means and the variances of the parameter distributions. The Latent Class (LC) model integrates preference heterogeneity via the systematic component of utility, and treats heterogeneity assuming a discrete mixed distribution of preference parameters (Marcucci and Gatta, 2012).

If DCM represent valuable instruments in addressing, from a theoretically well-grounded perspective, stakeholders' heterogeneous preferences with respect to alternative policy configurations, however, they are not versatile in simulating interaction effects, which represent, especially in the case of UFT, a particularly relevant issue considering the likely relevant interaction effects derived from system complexity (Le Pira et al., 2017b). In this respect, a dynamic simulation approach is more adequate to reproduce a social system where single entities interact collective phenomena emerge from their interaction.

2.2. Agent-based modelling for scenario simulations

ABM are typically used to model complex systems and reproduce communities of autonomous and intelligent agents, acting and interacting with the environment and the other agents according to their interests (Macal and North, 2010). One of the main ABM characteristics is the emergence of collective phenomena, not easily predictable from agents' simple behavioural rules. In the field of freight transport, they have been used to simulate stakeholders' interaction and trigger their reaction to some policies or regulations (e.g. Taniguchi and Tamagawa, 2005; van Duin et al., 2012; Roorda et al., 2010). In the field of consensus building and collective policy-making, ABM have been used to reproduce the dynamic interactions between stakeholders, linked in social networks and cooperating to find a convergence of opinions towards a shared solution (Le Pira, 2018). These models allow reproduction of different contexts of decision-making processes involving stakeholders, understanding the role of network topology and other sensitive variables in reaching a convergence of opinions. However, they usually lack sound data to represent the true preferences of the agents. In general, this leads to the assignment of hypothetical assumed values to the attributes to study the emergence of collective phenomena in a bootstrapping fashion. In this regard, data characterizing single agents' preferences, such as utility functions derived, for example, from SP surveys and DCM, can effectively improve the predictive capacity of the model as well as its reliability (Le Pira et al., 2017b; Marcucci et al., 2017).

2.3. The integrated modelling approach

Le Pira et al. (2017a; 2017b) proposed a procedure to integrate DCM with ABM with the overall aim to perform an ex-ante evaluation of stakeholder policy acceptability in UFT. This approach could be used both to simulate participatory decision-making processes and to investigate the potential acceptability of different UFT solutions. Here, we propose this framework with the aim to investigating the potential acceptability and adoption of e-grocery, by simulating different scenarios of e-grocery and interaction among agents.

The block diagram of Fig. 1 summarizes the main features of the integrated model with the combination of individual behaviour components, based on agent-specific utility functions, and social interaction mechanisms (Le Pira et al., 2017a). In more detail, from SP experiments and DCM it is possible to derive utility functions that allow simulation of stakeholders' response to different scenarios. The connections among agents depend on the topological structure, i.e. forming social networks. The influence of the social network is important to understand how agents' decisions can be affected by the other agents and change their behaviour. Information about the potential influence and "influenceability" by other agents can be acquired via appropriate questions, investigating the "social component" importance on agents' behaviour (Zanni and Ryley, 2013). Agents react to the environment by updating their choice at each simulation step according to the local state of the system, i.e. the utility perceived and the influence of the other peers. Agents' behavioural rules depend on their objectives. The objective can be to maximize their utility, which is also influenced by their previous experience and that of the peers. Their interaction can follow opinion dynamics mechanisms. Opinion dynamics models aim at defining the opinion states of a population and the elementary processes governing the transitions between such states (Pluchino et al., 2005). The type of opinion dynamics depends on the interaction process under investigation (Le Pira, 2018). The use of utility functions derived from SP data and the estimation of DCM provides higher robustness and realism to the ABM, which is able to simulate the dynamic behaviour of interacting stakeholders with heterogeneous preferences according to the rules of the opinion dynamics model and the topology of the social network.

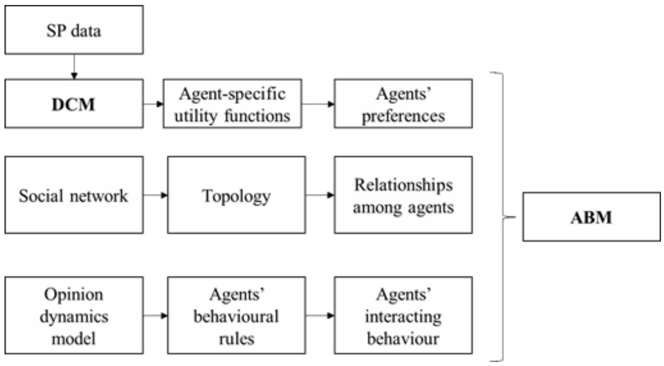

Fig. 1. Framework of the integrated approach (Le Pira et al., 2017a).

In the following, the integrated approach is proposed to investigate the potential spread of e-grocery, taking into account consumers' preferences and peer influence.

3. Methodology

3.1. The survey

A preliminary investigation of consumers' preferences for buying groceries on-line with respect to buying them at the supermarket has been performed in Rome, where students of Roma Tre University have been interviewed as early adopters of such innovative concepts.

The interviews aimed at: (1) understanding students' purchase habits (to set their *status quo*) and attitudes towards e-commerce in general; (2) investigating SP for alternative scenarios of e-grocery with respect to their *status quo*; (3) exploring their social network and their attitudes to influence/be influenced by their peers. This last point is very important to infer how e-grocery might spread among peers, due to the contagion effect, amplified by the easiness of connections and exchange of information provided by the new technologies.

We assumed a scenario with three ways to buy groceries, i.e.: *Status quo* (SQ) (consumers make a journey to a physical store to purchase grocery); Home delivery (HD) (once the order has been placed online, the delivery is performed in the place selected by customers, e.g. home); Click-and-pick (CP) (once the order has been placed online, the goods can be picked up at a pick-up point, e.g. supermarket).

The SP questionnaire was divided in four main parts, i.e.: (1) pre-interview, to acquire main interviewee's characteristics with respect to e-groceries issues, (2) SP tasks, (3) post-interview (possible future scenarios and reactions), (4) socio-economic/attitudinal variables.

Some questions of the pre-interview included: *Are you aware of the possibility of buying groceries online?; Have you ever considered buying groceries online?; Which transportation mode do you usually use for shopping?*. Questions of the post-interview included: *Do you think online grocery shopping reduces* CO_2 *emissions?; Should scientific reports demonstrate shopping groceries online reduces* CO_2 *emissions, would you be willing to do so?*.

Besides, typical socio-economic information were acquired (e.g. income, age, gender, family composition, etc.), together with data regarding their social network (i.e. *how many people compose your social network*?), agents' social properties (influence/influenceability) and behavioural rules (i.e. *when you expressed your preferences, did you consider what other people in your social network would have chosen?; Would you change your mind if the opinions of others in your social network were different?)*.

The attributes and levels for the SP experiment were chosen from an analysis of literature and of the current state of the art of e-grocery in Rome (i.e. supermarkets allowing online shopping), and were refined with focus groups with

University students. The resulting attributes, each with three levels, are: purchase cost (PC); transport cost (TC), lead time (LT), time windows (TW), range of products (RP) (see Table 1).

Table 1. Attributes and levels used in the SP survey

	LEVELS		
ATTRIBUTES	1	2	3
PC [%]	-10% with respect to current	current	+10% with respect to current
TC [euro]	0	3	6
LT [h]	1	6	12
TW [min]	30	60	90
RP [%]	50%	75%	100%

A two-stage efficient design was used for the SP experiment (Gatta and Marcucci, 2016): an orthogonal (simultaneous) fractional factorial design with blocking strategy for 78 respondents, and an S-efficient design with blocking for 234 respondents.

3.2. The agent-based model

The structure of the model is described here, with the intent to present the framework that will be used for a comprehensive behavioural analysis. The aim is to simulate different e-grocery scenarios, reproducing the decision-making process of consumers that can decide to (1) go to the supermarket, (2) buy online and have their grocery at home ("home delivery") or (3) pick it up at the supermarket or at a collection point ("click and pick").

The agents of the systems are consumers, supermarkets (or pick-up points) and vehicles.

The environment is represented by a multilayer network (Marcucci et al., 2017; Boccaletti et al., 2014), with two interrelated levels, i.e.: the "transport layer", composed of the transport network, supermarkets, vehicles, and consumers each associated with a given node of the network (the closest to the agent), where the demand for goods is ideally concentrated; the "social layer", consisting of interacting consumers linked in social networks.

Basic agents' properties are: for consumers, utility functions, influence and influenceability (with respect to their neighbours, i.e. the directly linked nodes in the social network); for vehicles and supermarkets/pick-up points, their capacity to transport/store goods.

The dynamics of the system is based on multiple models: optimization algorithms, based on ant colony systems (Dorigo and Birattari, 2011) to simulate the optimal last-mile delivery process from the supermarkets to final consumers, and an opinion dynamics model to simulate interaction among consumers influencing their shopping strategy (Castellano et al., 2009).

Different scenarios can be simulated by varying the attributes' levels of the experimental design. A simulation time is chosen (e.g. 1 month) and the model works as follows:

- at time t = 0, the network with the agents is created; consumer-agents are randomly created in the network and are endowed with a utility function and the other social properties (influence/influenceability); each agent decides how to shop according to the probability associated with the different alternatives (based on the analysed scenario).

- Once the dynamics starts, each supermarket receives the order requests with the related destinations; the optimization algorithm evaluates the optimal path for the vehicles to transport and delivery goods from the supermarket. Meanwhile, "off-line" consumers go shopping to the nearest supermarket by private vehicle (or walking, if the distance is within a walkable range). Key indicators, e.g. travelled km, vehicle load factor, and delivery time are recorded.

- At each step of the simulation (e.g. 1 day), consumers' decisions is dynamically updated, based both on the efficiency of the delivery service and associated perceived utility (in the "transport" layer), and on the influence of their peers (in the "social" layer). In this respect, each consumer-agent has memory of the last shopping experiences, and can see the past shopping strategy of their neighbours. A satisfaction index based is thus combined with peers' influence, determining the new agent choice.

- At the end of the simulation, it is possible to evaluate the potential e-grocery spread/adoption and its functioning, in terms of both transport efficiency and sustainability (e.g. travelled km, CO_2 emissions, vehicle load factor).

4. Preliminary results and further research steps

In the following, DCM results from the SP survey and the first version of the ABM will be presented and discussed, paving the way for next research steps.

A total of 312 interviews were conducted in the two phases, with a percentage of 43.9 of females and an average age of 24 years. Overall 92% is composed of e-buyers, and 24.7% declares to have bought an item online in the last month. 76.3% of interviews knows about the possibility to buy grocery online, but only 30.8% of them considers it as an option. It was found that 71.8% has a private vehicle available and 79.5% goes shopping for e-grocery at the supermarkets. A total of 53.8% uses private car, followed by walking (32%). Overall 67.3% stated that they perform an *ad-hoc* trip to supermarkets (5 minutes average trip), and the average cost of shopping is 34 euro. For what concerns the potential impact of e-grocery, 48.7% thinks it can be beneficial to reduce CO_2 emissions, and 72.8% states they would shift to e-grocery if the reduction of CO_2 would be demonstrated.

Talking about social network, 50.3% stated that their social network is composed of 5-10 people, and 83.7% declared they were not influenced by what others members of their social network would have answered. Besides, 86.5% stated they would not change their mind even if the opinion of other members was different, while 8.3% would change opinion if the majority of members answered differently, and 5.1% even with a minority of them answering differently. These results can give useful input to characterize agent's behaviour, in terms of size of the social network and the potential influence/influenceability, and will allow for the evaluation of the potential spreading due to social network effects.

SP exercises for alternative purchase scenarios allowed for the estimation of the importance of specific characteristics of the service that might determine the success/failure of e-grocery companies. Different DCM (MNL, ML, LC) were estimated using NLOGIT software. Results are presented in Table 2.

Table 2. MNL results

	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval
PC	-.13644***	.01547	-8.82	.0000	-.16676 -.10611
TC	-.23260***	.03006	-7.74	.0000	-.29151 -.17369
LT	-.10424***	.01156	-9.02	.0000	-.12689 -.08158
TW	-.00677***	.00209	-3.23	.0012	-.01088 -.00266
RP	.02001***	.00244	8.19	.0000	.01522 .02480
ASC_CP	-1.21329***	.15633	-7.76	.0000	-1.51969 -.90690
ASC_SQ	-.86933***	.16260	-5.35	.0000	-1.18802 -.55064
***, **, * ==> Significance at 1%, 5%, 10% level					

The model fits the data very well (pho^2=0.25). All the attributes are statistically significant at 1% level and with the expected sign. Under this respect, purchasing cost (PC), travel cost (TC), lead time (LT) and time windows (TW) show negative signs (the more the cost/time, the less the perceived utility), while the range of products (RP) is the only attribute with positive sign. There is a general aversion towards *status quo* and the alternative "click-and-pick", which is promising for home-delivery based e-grocery spreading.

These preliminary results represent a starting point for a wider in-depth behavioural analysis investigating the social and economic acceptability of e-grocery.

In particular, a first version of the ABM has been set up, using the NetLogo modelling environment, which is entirely programmable and with a user-friendly interface (Wilensky, 1999). Agents are characterized with agent-specific utility functions derived from the LC model† with two classes that is the most performing one in terms of goodness of fit. Individual-specific posterior estimates of the coefficients were obtained by averaging class parameter estimates weighted by person-specific conditional class probabilities (Marcucci et al., 2017).

The analysis focused on a square of 1x1 km in Rome, i.e. the neighbourhood of San Paolo, where University sites are located and where the survey was conducted. The transport network is re-created according to the street network in the area, where there are four supermarkets (Fig. 2a). A total of 500 consumer-agents are randomly created in the area‡, and are linked with on average five other nodes (Fig. 2b).

Different scenarios can be simulated by varying the attributes' levels used in the experimental design. Each consumer-agent at time t = 0 evaluates the utility associated with the three shopping strategies (HD, CP, and SQ) and makes a choice according to the probability to choose one of them, which depends on the perceived utility.

The next steps of the model are to implement the dynamics, i.e. the optimization algorithm for the vehicles that need to deliver goods, the dynamics of agents going shopping by private vehicles (or walking) and the opinion dynamics model, which will allow investigating the effects of social network and peer influence on consumer choice. Under this respect, agent satisfaction will be based either on the "performance" of the "physical" layer (i.e. efficiency of delivery/shopping at the supermarket), and by the interaction with neighbours in the "social layer". Key performance indicators to monitor will be: the percentage of consumers buying online/offline according to the different typologies, the number of km travelled by freight vehicles, with respect to the served consumers and the load factor, and the number of km travelled by consumers going directly to the supermarkets. Km travelled can be easily converted into CO_2, allowing additional estimation to be done in terms of efficiency of e-grocery solutions.

a

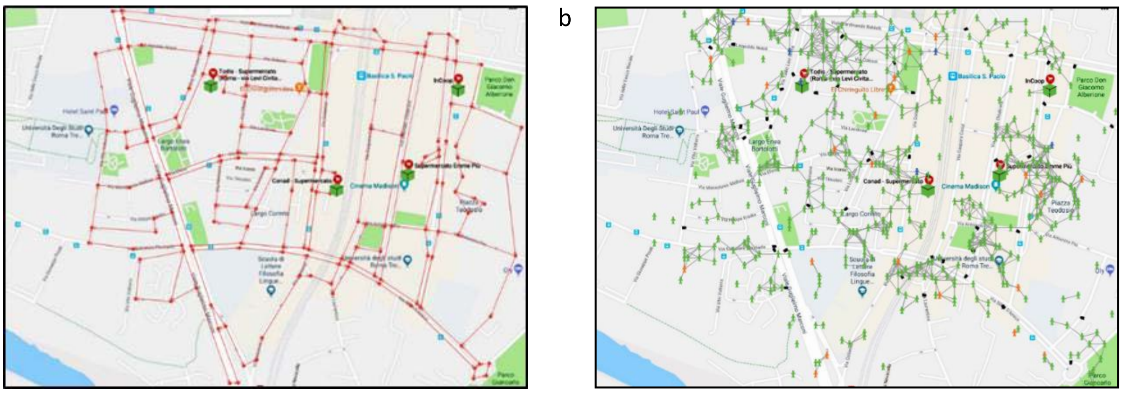

Fig. 2. (a) Transport layer; (b) Social layer.

5. Conclusions

Since buying groceries is a recurrent activity for any household, the way people will buy groceries will have a substantial impact on how the goods reach houses, where they are consumed, and the environmental consequences on the city. Policy-making should take these new phenomena into due account and develop policies capable of jointly accommodating consumer preferences while pursuing sustainability. This paper presents a modelling framework to investigate the potential acceptability and adoption of e-grocery, via a discrete choice agent-based approach. The aim is to simulate different e-grocery scenarios and the potential spreading of this solution in accordance with the results from SP surveys, taking into account peer influence. This will allow evaluation of stakeholders' acceptability and the potential impact of different of e-grocery solutions considering their heterogeneous preferences and interactive

† In line with the MNL results, coefficients of the LC model are statistically significant and with the expected signs. They are not reported here due to page limits.

‡ This number is based on the average population density in San Paolo area, i.e. 2000 inhabitants per square km, considering an average household size of 4 (in agreement with the result of the survey), and 1 person in the household in charge of buying grocery.

behaviour. The goal would be to find a trade-off between fragmented last mile grocery deliveries and their negative impacts, i.e. between UFT efficiency and sustainability.

References

Ben-Akiva, M., Lerman, S. (1985). Discrete Choice Analysis: Theory and Application to Travel Demand. MIT Press, Cambridge.

Boccaletti, S., Bianconi, G., del Genio, C. I., Gómez-Gardeñes, J., Romance, M., Sendiña-Nadal, I., Wang, Z., Zanin, M. (2014). The structure and dynamics of multilayer networks. Physics Reports 544, 1-122.

Cagliano, A. C., Gobbato, L., Tadei, R., & Perboli, G. (2014). ITS for E-grocery Business: The Simulation and Optimization of Urban Logistics Project. Transportation Research Procedia, 3(Supplement C), 489–498.

Casaleggio Associati, 2018. E-commerce in Italia 2018. Report Maggio 2018 n 16

Castellano, C., Fortunato, S., Loreto, V., (2009). Statistical physics of social dynamics. Rev. Mod. Phys. 81 (2), 591-646.

Dorigo M., Birattari M. (2011). Ant Colony Optimization. In: Sammut C., Webb G.I. (eds) Encyclopedia of Machine Learning. Springer, Boston, MA.

Gatta, V., Marcucci, E. (2016). Stakeholder-specific data acquisition and urban freight policy evaluation: evidence, implications and new suggestions. Transp. Reviews. 36(5), 585-609.

Gatta, V., Marcucci, E., Le Pira, M., Ciccorelli, A. (2018). Integrating direct and reverse logistics in a "living lab" context: evaluating stakeholder acceptability and the potential of gamification to foster sustainable urban freight transport. In: Taniguchi, E., Thompson, R. G. (Ed.). "City Logistics 3. Towards Sustainable and Liveable Cities", pp. 1-18. ISBN : 9781786302076

Le Pira, M. (2018). Transport planning with stakeholders: an agent-based modelling approach. International Journal of Transport Economics 45, 1, 15-32.

Le Pira, M., Marcucci, E., Gatta, V., Ignaccolo, M., Inturri, G., Pluchino, A. (2017a). Towards a decision-support procedure to foster stakeholder involvement and acceptability of urban freight transport policies. Eur. Transp. Res. Rev. 9: 54.

Le Pira, M., Marcucci, E., Gatta, V., Inturri, G., Ignaccolo, M., & Pluchino, A. (2017b). Integrating discrete choice models and agent-based models for ex-ante evaluation of stakeholder policy acceptability in urban freight transport. Research in Transportation Economics, 64, 13-25.

Macal, C.M., North, M.J. (2010). Tutorial on agent-based modelling and simulation. Journal of Simulation 4, 151–162.

Marcucci, E., Gatta, V., (2012). Dissecting preference heterogeneity in consumer stated choices. Transp. Res. Part E 48, 331–339.

Marcucci, E., Le Pira, M., Gatta, V., Inturri, G., Ignaccolo, M., & Pluchino, A. (2017). Simulating participatory urban freight transport policy-making: Accounting for heterogeneous stakeholders' preferences and interaction effects. Transportation Research Part E: Logistics and Transportation Review, 103, 69-86.

Nielsen, N. V. (2015). The future of grocery: Ecommerce, digital technology and changing shopping preferences around the world. An Uncommon Sense of the Consumer, 1-35.

Pluchino, A., Latora, V., & Rapisarda, A. (2005). Changing opinions in a changing world: A new perspective in sociophysics. International J.of Modern Physics C, 16(04), 515-531.

Roorda, M. J., Cavalcante, R., McCabe, S., & Kwan, H. (2010). A conceptual framework for agent-based modelling of logistics services. Transportation Research Part E: Logistics and Transportation Review, 46(1), 18-31.

Taniguchi, E., & Tamagawa, D. (2005). Evaluating city logistics measures considering the behavior of several stakeholders. J. East. Asia Society for Transp. Studies, 6, 3062-3076.

van Duin, J. R., van Kolck, A., Anand, N., & Taniguchi, E. (2012). Towards an agent-based modelling approach for the evaluation of dynamic usage of urban distribution centres. Procedia-Social and Behavioral Sciences, 39, 333-348.

Visser, J., Nemoto, T., & Browne, M. (2014). Home delivery and the impacts on urban freight transport: A review. Procedia-social and behavioral sciences, 125, 15-27.

Wilensky, U. (1999). NetLogo. Center for Connected Learning and Computer Based Modeling. Northwestern University, Evanston, IL. In: http://www.ccl.northwestern.edu/netlogo

Wygonik, E., Goodchild, A., (2012). Evaluating the efficacy of shared-use vehicles for reducing greenhouse gas emissions: a US case study of grocery delivery. Journal of the Transportation Research Forum, 51(2).

Zanni, A.M., Ryley, T., (2013). Discrete choice and social networks: an analysis of extreme weather uncertainty in travel behaviour. In: ENVECON Conference, London, The Royal Society, 15 March 2013.