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D3.8 Lyon Value Case

Final demonstrator

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Author(s): Baptiste Mougeot (LYON), Elsa Roussellet (LPA), Sebastian Hörl & Yann Briand (ISX)

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Authors:		**Baptiste Mougeot (LYON)** **Elsa Roussellet (LPA)** **Sebastian Hörl** **Yann Briand (ISX)**	
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1.1	05/05/2023	Version for internal review
1.2	24/05/2023	Updated version by SPL and ISX following ZLC and BKK feedbacks
1.3	05/06/2023	Updated version by SPL and ISX based on ZLC's comments
1.4	19/06/2023	Updated version with the KPIs and some minor improvements.

Reviewers List

Name	Company	Date	Signature
Carolina Ciprés, Beatriz Royo	ZLC	14-05-2023	
Aletta Büki	BKK	12-05-2023	
Ioanna Fergadiotou	INLE	27-06-2023	

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Acronyms

Acronyms	Explanation
API	Application Programming Interface
BAU	Business as usual
B2B	Business to business
B2C	Business to consumer
COPERT	EU standard vehicle emissions calculator
DDDAS	Dynamic Data-Driven Application System
DT	Digital Twin
KPIs	Key performance indicators
LEZ	Low emissions zone
LL	Living Lab
MVP	Minimum Viable Product
ST	Sub Task
UCC	Urban consolidation centre
VRP	Vehicle Routing Problem
WP	Work Package

Executive Summary

Lyon Living Lab is focused on parcel deliveries. Two pilots have been based in an underground Marché Gare car park as an Urban Consolidation Centre (UCC). The first solution initially considered was the delivery of small parcels using cargo bikes. The second approach has been based on a set of lockers to deliver supplies for local construction sites. Two operators were recruited to implement large-scale experimentations to and from the UCC in 2022. However, operators have experienced upheavals that have not allowed the implementation of solutions in 2022. A new operator has been integrated in 2023. This deliverable provides details on the pilots, their results, pros and cons, and lessons learnt, critical for the replication phase.

Modelling activities aim at delivering answers to the following queries: "*how can a UCC help to consolidate parcel deliveries in the city of Lyon, and specifically in the Confluence peninsula?"; "How could local operations be optimised to reach the objectives of predefined Key Performance Indicators (KPIs)?*" A model based on open data was set up, representing the regional population and their daily demand in parcel deliveries. It supports the examination of delivery routes through an UCC. At the same time, an optimization pipeline has been developed to consider the flows of goods handled by multiple operators. Additional simulations exploring the use of delivery robots have been performed.

These combined approaches will contribute to prototype an observatory for local logistics schemes and flows, together with decision support tools for further strategies or policies.

This report includes detailed information on a reproducible regional parcel modelling pipeline based on open and publicly accessible data. The report explains the approach retained to elaborate synthetic population model used to generate a synthetic representation of a territory's population and their mobility behaviour. Information is provided on the parcel synthesiser, a novel model based upon a synthetic population and using aggregate statistical information on parcel deliveries to generate a realization of parcel deliveries for an average day across the population.

A range of KPIs measurement protocols in relation with the digital twin approach are specified, together with the primary baseline indicators as references for further simulations.

1 Introduction

1.1. Scope and objectives

This report provides an updated and final version of the activities and results presented in D3.3 with the objectives to report the final release of the demonstrator including user acceptance, recommendations and lesson learned, present the final artifacts/models of the LL3 Digital Twin and set of explanatory simulation scenarios demonstrating the efficiencies achieved.

Table 1 contains the deliverable adherence to LEAD LL objectives covered during the final phase.

Table 1. Deliverable's adherence to LEAD objectives and Work Plan

LEAD GA Requirements	Section(s) of present deliverable addressing LEAD GA	Description
ST3.2.1 Preparation. MVP Specification and Modelling.	*Chapter 2*	*The chapter summarizes the results from D3.7 on the pilot in Lyon following MVP approach.*
	Chapter 3	*The chapter describes how the digital twin modelling pipeline has been set up (concept, methods, data sources) and how it can be integrated with the LEAD modelling platform.*
ST3.2.2. Digital Twin Verification.	*Section 3.2* *Chapter 5*	*The sections describe how the models have been introduced to experts and practitioners and include the obtained feedback*
	Section 3.4 *Chapter 4*	*These sections report on the results of the KPIs described in D3.1 for the baseline case and What If scenarios.*
ST3.3.3. Real-life implementation.	*Chapter 2.2. Physical pilot activities*	*This section summarizes the steps taken in D3.7 for the implementation of the physical demonstrators and documents all further developments of the activities.*
	Chapter 6 *Chapter 7*	*Lessons learnt from the physical implementation are given as well as steps forward.*
ST3.6.4. Evaluation impact assessment	*Chapter 5*	*These sections show the results from the validation survey done after the workshops.*

1.2. How does this deliverable relate to other deliverables?

This report is the updated version of the version of the D3.7 and contributes to the D3.2 and D3.15.

1.3. Structure of the document

- Chapter 1: Introduction
- Chapter 2: Lyon pilot description
- Chapter 3: Simulation environment
- Chapter 4: KPI measurements
- Chapter 5: Validation and user acceptance
- Chapter 6: Learnings and recommendations
- Chapter 7: Summary and outlook

2 Lyon pilot description

2.1 Minimum viable product

Stretching over 1.5 km^2, Confluence is a distinctive district as it naturally encompasses the peninsula tip of Lyon's historical centre, while fostering massive urban construction with over a million square meters built between 2000 and 2030. Hosting and being surrounded by some iconic landmarks of the city, Lyon Confluence combines commercial, economic, and cultural activities with housing.

Urban policies are looking forward to settling a peaceful and low-motorised environment, hence confronting the still-roaring automotive mobility. Another goal is also to ensure a better share of public spaces.

These objectives have been affirmed and made even more ambitious through the new directions[1] defined in 2022 by Lyon's elected officials, especially:

- Direction 2: "Create public spaces dedicated to pedestrians and active modes of transportation"
- Direction 5: "Continue to innovate and accelerate the ecological transition"

The MVP and collaboration with Swoopin and Rexel have been described in Chapter 2.1 of Deliverable D3.7. The aim was to use a car park as a consolidation centre where two companies would come to test solutions that would reduce the distances travelled by thermal vehicles for the delivery of goods and facilitate delivery by cargo bikes.

Since then, the pilot experienced serious and unexpected disruptions and barriers, which did not allow the implementation of the solutions described in the MVP *(see Chapter* 2.1 of this do*cument)*.

[1] https://www.lyon-confluence.fr/en/news/lyon-confluence-new-directions

2.2 Physical pilot activities

As described in Chapter 2.3 of Deliverable D3.7, all the necessary adjustments to the car park had been made by LPA and SPL Lyon Confluence so that Swoopin and Rexel could begin the experiment in early 2022.

The physical pilots presented some challenges and delays. However, LL3 could adapt to the situation and could find other operators (see sections 2.3.3 and 2.3.4). A new use case on decarbonising waste management could be tested, signing an agreement with Rexel, one of the operators selected at the beginning of the project. Another one has been started since end of May 2023, to build on what had been deployed with Swoopin. These two new use cases will continue after the end of LEAD.

On April 14, 2022, the LEAD pilot was officially launched and opened in the Marché Gare car park, in the presence of Mr. Grégory Doucet (Mayor of Lyon, Vice President of the Metropole of Lyon and President of SPL Lyon Confluence) and Mr. Fabien Bagnon (Vice President of Mobility at the Metropole of Lyon and President of LPA):

Figure 1. Opening speech by Mr Doucet and Mr Bagnon ®SPL Lyon Confluence

Following the opening ceremony, the first workshop was held *(see Chapter 5)*.

2.2.1 Collaboration with Swoopin

As explained in D3.7, more than 40 parking spots in the first underground floor of the Marché Gare car park were reserved for the parking of Swoopin's electric cargo bikes, as show in green on the map below (Figure 2):

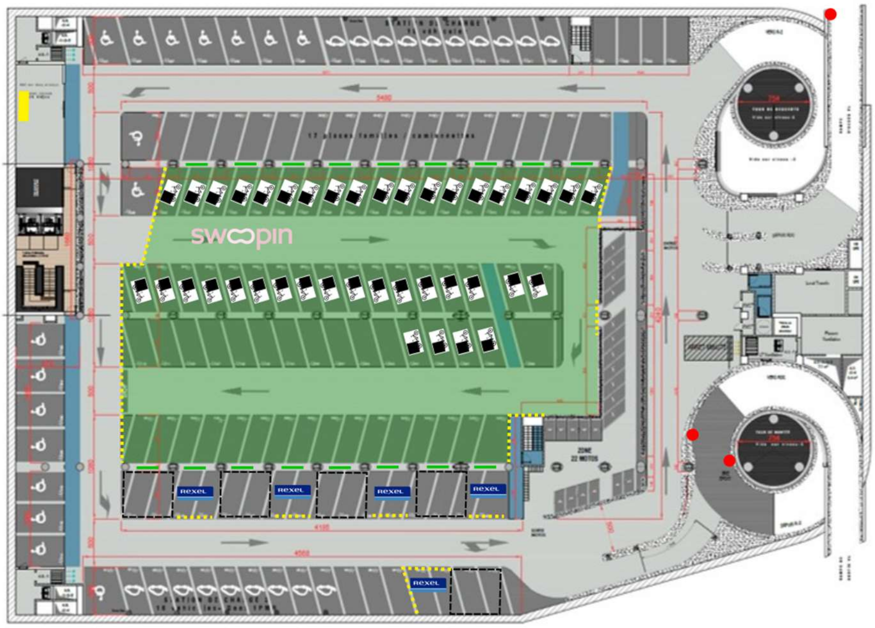

Figure 2. Marché Gare Car Park – Level 1 – Consolidation Centre for Swoopin and Rexel

A space was reserved for Swoopin in the car park. Swoopin was also provided with access to specially installed sockets for recharging the available bikes. The ramps in the car park were secured with traffic signs to alert car driver that of potential cargo bikes in the car park.

Swoopin was able to carry out all the necessary tests in the first half of 2022 (see photos in chapter 2.3 of deliverable D3.7) and actively participated in the inauguration on 14 April 2022:

Figure 3. Opening speech by Nicolas Spielmann, former CEO of Swoopin, ®SPL Lyon Confluence

Unfortunately, despite extensive support from the Lyon consortium to Swoopin and even though the cargo bikes were ready (see image below), very little activity was observed in the UCC until the summer of 2022.

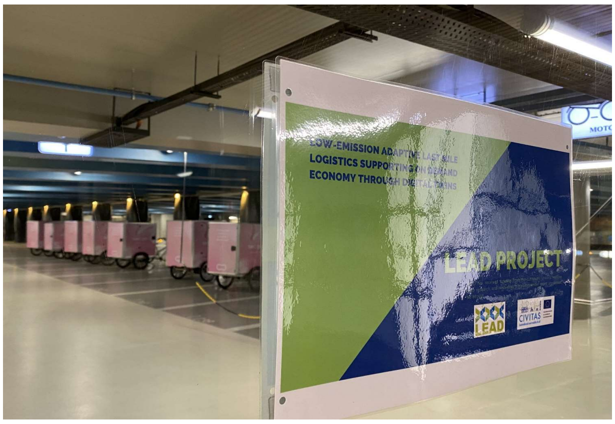

Figure 4. Swoopin's e-cargo bikes in the Marché Gare car park

In September 2022, Swoopin finally stepped up its activities in the Marché Gare car park and "manually" provided us with some data *(see image below)*:

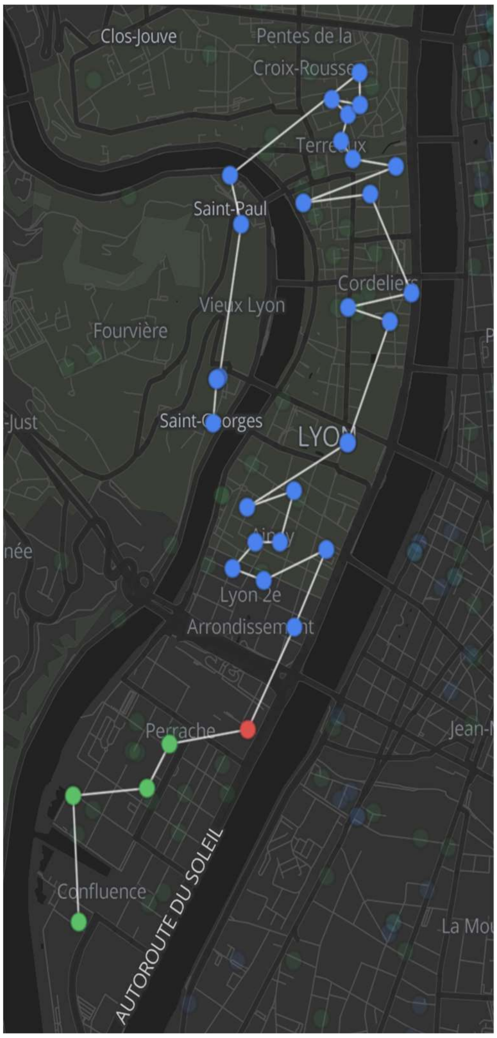

Figure 5. First data provided by Swoopin (September 2022)

Swoopin informed us that their activity should have accelerated by the end of the year. Unfortunately, this was not the case and Swoopin informed us in November 2022 that they were filing for bankruptcy. All activity with Swoopin then ceased.

2.2.2 Collaboration with Rexel

As with Swoopin, everything was installed in the Marché Gare car park in the first quarter of 2022 and Rexel actively participated in the opening day:

Figure 6. Opening Speech by James Tricot, Lyon Metropolitean area manager at Rexel ®SPL Lyon Confluence.

Even though Rexel is a very large company, their activities in the Marché Gare car park were slow to get off the ground. Rexel presented the solution installed in the Marché Gare to its clients. Just a few of them showed interest.

Smaller Rexel clients tested the locker system installed in the UCC for a few weeks. A larger Rexel customer also tested the solution:

Figure 7. One of the five lockers Rexel installed in the Marché Gare UCC.

Unfortunately, these clients did not use the lockers on a long-term basis. Several issues explain the lack of results:

- Companies only use the lockers when they have a construction or work site very close to the UCC. When their job is finished, they do not use the lockers for other jobs. Rexel has not been able to convince enough clients to use this solution so that the lockers are used permanently.
- Companies have long-established habits and logistics solutions, and it is hard to convince them to change them; although it may save them time and money. This requires a profound accompaniment of these companies to encourage them to change and to make them understand the economic and environmental interests of the solution developed within LEAD. Because of the private-private legal arrangement (between Rexel and its customers), neither LPA, nor IRT SystemX, nor SPL Lyon Confluence have had the opportunity to approach Rexel's clients directly in order to raise their awareness on these topics.
- Rexel also believes that the UCC is too close from their actual shops where most of its clients come to buy and get their equipment. Even though this shop is not in the city centre, it is not far enough from the city centre to make people change their habits and use the UCC.
- Last, Rexel still offered a cheap and fast delivery service even for short distance delivery during the experiment. Rexel did not adjust their policy. As a consequence, clients are not encouraged on that point to change their habits.

To solve this situation, LPA and SPL Lyon Confluence conducted a benchmark to get some leads on which companies could have an interest in using Rexel’s lockers in the UCC.

2.2.3 Collaboration with SUEZ Environment

SUEZ Environment showed a strong interest. This company is in charge of collecting and recycling the paper waste from companies based in Lyon’s city centre.

At present, SUEZ uses trucks to collect waste in downtown Lyon. The trucks go through the city centre and then go back to the recycling centres in the outlying districts of Lyon. However, more and more areas in the city centre of Lyon are not reachable with trucks due to pedestrianisation and low emission areas. To address these issues and reduce its carbon footprint, SUEZ aims to collect all the waste with cargo bikes when trucks cannot access the city centre. To do so, SUEZ needs consolidation centres, where cargo bikes can store the collected waste, and from which trucks will take the waste collected to the recycling centres.

Since mid-May 2023, SUEZ has used a place in La Confluence (OuiCompost) as a first UCC. Because of its ambition in deploying waste collection by cargo bikes, SUEZ keeps looking for another place in La Confluence as a second UCC. The Marché Gare car park would fit perfectly, and Rexel’s lockers would be a good opportunity as a storage system for SUEZ.

SUEZ attended the second workshop and contributed to validate both the pilot and the digital twin solution (see Chapter 5).It insisted on its strong interest for collaboration and data sharing activities and testing new logistics innovation to complement its on-the-ground decarbonised solutions adding the digital dimension.

Thus, our new strategy is to sign a private partnership between Rexel and SUEZ and find a new use for Rexel's lockers beyond the project. Indeed, the signature of an agreement between REXEL and SUEZ is now on track.

2.2.4 Collaboration with UPS

LL3 was looking for a company providing a similar service to Swoopin, needing to use a logistics centre in the centre of Lyon, and agreeing to take part in the LEAD innovation project.

In May 2023, discussions have begun with UPS. UPS wants to use the space initially reserved for Swoopin for a similar purpose: to use the space as a load break point for decarbonising last-mile deliveries using e-cargo bikes.

UPS will use the electric charging points initially installed for Swoopin to recharge the batteries of its electric cargo bikes.

UPS has just tested the ramps in the Marché Gare park to see if they can be used by its cargo bikes.

To enable UPS to set up quickly, an agreement will be signed directly between UPS and LPA. This is a private-private agreement for the provision of space managed by LPA, and not a temporary public-private occupancy agreement signed with the Metropole de Lyon. The private-private contract drastically reduces the time required to sign the agreement; so that the new pilot can start as soon as possible.

3 Simulation environment

3.1 Digital twin: Scenarios modelling

In terms of the modelling activities, the previous version of this deliverable gave details on two approaches. The first is a tool based in the local context, where logistics operators can input their flows of goods that are delivered to a certain study area. The tool then allows placing an Urban Consolidation Centre in this area and to simulate what will happen if all flows arriving in the perimeter are routed through the UCC and are then distributed by low-emission vehicles such as cargo-bikes or delivery robots. The tool is then able to optimize the delivery schemes and provide the operational costs of switching from a per-operator distribution scheme to consolidated and aggregated flows. The tool has been presented in the previous report, with accompanying screenshots of the graphical user interface. While the tool is operational, operational data could not be obtained from the operator in the Lyon living lab until now. However, a set of new use cases based on this tool are planned in the scope of the Horizon Europe project DISCO (grant agreement is currently being finalized) for the city of Copenhagen.

As the difficulty of having the relevant data to test the tool was well anticipated early on in the project, a second stream of research was set up to work on system-scale models on parcel deliveries as, in this case, we saw a potential in developing models based on open and publicly available data. The approach attempts to model all parcel deliveries in the region around Lyon, based on synthetic population data. Additional data collection efforts have been performed to obtain information such as the market shares and cost structures of the parcel operators. The process has been described in the previous report and reaches from generating a synthetic population (households and persons), to deriving a daily parcel demand (based on sociodemographic information), collecting information on the parcel system (operator market shares, distribution centres, …) from public data, and then minimizing the operator costs per distribution centre by letting them choose the type and number of vehicles as well the sequences of the deliveries. The major idea is to gain basic insights into the impact of the introduction of Urban Consolidation Centres (and specifically the one proposed in the Confluence area) on the delivery schemes in the city. A visualization platform to explore the model outputs has been developed (Annexe 1).

Note that, while it currently can only be used with synthetic or test data, the local UCC configuration modelling pipeline was integrated into the LEAD DT platform as initially planned. Hence, below, we describe the modelling pipeline (based on the previous report) for this practical approach. On the contrary, the KPIs reported in the next chapter are based on the system-level model, because it gives the regional and local policy-makers valuable insights into the restructuring of the parcel delivery network and the impacts of implementing a UCC. The systemic modelling approach should be seen as an innovative experimental research activity which is not yet sufficiently standardized and mature to be integrated into the DT platform.

Both activities, the utilization of the local operational tool (as part of the DT platform) and the further development of the systemic model, will be pursued in the upcoming Horizon Europe project DISCO.

As a connected activity, it was proposed to use traffic cameras to estimate the flows of logistics vehicles in the city. While the cameras could not be installed in the Confluence area due to GDPR restrictions and a change in the local transport policy, a cooperation framework with Paris2Connect (Ville de Paris and RATP) brought the opportunity to exploit another source of video data. Traffic classification algorithms generated raw data on the shared use of the road infrastructure for both mobility and logistics purposes. The modelling aspects related to this activity could be pursued if an extended experimental process would be possible to eventually inject the processed information in the digital twin. GDPR constraints are very strong on this matter and offer no opportunity in the current French legal framework.

3.1.1 Description of the LL3 Generic Models and connections

In the following, we summarize the models that have been integrated to the DT platform from the Lyon living lab. The set of models has only slightly changed from the previous report. The tables below provide a brief summary of each model. In the next section, the connection structure is described in more detail.

Table 2. Summary of the generic models developed in the framework of LL3.

Model	Description
irtx-synpop	The model generates a synthetic representation of households, persons and their daily activity chains.
irtx-parcels	The model uses a synthetic population to generate the daily parcel demand of a region. While it is based on marginal survey data from France, it can theoretically be applied to other use cases as well.
irtx-jsprit	The model makes use of the open-source route optimization library JSprit. In LEAD it has been adapted to the specific use case of the Lyon living lab, but with the ambition to provide a generic route and fleet size optimization tool that can be applied to other cases.
irtx-matsim	This model is a wrapper around the multi-agent transport simulation framework MATSim, which is used to simulate the daily mobility patterns of a city.

Table 3. Summary of the generic models integrated in the framework of LL3.

Model	Description
COPERT	EU reference model for emission calculation
NOISE	Noise model developed in LEAD to assess the impact of noise from logistics operations in an area based on a sender-receiver approach

Table 4. Summary of the LL3 model connectors.

Model	Description
Synthetic population to parcel model	Trivial connector: The parcel model makes direct use of the synthetic population output
irtx-parcels-jsprit-connector	Prepares the parcel data and combines it with external flow information to prepare the optimization cases for the JSprit route optimization.
irtx-jsprit-matsim-connector	Prepares the route optimization output so it can be integrated as individual vehicle agents into the agent-based transport simulation
irtx-jsprit-copert-connector	Prepares the outputs of the route optimization to be directly analyzed by the emissions model
irtx-matsim-copert-connector	Prepares the outputs of the agent-based simulation (including shipments and passenger cars) to the analyzed by the emissions model

Model	Description
irtx-matsim-noise-connector	Prepares the agent-based simulation output to be sent to the noise model (receiver locations and vehicle trajectories)

3.1.2 Configuration of the DT

To summarize, for the DT platform, we propose a process in which (1) a synthetic population (households, persons) can be generated from open census data, (2) a synthetic parcel demand can be generated based on sociodemographic characteristics and corresponding surveys, (3) the resulting parcel data can be combined with flow data from external operators, and (4) a route optimization is performed taking into account various scenarios for the deployment of a UCC that can bundle the proposed flows. Optionally, the resulting flows can be integrated into a full agent-based simulation of the city to assess congestion effects. The results can be transferred to the COPERT model (external LL3) to calculate emissions. Additional to the previous report, we also provide a connection to the NOISE model (external LL3) to perform noise analyses. The updated process shown in the Figure below:

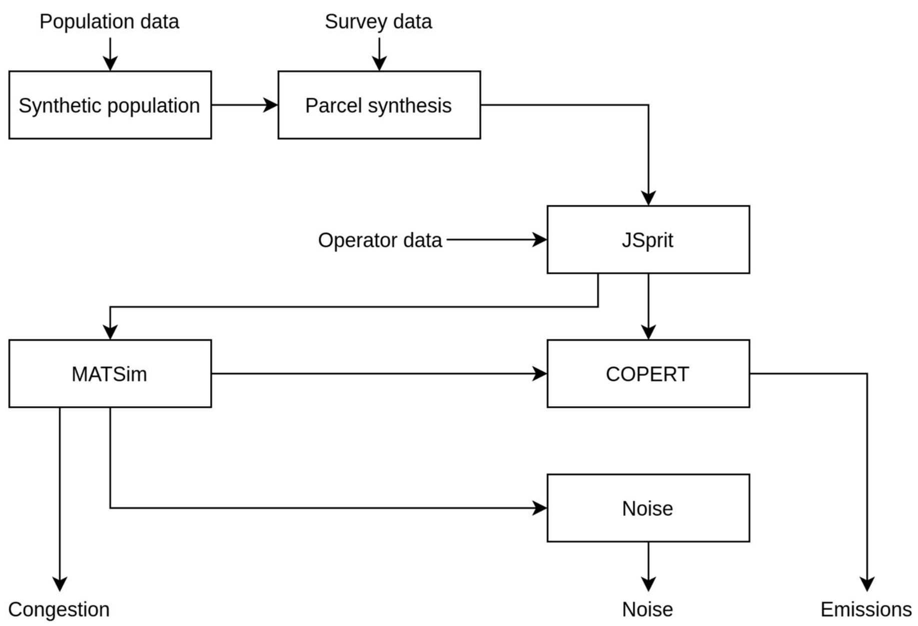

Figure 8. Pipeline configuration for the LEAD platform

3.1.3 Data collection and anonymisation

In the previous report, we were expressing the hope to receive operational data from operators working in the scope of the Lyon LL to run the models implemented in the DT platform. Unfortunately, this data has not been received, hence there was no need for specific anonymisation.

Similarly, traffic camera data in Lyon could not be obtained; deploying video cameras on the urban environment had been rejected by the local authorities. Although the potential of the specific logistics traffic data is recognized, the GDPR constraints are too strong to allow the deployment of experimental equipment in Lyon. A cooperation with Paris2Connect (Ville de Paris and RATP) brought the opportunity to assess some video samples. A large-scale exploitation is currently impeded by the legal framework.

As described in the previous report and in the section above, our systemic modelling approach is based on open data. The specific data collected from public sources is described in further detail in the next section.

3.1.4 Definition of the modelling conditions

The first step in the system-level modelling pipeline is the creation of a synthetic population for the department of Lyon and the four surrounding departments. In total, 795,000 households with 1.6 million persons are generated based on our open methodology for synthetic population generation (Hörl and Balac, 2021). The population is based on open census data from 2015 that has been scaled up with data from the French Statistical Office (INSEE) to represent the population for 2022.

In the second step, we make use of survey results on the purchasing behaviour of the population in the Lyon area (Gardrat, 2019). It links sociodemographic attributes of the population to the number of orders issued by the households. Using a methodology (Hörl and Puchinger, 2022) that has been developed in the scope of the LEAD project and presented at the Transport Research Arena conference, we generate an average daily disaggregated parcel demand for the area. For each individual household with its place of residence, we generate a realistic number of daily (B2C) parcels. In total, we generate 16,252 parcels in the area which are shown in the Figure below:

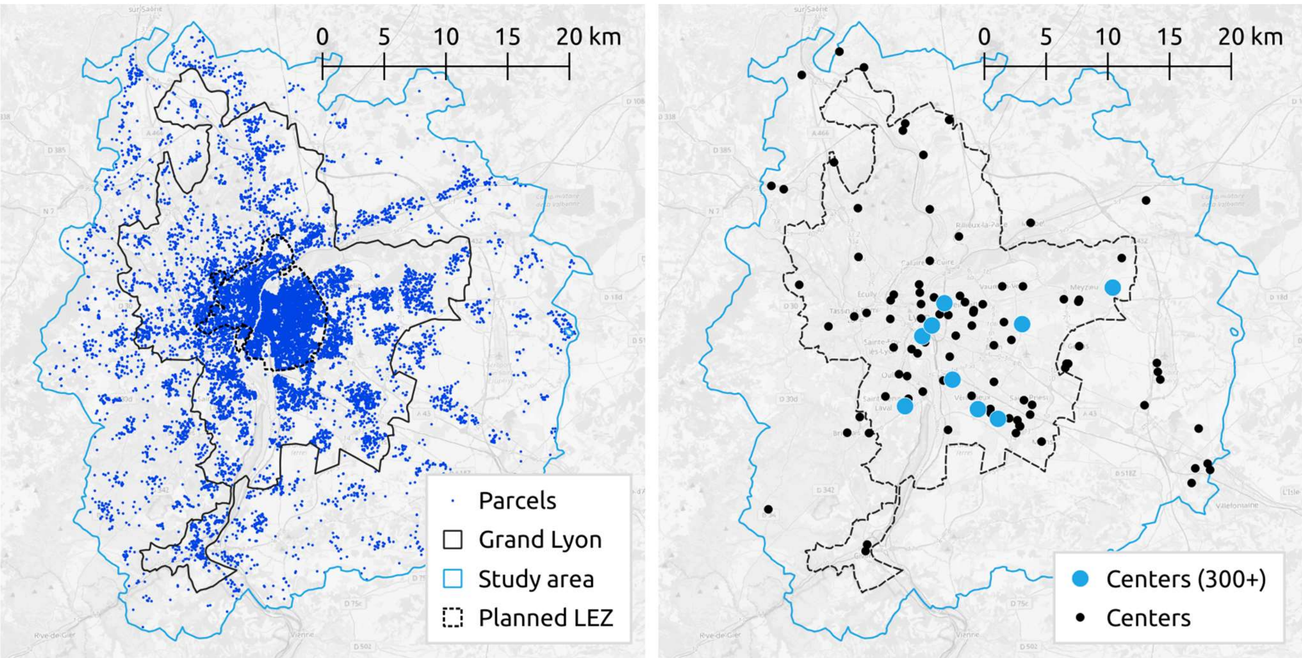

Figure 9. Map of the study area, generated parcels, and distribution centres (Background: OpenStreetMap)

Third, we define the supply side of the regional parcel delivery system. For that, we first identify all relevant operators for B2C parcel deliveries in the study area (see Figure 9 above). They are listed in Table 5. Based on grey literature and annual reports, we have developed a market share model that yields the percentage of parcels delivered by each operator in France (and, by generalization, in the Lyon area). The obtained market shares are also shown in Table 5. Additionally, for every operator, we identify their distribution centres. This analysis is based on an open data enterprise census that is available publicly in France.

Table 5. Operator statistics

Operator	Distribution centers	Market share [%]	Parcels
La Poste (Colissimo)	72	40.08	6,384
Chronopost	6	14.98	2,430
UPS	2	13.55	2,210
DPD	3	9.94	1,632
DHL	8	8.95	1,477
GLS	2	6.93	1,169
Colis privé	2	5.36	817
FedEx	9	0.21	33
Total	**104**	**100**	**16,252**

Forth, we assign an operator to each parcel based on the shares obtained in the previous step. Then, we search for the closest distribution centre of that operator such that we know which parcel should be delivered by which distribution centre. The assumption that parcels are always delivered from the closest distribution centre is a strong assumption that should be validated in future research. Table 5 shows statistics for the operators with their number of distribution centres, market share and assigned parcels.

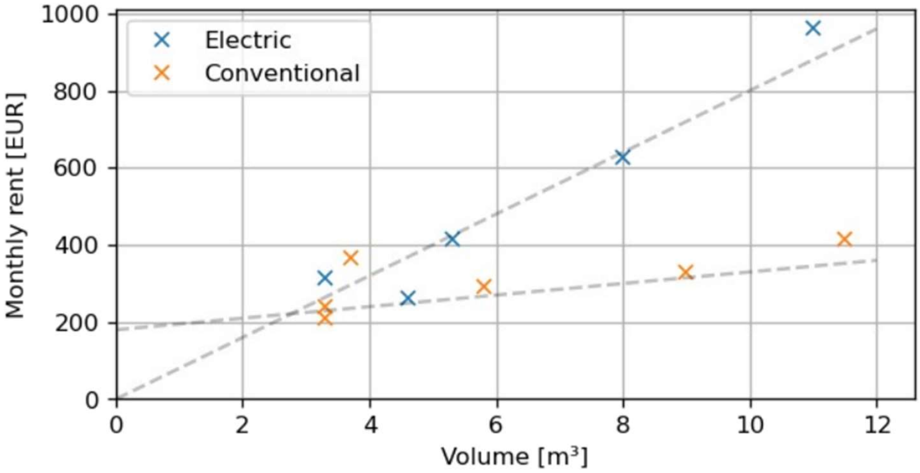

Figure 10. Monthly rent versus transport volume

The rationale behind our model is that the operators minimize their overall operational and capital expenses. For simplicity, we will perform this minimization per distribution centre. Therefore, in the fifth step, we define the cost model of the operators. Their main costs are composed of salary costs, per-vehicle (investment) costs, per-distance costs for covering the daily routes in terms of energy consumption. For personnel costs, we assume an effective net salary of 1,300 EUR per month per driver, leading to an approximate gross salary of 1,700 EUR, and to monthly costs of about 3,400 EUR per full-time employee and month for the operator. Divided by 25 operating days, we arrive at daily salary costs of 136 EUR. In terms of per-vehicle costs, we have examined the long-term rental offers of the major French vehicle manufacturers, along with the characteristics of the advertised vehicles. This analysis has yielded distinct vehicle classes (of about 3.3m^3, 5m^3, 10m^3) for which costs increase linearly with the transport volume. This is true for thermal and electric vehicles, while the slope of the latter is higher (Figure 10 above). We document the daily unit costs per prototypical vehicle that are used in our model in Table 6 ranging from 210 EUR for a small thermal vehicle up to 800 EUR for a large electric truck. In the final optimization, we divide these costs by 25 active days per month. Additionally, we have noted down representative CO_2 equivalent emissions rates (in g CO2eq/km) for each vehicle type. The rates for thermal vehicles are based on our manufacturer analysis, while the rates for electric vehicles are based on the French average of 90g CO2eq/kWh for electricity production. Finally, Table 6 shows the values for a prototypical cargo-bike (Be) based on current rental offers in France and typical consumption rates.

Table 6. Cost model

Vehicle type	St	Mt	Lt	Se	Me	Le	Be
Size	S	M	L	S	M	L	S
Propulsion	T	T	T	E	E	E	E
Capacity	33	50	100	33	50	100	14
Fuel consumption [L/100km]	5	6	8	-	-	-	-
Electricity consumption [Wh/km]	-	-	-	160	200	300	42
Unit cost [EUR/month]	210	260	370	260	400	800	160
Distance cost* [EUR/100km]	304.50	377.00	522.00	14.00	18.00	27.00	3.80
Emissions** [gCO2eq/km]	130	160	215	14.4	18	27	3.8

Be: Cargo-bike; Size: S – Small, M – Medium, L – Large; Propulsion: T – Thermal, E – Electric; *Indicative distance costs based on 1.45 EUR/km and 9ct/kWh; **Electric vehicle emissions based on 90g CO2eq/kWh

In the final step, we perform the cost optimization defined as a Vehicle Routing Problem. The goal is to minimize all cost components by choosing the number of vehicles (fleet composition) along the available vehicle types and finding the optimal delivery routes within a predefined daily active time of the vehicles and drivers. The resulting system-level KPIs are noted down further below in this report (Chapter 4). In conclusion, the model aims at representing in an optimistic (optimized) way the parcel deliveries in the area. Clearly, the resulting distances and KPIs are an underestimation as it only concerns the last mile of the system (from the distribution centre to the final customer) and does not consider combination with B2B transport. Furthermore, the real system is likely to be less optimized than the results presented here. In that sense, the results should be seen as an optimistic estimate that gives a lower bound on the real distances driven and emissions.

3.2 Digital twin: verification process

The model is complex and makes assumptions at every stage of the modelling process. Since no reference data on the overall parcel deliveries, the distance travelled for their delivery, etc. are available, the model is mainly meant to provide the general tendencies (when testing varying scenarios) and magnitudes of the relevant KPIs.

To verify the functioning of the model, the individual modelling steps have been presented to experts. Among others, we gathered information and feedback by presenting the approach to:

- Transport planning experts from the Grand Lyon metropolis administration
- Transport planning experts from the *Productive Systems, Logistics, Work and Transport Organization Laboratory* (SPLOTT) at Université Gustave Eiffel
- Transport economics experts from the *Transport Planning and Urban Economics Laboratory* (LAET) at the *National School of Public Works of the State* (ENTPE) in Lyon.

In general, the model was well-received by the experts. A value that has been outlined by most of them is the data collection part, which is very important for such a data-driven model. Part of the model development was to obtain the relevant data and present it in a systematic way (as done in the previous section). Having this information structured (for instance, the cost structures of the operators) is a valuable contribution to the ongoing discussion on last-mile city logistics. In general, the experts stated that the obtained values look plausible.

Regarding the model outcomes, a couple of limitations have been identified with the experts:

- Currently, the model only covers B2C parcel deliveries. Companies are likely to combine B2C and B2B operations in their daily service. However, it is unlikely that by combining these activities absolutely less distance will be driven or emissions will be produced. Hence, our values still provide a valid lower bound for the overall impact of the delivery system.
- Currently, we choose the closest distribution centre for each parcel. This is likely not the case for every parcel in reality, depending on the upstream arrival of the parcels in the region. However, the experts agree that it is a viable first approximation. IRT SystemX is in contact with researchers having access to data from large French parcel operators and we will likely be able to confirm this assumption with them in future projects.
- In the same sense, operators, in our model, optimize costs per distribution centre. However, it is very probable that operators cross-subsidize their operations to provide a territory-covering service. However, it is difficult to obtain this information as it goes deep into the business structure of the operators, so the experts agree that this is a valid first assumption.
- Only home parcel deliveries are considered right now. However, we plan to include deliveries to pick-up points as this has become a very common distribution scheme in France over the past years. The necessary data (locations of the pick-up points) is available.

In terms of the scenarios, the experts have noted that there is still a large potential in exploring different configurations of the system. Among others, frequent requests were:

- To include specific driving restrictions for the delivery vehicles (specific roads or areas). This would be feasible in combination with the inclusion of pick-up points (see above).
- To test policies on delivery times. This would be a straight-forward extension to the model as we already define time windows for vehicle operations and the underlying solver allows to define time windows for individual deliveries.
- Including upstream logistics. Especially for our scenarios based on UCCs a large limitation is that we only look at the last mile. This means that we only consider distances and emissions that are produced between the distribution centre (original one vs. UCC) to the final destination. However, in such a restructuring of the system, parcels need to be delivered to the UCC. Including a viable logic for this stage (parcels arriving from a larger sorting centre to the UCC) would uncover additional aspects such as how externalities are shifted between individual stages of the logistics chain when implementing consolidation schemes.

To get further feedback by the research community on the developed approach, a paper has been submitted to the 11th Symposium of the European Association for Research in Transportation and a journal version is in preparation.

3.3 Digital Twin: “What if” scenarios definition

A range of What If scenarios has been defined using the simulation infrastructure for Lyon. The first scenario closely refers to the physical implementation case while the other scenarios take at a longer term and policy-oriented perspective. The latter future scenarios are an input to deliverable D3.15.

3.3.1 UCC Scenario

The main What If scenario (whose KPIs are documented in detail in Section 4) concerns the specific use case that is experimented in reality: the introduction of an Urban Consolidation Centre in the city. In our specific scenario, we introduce three consolidation centres at underground parking garages managed by LPA. These are Confluence (which has been the subject of the physical demonstrator), Part-Dieu (attached to Lyon’s main rail station), and Cordelier (in proximity to the historical centre and city core of Lyon). The locations of the UCCs and their respective operating areas are shown in Figure 11.

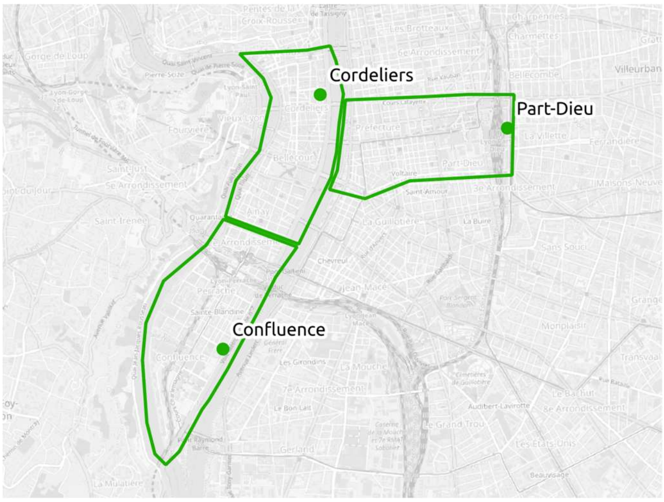

Figure 11. The three UCCs of the local What If scenario (Background: OpenStreetMap)

In this scenario, all parcels that are delivered within the indicated areas in the baseline scenarios are now delivered from the UCC locations. Furthermore, we enforce delivery by cargo-bikes. Note that the simulation then still allows through-traffic in the respective areas.

3.3.2 Future scenario: Baseline 2030

Another range of scenarios is defined based on an extrapolation of the parcel delivery system to the future state in 2030:

- The population growth according to the “likely” scenario developed by the French Statistical Authority INSEE is applied to our synthetic population.
- A per-capita increase of parcel deliveries is implemented into the model. In total, we assume a doubling (+100%) of parcel volumes, which is in line with current predictions.
- Specific increases in population are taken into account, especially in the Southern part of the Confluence area.

The scenario results in an increase of the vehicles needed and the distance driven to perform all parcel deliveries on a day.

3.3.3 Future scenario: Electric LEZ 2030

In the coming years, Lyon will implement a Low Emissions Zone in the city centre (Figure 9). In our “Electric LEZ” scenario, we assume that only electric vehicles are allowed to enter this zone and deliver parcels. The scenario is based on the 2030 baseline case.

3.3.4 Future scenario: All electric 2030

As a hypothetic comparison case, we define another scenario in which 100% of the vehicles in the region (also outside of the LEZ) must be electric. The scenario is based on the 2030 baseline case.

3.3.5 Future scenario: Pricing 2030

Finally, we define a quantitative scenario in which we vary a penalty factor on the price of thermic vehicles. Such a factor model either a comparative advantage of electric vehicles (subventions) or disadvantage of thermic vehicles (taxes). We vary between factors of +20%, +40%, and +60%.

3.3.6 Supplementary scenario: Delivery robots

Additionally, we have performed simulations with delivery robots, which, however, do not take into account the whole logistics chain. The idea is to delivery (like in the UCC scenario) all parcels in the Confluence area using small autonomous robots to estimate the number of trips performed by those robots and the required number (to estimate the requirements in terms of cybersecurity). For these simulations, we start with the same demand as obtained for the Confluence area today and then perform a scaling experiment where we uniformly increase the number of parcels per household.

A specificity of the robot model is that, since our demand is based on a synthetic population, we can obtain information on when at least one eligible person is at home at each household to receive the parcel. The process, hence, assumes that households are able to communicate their availabilities to the operator and the robots will be dispatched accordingly.

3.4 Digital twin: "What if" scenarios simulation and results

In the following, the simulation scenarios are described. First, we look at the Baseline scenario for 2022 that has been described throughout Section 3.1. After, we investigate the UCC Scenario that refers to the physical implementation case, followed by our collection of Future scenarios (see above) that are compared to each other. Finally, the results of the supplementary delivery robot scenario are reported.

3.4.1 Baseline scenario

Before looking into the results of the AS IS scenario where we require all parcels in the Confluence area to be passed through a UCC, the baseline situation of the model is described here (see Section 4 for the respective tables). In the baseline case, a total number of 16,252 parcels need to be delivered, which will remain the same in the TO BE scenario (only with a different distribution chain). The required vehicles drive a total distance of more than 12,000 km. As a result, 6855 kWh of energy are consumed per day (electricity and fuel), and 1,750 kg of CO2 equivalents are emitted per day. The average cost per delivery in the system (only including the last mile) is estimated at 2.09 EUR per parcel.

3.4.2 UCC scenario

For the UCC scenario (TO BE, see Section 4 for the respective tables) that is oriented towards the physical demonstrator, results on two levels have been obtained: What is the impact of implementing the UCCs on the whole system of parcel deliveries in the study area, and what is the impact on the local perimeter of Confluence? The results are indicated in Chapter 4 (in blue). Note that due to the systemic nature of the transport operations, not all indicators can be given on the local level (as operators cross-subsidize and holistically optimize costs). For the local context, for instance, the local CO2 indicator shows the CO2 emitted (distance driven) within the perimeter of Confluence, divided by the number of parcels delivered. Hence, the environmental indicators also contain through-traffic by vehicles that are unrelated to the UCC.

Table 9 shows that implementing the three UCCs at the LPA garages has a slight impact on the overall indicators with around -7% for energy consumption, CO2eq emissions, and air quality in the region. The local indicators for Confluence change strongly since all parcels are delivered by cargo-bikes. In terms of energy consumption and emissions, decreases of about -70% are obtained compared to today's baseline.

In terms of costs

Table 11 shows that costs stay roughly the same on the regional context. Since parcels are delivered from outside the Confluence perimeter, we cannot derive a meaningful specific cost for delivering a parcel to this area. However, we obtain a cost of about 1.82 EUR in the UCC case for the parcels that are delivered from the Confluence UCC. This value is below the average costs of delivery today (estimated to be around 2.09 EUR).

3.4.3 Future scenarios 2030

The base future scenarios (Baseline 2030) and the derived scenarios (Electric LEZ, All Electric, Pricing) have been prepared as an input to D3.15. Here, only a summary of the results is given.

The first analysis focuses on the comparison between today's baseline scenario and the 2030 baseline scenario (only including an increase in parcels). Table 7 shows in increase of overall parcels of +108% leading to an increase of more than +70% of CO2eq emissions, energy consumption, and fuel consumption. These shifts are caused by an increase of +45% of the driven distance and the corresponding fleet mix in the simulation output. Due to scaling effects the cost per delivery *decrease* by about 15%.

Table 7. Comparison of today versus future 2030 baseline (KPIs per day, whole study area)

	Today	Future 2030	Change [%]
Deliveries	**16252**	**33923**	**+108%**
Distance [km]	12451	18129	+45%
Energy [kWh]	6855	11925	+74%
CO2eq [kg]	1750	3115	+78%
Fuel [L]	635	1143	+80%
Electricity [kWh]	510	500	-2%
Cost per delivery [EUR]	2.09	1.77	-15%

This analysis shows that action on reducing the environmental impact of parcel deliveries is necessary, not only to reduce emissions today, but also to counteract the expected increase until 2030. Figure 12, therefore, shows a comparison of the future scenarios. The figure relates the annual (scaled up) CO2e emissions for parcel deliveries to the costs per parcel.

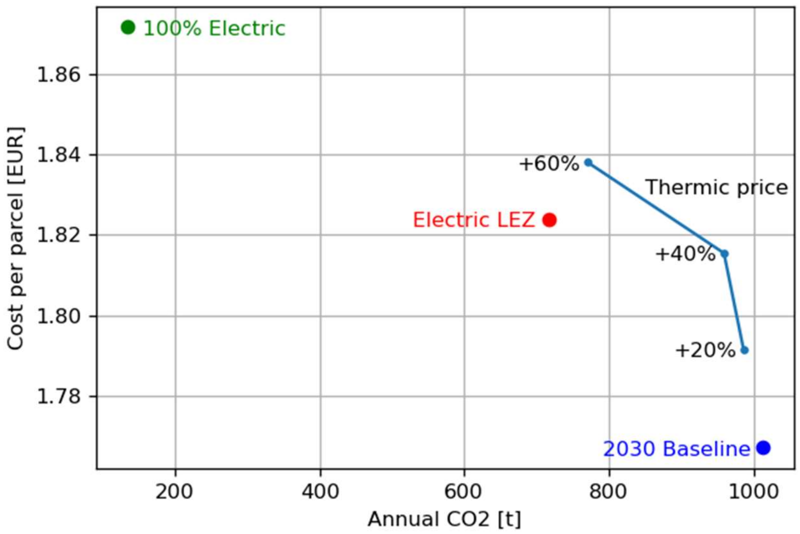

Figure 12. Comparison of future scenarios

On the bottom, the baseline case ("do nothing") is shown. It provides the lowest per-parcel costs, but also yields the highest emissions among the analyzed scenarios with more than 1000t of CO2eq per year. The electric LEZ with its limited scope (see Figure 9) arrives at about 700t CO2eq with a higher price of 1.82 EUR per parcel. Here, many vehicles serving the surroundings of Lyon are still not electrified. In case all vehicles are required to be electric (upper left corner) we obtain costs of 1.87 EUR per parcel (which is still lower than the calculated price today) at about 100t CO2eq per year which are then only resulting from the production of electricity and depend on the specific energy mix.

In comparison, we also show the pricing scenarios in Figure 12. One can see that the initial reduction of CO2eq with an increase of thermic vehicle costs of +20% is limited compared to the baseline case. Even with +40% in costs more than 900t will still be emitted. Starting at an increase of +60% the emissions start to decrease almost to the level of introducing the Electric LEZ.

3.4.4 Robot scenarios

The results on the robot scenarios were presented at the Transport Research Arena conference in November 2022. (Hörl and Puchinger, 2022). Figure 13 (on the left) shows the first result of the study as an analysis of the demand data set in combination with the synthetic population. On the left, we show how many households at each time of the day are ready to receive a parcel, because at least one person over the age of 14 is at home. One can see how in the early morning and in the evening most of households can receive parcels (and we excluded deliveries before 6am and after 10pm), and that the percentage drops to values as low as 40% in the afternoon. In the robot simulations, the delivery vehicles adapt to the underlying time windows of the households that are to be delivered a parcel.

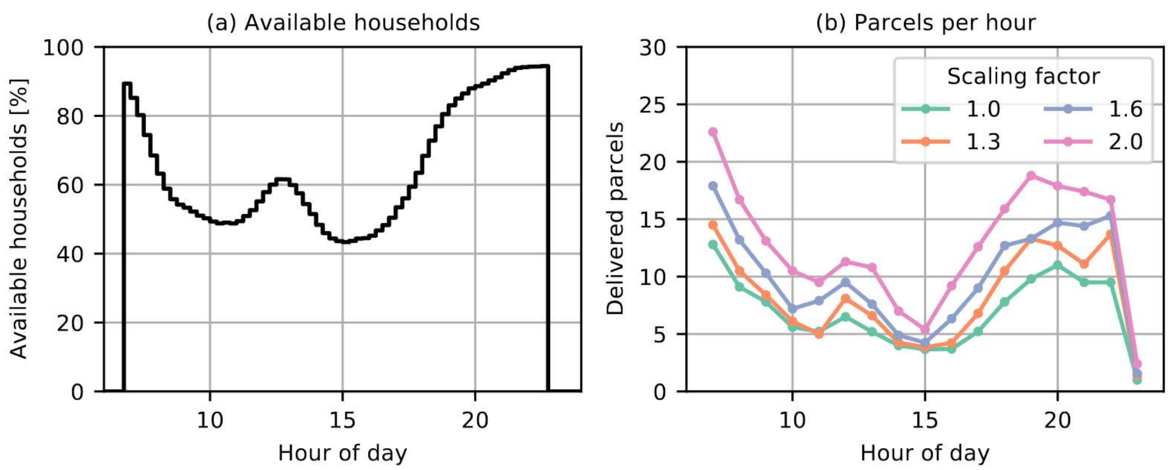

Figure 13. Temporal analysis of the robot scenarios

In the experiments for the robots, ten different demand data sets have been generated with different random seeds to also observe the stochastic influence in the model. Additionally, four scaling factors scaling up the number of households in the Confluence area were defined that correspond to an increased demand. After, the VRPs as described above were solved, with the following characteristics:

- The depot is located at the LPA UCC in Confluence and is used as the starting and ending location of the vehicles.
- Vehicles drive with a speed of 5km/h (similar Simoni et al., 2020) which is a common assumption for delivery robots in literature. They have capacity of four parcels at a time (assumption by the authors).
- Pick-up at the depot is assumed to be quick (60s) while the interaction with the customers is expected to take substantial time. We assume 5 minutes per delivery.

Table 8 shows the results of the robot simulations. For the baseline case (today's) demand we obtain that on average (over the different random seeds) the expected value of vehicles needed it about four to perform all deliveries on a standard day. In total the robots will cover at distance of about 67 km. These values increase when the demand is scaled up. For double the demand (see our assumptions for 2030 in the future scenarios), seven to eight (average 7.4) robots are needed, which however, is a sublinear scaling. This indicates that also in this use case we observe economies of scale as less than twice the number of vehicles is necessary to delivery double the demand. In terms of distance, however, the doubled demand corresponds to 125 km which is slightly more than double the distance in the baseline case. This is due to an increased number of tours (at the same capacity of the vehicles) to delivery all parcels. Regarding the cost of the robots, no assumptions have been made in this study as all deliveries were imposed to be delivered by them. However, per-parcel delivery costs for delivery robots in general are reported to be lower than with human operators (Forbes, 2021). Arguably, this depends on the specific situation, but the presented use case of a central UCC in a nurban and recently modernized district provides ideal conditions for such a service. More detailed studies, especially in comparison with the other presented alternatives, are necessary in the future, as well as a more detailed elaboration of the taken assumptions (capacity). The computational model does not give any insight on the acceptability of the service. However, our use case that is based on synchronizing flexibly with the available home slots of the population provides a surplus in comfort for the customer.

Table 8. Results of the robot simulations

Scaling factor	1.0	1.3	1.6	2.0
Households	112.20	138.30	167.90	217.80
Parcels	113.50	142.30	172.30	225.40
Vehicles	4.10	5.00	5.40	7.40
Distance [km]	67.64	82.95	102.42	125.02

4 KPIs measurements

In the following, the KPIs for the Lyon LL are shown. As explained above, our simulations cover the whole region around Lyon to capture interaction effects with the Confluence area, which is the focus of the Lyon LL. Some simulation-based KPIs can be localized to the Confluence area (for instance, the share of distance driven in the Confluence perimeter), others are only available on the system level (like the price per parcel) because their effects are not localized. The following tables show **KPIs for the Confluence area** (based on the distance driven in the area) in **bold**, while the system-wide indicators are indicated below. The following tables show all **simulation-based KPIs in blue** while KPIs from other sources are not marked specifically. Note that, as explained above, the KPIs refer to the *last mile*. Some of the externalities (like congestion and emissions) may be shifted upstream. Target values are as indicated in Deliverable 3.1. As no data was provided by the operator (see Annexe 2 for the calculation method and those KPIs that were supposed to be provided) some KPIs cannot be shown here.

Some of the KPIs (see Annexe 2 for the calculation method and those KPIs that were supposed to be provided) are not related to the simulations, but rather to the real-world implementation of the LEAD strategies. Since in the Lyon living lab the demonstrators did not enable us to collect data from the operators (see Section 2) our analysis focuses on the simulation-based KPIs. Hence, a number of KPIs could not be obtained as the services itself did not successfully start.

The simulation-based KPIs have been obtained as closely as possible to the definitions provided in D3.1 (see also Annexe 2 for a detailed description). The Noise KPI could not be obtained as we relied on the completion of the Noise model external to the Lyon LL. However, the models used in the Lyon LL are complex and computationally challenging, so they could not be integrated into the LEAD platform early enough to reliably transmit the resulting information to the Noise model. Additional work would be required to make the outputs compatible with the provided Noise model. For information, we denote in the table below the average noise level in the residential part of the Confluence area according to data from the Metropolitan region (Grand Lyon, 2023).

For the delivery costs, interpretation is difficult as in our model the operators are active on the whole territory. On the systemic perspective, we observe a slight increase of +0.5% when the costs of all operators in the territory are divided by the number of parcels. Hence, implementing a UCC in Confluence has low impact on the overall system. However, our analyses have shown that the UCC operator, if not forced to make use of cargo-bikes, switches to other vehicle types. It is hence not the cost-minimizing choice of the operators. The slight increase is hence an effect of a policy-oriented restriction on cargo-bikes. For the Confluence area itself we can only state the cost of delivering parcels *from the UCC* and *within Confluence* in the TO BE case as here we have a direct relation between the parcels stored in each UCC, and their costs of delivering the parcels. For the baseline case, he parcels delivered to Confluence arrive mostly from distribution centres outside the area that operate the whole surrounding area as well, so it is not possible to give a specific cost for a parcel delivered to the Confluence area (except than the overall system average).

In terms of congestion, we show the distance driven by the delivery vehicles. A reduction of 5% was targeted (driven by motorized vehicles) which is strongly outperformed in our scenarios with -76% in the Confluence area. However, this value does not include the distance driven by cargo-bikes, which, however, are expected to have a much lower impact on congestion. On the system level, this only corresponds to a reduction of -0.5%. Additionally, we measure the number of parcels delivered during the most congested hours (8h00, 17/18h00 according to the TomTom Traffic Index for 2023). While the value of about 6% stays constant on the global scope, it increases from about 10% to 15% in the Confluence area. However, these deliveries are mostly performed using cargo bikes.

The Internal Rate of Return is calculated as follows: To set up the UCC and maintain the service, we calculate costs at 1.82 EUR/delivery. On the other hand, on the system level, costs are about 2.10 EUR/delivery. In consequence, the UCC operator has a profit margin of 0.28 EUR per delivery. If the margin is fully added to the customer price, the operator earns 0.28 EUR for every EUR that has been invested to run the service. We arrive, hence, at a rate of about 15%.

Table 9. LEAD Environmental KPIs: LL3 Lyon "as is" vs "to be" scenarios.

KPI	Baseline value (AS IS)	Final Value (TO BE)	Target	Δ (AS IS – TO BE)
Energy consumption (MJ/delivery)	**1.018** 1. 518	0.294 1. 426	-70%	**-73 %** -6%
GHG emission (gCO_2eq/delivery)	**69** 107	**15** 99	-50%	**-78%** -7%
Air quality (mgPM2.5/delivery)	**0.32** 0.65	**0.07** 0.64	-	**-78%** -1%
Air quality (mgNO_x/delivery)	**368** 570	**79** 525	-	**-78%** -8%
Air quality (mgV$_O$C/delivery)	**11** 17	**2.4** 16	-	**-78%** -5%
Noise impact (dBA)	**45**	**45**	-50%	0%

Table 10. LEAD Social KPIs: LL3 Lyon "as is" vs "to be" scenarios

KPI	Baseline value (AS IS)	Final Value (TO BE)	Target	Δ (AS IS – TO BE)
Jobs created	-	1		+1
Quality of the jobs	**3.5**	4.6	-	+31%
Neighborhoods quality of life	**3.5**	4	-	+14%

KPI	Baseline value (AS IS)	Final Value (TO BE)	Target	Δ (AS IS – TO BE)
Users sustainable behaviour	**3.5**	4.3	-	+28%
Cooperative solutions & incentive measures	**0**	1	2	1

Table 11. LEAD Economic KPIs: LL3 Lyon "as is" vs "to be" scenarios

KPI	Baseline value (AS IS)	Final Value (TO BE)	Target	Δ (AS IS – TO BE)
Average delivery cost of the business model (EUR/delivery)	**-** (2.09)	**1.82** (2.10)	-5%	+0.5%
Congestion 1 (Congested shipments)	**10.08%** 6.17%	**15%** 6.10%	(5% of overall)	+48%
Congestion 2 (Congestion from vehicles) [km]	**36.16** 10,588	**8.57** 10,556	(5% of overall)	**-76%** -0.5%
Urban storage and parking space	**0**	44	<1000m2	44
Financial internal rate of return of the investment conducted	**0%**	15%	-	-
Shop/retail benefits (shippers)	**3,5**	4.125	10%	18%
Delivery time	-	-	-5%	0%
Delivery reliability within the time window	**-**	-	-	-

The KPIs above have been calculated based on the pilot conducted jointly by SUEZ and Rexel. The figures do not intergrate the pilots with Swoopin nor just Rexel, nor the future one with UPS.

5 Validation and user acceptance

Two workshops were organised jointly by the LL3 local consortium members. They were important steps as they were organised at two strategic times of the LEAD project:

- The first one was held the afternoon of the opening day of LEAD by the City and the Metropolis of Lyon.
- The second one was held one year later, to get feedback from different stakeholders' part of the logistics field after one year of experimenting. This second workshop aimed to validate the user acceptance of both pilots and digital twin.

Since the two workshops had different purposes, the targeted speakers and participants were different. The first workshop aimed to provide a political vision of urban logistics at the scale of the Lyon metropolis and to introduce the LEAD project to local actors and the logistics world.

The second workshop aimed to prepare the improvement and replication phase of the pilot, by inviting urban logistics operators to the table, but also real estate developers, design offices, architects, etc.

Between these two workshops was organised an exhibition event on decarbonised logistics transportation (see Annexe 5).

5.1 Workshop 1: Low-emission city logistics: experimenting with new methods

French workshop title: Logistique urbaine à faibles émissions : expérimentons de nouveaux procédés

Figure 14. Round table during the first LL3 workshop

The first workshop took place in SPL's venue, next to the Marché Gare UCC. It was held on 14 April 2022, right after the LEAD opening by the local and metropolitan authorities, in order to have a broader and larger audience.

The participants came from different backgrounds: logistics operators, local authorities, urban planners, consultancy firms, Chamber of Trade and Crafts. Around 30 people stayed after the opening to attend the workshop sessions. Opening and workshop information was published in the press a few days after as numerous journalists from various media companies were present on site: France 3, Bref Eco, Le Progrès, Les Echos, Nouveau Lyon, Lyon Demain, Tribune de Lyon, Tout Lyon, Lyon Capitale, Radio Scoop, Lyon Pole Immo.

At that time, the two operators – Swoopin and Rexel – just started the pilot in the UCC: Swoopin was beginning to take over the dedicated space with its cargo bikes and Rexel's lockers had just been set down.

Therefore, the objectives were to present to a large board of actors:

- the LEAD project,
- The pilots led by Swoopin and Rexel,
- the strategy in La Confluence,
- the strategy of LPA to support freight decarbonation,
- the strategy of the Metropolis of Lyon,and
- the added value of using data and digital twin.

Several actors had the opportunity to speak in turn: the IRT SystemX team, the head of mobility and the director of sustainable development and innovation at SPL Lyon Confluence, the general manager of LPA and the project manager in charge of urban logistics at the Metropolis of Lyon. A time of discussion took place after each intervention..

5.2 Workshop 2: Agile and flexible undergrounds - what levers for a sustainable urban logistics with last-mile deliveries ensured by soft mobility solutions?

Title in French: Les sous-sols capables, quel levier pour une logistique urbaine durable où la cyclo logistique assure les derniers kilomètres ?

The final LEAD LL3 workshop was held on 28 March 2023 in SPL Lyon Confluence's venue. Additionally, to the LL3 partners, 28 other people attended the event. Their position is available in the next section (survey results).

The workshop was co-organised with Ville Aménagement Durable. Ville & Aménagement Durable (VAD) leads a network of professionals in Auvergne-Rhône-Alpes (Lyon region), around the issues of sustainable building and development. Its role is to think about the territories of tomorrow, based on feedback (expertise, field feedback), debate, training and information. VAD brings together more than 430 members: local authorities, social landlords, developers, planners, urban planners, landscapers, architects, consultancies, companies/manufacturers etc.

The collaboration with VAD enabled to invite members of the VAD network interested and relevant in the logistics field; and have a broader audience and collect ideas from people with different profiles and expertise.

The **first objective** of the session was to **present the results of the LEAD LL3 pilots** to get external and impartial **feedback** from the audience: the positive aspects, causes of the difficulties encountered, what we could have done, how to improve in the future and replicate.

Figure 15. Introduction of the second LL3 workshop

The **second objective** was to present also the **digital twin** developed by IRT SystemX and to receive **feedback** from the attendees: open discussions and other experience, relevance of the indicators, other scenarios to be modelled, interest for stakeholders such as local policy makers or logistic operators.

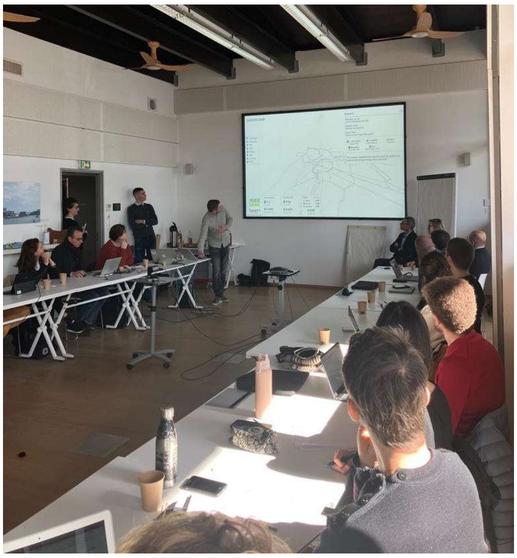

Figure 16. Presentation of the digital twin during the second LL3 workshop

Last, after presenting the results of LEAD and collecting feedback from the audience, the **third objective** was to get the **thoughts** of the participants **on replication** and how to design the next UCC in Confluence.

The agenda of the workshop is available in Annexe 6.

To maximise feedback and facilitate discussions, it was decided to organise two parallel round tables: one focusing on the pilots and the other on the use of the data.

Details on the two round tables are available in the two next subsections.

5.2.1 Round table 1: What uses and combinations of uses for tomorrow (propose uses, associated equipment, targets and possibly partners)

The group that forms around this subject starts by listing the uses we talked about in the first part of the morning and pointing out the equipment / facilities needed to ensure their proper functioning.

Figure 17. Brainstorming session of the first-round table during LL3 second workshop

Then comes the imagination, the possibilities that we could consider on this type of space?

All the insights have been gathered and summarised in Annexe 7

5.2.2 Round table 2: What strategies for decarbonising urban logistics (organisation, infrastructure, data exchange)

The second-round table has been organized as a brainstorming session around three major topics that enable decarbonization pathways for future urban logistics:

- Organisation: How should operators, shippers and public authorities organize to allow for decarbonisation pathways?
- Infrastructure: Which infrastructures are necessary for allowing sustainable urban logistics?
- Data exchange: What data needs to be collected and exchanged to foster a sustainable transition?

Each participant provided ideas on the three topics from their own perspective. After, a discussion was led on the provided inputs. An interesting discussion emerged between participants from diverse backgrounds (urban planning, bike logistics, fluvial logistics…).

Figure 18. Brainstorming on decarbonization strategies for Round Table 2

5.3 Pilot validation and user acceptance

Results of the survey on the pilot validation led during the final LL3 workshop are show in the table of Annexe 3.

The survey focused on the pilot deployed with Rexel with whom the pilot is still working. Its aim was to validate the pilot with Rexel.

From the answers collected (see Annexe 3), we can first conclude that there is no clear link between the job positions of people answering the survey and the results given.

Also, it is clear that participants in the workshop understood the issues faced with the pilot but thought that the solutions aimed to be implemented were relevant and of interest, and could have a real impact if replicated at the metropolis scale. They proposed some ideas that could have enables us to get better results:

- Select more delivery companies, or a bigger one with a stronger business model than Swoopin's,
- Provide a storage place. Rexel lockers could be a relevant solution, and B2B should be investigated between Rexel and other private companies, beyond the companies' part of Rexel's clients.

Therefore, the pilots have been clearly accepted and their relevance was not challenged.

The logistics operators confirmed that the pilots led within LEAD have a strong interest; as lots of logistics operators and other private companies having vehicles going through the city centre need UCC and are really looking for spaces such as the Marché Gare car park. The workshop attracted real estate developers and architects anticipating the new uses of car parks and so the new skills they should develop; they will need to design, build and find a new business model for the next underground spaces, not necessarily devoted to parking cars.

5.4 Digital twin validation and user acceptance

Results of the survey on digital twin validation led during the final LL3 workshop are shown in the table in Annexe 4.

This survey aimed to collect feedback from the participants to assess and validate the user acceptance and understanding of the digital twin

Results of the survey (see Annexe 4) confirmed the conclusions of the discussions we could have during the workshop.

Participants agreed on the relevant of the use of a digital tool as a decision-making tool, and the digital twin developed within LEAD was perfectly understood by the audience.

The main concern raised by the participants is that the model so far does not include B2B activities while it is acknowledged that data is scarce (See Section 3.2 for a detailed list of open questions and propositions on the model by the experts). Taking into consideration the B2B activities would clearly add a huge value to the model, but the availability of B2B data a huge barrier.

6 Learnings and recommendations

The objective of the LEAD project in Lyon was to test and define the stakes and risks for the deployment of new solutions of logistics and mobility in spaces historically devoted to the parking of individual thermal vehicles. Although the experimentation with the operators, Swoopin and Rexel did not lead to the expected results, the lessons learned will be of great interest to all the members of LL3 in the pursuit of their activities - which must adapt to the challenges of mobility in the city (reduction of the number of parking spaces, enlargement of Lyon's low-emission zone, growing needs for bicycle parking, etc.) - and to the expectations of the Metropolis of Lyon, especially the use of data.

The experience and knowledge gathered in the LEAD project has been critical to draw up a list of priority issues to be addressed in order to replicate and develop a new UCC in Confluence.

First of all, the targeting of mobility needs, both for people and goods, is essential. This should be the preliminary step in choosing the services and operators that will use the UCC. The definition of these needs should be carried out by a consultancy firm with expertise in mobility, preferably one that has already carried out studies and collected data on the area under study. Given the urgency of the climate and the exponential need for infrastructure to enable the widespread deployment of alternative, low-carbon mobility and delivery solutions, this study of needs should be carried out rapidly with the strong support of the project owner (in the case of LL3, SPL Lyon Confluence). It is necessary to be able to obtain a list of needs quickly, without neglecting the quality of the results, since this first stage will then be used to define the services and select the operators.

The definition of the needs could become more refined by using cameras as it was preliminary foreseen within LEAD, but could not be deployed due to legal barriers. Infrared cameras should be used as they allow to avoid the legal constraints of recording of the public streets.

Then should come the phase of defining the services needed to reduce the carbon footprint of mobility and logistics, without constraining individuals in their movements or blocking the delivery of goods. The definition of these services should be based on:

- the study conducted in the previous phase to make sure needs and demands fit.
- a benchmark of existing mobility solutions on the market. The LEAD project has enabled us to build an ecosystem of logistics and mobility players, in particular through the organisation of workshops. A club or a "local mobility council" can therefore prove to be very relevant in order to have a map of all logistics operators and mobility services.
- Regulatory constraints (Low emission areas, parking restrictions for instance).
- The local ecosystem: other car parks or UCC in the district, charging spots, public transportation, etc.
- a digital decision-making digital twin, such as the one developed within the framework of LEAD by IRT SystemX. The DT can be supplied with data and serve as a standalone tool to support decision making by executing different scenarios depending on the operators/services

selected for the UCC. Then, once the operators have been selected, new real time data can be provided to get the modelling better.

As with the first step, the second step (definition of the mobility and logistic services needed in the area) should be carried out quickly without neglecting the quality of the results.

Once the needs and services have been defined, the "implementation of the new UCC" stage can start.

A precise definition of the expected services then gives an idea of the type of operators that the UCC should be able to accommodate. The project owner should then contact diverse operators to find out their infrastructure requirements.

Overall, the LEAD project has already enabled us to identify certain infrastructure requirements: size of lifts, ceiling height, slope of the ramp, surface area of the dedicated area, electricity, water, light, etc.

Specifically, each use case was a source of ideas to overcome the challenges and identify new forms of transforming urban freight toward more efficient and sustainable business models.

Lastly, we can differentiate two use cases:

1. There is already a place in the area capable of hosting mobility and logistics services; as was done in LL3 with the Parc Marché Gare. The necessary and possible arrangements can then be made (delimited spaces, provision of electric recharging zones, etc.); and the legal issues guaranteeing the safety of all must of course be resolved. The LEAD project already brought answers and enabled us to gather experience.
2. There is no such space. An UCC should be designed and constructed. Due to the high density in the city centre, there are few open spaces outside to set up consolidation centres. In Confluence, a district in full redevelopment, the choice was made to build underground spaces under the new buildings dedicated to new mobility uses, other than individual vehicle parking. We recommend working as soon as possible with the project owner (mostly real estate developers) who will oversee the construction of the buildings and its underground spaces. Workshops with local stakeholders, at least monthly, should be organized from the design phase of the project. These workshops should bring together the project owner, the local authority or the urban developer, technical experts (architects, design offices), economic and legal experts. Indeed, the spaces under the buildings have always been used for parking, and the change of use raises many questions - various and varied - to which it is necessary to answer quickly: how to bring in natural light in order to respect the work code? Which business model? Who manages the space? Which networks (water, electricity, ventilation, etc.)? What structure can accommodate storage uses (high weight constraints on the concrete slab) while ensuring the strength of the structure? What ceiling height? How to build a space capable of accommodating different uses over the years? How data can be used to manage the UCC? More similar questions can be formulated based on the local community setup.

7 Summary and outlook

To conclude, the Lyon living lab faced challenges in implementation of the planned services. While both planned services could be installed in the test site (cargo-bikes and lockers) and demonstration could be performed in the initial stages of the project, the services could not be deployed as expected by LL3. However, the project provided important lessons learned for future experimentation in this kind of project framework, as outlined above, by generating synthetic data and exploring alternative what-if scenarios using Digital Twinning capabilities. Similar experimentation, but in a wider scope of sustainable reconfiguration of urban districts, are planned within the Horizon Europe project ASCEND (https://ascend-project.eu/), that started recently with Confluence as one of the test sites. A new UCC will be built in Confluence. The design phase has started, and several workshops already took place with the real estate developer and its technical team to build an UCC capable of carrying lots of different activities for decarbonising last-mile logistics. Feedback on the LEAD project and ideas raised during the second workshop were largely shared to the stakeholders involved in the design and the construction of the future Confluence UCC.

On the simulation side, the Lyon living lab allowed for noteworthy advances in terms of the modelling of transport systems. The regional parcel simulation model shows clearly the potential of open data for urban city logistics and gives valuable insights into future scenarios and policies for parcel-related logistics policies. The second component of the simulation infrastructure, a hands-on tool to plan the deployment of UCCs, has been developed but could not be tested with concrete data from the operators. Both tracks of modelling tools and methodologies will be advanced by IRT SystemX in the Horizon Europe project DISCO on urban logistics for the use case of Copenhagen.

8 References

LEAD Deliverable D3.1 Living Labs planning, setup and management

LEAD Deliverable D3.7 Lyon value case (first version)

LEAD Deliverable D3.15 Impact Assessment, Solutions Validation and Learning Conclusions (not yet available)

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Grand Lyon, 2023. Prévention du bruit / Carte de bruit routier - Journée complète (24h) - Niveau de bruit https://www.grandlyon.com/services/prevention-du-bruit

Annexe 1: Visualisation platform

The visualisation platform guides the user through the individual modelling steps that have been outlined in the deliverable above:

- Creation of a synthetic population (Figure 19)
- Creation of the respective synthetic parcel demand data (Figure 20)
- Exploration of individual scenarios and their outcomes in terms of KPIs (Figure 21)
- Comparison of scenarios (Figure 22)

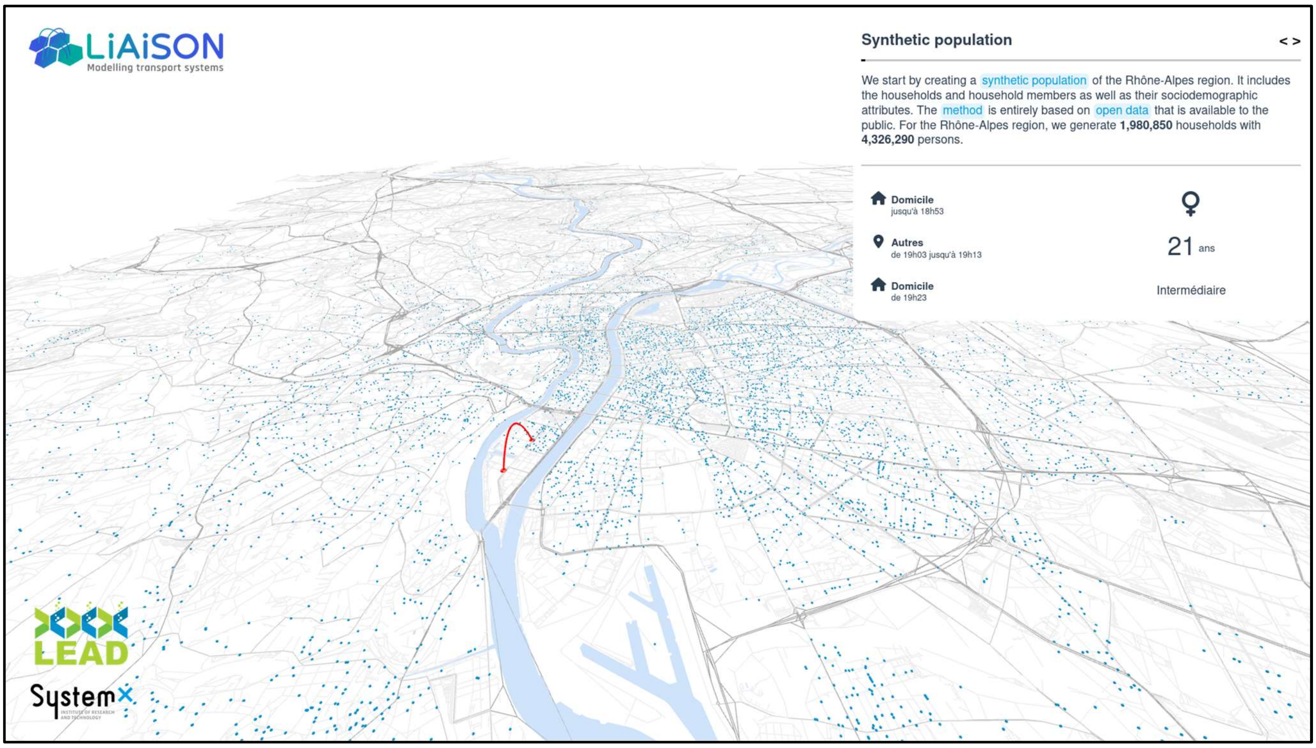


Figure 19. Visualization: Creation of a synthetic population

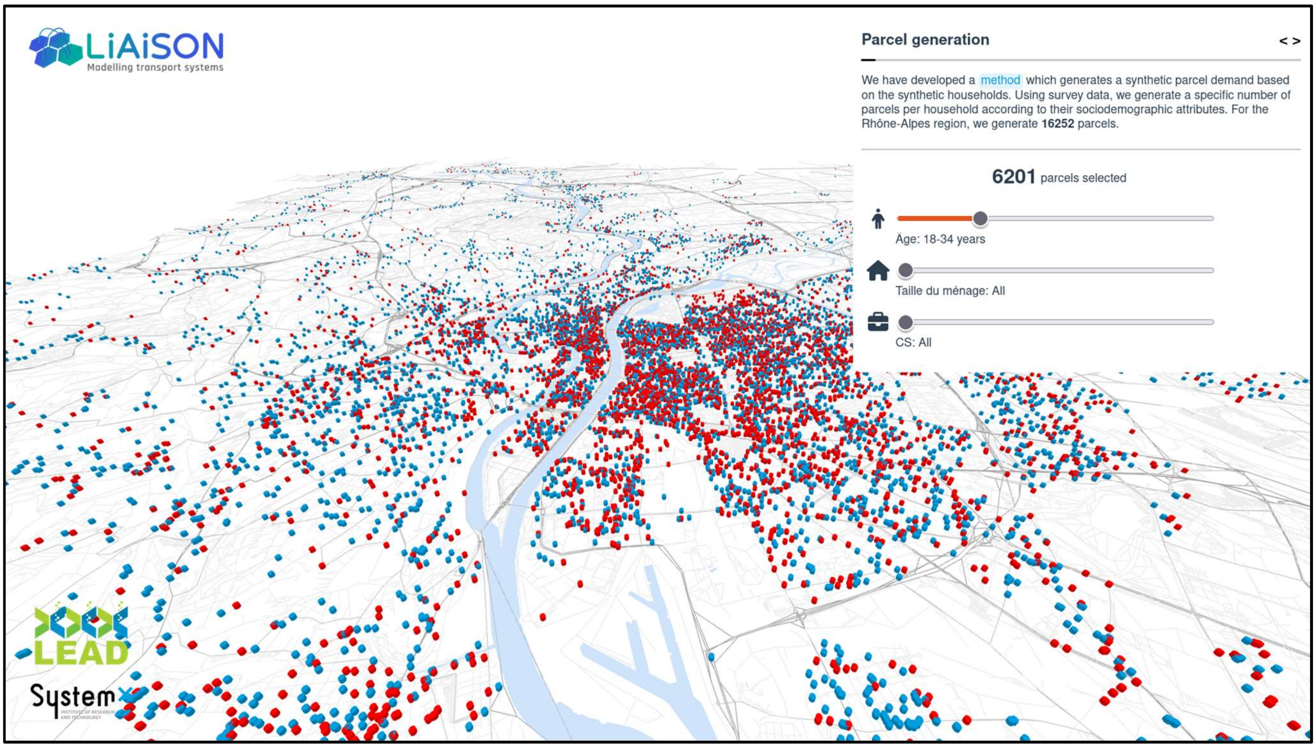


Figure 20. Visualization: Creation of a synthetic parcel demand data set

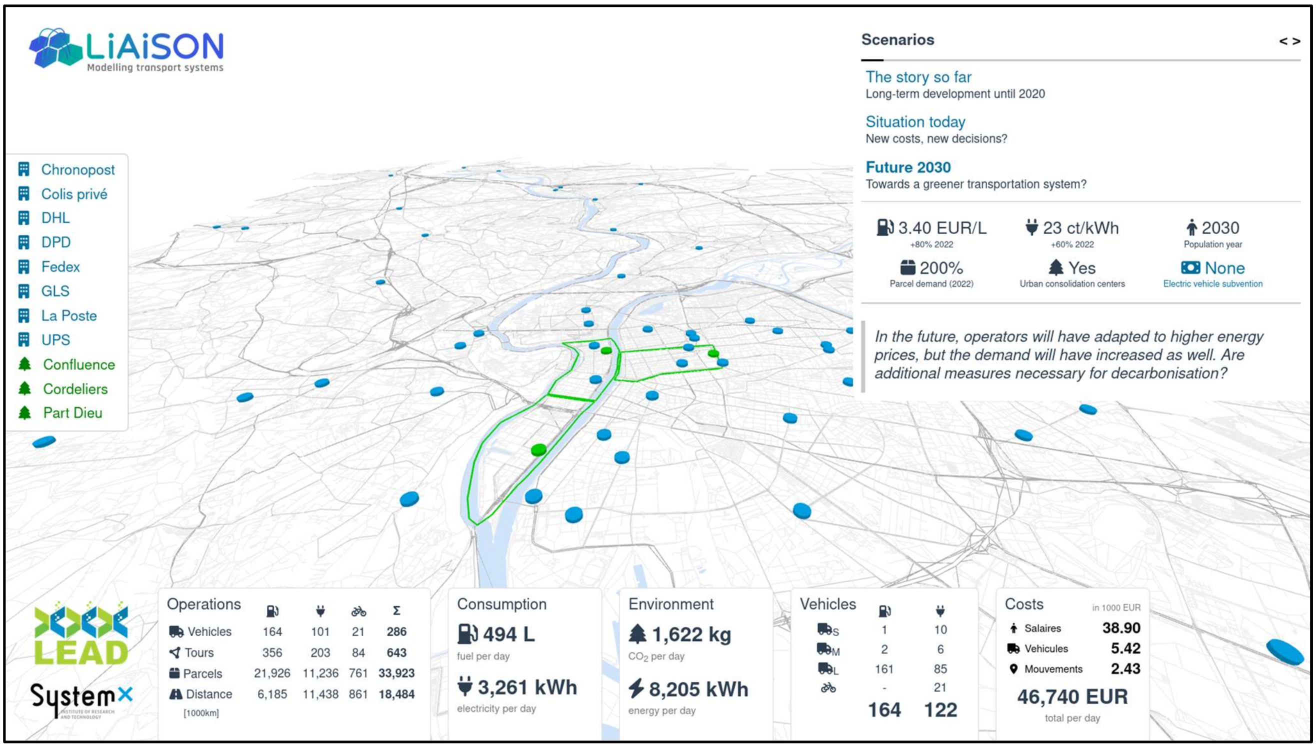


Figure 21. Visualization: Exploration of individual scenarios

Figure 22. Visualization: Comparison of scenarios

Annexe 2: KPIs calculation[2]

Table 12. LEAD Environmental KPIs: LL3 Lyon calculation method

<table>
<tr><th>KPI</th><th>Calculation Method</th><th>Measurement units</th></tr>
<tr><td>Energy consumption</td><td rowspan="2">Simulation: Based on our literature analysis, we have defined seven vehicle types (see above) with individual energy consumption per distance unit and CO2eq production per distance unit. The distances are a direct result of our model.</td><td>Energy consumption per delivery (MJ/delivery)</td></tr>
<tr><td>GHG emission</td><td>CO2eq production per delivery (gCO2eq/delivery)</td></tr>
<tr><td>Air Quality</td><td>Simulation: We perform a distance-based calculation based on the values used by EMEP/EEA (2022).
<table><tr><th>Type</th><th>PM2.5</th><th>NOx</th><th>VoC</th></tr><tr><td>Thermic</td><td>0.001</td><td>1.15</td><td>0.035</td></tr><tr><td>Electric</td><td>0.001</td><td>-</td><td>-</td></tr><tr><td>Cargobike</td><td>-</td><td>-</td><td>-</td></tr></table>
Production rates are given per km. Final KPIs are given in mg instead of g due to the small quantity.</td><td>Various units: mgPM2.5/delivery, mgNOx/delivery, mgVoC/delivery</td></tr>
<tr><td>Noise impact</td><td>Not obtainable from our simulation, not measured in the demonstrator, no data provided. We provide average values provided by the Lyon Metropolitan region (Grand Lyon, 2023).</td><td>-</td></tr>
</table>

[2] The lack of pilot results did not enable us to get the figures

Table 13. LEAD Social KPIs: LL3 Lyon calculation method

KPI	Calculation Method	Measurement units
Jobs created	Data from operator	Number of employees
Quality of the jobs	-	-
Neighbourhoods quality of life	-	-
Users sustainable behaviour	-	-
Cooperative solutions & incentive measures	Data from operator	-

Table 14. LEAD Economic KPIs: LL3 Lyon calculation method

KPI	Calculation Method	Baseline scenario value
Average delivery cost of the business model	Simulation: No UCC is implemented currently in the study area, so no baseline for the cost of the business model can be given. For the TO-BE scenario, the total expenses (distance, vehicles, salaries) of the UCC are divided by the total number of deliveries. In brackets, we show the overall average cost of delivering parcels in the region (total costs of all operators divided by the total amount of parcels, including UCCs).	Cost per delivery (EUR/delivery)
Congestion 1 (Congested Shipments)	Simulation: We count the number of parcels being delivered in the peak hours (see text above).	Percentage of deliveries at 8h00, 17h00 and 18h00
Congestion 2 (Congestion from vehicles)	Simulation: As a proxy for congestion, we show the total distance driven by *motorized* (without cargo bike) vehicles per day	Daily total distance driven in km
Urban storage and parking space	Data from operator	-
Financial internal rate of return of the investment conducted	Simulation: See text. We compare the cost per delivery on the local level vs. the overall system market cost per delivery.	-

KPI	Calculation Method	Baseline scenario value
Shop/retail benefits (shippers)	Local survey involving Shops/Retails (not performed as no service was fully active)	
Delivery time	Data from operator	-
Delivery reliability within the time window	-	-

Annexe 3: Results of the pilot-related survey led during the workshop n°2

(0=lowest, 5 = highest)

Table 15. Results of the survey on pilot validation

Job position	*Success of Rexel pilot (out of 5)*	*Business model of the solution*	*impact of this solution compared to the one envisaged at the beginning of the project*	*Agree or disagree with the medium-long-term impacts of last-mile logistics LEAD strategies presented ?*	*Feasability of scaling up Rexel's solution*	*If largely deployed in the metropolitan area, impact on the quality of life of the Lyon inhabitants?*	*At the metropolis level, Estimated impacts of Rexel solution's replication on the activity of other logistics operators*	*Positive aspects of the LEAD pilot to be remembered?*	*What aspects of the LEAD pilot deployed in Lyon should be improved?*
Association	3	3		4	3	4	4	Sharing space	Integrating more stakeholders related to cycle logistics
Consultancy company	4	3		4	3	4	4	Reduction of deliveries by shipping companies	Providing storage spaces to Swoopin
Independant professional	2	2	2	4	4	4	4	Local low-carbon logistics	Regulation of working conditions in underground spaces, accessibility of urban logistics sites
Logistics operator	1	2		3	3	3	4	Taking feedback into account in the development of future car parks	Taking into account beak loads/transhipments which increase the costs
Public administration	3	3	3	4	3	4	4	A solution to limit travel within the territory	Deploying the solution at a larger scale

Job position	*Success of Rexel pilot (out of 5)*	*Business model of the solution*	*impact of this solution compared to the one envisaged at the beginning of the project*	*Agree or disagree with the medium-long-term impacts of last-mile logistics LEAD strategies presented ?*	*Feasability of scaling up Rexel's solution*	*If largely deployed in the metropolitan area, impact on the quality of life of the Lyon inhabitants?*	*At the metropolis level, Estimated impacts of Rexel solution's replication on the activity of other logistics operators*	*Positive aspects of the LEAD pilot to be remembered?*	*What aspects of the LEAD pilot deployed in Lyon should be improved?*
Real estate developer	4	4		4	4	4	4	The principle of sharing spaces	Communication and dissemination among all the stakeholders to make the solutions known
Logistics operator	3	3	4	4	4	4	4		
Shipper	2	2	2	4	3	4	4	Opportunity of mass-marketing	Co-creation with the different stakeholders to bring them together
Independant professional	4	4		5	4	4	4	Time saving for the end customer, pollution reduction in travel	Multiplicity of proposed delivery points (clustering)
Consultancy company	3	3		5	4	5	5	Experimentation that highlights an innovative idea of using and sharing an underground space	Search for actors to be delivery operators: Rexel is not specialised in delivery/logistics and risks not being able to make proposals.
Real estate developer	3	2		4	4	5	4	Consideration of all users within the car parks. Taking into account feedback in order to improve performance	better efficiency of the last-mile delivery in terms of scope of action for the partner companies

Job position	Success of Rexel pilot (out of 5)	Business model of the solution	impact of this solution compared to the one envisaged at the beginning of the project	Agree or disagree with the medium-long-term impacts of last-mile logistics LEAD strategies presented ?	Feasability of scaling up Rexel's solution	If largely deployed in the metropolitan area, impact on the quality of life of the Lyon inhabitants?	At the metropolis level, Estimated impacts of Rexel solution's replication on the activity of other logistics operators	Positive aspects of the LEAD pilot to be remembered?	What aspects of the LEAD pilot deployed in Lyon should be improved?
Association	2	3	2	4	2	2	3	Allows for experimentation	Develop spaces suitable for cycling
Real estate developer	3	3		4	3	4	3	the principle of the "materials counter" is very interesting to pursue, in a "supervised" buffer stock in the basement	It is still early days for this pilot.
Consultancy company	2	2		3	3	3	3	interest of decentralised stocks to supply building sites or others according to theme	It seems that the main logistics operators (La Poste, DHL etc...) are missing in the reflection (don't they have needs?)
Association	3	4		5	3	5	3		
Real estate developer	2	4		4	4	4	4	small temporary storage model close to the delivery site	Develop storage solutions and not only logistics' ones
Shipper	2	4		4	5	5	5	Finding new spaces for local urban logistics. Intelligent use of the data generated	Working with sustainable local actors

Job position	*Success of Rexel pilot (out of 5)*	*Business model of the solution*	*impact of this solution compared to the one envisaged at the beginning of the project*	*Agree or disagree with the medium-long-term impacts of last-mile logistics LEAD strategies presented ?*	*Feasability of scaling up Rexel's solution*	*If largely deployed in the metropolitan area, impact on the quality of life of the Lyon inhabitants?*	*At the metropolis level, Estimated impacts of Rexel solution's replication on the activity of other logistics operators*	*Positive aspects of the LEAD pilot to be remembered?*	*What aspects of the LEAD pilot deployed in Lyon should be improved?*
Consultancy company	2	4		4	4	4	5	partnership between private logistics actors and public authorities' material resources (car parks)	ask for the needs of the end customers (construction companies)
Engineering firm	4	3		5	4	5	4		
Public administration	3	3		5	5	5	5	Use of car parks as a logistics hub	The duration of the project and increase the number of partners
Independant professional	2	2		2	3	4	4	The collection of data, the understanding of flows and consequently the increasing stability of prospective models.	The compilation and merging of all data, and prospecting applied to areas still in their infancy (e.g. river traffic).
Public administration	3	3		3	3	4	4	Deployment of the model developed by SystemX	Business model of the UCC
Consultancy company	3	3		3	2	2	3	Moving consumers to a specific and known location	Gain visibility by being connected to existing uses and habits

Annexe 4: Results of the digital twin-related survey led during the workshop n°2

(0=lowest, 5 = highest)

Table 16 Results of the survey on digital twin validation

Job position	From a non-technical perspective, is the objective of the digital twin sound and understandable?	Is the output provided by the DT clear an easy to the understand by non-technical people?	In your opinion, does the DT replicate the logistic operations with enough accuracy?	Does the DT include most of the information needed by planners and policy makers?	Will the DT be useful for planners and logistic companies to achieve their objectives?	Point out what specific topics/aspects do you miss within the DT:
Association	3	4	2	3	4	The roads taken
Association	4	3	2	2	4	B2B flows (although it is known that data is difficult to get, a collaboration with ColisActiv' could be considered)
Consultancy company	4	3	2	3	5	B2B
Shipper	4	4	2	2	4	B2B
Independant professional	4	3	3	2	3	Dates/times of the current logistics operators
Public administration	5	5	3	2	5	There is a lack of data for all possible scenarios

Job position	From a non-technical perspective, is the objective of the digital twin sound and understandable?	Is the output provided by the DT clear an easy to the understand by non-technical people?	In your opinion, does the DT replicate the logistic operations with enough accuracy?	Does the DT include most of the information needed by planners and policy makers?	Will the DT be useful for planners and logistic companies to achieve their objectives?	Point out what specific topics/aspects do you miss within the DT:
Real estate developer	3	3	4	4	4	We only have B2C. The B2B is missing.
Shipper	5	5	2	3	2	The reality and the issues faced in "real life"
Association	5	5	2	3	5	
Real estate developer	4	4	4	2	3	travel times, and inclusion of the flows in the other daily flows of the city under study
Real estate developer	2	2	2	2	2	B2B
Consultancy company	5	4	3	3	4	the degree of sensitivity of the model's structural assumptions, to anticipate model weaknesses.
Shipper	4	5	3	3	5	Without having an exhaustive vision, it seems necessary to me to have advanced scenario-building functionalities, so that local authorities can test the impact of the policies they intend to implement.
Consultancy company	4	4	3	4	3	the main logistics operators (La Poste, DHL, etc.) do not seem to have shown any interest in this subject - it is rather their lack of feedback that raises questions
Real estate developer	4	4	4	2	5	
Logistic operator	3	3	3	3	3	B2B and reverse logistics

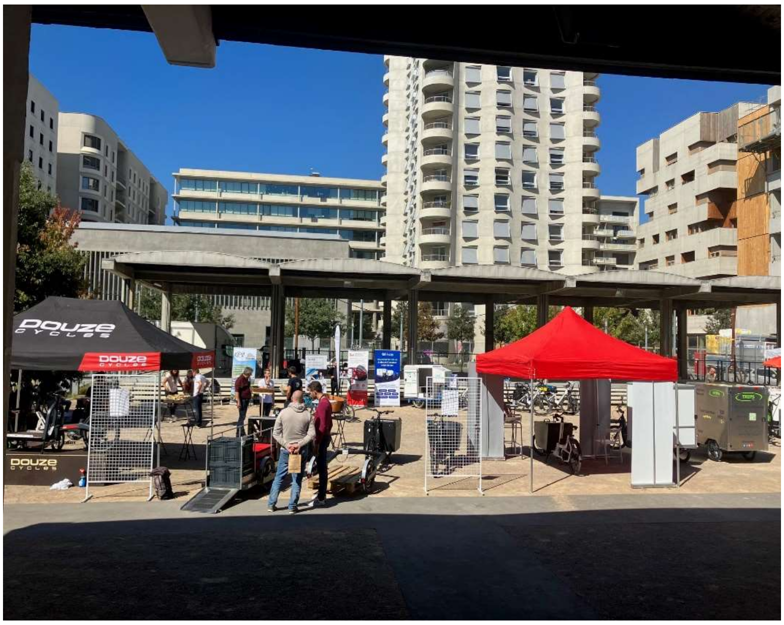
Job position	From a non-technical perspective, is the objective of the digital twin sound and understandable?	Is the output provided by the DT clear an easy to the understand by non-technical people?	In your opinion, does the DT replicate the logistic operations with enough accuracy?	Does the DT include most of the information needed by planners and policy makers?	Will the DT be useful for planners and logistic companies to achieve their objectives?	Point out what specific topics/aspects do you miss within the DT:
Consultancy company	2	4	3	3	5	B2B
Public administration	5	5	3	3	5	B2B
Environmental consultancy	5	4	3	3	5	
Independant professional	4	4	2	3	3	B2B and unexpected issues on the ground
Consultancy company	4	4	4	2	2	Quantify the urban impacts Add urban mobility to have the whole travel logic

Annexe 3: Intermediary exhibition event

On 22 September 2022, the Chamber of Trade and Crafts (in French, CMA) organised an exhibition event in the centre of La Confluence, right next to the Marché Gare car park.

The objective was to raise awareness and present alternative mobility and delivery solutions to skilled workers and craftsmen.

Photos of the exhibition are shown below: Exhibition of cargo bikes and low-emissions transportation to professionals by CMA



Annexe 4: Agenda of the 2nd workshop

https://www.ville-amenagement-durable.org/Logistique-Urbaine

- Round table
- Presentation of LEAD by LPA and SPL Lyon Confluence
- Presentation/reminders on the LEAD project
- Presentation of the pilot and results
- Lessons learnt
- Q&A session
- Live presentation of the digital tool by IRT SystemX followed by a Q&A session
- Surveys: validation of the pilot and of the digital tool
- Presentation of the D3 project in Confluence (by SPL Lyon Confluence): the to-be-built underground space capable of receiving all types of services, especially logistics' ones.
- To support the design of the D3 underground space, two parallel round tables to get vision from the participants on:
    - What uses and combinations of uses for tomorrow (propose uses, associated equipment, targets and possibly partners)
    - What strategies for decarbonising urban logistics (organisation, infrastructure, data exchange).

Annexe 5: Insights of Round table 1 of the 2nd workshop

- MOBILITY (car-sharing, bike fleet, citiz, electric recharging etc.) and associated services (maintenance / repair - test / trial of other means of transport
- LOGISTICS (BTB / BTC / CTC - on the rise - to be prioritized according to local potential) ((re)new need: ensuring the movement of luggage for individuals who use soft means of transportation and who have their luggage transported by other means)
- STORAGE: BTB - for logistics operators / companies with "fallback space / buffer space" - and BTC for the inhabitants / users of the district = box, self-storage) - Optimization / mutualization of storage spaces according to temporalities (e.g.: op log needs a lot of storage in the morning and at the end of the tour: how to optimize this land)
- ENTERTAINMENT / LEISURE / CULTURE: Escape Game (on existing and low light level), gym (coupled with electricity production), library (shared between residents / users of the neighbourhood)
- THE + ROOM: for the inhabitants (guest room, workshop, laundry room, music room, etc.), for the employees/users (herbal tea room, changing rooms/showers, multi-use room)
- URBAN AGRICULTURE: On existing buildings, constraint of the weak light, mushroom beds, endives - in new buildings, it is possible to bring natural light and thus to envisage all types of plantation.
- DATA CENTER: (installation coupled to the building / island for optimization of energy consumption / heat sources)
- “Super” CONCIERGE: locker / parcel locker; rental space (multiple: tools, vehicles, household appliances etc.) between users, market place (create links with local artisans / stores: ordering space, product withdrawal ...), Pop Up Store?

Necessary equipment & facilities:

- Access: secure and independent
- Partitioned and modular spaces
- Natural light (allows a greater diversity of use)
- Adapted elevator / elevator (cargo bikes / pallets, etc.)
- Porosity / interfaces (basements are often poorly considered ... if the ground floor is linked to the basement it is considered differently, we want to go there >> the sub-plex)
- A space of retreat
- Reception with manager & animator (new job)
- Ramp, lanes, parking adapted to new mobilities

Targets:

- Residents
- Workers
- In transit
- (Reverse) (cyclo)logistics operator
- Craftsmen / companies (+ give preference to local ones)

Some points to watch out for:

Free services are an obstacle to behavioural change. When you are told that delivery is free, you are happy but you do not try to understand how this service, which mobilizes a large number of operators, can be free. The free charging of electric vehicles in parking lots implies that the user will not come to move his vehicle once charged but will be able to mobilize the terminal for a longer time than necessary.

It is important to take into account the flexibility of the structures from the design stage. Indeed, in LPA car parks, the strength of the slab is 250kg/m² which is not enough for some logistics operations (in the Cité International park, it is 750kg/m²). The slope and curvature of the ramp, the height under the ceiling are also elements to be reconsidered to allow these infrastructures to accommodate other uses / vehicles (than the lambda car for which they were built). This principle also applies to bicycle paths, which are not always adapted to the circulation of cargo bikes.

The regulations for this type of structure are also a point of vigilance. Indeed, from a certain depth, it is the mining code that applies, limiting the feasibility for certain uses. And generally speaking, the regulations that apply to a space depend on the function that is assigned to it, so these multifunctional, reversible spaces do not always fall within a regulatory framework.

Technology must be at the service of human well-being. The reflection should not push us to embark on technology for all systems. This could counterbalance the environmental impact, but it must be at the service of the mutualization of the optimization of flows so that it is acceptable for all.

The animation / management of the place is essential so that the combinations of uses do not create misuses, that the mutualization of certain functions is optimised (in time).

Taking inspiration from the economic and governance models of third-party and coworking spaces should be further investigated.

The underground spaces can bring coolness for people living in the district or going through it. It is highly relevant considering the increase in heat waves.

Considering the time factor is a lever to allow mutualization, adapting to the rhythms of objects/people should be considered - as logistics are carried out at night, very early in the morning and at the end of the day. This will optimize the round trips with reverse logistics.