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The role of co-creation in the introduction of innovative clean city logistics alternatives - Lessons learnt from demonstrations.

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Abstract

The HARMONY project supports and enables several metropolitan areas to lead a sustainable transition to a low-carbon new mobility era. For city logistics, innovative services and developments can serve as promising solutions to reduce greenhouse gas emissions and energy consumption in metropolitan areas. The focus of this paper is on the importance of co-creation to achieve the desired reduction in emissions, including both engagement activities and (small scale) demonstrations. The constant and simultaneous involvement of cities, service and technology providers, research entities but also the civil society, is crucial for identifying success factors and lessons learnt.

Keywords: city logistics; co-creation; demonstrations; drones; delivery robots

1. Introduction

Cities are responsible for more than 70% of energy-related global greenhouse emissions, while it is estimated that transport accounts for one third of these (Matsumoto et al. 2019). A sustainable transition to low-carbon mobility is therefore crucial. When decomposing urban transport, a rough distinction between the movement of people and the movement of goods can be made. This distinction is important as both have different possibilities to make a transition towards low carbon transport, and eventually decarbonization (Hickman et al., 2011; Macharis and Kin, 2017). For city logistics, both electrification of current vehicles and consolidation in different types of hubs are widely addressed

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(Akgün et al., 2020; Scorrano et al., 2021). More recently, innovative, and more tailored vehicles for small deliveries receive more attention. Such vehicles can contribute to a reduction in emissions as well as energy consumption in metropolitan areas. Examples of solutions, for specific, and often small freight flows are unmanned aerial vehicles (drones), autonomous fully electric vehicles, delivery robots and (electric) cargo bikes (Buldeo Rai et al., 2022; Ranieri et al., 2018).

Authorities face several challenges when it comes to harmoniously integrating new mobility services and technologies into spatial and transport plans to improve wellbeing and achieve environmental targets (Jaller et al., 2020). Given the rapid technological advances and the emergence of new mobility services, metropolitan authorities are often in need of expertise, knowledge, and tools for multiscale spatial and transport planning. To meet the needs and ensure deeper engagement in mobility planning, co-creation and stakeholder engagement activities are vital (Janjevic et al., 2019).

Demonstrations can be a great support and assessment tool for clean city logistics solutions. This has also been investigated as part of the HARMONY project that focuses on supporting metropolitan areas in the transition towards the low-carbon mobility era. In various cities, demonstrations with delivery robots, electric vans and drones have been held in real-life conditions, integrating them with traditional transport modes to understand the requirements, reactions, and barriers and to collect real-world data. Data from the demonstrations can then be combined with telecommunication, socio-cultural, economic, spatial, and environmental data to derive thorough information to feed Sustainable Urban Mobility Plans (SUMPs). Such demonstrations also offer an indication with respect to the technological readiness of some of these solutions, as well as to their public acceptance and societal impacts. These can be achieved by taking a co-creation approach, ensuring that all the relevant stakeholders are involved.

The overall objective of this study is to develop general guidelines for the set-up, operation, evaluation, and knowledge exchange of co-creation labs. Further, their role into performing real-world demonstration activities is described, via example case studies in three European metropolitan areas. The next section first describes the role of co-creation in innovations in city logistics, after which the co-creation process is described. This is followed by a description of three co-creation labs. The paper is completed with the lessons learnt and conclusions.

2. The role of co-creation

There is a growing acknowledgment that co-creation and end-user involvement are essential elements for the processes of innovation development and successful deployment (Kazadi et al., 2016; Nesterova and Quak, 2016). Co-creation as a method has been used in different domains for collaborative and creative work, where it brings together people from different backgrounds and expertise to achieve a final goal. It is aimed at creating an innovative product or solution that is mutually valued and accepted by all partners and, therefore, sustainable on the long-term (CITYLAB, 2015a; Quak et al., 2016). Overall, co-creation is important for several reasons. First, it helps to align conflicting objectives and identify the common ambition in the process, while it allows for gaining valuable insights into all the facets of the solution. Further, it aims to increase participation of the end-users in the development of the final solution and as a result increases the chances of the innovation adoption. It also helps to raise awareness towards important issues within participating groups of stakeholders and it builds relationships between groups/ individuals that exist well beyond the scope of a project. Moreover, co-creation can lead to the generation of critical scenarios to be examined, which would also identify important elements needed, such as data and modelling requirements, stakeholder involvement, demonstrations etc. In the field of urban transport, several studies have investigated the use of co-creation. Co-creation is recognized as a process where new ideas are designed together with people, and not just for them (Pappers et al., 2020).

2.1. Orchestrating approach for the co-creation labs and data collection

Co-creation suggests the involvement of different (groups of) stakeholders in the demonstration processes, while it implies activities that are designed to support creativity when shaping actions carried out within the co-creation lab (Pappers et al., 2020, HARMONY D9.1, 2020). Enabling communication tools may involve, and are not limited to, events, workshops, interviews, surveys, etc. The orchestrating approach for co-creation labs is organized in four phases: setting up of the co-creation, operation of the co-creation lab, evaluation of the activities and demonstrations

carried out within the co-creation lab, and knowledge experience and exchange within the co-creation lab. What is also important is a continuous process of evaluation, aimed at capturing changes, drivers and barriers, key stakeholder engagement moments, success factors and lessons learnt.

Data collection in the co-creation process is essential to extract important qualitative information from relevant stakeholders and experts. In the case of mobility and city logistics these can be policy makers, transport planners, regulators, public transport authorities, mobility and data service providers, freight operators, academics, and citizens (Kin et al., 2017; Val and de la Cruz, 2020). The main aim is to extract their views and requirements on emerging mobility services and technologies, as well as future policies and their impact. Consolidation of experts' insights on these important aspects of the new mobility era enable the alignment of HARMONY objectives, research, and innovation activities with current experts' predictions for the future transport market, the public bodies' responses to those predictions, and the potential consideration of actions in their current strategy or research. Such a data collection process allows partners to further analyze stakeholders' responses and come up with specific interviews and surveys, which can later lead to a portfolio of future scenarios/use cases and objectives, of interest to various stakeholders. Initiating and holding various workshops, where stakeholders from all different countries are invited to discuss future mobility concepts, can offer important outputs and lead to stakeholder requirements and scenarios for regional spatial and transport planning. In the case of HARMONY, the analysis further allowed partners to build on workshop's output and plan interviews and surveys with stakeholders from the demonstration cities towards extending their existing portfolio of future scenarios of interest and co-creating use-cases that they would like to evaluate and investigate (for more information on the set-up of the data collection and co-creation in the HARMONY project, see HARMONY D9.1, 2020, HARMONY D1.2, 2020).

3. Demonstration activities

Demonstration activities can provide extremely useful insights in terms of readiness or maturity level of technologies, operational and economic feasibility, deployment plans requirements, data requirements, regulatory and legislative issues, and other challenges. Most importantly, success factors and facilitators, as well as risks and barriers can be identified during the process, which all lead to important lessons learnt to be used in follow-up trials or for real implementation (Janjevic et al., 2019; Nesterova and Quak, 2016). It is useful and recommended that evaluation of physical demonstrations is performed according to a predefined set of the indicators, developed on the level of each individual demonstration. Indicators to evaluate the results of physical demonstrations might include, for example performance indicators, public acceptance and adoption indicators, business model indicators and technological readiness of solutions (e.g., see CITYLAB, 2015b). Further, qualitative data collection from citizens and freight operators for user acceptance is essential for a more complete evaluation as the public acceptance can be a big challenge, while a necessity at the same time to reach successful introduction and implementation. Evaluation is a necessary step to draw conclusions on the experiences of co-creation labs and their activities, as well as lessons learnt from them.

Regarding the preparation of the physical demonstration of the co-creation lab, several steps are proposed. First, the operational preparation of the physical demonstration, i.e., what is necessary, concrete actions, who needs to be involved. Then, determining the demonstration location and preparation of the test environment, i.e., what is necessary to prepare there, who is involved, planning, etc. Lastly, preparation for events and organizing co-creative workshops for the user instructions, kick- off and learning curve. The following section describes three HARMONY co-creation labs which carried out demonstration activities on city logistics solutions.

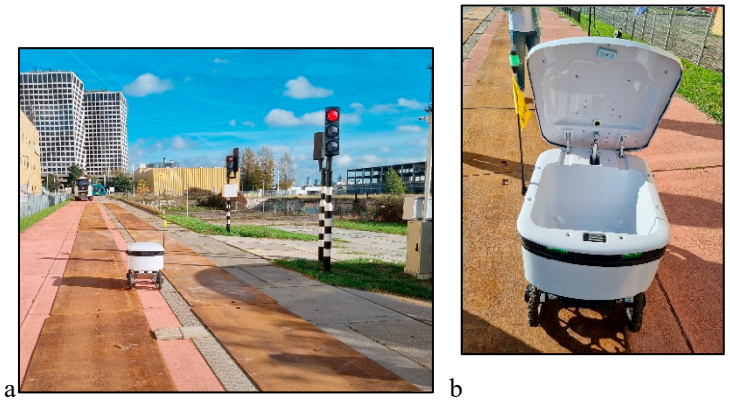
4. Case studies

During the HARMONY project, various European cities set up co-creation labs, while three of them carried out a demonstration of an innovative city logistics solution for last mile delivery. Collecting the opinions, requirements and experiences of citizens and involved stakeholders to co-create different services and evaluate them, is a short-term goal to be achieved for cities following a co-creation approach. In the longer term, demonstrations could help the process of turning the innovative service into a feasible permanent one to be implemented by the city. This also requires a thorough impact assessment considering both advantages and disadvantages of the solutions, as well as

their total costs, but this remains out of the scope of this paper. In the following sections, the objectives of the three HARMONY metropolitan areas co-creation labs and their demonstration activities are presented.

4.1. Rotterdam – The Netherlands

The municipality of Rotterdam aimed at investigating whether self-driving delivery vehicles could contribute to making the logistics chain in the city more sustainable. The Rotterdam co-creation lab has been carried out in close engagement with logistics stakeholders, national and international stakeholders, and citizens, aiming at recommendation of updates for the spatial and transport planning strategies. For this, a demonstration with a self-driving, last-mile delivery robot has been performed. Several sessions have helped informing stakeholders on draft policies and getting feedback from them, while cooperation with knowledge institutions resulted in development and application of simulators for further modelling activities. The demonstration was conducted to understand in what conditions, safe deployment of these types of systems can be achieved in the city.



a b

Fig. 1. (a) The delivery robot in action, (b) The inside part of the delivery robot

As part of the Rotterdam co-creation lab, one of the workshops was transformed into a serious game, developed as part of HARMONY. The serious game facilitated the interactions and discussions between the engaged stakeholders. Participants from the stakeholder group of logistic service providers, as potential users of automated delivery vehicles and/or services, provided insights into their attitudes regarding the transition towards zero-emission city logistics and to the role autonomous vehicles could play in it. This information improved the design of the physical pilot.

Introducing and testing the innovative delivery robot has allowed the demonstration of its abilities in terms of adaptation and navigation to different environments, road types and weather conditions, making it a potential asset in deciding the most efficient routes. Different traffic scenarios have been tested where road users obey rules and where there are no specific traffic rules. Identified challenges during the Rotterdam co-creation lab relate to the technological set up (mapping the area, defining the starting and end points, establishing the communications with a tele networking platform), to operational requirements (use of charging and a storage facility, the maintenance of the robot, and the supervision of the robot) and, lastly, to policy and legal issues (understand how to allow these new forms of mobility in their ecosystems, and under what requirements, while part of this is also a liability matter and the insurance for these new forms of mobility). The potential of these robots to reduce last mile delivery trips, energy, and CO_2 emissions, must also be assessed, and is strongly connected to their limitations in terms of operating speed, range, and payload.

4.2. Trikala – Greece

The main objective of the Trikala co-creation lab was on performing a demonstration with drones for medicine delivery, via a pharmacy logistics center directly to pharmacy stores. Through co-creation, the aim was to foster social embracement and public acceptance for such a logistics concept, which could serve more remote, peri-urban areas. The local HARMONY partner, e-Trikala, along with the scientific support of the University of the Aegean and University College London (UCL), started the setup of the demonstration. The first step was to initiate dialogue with local stakeholders and the community to discuss the barriers and opportunities of this concept. Engaging and working with crucial stakeholders, such as local pharmaceutical warehouses and pharmacies, the Medical Association of Trikala and Greece, and citizens, in a structured way, through the organization of co-creation labs has been essential in this case. Workshops for user instructions were necessary to be held too. At the same time, HARMONY also collaborated closely with the Hellenic Aviation Authority to secure approval for the flight paths (the routes that the drone would follow) to make sure that the drones would not put citizens in danger. The approval, support, and guidance of the Hellenic Aviation Authority was vital for the initiation of the demonstration. During the European Mobility Week 2021, an event was organized to inaugurate the demonstration, where several local and national authorities participated and discussed about barriers and opportunities.

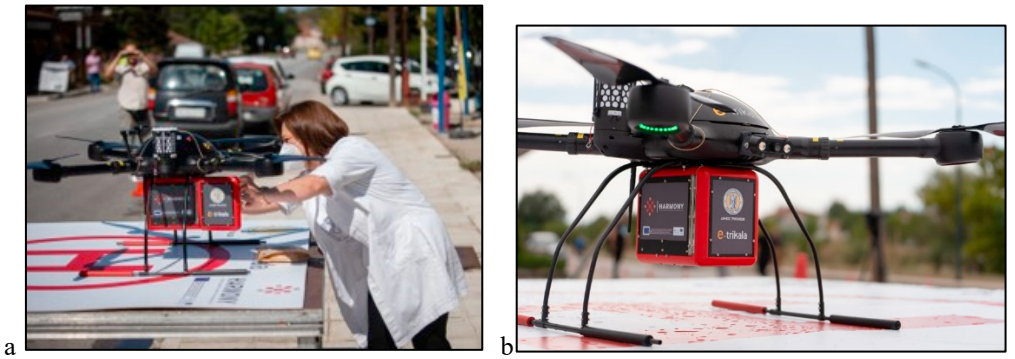


Fig. 2. (a) The landing process of the drone, (b) The drone used during the trial

Eventually, three different locations in Trikala region were selected to perform in total 24 drone flights. The drone received and dropped its payload from certified staff at designated take-off/landing areas. A total distance of 170km was covered, while the total duration of the flights was 632 minutes (10.5h), with an average speed of 10m/s. Apart from process evaluation, several KPIs for impact evaluation were collected, such as energy consumption, noise levels and air pollution. Limited battery technology and limited payloads must also be accounted for potential impacts. Considering the size and duration of the demonstration, no strong conclusions can be drawn, as data from a longer period would offer more valid insights and no quantitative information can be shared at this moment. Public acceptance has been investigated through questionnaires, which were distributed to citizens and end users (pharmacists). Although responses came from a rather small sample size (45 people), some first insights have been gained, revealing that the usability of such a service is still unclear to the public, however added value in terms of avoiding traffic jams and efficient route planning can be recognized.

A big challenge identified during the Trikala drone demonstration is the lack of permanent urban air mobility (UAM service). This implies required changes in the institutional landscape, such as need for permanent flight permits and, also, investment in physical as well as digital infrastructure. All the above depend upon co-creation activities and political support to meet several technological barriers and solutions.

4.3. Oxfordshire – United Kingdom

The Oxfordshire co-creation lab is aimed at contributing to the demonstrations of drones in the UK, to evaluate the feasibility and viability of this urban air mobility solution, in combination with an electric freight van. The use cases included parcel delivery of gifts, tools, and medical equipment in the Milton Innovation Park. A meeting was initially planned with all stakeholders at the demonstration site, where multiple discussion sessions took place on use cases for drone trials to help to identify use cases and zone of operation and to create a template for managing demonstrations. Regular meetings were held to align use cases, content, and details of the demonstration. A thorough pre-check on premises was supported by Milton Park Management, Oxford City Council (OCC) and the commercial drone service provider, which was a key event to grant safe execution of all flights. Extensive discussions with the Civil Aviation Authority on regulatory approval application process had to take place.

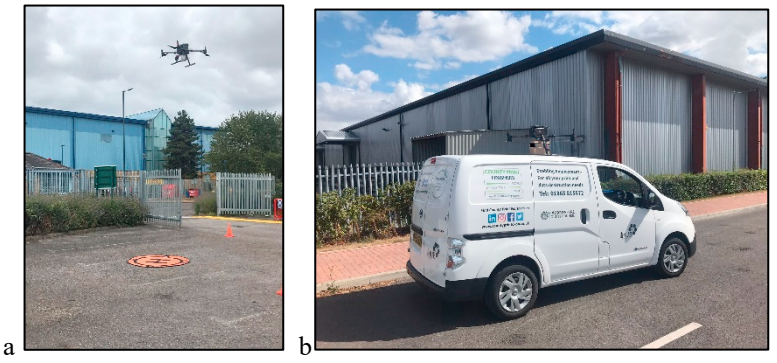


Fig. 3. (a) The drone flying in the campus, (b) The drone landing

The duration of the demonstration was only two days, however, it offered the chance to test the concept of combining a drone with an electric van, which can further be seen as a connection between (smart) city management and aviation services. It was interesting to see the feasibility to connect air and road traffic management. The facilitation of the trial required close interaction with the Urban Traffic Management Centre who was also part of a co-creation workshop to understand the integration between road and air traffic. The tools provided are a re-use from airspace management and air traffic management (ATM) solutions, which have proven to work reliably and safely in the aviation sector. The goal of such a demonstration was to showcase the potential of electric vehicles and drones in real-world conditions by integrating them with traditional modes of transportation and this has been achieved to a satisfying degree. The different challenges identified during the process of setting up and implementing this demonstration concern regulations, but also challenges related to public acceptance and cordoning locations for testing. As has been realized, scalability and replicability will be enabled via the smooth implementation of such a project, combined with rigorous exercises on social acceptance and integrated policy requirements.

5. Lessons learnt

Co-creation and stakeholder engagement processes are of crucial importance to reach the desired results when it comes to exploring innovative logistics solutions. The first identification of stakeholders of the local and national mobility ecosystem (mobility authorities, urban transport providers and users, citizens, etc.) can set the basis for co-initiation and later sharing of knowledge, as well as facilitate good alignment needed to identify the common goals and the approach and formulate use cases. The knowledge that can be shared via a co-creation lab and the process of public engagement with the citizens and stakeholders is proven to be a fundamental way to develop and implement a demonstration activity. It can be a rather burdensome process, depending on the number of stakeholders that need to be involved, which may differ widely according to the country and their policy ecosystems. Therefore, efficiency in the communication is crucial, when collecting feedback and integrating the different views. Interviews and surveys

can provide important insights, however physical meetings and active participation in various events have proven to be much more advantageous. Constant communication with the key stakeholders that need to be regularly engaged is essential. Continuous bilateral contacts and consultations with several stakeholders are also vital to take place to co-create a demonstration and have public acceptance. The demonstration itself is useful to be set up as an event for bringing different stakeholders together (citizens, local authorities and policy makers, end-users, service and technology providers, knowledge institutions) to increase their involvement and understanding. Dissemination of results afterwards is key to discussing in depth the outcomes and identify next steps. Interviews or questionnaires with the stakeholders involved can provide further insights with respect to the overall experience and public acceptance.

Looking at the outcomes of the demonstrations described, co-creation activities can end up varying quite a lot in format and different types of communication can be more or less suitable, depending on the environment, the stakeholders involved and the stage of the process. One important thing to be mentioned is that these demonstrations took place during the COVID-19 pandemic, which set additional barriers considering the nature of the planned activities. However, important lessons learnt in terms of mitigating measures, contingency plans, as well as flexibility in terms of ways of communication (i.e., virtual meetings) have been further recognized.

The most important challenges as identified by the different cities are related to the geo-morphological landscape, to the re-arrangement of ground mobility services for integration of more innovative modes, to the institutional frameworks in the EU and national level, to the political support and public acceptance, to the technological barriers, to the investments needed, to the operational requirements and technological set up. In general, through the process, all the cities had the chance to learn about technologies and certainly gained a better understanding of the various technical and operational issues, the opportunities, and the challenges. A key finding from the lessons learnt is that co-creation and demonstrations are the best ways to engage a variety of community members and bring them onboard into a new experience.

6. Conclusions

The focus of this paper is on the importance of co-creation as an approach to engage different stakeholders and achieve desired results when it comes to innovative city logistics solutions. Guidelines on how to build an integrated approach for the orchestration of co-creation labs and testing of city logistics solutions are presented. Three metropolitan areas, participating in the HARMONY project, used demonstrations to showcase the potential of the solutions. Since the focus of this paper is on the added value of co-creation, no lessons, or outcomes in terms of this potential have been addressed, however several factors that must be considered in an impact assessment have been mentioned. While various stakeholders have expressed interest in experimenting with such innovative concepts, it is a matter of fact that the added value of regular usage is hard to be recognized. Longer periods of demonstrations are needed to integrate more with local stakeholders, establish new delivery services, as well as a customer base. However, opportunities for community engagement and staff learning were provided and accomplished even in a shorter time period because of the co-creation approach.

Many challenges and barriers, limitations, success factors and future considerations are identified in such a process, which relate to stakeholder engagement, as well as public acceptance, also as part of the preparation for and evaluation of a physical demonstration. Overall, a strict and stable planned coordination is mandatory to ensure the quality of the results and findings of each area and to allow comparisons across different geographic areas.

Opinions, requirements, and experiences of citizens and involved stakeholders to co-create the service and evaluate it, need to be collected. The demonstrations described have been successfully pulled off, although it has been a rather challenging and demanding procedure for the cities. Valuable learnings have been provided, which is also a desired outcome of a project like HARMONY. All cities have reported gaining a better understanding of the amount of effort and work it takes on both the supply and demand sides, to realize a demonstration, while adopting a truly co-creative approach. Participation in such large EU projects, facilitates the process towards stakeholder engagement and involvement in exploring-via-testing new technologies.

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