Design research on sustainable mobility: an electric vehicle sharing service for Milano, Italy

Beatrice Villari,
Design Department - Politecnico di Milano, Milano, Italy
beatrice.villari@polimi.it

Alessandro Luè
Design Department - Politecnico di Milano, Milano, Italy
Poliedra - Politecnico di Milano, Milano, Italy
luè@poliedra.polimi.it

Abstract

The paper presents the on-going results of Green Move, an applied and multidisciplinary research promoted by Politecnico di Milano and Lombardy Region. Green Move aims at designing an innovative electric vehicle sharing service in Milan, in the attempt of overcoming the obstacles that limit the diffusion of both electric and traditional car-sharing initiatives. The paper mainly focuses on the early stage of the research, describing the activities aimed at developing the mobility service scenarios and ideas. The process was structured to support the case study analysis, the user profile definition, the creative process and the visualization and description of the mobility service ideas to be shared in the next research phases. What emerged from the design activity are six interesting service mobility scenarios, connected with four service configuration ideas. The outcome will be further developed considering a travel demand analysis and a survey with key stakeholders, and tested in a pilot project. The ongoing results evidence how the different competencies involved in the research process (engineers, designers, managers, policy makers and other stakeholders) added different values and contributed at both theoretical and practical levels.

KEYWORDS: sustainable mobility, vehicle sharing, electric mobility, service design, peer-to-peer services
Introduction

The paper discusses the initial stages of a project - Green Move research – focused on electrical vehicle sharing to be developed in the city of Milan (Italy). In particular, the authors focus on the generative phases developed in the early stage of the research process.

The paper is structured in four parts: the first one introduces the main characteristics of the electrical vehicle sharing based on the literature; the second describes the creative phases of the research process and the design scenarios identified to be developed and tested during the future research steps; few considerations on the further research activities and the implications on designing vehicle sharing services based on collaborative approaches are discussed.

1. Vehicle sharing and electrical mobility

Increasing both the efficiency and the quality of public transport systems, as well as developing alternative transport systems, may help in decreasing traffic congestion and air pollution in urban areas and improving accessibility for all citizens, including those who cannot use a private vehicle. This is the rationale behind the soft transport measures (Cairns et al., 2008; Richter et al., 2010), which generally do not require new infrastructures but try to shift the users’ modal choice from the private car to more sustainable modes. Soft measures include flexible transport services (such as bike sharing and car sharing), and mobility management measures, which are based on information, communication, coordination, and organization. For detailed information on mobility management measures and best practices, see for instance the European Platform on Mobility Management, (http://www.epommweb.org).

The Green Move research – discussed in this paper - considers in particular vehicle sharing services, which are transport systems that bridge the gap between public transport and private cars (Britton, 2000). Car sharing services have a decades-long history, starting from the first experience documented in 1948 in Zurich (Shaheen et al., 1998). The concept of vehicle sharing has been characterized in different ways, over the years and depending on local conditions (Barth and Shaheen, 2002; Shaheen and Cohen, 2007). The most important factor for the success of car sharing is represented by the difficulty of reaching a critical mass of users to ensure an economic balance (Brook, 2004), hence the frequent need for public support (Burlando et al, 2007). The two main barriers for the use of the service consist in the distance from the origin and the stations, and the concern of not having always available a vehicle (Katzev, 2003).

In recent years, electric mobility has attracted increasing interest from public opinion, policy makers and researchers. Although the internal combustion engine will probably remain the dominant propulsion technology at least until 2030, the use of electricity, biofuels, liquefied petroleum gas, and compressed natural gas is supposed to replace fossil fuels by 2050 (European Road Transport Research Advisory Council, 2010; European Expert Group on Future Transport Fuels, 2011). The use of electric cars for vehicle sharing is a recent application, thus few information about its success is available. However, the initiatives are multiplying; see for
example the Autolib service (www.autolib.eu) based on the concept of self-service electric cars or of a size much smaller - eVai (www.e-vai.com), an Italian service aimed at solving the mobility issues of commuters offering the electrical car sharing service integrated with the rail system.

The environmental benefits of vehicle sharing services are mainly related to the reduction in the number of cars owned by households, which brings also to more sustainable mobility behaviors (Martin e Shaheen, 2011). Moreover, the use of electric vehicles (EVs) would help to decrease local emissions in urban area, since the energy is generated by power plants located in non-urbanized area. However, the real sustainability depends strongly on the energy sources used for electricity generation.

Within this mobility context, the most interesting innovations may come through a bottom-up process, where innovations are conceived, built and run by the people involved. We speak here of community-based innovations, such as those related to the collaborative services. Within collaborative services, end-users are actively involved and assume the role of co-designer and co-producers (Jégou and Manzini, 2008). Through collaboration, mutual assistance and shared use, collaborative services can lead to a significant reduction in the needs of each individual, in terms of products, living space and resource use. This kind of innovation today seems to be particularly relevant, because the attitudes and abilities of people are changing, with an increasing use of creativity and entrepreneurship (Meroni, 2007).

2. Research context: the Green Move project

Green Move is a project co-financed by Regione Lombardia, whose objective is to identify a successful model of EV sharing for the city of Milano (Luè et al., 2012). Eight different departments and research centers of Politecnico di Milano are involved in the project: DEI (information communication and vehicle technology), DIG (economic assessment and stakeholders’ analysis), DIAP (cost-benefit analysis and urban planning), DIIAR (geographical information systems), Fondazione Politecnico (administrative management), INDACO (service design and communication), MATE (mathematical models), and Poliedra (sustainable transportation and evaluation). The main idea behind Green Move is to create a flexible service of vehicle sharing, based on electric cars and open to a wide range of different typology of users. The system will be made easily accessible thanks to an add-on device, the Green e-Box (Savaresi and Alli, 2011), a bridge between the user, the vehicle and the control center, that allows any vehicle to join the service network. In this way, single users, private companies, and associations may share their personal car or fleet (peer-to-peer approach).
Figure 1 – The Green e-Box (Savaresi and Alli, 2011)

Figure 2 depicts the main phases of the project. In the first phase, a worldwide survey of the present car sharing services has been carried out and the scientific literature has been analyzed (Best practices and literature review), the travel demand and offer, the urban context, the stakeholders and the vehicle-sharing systems already in place have been analyzed (Context analysis), and the vision about the possible future services has been outlined and shared among the partners (Service idea). Starting from such results, the team identified innovative service configurations, each of them declined in several possible service options (Configurations’ definition). The fourth phase (Options’ evaluation) selects, using a multi-criteria and cost-benefit analyses, the most effective and efficient solutions, choosing the ones with the highest level of economic, social and environmental sustainability. Simultaneously, the technology necessary to manage the physical system (i.e. the software and hardware for the vehicles, the recharging stations, and telecommunications) is tested and prototyped (HW and SW development). The last phase concerns a trial to experiment both the technology and the service (Trial), in order to draw the final recommendations to the Regione Lombardia on how to promote a vehicle sharing service.

In this paper, we mainly focus on the initial part of the research to understand the connection between research and creative phases. In the following paragraphs, we briefly describe the idea generation process and the description of the service scenarios that will be further described and verified in the future phases to support the trial.
3. The design approach: collaborative product service systems

One of the Green Move research hypotheses is based on the idea that collaborative and participatory approaches are fundamental to the development of innovative solutions for electrical vehicle sharing, in order to face urban challenges as the way of interaction between communities, the social, environmental and economic issues. Accordingly, to orient the generative phase, particular attention was given to the concept of collaborative consumption (Botsman and Rogers, 2010) and the idea of social innovation (Mulgan et al., 2007). These models describe the possibility to swap, barter, trade, rent and share resources and services among users’ communities (e.g. services based on sharing spaces, way of working, transports or crowd mechanisms), also taking advantage of the opportunity to reach a wide audience given by the ICTs. These issues point out the broader concept of sharing economy based on the idea of accessing services and goods rather than owing them. These are collaborative models that significantly influenced the current scenario to design, produce and consume goods and services.

Leadbeater (2007) - describing the concept of we-think - emphasizes the idea of mass creativity enabled by the Internet - based on the use of social networks, online platforms as a way to innovate. It is not just about buying a good, but in participating in its implementation, rethinking the way of experiencing the everyday consumption. People and communities are at the centre of this process as collective actors actively involved in supporting and participating in creating solutions (co-design and co-produce).

From design perspective, the Product Service System (PSS) approach satisfies the above conditions. The design process is geared to solve complex problems rather than providing only
functional solutions (e.g. reflecting on users’ needs and mobility activities rather than designing a new car or new transports). This is related to the idea of servitization that - in the productive contexts – describes how products are being transformed into services, reinforcing the connections between them.

In this framework, the electrical vehicle sharing concept development is conceived in holistic terms, considering the perspectives related to the company value offering as well as those related to the users’ needs. The design solutions are considered as result of a collaborative process in which multiple stakeholders co-produce the final concept. Furthermore, referring to the Product Service System approach, the idea is to focus not only on new physical products (vehicles, interfaces, hardware, infrastructures) but also on the whole performances that the systems satisfy. This highlights a shift from the idea of property to the idea of sharing (inherent concept of Green Move research) concerning all design levels, from the production and delivering a solution to the distribution of a mobility service.

3.1. Defining service design scenarios for EV mobility

The service idea generation phase has been developed since the initial steps of the research process. It was strictly connected to the literature review, and the best practice and context analysis. To support the service ideas development phase, different mobility services - delivered around the world – have been studied. In particular, the best practice analysis supported the understanding of the design matters related to the technology, vehicles performance, user experience and the link between the service offerings and the context of use.

The service idea development can be summarized in three main steps:
» organizing and systematizing the best practices collected (mapping);
» generating ideas of product-service systems (participatory workshop);
» developing mobility scenarios based on electric vehicles.

In the following sections, these activities will be described through the design process and the tools used.

Organizing and systematizing best practices

The research teams selected 33 existing cases on mobility services. These have been divided into four categories describing the main characteristics of the service offering and the mobility model: (i) services that use traditional vehicle sharing, (ii) peer-to-peer approaches, (iii) service that use electrical vehicles, and (iv) services that offer direct production of energy. The first category includes mobility services that are characterized by innovative models in service or in business and use non-electrical vehicles; the second category encompasses that services characterized by a collaborative approach in experiencing or delivering the service; the third focuses on ‘green’ vehicles; the last one considers some cases that include energy production as an element of the service system.
Hereafter, the cases were described through brief descriptions (cards) and clustered by defining some parameters such as the partnership characteristics, the pricing, the use of energy, the capillarity of the infrastructures, the community of users, the service accessibility, the quality of touchpoints, and the presence of support assets. The main characteristics of each case were described also visualizing a scheme representing the customer journey (Figure 3). This points out the user interaction through the main touchpoints. Five main elements were considered: the access to the service and the vehicle (using desks, web, smartphones, RFID), the elements that support users while using the service and during the returning/leaving the vehicle in the station/parking (using internal/external drives, key box), the infrastructure and parking areas (considering charging stations).

The analysis of best practices and the study of literature have been activities useful to define the main design problems to be discussed during the creative phase.

**Figure 3 - Customer journey map**

*Generating ideas of product-service systems*

The idea generation activity has been based mainly on the results of the context analysis (characteristics of the mobility system and electrical vehicle offering in Milan) and the best practice collection.

The concept generation activity has been developed through a participatory workshop that involved different stakeholders: research teams, some representatives of institutions and companies. The ideas generation activity focused on sustainable urban mobility solutions describing the user experience, the use of technology and energy, the development of new business models and the possibility to include cooperative and participative models between
users and users/service providers. Imagining new service solutions and new ways to structure service offering have an impact on vehicles design and performances, the whole service system and its organization, and the users’ behaviours and experiences, more over on the urban context and its mobility system.

The idea generation process has been structured in order to propose a large number of service ideas that consider future challenges for electrical mobility and urban sustainable mobility scenarios.

The creative phase of Green Move research involved a multidisciplinary team composed of designers, engineers, researchers, and students that actively participated in brainstorming phase and in the subsequent reflection on service proposals. The brainstorming activities have been done during a design workshop to imagine – in a collaborative way - new service models, new businesses and new offering structures.

In order to facilitate the brainstorming activity, three cross schemes have been proposed each defining four design directions:

(i) the user experience (active/passive users - community/single users);
(ii) the use of technology (relieving/enabling system - personal/shared technology);
(iii) the energy production/energy management (energy producers/consumers - B2B/B2C approach).

Participants were asked to propose different service ideas/mobility models for each of the cross schemes presented in order to obtain a large number of concepts. The collaboration between researchers with different backgrounds and external actors helped the creative process, the knowledge sharing and the discussion on different design perspectives and strategies considering for example the users’ experience, the technology and the technical issues related to the energy production.

Defining mobility scenarios based on electrical vehicles

The rough ideas generated during the brainstorming activity (total number of 67) were subsequently clustered into six design scenarios (areas of innovation). The description of the service scenarios considered the design challenges derived from the case study analysis and the heterogeneous stimuli derived from the concept generation.

In particular, six macro areas for mobility services have been recognised: (1) business model, (2) information management, (3) user interaction, (4) cooperation/peering, (5) co-production services, (6) energy infrastructure/energy management. These areas enclose the main design topics to be considered while defining new electrical vehicle service proposals, coherent with the urban system and resources and the needs of users and communities involved.

For each scenario, some promising ideas have been identified, in particular:
Pricing/incentives (adopting different fares for urban zones and trips);
Fleets management (using external firm fleets to widen the service offering, for example during the night);
Procurement/Consulting (defining specific offers for B2B services);
Education (fostering education about the use of the EV sharing also trough social technologies);
Real time on the move (intercepting a wider demand connecting car pooling and car sharing);
Feedback management (improving the idea of service community using the users feedback);
Customization/profiling (designing services for specific users’ communities);
Communities (adapting/scaling the service to particular communities such as co-housing models);
Coop (proposing collaborative models for the service production, delivery and management using peer-to-peer approaches);
Micro-entrepreneurship (expanding the service offering including other small companies – as co-producers - that can provide additional services).

The above described areas have been discussed and elaborated within the different research teams (designers, engineers, managers) in order to select the most promising service concepts considering the complexity of the mobility service systems including infrastructures, vehicles, organization, interactions, capillarity, economical, social and environmental sustainability.

3.2 Describing service ideas

After the refinement and the selection of the different ideas emerged from the previous phase, we defined four specific service configurations that are characterized by the aim of offering a service that is more tailored on users’ needs (Arena at al., 2012):

- condo-sharing;
- service integration;
- the new business fleet;
- peer-to-peer.

The four configurations rely on the hypothesis that is not possible to plan a vehicle sharing suitable for all the possible mobility needs. Therefore, they aim to answer to different use profiles in a complementary way (Figure 4).
Figure 4 – The four service configurations

Condo-sharing

A fleet of vehicles is shared among people that already share at least spaces and expenses, and can be parked inside (or close to) the condominium. In such a way, one of the principal barriers that obstacle car sharing use is overcome, i.e. the distance from the station of collecting/delivery of the vehicle (Shaheen et al., 1998). Moreover, the proximity of the departure point and the familiarity among the residents of condominiums are able to favour the integration of mechanisms of car pooling.

Services integration

The idea is to create a network and involve other service providers in the vehicle sharing initiative by positioning the stations of Green Move in key areas of the city (e.g. shopping centers, cultural centers, health structures city center, public transport stations), to satisfy the needs of mobility of employees/users/visitors, and integrating other mobility systems and services offered within the area in a proper manner.

The new business fleet

The business fleets owned by local companies are substituted with a shared fleet (i.e. private companies may purchase from Green Move a mobility package). The vehicles are used by the companies on working time, and by their employees for private use on spare time (e.g. evenings and weekends). This configuration does not solve the last-mile problem, which is a key issue for station cars configurations (Barth and Shaheen, 2002), but it provides workers a potentially interesting alternative for facing other mobility needs.
Peer-to-peer

Users can share their private cars with other members of the system. The provider usually offers a web-based platform to support the matching between demand and supply, and provides additional services for the owners, such as an extension of the insurance and the courtesy car in case of accident. In respect to traditional car sharing, peer-to-peer services realize more pervasive car diffusion on the territory, reducing the necessity of purchasing new vehicles and the pressure on the parking lot. It is interesting to highlight that a similar mechanism could be implemented also in other two of the proposed configurations (condo-sharing and the new business fleet), in which exists an implicit sharing circle represented respectively by the condominium and the firm.

4. Final remarks and future works

The paper presented the first results of an ongoing research on electrical vehicle sharing service characterized by a multidisciplinary team involving researchers, engineers, managers and designers working in collaboration with the public administrators and representatives of the industry sector of electrical mobility.

The configurations for EV sharing services we presented derive mainly on the literature review and the analysis of international case studies, and therefore can be considered interesting in general. The main results are an overview of the main existing theoretical models, a world wide map of a large number of cases on sustainable mobility services and EV sharing and the definition of six service scenarios and four related services ideas regarding the electrical vehicle sharing for Milan. Even if the results presented are related only to the initial stage of the research, some general considerations can be outlined to support the future activities.

Open issues on design challenges

Car sharing and electrical vehicle sharing are very interesting areas where design can intervene at different levels: product design, communication design, interaction design, strategic design, and service design. Designers are rethinking the car (www.guardian.co.uk/service-design/car-industry) but also they are contributing in promoting an efficient way to use fewer resources and deliver sustainable services and platforms in order to switch from a vehicle owner’s perspective to a vehicle sharing one.

For designers, the challenges concern not only to the design of the vehicle (e.g. reducing the energy consumption and the ecological footprint impact) but also the whole mobility system. This means that the tasks are related to the behavioural changes, the quality of interactions, the capacity to orchestrating new users’ experiences.

The design proposals cannot be considered as a partial solution of a wider problem; these should face with macro levels - such as policy issues (sustainable development models) and design
strategies (users’ behaviours and consumption models) – and interrelated micro levels – such as solutions, new products and services. Thus, the design intervention should refer to:
» the mobility system in which new products and services will be delivered;
» the design strategies related with the mobility model and its adoption/diffusion;
» the final solutions that need to be coherent to the macro problem setting and
» the tools used to support the overall objectives of the design process and the related collaborative activities.

From this perspective, the grand challenge for designer is to collaborate with governmental institutions, urban planners, energy providers and mobility service providers to support (and make together) a new model for urban mobility.

Future works
The results presented in this paper are the basis to develop the next research steps. These will concern the market profiling (the specific demand for each of the service ideas proposed), the service offering structure (the different levels and characteristics of the mobility services and their support assets), the technological issues (the hardware and solutions needed to be applied on the infrastructures and the service systems).

In particular in the next months, we will customize these results on the specific situation of Milano, in terms of territorial issues, actual user potential demand, and stakeholders involved. The mobility habits and the potential demand will be estimated by a specific survey designed in two steps. First qualitative and macro information will be deduced by means of focus groups. Then, based on the first step results, a detailed survey, involving a wide range of users, will be performed through stated preferences analysis (Ben-Akiva and Lerman, 1985). The aim is to obtain quantitative statistical results useful in the following phases to run models and compare service options. Moreover, the most important stakeholders will be interviewed in order to further widen the points of view to be taken into account in the project design.

Acknowledgement
The authors would like to thank the coordinator of GreenMove, Prof. Alberto Colorni (Politecnico di Milano – Design Department) and the colleagues involved in the research phases described in the paper, Prof. Stefano Maffei who coordinated the service design phase with Prof. Carlo Vezzoli. Thanks to Dr. Sara Cortesi, Dr. Lucia Orbetegli for participating in the design activities. A contribution for the scientific coordination of the research is also given by Prof. Sergio Savaresi and the Dr. Marika Arena who are involved in the development phase of the project.
Reference


Leadbeater, C. (2007). We-Think: The power of mass creativity. Profile, UK


