Designing a City Logistics Living Lab

Master's Thesis

By

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Abstract

Parcel deliveries have become everyday occurrences in the lives of people everywhere. People have started to rely on being able to receive anything they order to their home in a manner of days if not hours. To make this possible, the field of city logistics deals with the difficulties, problems, and solutions that come with the transportation of goods in urban centres. Attempting to minimise pollution, traffic, and accidents through improvements in efficiency, technology and policy that govern urban freight. One way to improve city logistics is through living labs. These are experiments done in a live setting where it is possible to monitor real users' interactions with new technologies. One such living lab is proposed by the EU LEAD project in Den Haag to investigate and attempt to improve the city logistics in this city. The objective of this thesis is to design this city logistics living lab in Den Haag.

The goal of the thesis is layered, primarily the thesis provides a structured approach on how to design a City Logistics Living Lab, something that is lacking in city logistics literature at the moment. With the ultimate goal being that future researchers will be able to use this thesis as a guide on how to design their own living labs in the city logistics field. To do this an experiment design methodology is needed that will guide the design process of the living lab. In this case a unique mix of experiment design methodologies is used. This incorporates the Design Cycle to rigidly guide the process, informed by Action Research best practices, and with a Case Study framework. By rigorously following this methodology the thesis shows what steps need to be taken to successfully design a City Logistics Living Lab.

Within this experiment design there is a secondary goal, which is what this specific living lab is designed to test for. The Den Haag living lab's purpose is to evaluate the effects of introducing a platform that connects several logistics services in the Den Haag area. This entails that the experiment introduces various interconnected services related to the parcel delivery business in the Den Haag area, like crowd-shipping, cycling couriers, parcel lockers, and mobility hubs, through a new platform. These services are then tested in a living lab to evaluate how they operate in this new environment and how they perform when interconnected with the other logistics services offered by the different stakeholders.

Designing a living lab with various interested stakeholders requires close collaboration. This is achieved through meetings, interviews and workshops were the stakeholders express their interests in the project, their objectives for joining the experiment, what they are capable of during the living lab and what their worries are going into the experiment. All of which is necessary to consider when designing the experiment and to achieve a level of participation of the stakeholders.

To design this experiment, the design cycle was followed, starting with an analysis of the problem and the stakeholders involved using a saliency model to map their influence and business model canvases to illustrate their business models. This analysis leads to a better understanding of the stakeholders and from which the requirements of the design can be extracted. These design requirements are the objectives that each stakeholder has for their participation in the living lab, which are operationalized into KPIs that can be measured and evaluated through the experiment. By combining the knowledge gained in the previous steps, a design is created that considers the needs and capabilities of each stakeholder involved. This design follows the minimum value approach, where four iterations of the experiment are planned each one introducing the logistical services of a different stakeholder. This allows for the measurement and evaluation of the effect of each logistics service before another stakeholder is introduced to the experiment. Finalizing with all of the stakeholders offering their services in the living lab through an interconnected platform.

The design is validated by the stakeholders themselves, who respond positively to the design and the way most of the measurements are set up to be recorded. This achieves the secondary goal of designing a living lab that tests the effects of introducing connected logistics services to the satisfaction of the stakeholders involved. The primary goal of the thesis is achieved by following the steps of the determined methodology and recording each step and their results clearly to guide future researchers replicating the design process. Resulting in an outline for future City Logistics Living Labs.

To support the primary goal the thesis concludes with what was learned through the design process, giving future researchers more context on how the final design was achieved and what could be improved in the future. The most important factor to the success of the design process is the collaboration between the designer and the stakeholders and between the stakeholders themselves. Having individual interviews with the stakeholders is shown to be vital as a place where they can express themselves comfortably, expressing their objectives and worries without filter. Having multiple meetings that involve multiple stakeholders is also indispensable as a way to establish a dialogue between the different stakeholders that can be developed into alliances. The second factor important to the success of the design process it was determined that having a clear methodology in mind with steps that need to be followed makes it easier to deal with the dynamic nature of living labs and the complexities of multiple stakeholders with conflicting objectives.

The contributions of the thesis are twofold. Firstly, in the practical sense a city logistics living lab was designed, which is actionable and where the stakeholders approved of the experiment design. This can be used by the LEAD project to outline how the Den Haag living lab is organized and as a blueprint for agreements between the stakeholders. Secondly the thesis contributed to the theoretical field of city logistics as an outline for future researchers designing their own city logistics living lab, giving them a step-by-step process that can be followed with an evaluation of the process on what to consider and what can be improved.

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I. Research Context

1. Introduction

1.1 City Logistics

With the onset of Covid-19, the trend of package deliveries that had been increasing throughout the years has accelerated. With more limitations on physically going out shopping, the number of people ordering groceries and other packages for home deliveries is at an all-time high. There are no expectations that this trend of home deliveries will decrease anytime soon. These deliveries have several negative effects, like traffic congestion, energy consumption, and noise and air pollution. These externalities can be limited through the use of effective *city logistics*.

City logistics is the optimisation of all the activities surrounding the movement of goods in the urban environment (Anand, 2015). The field attempts to ensure that the delivery of goods happens as efficiently as possible. Some of the problems that arise from inefficient city logistics are those of accessibility (congestion), environmental issues (pollution), and safety. The solutions can range from simple restrictions of delivery vehicles (deliveries limited to night-time) to much more complex policy solutions. One of the main problems in city logistics is a lack of collaboration between stakeholders (Anan, van Duin, & Tavasszy, 2015). Where private and public parties each work towards their own goals, ignoring the work of others. A more holistic approach that takes input from all the relevant stakeholders is needed.

1.2 Lead Project

The LEAD project follows such a holistic view. This EU project aims to "develop a range of logistics solutions for shared, connected and low-emission logistics operations" (LEAD, 2019) through the use of Living Labs and Digital Twin models. One of these Living Labs is the Den Haag Value Case: "Integrated last-mile logistics with demand-supply matching platforms". This project attempts to investigate how shipments inside of Den Haag are currently taking a much longer route than necessary, using hubs outside of the city. Instead, the idea is to explore a new approach to integrate the different networks, allow for local-to-local deliveries, and find alternative services that can improve the parcel delivery service in Den Haag.

This will be done through the collaboration of different firms involved in the parcel business, the municipality of Den Haag, and the Delft University of Technology. Next2Company will support the integration of the software platforms of these different firms with the goal of offering alternative services in the Den Haag parcel delivery industry. These services can include crowd-shipping, cycling couriers, locker drop-off and pick-up sites, and logistical hubs within the city. The Lead project hopes that the Living Lab will be the right environment to test out these innovations. In addition, conjunction with Digital Twins, it will make it possible to evaluate the potential of these new services and the integration of their different platforms.

1.3 The Living Lab

Living Labs are a concept where research is done in a live setting, where it possible to monitor real users' responses and interactions with a technology, in this way advancing the development and deployment of innovations (Quak, Lindholm, Tavasszy, & Browne, 2015). It can be considered a Test & Experimentation Platform where the design focus is higher than in field trials, but the commercial maturity is lower than in market pilots. According to Niitamo et al. (2006), a Living Lab needs to bring access to state-of-the-art

technology, but of competing technologies delivered through different business models. This is exactly the situation in the Den Haag case where the various firms can introduce competing and collaborative platforms and business models. Public interest, in this case represented by Den Haag municipality, is also important, because especially in Europe they are responsible for overall innovation systems. What sets Living Labs apart is the ability to interact with the users. To ensure a successful Living Lab, Niitamo et al. (2006) suggest these steps are taken, shown here with an explanation of how it relates to the Lead project:

- 1. Cooperation with technology and application providers
 - Working closely with Next2Company and the logistics firms.
- 2. Technology availability
 - Platforms will be freely available to the Den Haag userbase.
- 3. Vertical Co-operation within the Value Chain
 - Workshop and discussions with a variety of organizations and users to incorporate their views and worries into the project.
- 4. Openness and Neutrality
 - The Living Lab remains open for other players. Attempt to avoid path dependency or lockin and invite interested stakeholders.
- 5. Public Involvement
 - Both Den Haag municipality and EU funding involvement.
- 6. User Involvement
 - Customers will be serviced throughout the Living Lab and are paramount to the experiment.
- 7. Research Involvement
 - Lead project should ensure that knowledge created in Living Labs is transformed and transferred to other areas.

1.4 Objective

The LEAD project is a three-year project, involving the design and implementation of the Living Lab and the development of a digital twin for the city. My involvement will be in the beginning/planning stages of the project. The main objective is *to make a first design of the eventual Den Haag Living Lab experiment*. The planned schedule is to deliver a design for the Den Haag experiment by the start of 2021 for the stakeholders to be able to discuss and improve on, leading hereafter to the final experiment planning and operation that will be outside of the scope.

The thesis will be supplemented with literature research that will frame how the decisions and design of the experiment were made as well as introduce the methods and tools used to design the Living Lab experiment. These will include an overview of city logistics and Living Labs as the main concepts treated in the thesis. As well as design research theory, case study, and action research that will guide the design process to ensure a theoretically founded design process. The design will be done in collaboration with the stakeholders involved in the Living Lab who will also validate the design before it is approved. Lastly, the thesis concludes with a review of how the process went and what could be improved, how the paper has contributed to the theory, and recommendations for the future.

1.5 Focus and Relevance

While there have been trials and demonstrations in city logistics Living Labs, they are usually terminated at the end of the trial and the experiences learned are not always continued in daily city logistics operations (Quak et al. 2015). In the literature, there are few examples of Living Lab experiments conducted in the city logistics field, and none that give a structured approach on how to undertake this task. This thesis' research will be contributing to the theory by being a Living Lab that is focused on mature technologies that are ready or near ready for deployment and by providing a structured, scientifically grounded approach on how to design such an experiment. Using a unique mixed research approach of design science research, to design rigorously the Living Lab, with case study research to provide a framework for the Living Lab, and action research, to inform how an interactive Living Lab should look will provide an innovative way of approaching a Living Lab experiment. By formalizing this process and evaluating the proceedings the paper can be of assistance to future researchers. They will be able to see this approach as an option in their design of a Living Lab in city logistics or other fields. With the knowledge created researchers will be able to follow the process steps when necessary and be able to avoid any pitfalls that this research could run into.

1.6 Research Questions

The main research question will guide the thesis as I attempt to answer it through my research.

How should a city logistics Living Lab experiment be designed to ensure that the stakeholders involved can achieve their objectives?

This question arises from both the objective of designing the Den Haag city logistics Living Lab and from the knowledge gap. Firstly, the aim of the project is to design a Living Lab in Den Haag that the various stakeholders will be satisfied with, which can be done by achieving each of their individual goals throughout the experiment. The research question directs the efforts of this paper towards fulfilling this goal. In addition, by answering this question, the paper will be able to serve as a source for future researchers as they seek to design their own Living Lab experiment. This example of a formalized design process will be able to be replicated and improved upon in future experiment designs. This research question is broad and difficult to answer, to help that three sub-research questions have been formulated to support the main research question. By answering each sub research question the main research question can be answered as well as give structure to the thesis:

1. What characteristics does a successful city logistics Living Lab experiment contain?

The first sub-research question will serve to better define what can be considered a successful city logistics Living Lab. It is essential to understand what the ultimate goal is before starting the process of attempting to reach said goal. To determine what is needed in a Living Lab, a mixture of literature and practical research will be done. Literature research that delves into city logistics, Living Labs, and the various components in a successful city logistics Living Lab. The practical research will entail discussing and asking the stakeholders involved what they believe is necessary for this specific Living Lab to be a success and the experiences of the researcher as they design the Living Lab experiment.

2. What process needs to be followed when designing a city logistics Living Lab?

The second sub-research question focuses on the actual process of designing the experiment. Again, the answer will have a theoretical and practical component. It is difficult to do literature research on previous

design processes of city logistics Living Labs, due to the knowledge gap discussed previously. Instead, literature research will be done on various design methodologies to see which ones would suit this particular experiment. Once the chosen design methodologies have been researched and chosen, they will be followed and recorded in this thesis. At the end of which the design process will be evaluated and used to answer the question.

3. How do the stakeholder expectations translate to learning goals and objectives of the Living Lab, how can these be measured and evaluated?

The final sub-research question deals more closely with the stakeholders than the previous two. This is why the answer will be based mostly on interactions with the stakeholders. Discussions and meetings held with the people involved in the project will give insight on what their objectives are in the Living Lab and how best this can be reflected in the final design. These discussions can be held individually with the stakeholders or in bigger groups through meetings and workshops to build a dialogue. Answering this sub question makes it possible to better understand what it takes to satisfy the stakeholders. As they are the ones evaluating the Living Lab, it is important to understand and be able to measure what it is they want to achieve throughout their involvement in the project. Without this it would be difficult to say whether the objectives of the different stakeholders where reached, or to what extend they were achieved. By synthesizing the answers to these three sub-questions, the main research question can be approached in a more cognizant manner.

1.7 Thesis Structure

The thesis is divided into three main sections, the 'Research Context', 'Experiment Design', and 'Discussion' each of which is made up of a number of chapters that each cover a different topic. The 'Research Context' starts with the *introduction*, which introduces the experiment, covering the main topics and expanding on the aim of the project, the learning objectives, and the main research questions. It is then followed by *literature research* into the main topics dealt within the thesis, mainly city logistics, Living Labs, and design methodology. Lastly, this section concludes with an overview of how the Living Lab will be designed, outlining the design *methodologies* chosen and the practicalities of the design.

The second section named 'Experiment Design' will follow the structure of the design cycle, with each chapter linked with one step of the design cycle. Starting with the *problem* step, where the problem that the experiment design is attempting to solve is defined. This is followed by an in-depth *analysis* of the relevant stakeholders and the current Den Haag city logistics environment. The next step in the design cycle is the *requirements* phase where the criteria of the design are formulated. This is then brought together in the *synthesis* chapter that coalesces the concepts discussed in previous chapters to set up the experiment design. Leading finally to the *design* chapter that outlines how the Living Lab should be set up and conducted, outlining the roles and responsibilities of the different stakeholders. After which it is necessary to have a *validation* chapter where the feedback on the design from the different stakeholders is discussed. Concluding with a *design evaluation* where the design is compared to the criteria set earlier to determine the success of this Living Lab design.

The thesis will then finalize with the 'Discussion' section. This section opens with the *conclusions*, which contextualizes the finding of the thesis, in the framework of the MoT master's program and the field of city logistics Living Labs, leading to a discussion on the research questions proposed earlier in this chapter.

The conclusion is followed by a chapter discussing the *limitations* of both the final design and the thesis as a whole. Finally, the thesis ends with a recommendation for *future research*, outlining what topics would be most interesting and beneficial to delve into deeper considering the context of the thesis.

2. Literature Review

This chapter will include a review of the relevant literature for the Living Lab project and give a theoretical foundation on which the experiment can be designed. It will start with an overview on the topic of city logistics. This will provide a foundation of what city logistics encompasses. Which will include discussing the problems that can be solved, and the challenges facing city logistics. Thereafter experiment design is discussed. Focusing on three methodologies: Case Studies, Design Science Research, and Action Research, and how these methodologies can interact. The chapter will then focus on Living Labs, attempting to define what it means to be a Living Lab and reviewing the literature behind designing a successful Living Lab. Lastly, a section will be dedicated to the minimum viable product approach and how this approach can be appropriate for a Living Lab experiment design.

2.1 City Logistics

City logistics is a broad topic with various definitions and explanations. City logistics can be defined as simply as, the delivery and distribution of goods in an urban area. Others go further, Taniguchi (2014) describes city logistics as the optimization of activities related to goods movement in urban areas within the framework of the market economy. This shows that city logistics can have a purpose, where it does not simply attempt to explain things, but improve and optimize. The ultimate goal of city logistics is to be efficient with freight movement within the urban area. Not only does city logistics have various and often vague definitions, but it is also often referred to by different terms, like urban freight, urban logistics, or city freight. In this paper, the term city logistics will exclusively be used for this concept.

City logistics has become more important as the world trends to a more urban composition. With cities growing disproportionately to world population as people move to urban areas in search for better paying jobs (Winters, 2011). This increase in urban areas as well as a shift in consumption patterns and global supply chains has resulted in more goods needing to be delivered and transported inside of cities, leading to a growing importance in city logistics. The concept of city logistics encompasses numerous activities, as anything that is relevant to the movement of goods in an urban area can be considered to be included in the term. Activities like the pick-up and delivery of packages, or larger freight, the trips of vans, trucks, or other vehicles, or even higher-level concepts like the implementation of city policy. These activities are performed and affect various different stakeholders, i.e., residents, shippers, carriers, and city administrators. This multitude of activities, stakeholders, and concepts means that city logistics has various problems with diverse proposed solutions.

2.1.1 City Logistics Problems

In general, the improvement of city centres for better economies and the removal or reduction of negative externalities are the objectives for policy makers in city logistics (Crainic, 2008). Private companies can have their own objectives, often in the line of reducing costs and improving the efficiency of their services. The city logistics problems that need to be solved can be categorized as accessibility and congestions, environmental issues, and safety.

Accessibility is the ability for, in this case, goods to easily reach different parts of the city. When goods can cheaply and quickly reach their destinations, the city can be considered accessible in city logistics terms (Halden, et al., 2000). This leads to a more efficient, cleaner, and safer city. One of the main reasons for inaccessibility is congestion. Congestion is usually a temporary phenomenon that occurs when the time needed to deliver a good is much higher than it would be at a time of lower demand. This happens when

the city infrastructure is over extended. For example, when there are more vehicles on the streets at rush hour than what the city grid was designed for. This is caused not only by the number of vehicles, but also by infrastructural and policy issues, like a lack of loading and unloading zones, lack of parking places, lack of public transportation, and many more (Anand, 2015). Due to the size of delivery vehicles and the frequency with which they stop to load/unload, these can be a large contribution to congestions, even if they are not a large percentage of the total number of vehicles. With an increase in congestion, accessibility becomes lower, and other negative externalities become higher.

The negative externalities usually associated with city logistics are the environmental issues caused by congestions, especially due to large vans and trucks. Not only are larger vehicles on average, more polluting than smaller ones, the frequent stop and go of city traffic and loading and unloading of goods make city logistics vehicles also more polluting than long-distance trucks and vans. This pollution comes mostly in the form of air pollution, but also the noise pollution caused by the vehicles and the act of unloading and loading the vehicles.

Air pollution in a city causes health issues, lowers property value, reduces recreation possibilities, and has global impacts as well, as climate change and a rising sea level (Mesjasz-Lech, 2016). Noise pollution can also cause health issues, like stress and headaches while lowering the quality of life of those impacted. Safety issues are a last negative externality caused by city logistics. This is due again to the large size of vehicles used in the delivery of goods and due to a lack of infrastructure that causes delivery vehicles to load and unload improperly. This can cause dangerous situations where car accidents can occur.

As stated before private companies have different issues they want to solve through city logistics, usually with the objective of improving the efficiency and economics of their deliveries.

2.1.2 City Logistics Solutions

These city logistics problems outlined above can be approached in three different ways, through policy, planning, or through technology (Anand, et al., 2012). The policy approach attempts to tackle the different city logistics problems by having the administrator implement different rules and regulations to change the way that companies involved in city logistics act. The concept is that by having these carriers and shippers follow these policy directives, it will result in a more efficient system. Policy solutions can take shape in the form of banning delivery trucks during peak hours, or implementing weight limits on specific roads, where the administrators believe that these decisions will result in an overall improvement for the city. The technology approach covers the advancement and implementation of new technologies in city logistics. This can be either implemented by administrators or by carriers and shippers on their own initiative. By implementing new technologies, delivery vehicles can be safer and cleaner, while the overall system can be made to work more efficiently. For example, administrators can use new technologies to provide real-time traffic updates and directives to avoid further congestions. Shippers can replace their older vehicles with newer electrical or more efficient vehicles that will largely reduce both sound and air pollution. Lastly, the planning approach deals more with how the city itself is planned and made. How changes in the infrastructure of the city itself can improve the logistics in the city. A special congested street can be alleviated by planning a deviation between the two destinations that will reroute some of the traffic in the affected area. Usually, it takes more than a single solution coming from different categories to properly tackle city logistics problems, often time needing contributions from all of the stakeholders involved.

According to Quak et al. (2016) to actually achieve positive changes in city logistics it is necessary to align the different stakeholders, who often times have conflicting objectives and ways of doing things. This means that their objectives, their abilities to act, and how they view the problem need to be aligned, it is not possible for one stakeholder, even the administrator, to take over and force their objectives on others. This is because no single stakeholder has a complete overview of the city logistics system, and it is impossible to accurately predict how every planning, policy, and or technology solution will turn out.

The idea of differing stakeholder ambitions and a lack of possible oversight can be studied through the use of Shared Situational Awareness (SSA) (Quak et al., 2016). This concept focuses on the idea that it is impossible for one stakeholder to be aware of the whole situation. Yet, if each stakeholder is aware of the relevant information, has the proper tools, and is willing to share and learn together with the other stakeholders in the network this problem can be minimized. This will mean bringing the SSA of each stakeholder from perception to participation.

Perception is the first maturity level in SSA, where each stakeholder is only aware of its own function in the system and concentrates on their own goals. Participation is the third maturity level where stakeholders cooperate with others in joint actions and adapt to problems in the system. This will make it possible for different stakeholders in city logistics to work together to reach possible solutions. To achieve this city logistics stakeholders need to create alliances through which they can discuss any logistics issues and try to find solutions together. By working together, the administrators can take into account private companies when they make changes in policy or planning, which will result in better results that benefit everybody. At the same encouraging the private companies to take actions that will benefit the group as a whole, instead of only one stakeholder at the cost of all others.

2.1.3 Crowd-shipping in City Logistics

Through technology advancement in app-based platform technologies crowd-shipping has risen as a possible city logistics solution. Crowd-shipping is defined by Rai et al. (2017) as "an information connectivity enabled marketplace concept that matches supply and demand for logistic services with an undefined and external crowd that has free capacity with regards to time and/or space, participates on a voluntary basis and is compensated accordingly". More straightforwardly a crowd-shipping app matches someone who wants to ship a package with a person that is willing to deliver the package for a fee. This usually happens in the last or first mile logistics and more commonly in urban areas where there is a higher density of willing participants and addresses (Le and Ukkusuri, 2018). This can mean that the courier makes a special trip for the package, but it can also mean that simply takes advantage of the courier's existing travel plans.

For crowd-shipping to succeed, there needs to be knowledge of both the demand and supply side of the crowd-shipping delivery process. There needs to be a clear understanding of what it is that the customers want and expect, and the reasons they might prefer crowd-shipping over conventional delivery. On the other hand, it is also vital to appreciate what incentivizes people to deliver packages, and what encourages them to participate as couriers in the app.

The supply side of crowd-shipping is different than in conventional delivery, the couriers participate in the market on a voluntary basis and their willingness to work needs to be studied. Rai et al. (2018) found that the most important factors for the willingness-to-work of couriers on crowd-shipping platforms were the "compensation", "good working environment" and "good platform operation" in descending order.

Studies (Le and Ukkusuri, 2018; Marcucci et al., 2017; Le et al., 2019) found that most (up to 80%) of people were willing to work as crowd-shippers, especially younger people (specifically students) and others who had worked in delivery previously. While many of these were concentrating on driving to deliver the packages, the use of underutilized public transportation, outside of peak hours is a more sustainable option of package delivery.

The demand side of crowd-shipping considers the willingness of customers, be they individuals or companies to use crowd-shipping as a way to deliver their packages. According to Frehe et al. (2017) what mostly affects whether customers use the platform is platform usability, trust in the company, quality of delivery and pickup, and environmental friendliness. Devari et al. (2017) also found that reliability, privacy, and accountability are big factors on whether customers decide to use a crowd-shipping platform. Though one problem with the demand side is connected to the supply in that if a company has no willing couriers there can be no customers, while the opposite is also true. To counteract that, there needs to be a growth in public acceptance of crowd-shipping platforms, to promote the even growth of both sides. As most of the interest and awareness of crowd-shipping comes from the age class 25-34, the awareness should increase in the future (Le et al., 2019)

The benefits of crowd-shipping to city logistics should be seen in both the economical and environmental aspects. A study by Gatta et al. (2018) focused on public transportation crowd-shipping, where couriers use public transportation instead of cars to deliver the packages. It showed that both shipping time and cost were lower than usual, and customers were happy they could plan out a date and time for the delivery, though found dissatisfaction in customers having to spend a large amount of time waiting for the couriers. There were societal improvements as well over conventional delivery. With less emissions of polluting gasses, and lower accident rates.

2.1.4 Data collection in City Logistics

The same problems that affect city logistics also affect the data collection in city logistics. There are many different conflicting stakeholders involved in every delivery. There is no one stakeholder with a full view of the process that can gather the data that might be needed. Instead, each stakeholder might measure data that they are interested in and is unlikely to make that data public with no incentive. Even if the data is measured, different stakeholders do not necessarily measure the same thing or use the same format. Freight can be measured through different metrics, usually categorized into two categories, freight generation, and freight trip generation. Freight generation is the actual generation of demand, the amount of freight being carried, for example, a weighed amount of goods. Freight trip generation is the generation of traffics which could, for example, be the number of trips, or van-kilometers (Holguin-Vera and Jaller, 2014). While these two are often linked, as more freight usually means more trips, there can be cases where these are not related, for example with empty trucks, there is no freight generation but there is a trip generation.

These difficulties in data collection of freight transport can make it difficult to have measurements in city logistics. Holguin-Vera and Jaller (2014) claim that the only way to properly collect data in this situation is by the data that each stakeholder is aware of and combining these together to form the most comprehensive collection possible. Table 1 shows the level of detail that can be gathered at different points of the logistics process. It illustrates that it is impossible to collect all the data necessary from one stakeholder or through one method. Instead, a combination of the different stakeholders is needed as well as gathering data from outside the city logistics stakeholders. For example, by relying on manual

counters to directly observe vehicles in a location to asses traffic flow, or using GPS tracking to accurately follow freight as it is being delivered.

Level of Exc Goo Son Low Onl	detail ellent id ne v y general	Encidat concretion data	г гевди успеганоп цага	Delivery tours			Economic	characteristics of	participating agents	Spatial distribution /	Location of	participating agents		Noticeals	INCLWOLD	Special choice processes				
Unit/ S	ampling	Production	Consumption	Sequence	Location	OD flows	Empty flows	Shippers	Carriers	Receivers	Shippers	Carriers	Receivers	Travel times, costs	Use restrictions	Capacity	Traffic volumes	Mode choice	Delivery time	Mode attributes
	Shipper								٥	٥		٥								۰
Establish- ment	Carrier							•		•				Đ					٦	٦
	Receiver							۰	₽		Ð	▣						٠		۰
Trip intercepts		۰	•	۰	۰		٥	•	D	•	۰	D	۰	٦	۰	۰			۰	۰
Vehicle								۰		•				•					٥	
Tour								۰		•				•					0	

Table 1: Data collection in the logistics environment, taken from Holguin-Vera and Jaller 2014

2.2 Experiment Design

The goal of any research is the development or improvement of theories, or solutions to problems through a systematic investigation (Gough et al, 2012). The reasons to start a study can come from filling a theoretical gap, to increase knowledge, and to effect scientific progress, usually referred to as pure research (Dresch et al. 2015). Applied research can also be conducted to generate results that can be used in practice to solve problems. These two types of research are not mutually exclusive, applied research can also cause scientific progress, and vice versa. What is important is that a strict methodology is followed to guarantee the reliability and replicability of results, which is the only way to produce scientific knowledge. Figure 1 shows an example of the steps that need to be taken to conduct proper scientific research.



Figure 1:Steps in carrying out scientific research. Taken from Dresch et al 2015.

As seen from figure 1, any study starts due to a reason for the scientific research. According to Booth et al (2008), this can be either due to an observation from reality or from a gap in theory. From this follows the goals of the study, be they to explain, describe, predict, or improve a phenomenon. With these goals in mind, a study can be designed to achieve these goals. These studies can take different shapes, each methodology having different requirements and benefits, some of which will be expanded upon in the following subsections.

2.2.1 Case Study

A case study is an in-depth and detailed examination of a particular case, where everything about the case can be researched, be they "individuals, groups, activities, or a specific phenomenon" (Cronin, 2014). Through case studies, there are attempts to better understand complex concepts in their actual context. According to Yin (2009), features of a case study are that it is a qualitative method with a small number of participants who are observed 'in the field'. It is usually conducted over a set period of time, where indepth data is obtained (Cronin, 2000). This data is obtained through observation, questionnaires, interviews, and meetings, which is often qualitative but can have some quantitative elements. This data is then used to either test out a theory, create a new theory, or describe the phenomenon (Eisenhardt, 1989). Yin (2009) argues that the case study is a powerful method "to explain real-life, causal links, with the researcher able to appreciate the subjective richness of individuals recounting their experiences in a particular context".

A case study has a subject and an object. Each of which must be defined clearly before the case study is conducted (Thomas, 2011). The subject is the case itself, while the object is the analytical frame through which the subject is viewed. The subject is a 'practical, historical unity' (Thomas, 2011). When choosing a subject for a case study, there must be specific reasons to decide why this case specifically is chosen to be studied. There are three reasons for this, the subject is either: a key case, an outlier case, or a local knowledge case. A key case is one where the subject is important, and there's an inherent interest in the case. A key case is one where the researcher can gain "exemplary knowledge" (Thomas, 2011). An outlier case is a subject that is chosen because it is different than others like it. This difference can offer the researcher more interesting and again "exemplary" data. Lastly, a local knowledge case is chosen when

the subject has existing firsthand knowledge of the subject, which will aid him in his research of it. Yin (2009) also adds another possible reason for choosing a subject, namely its typicalness. Where the results from this case study on this subject are expected to apply to a certain extend to other similar subjects. The object is the analytical frame of the study, it is the concept being studied in the context of the subject. The object of the case study can alter throughout the study as more data is collected and a better understanding of it is formed.

2.2.2 Design Science Research

Design science research is a research method that is focused on problem-solving (March and Storey, 2008). It is a method that establishes and operationalizes research with a desired goal like a recommendation, or artifact. An artifact being something man-made, an interface between the inner and outer environment (Dresch et al. 2015). Design science research is looking for solutions to specific problems, with the goal not of necessarily finding the perfect optimal solution, but a solution that works well enough for the circumstances. This is because, for real-life problems, an optimal solution oftentimes does not exist. While the method finds a solution to a specific problem, design science research should produce solutions that can be generalized and used for other similar problems (Vaishnavi and Kuechler, 2012). To do this, the methodology has to be rigorous so others can follow and replicate similar results.

Figure 2 outlines the basics of design science research. It shows how the research has to take real-life problems from the environment, which can be technological, organizational, or personal as an input to the process. And uses the existing knowledge base to develop theories and artifacts. These are then evaluated and justified using this same knowledge base that has been recognized as valid. It then outputs specific practical solutions while adding to the knowledge base through generalizations of these same solutions. It highlights the importance of relevance and rigor to the process. When conducting design science research, the relevance of the research to organizations needs to be clear while rigor makes sure that the results are viable and considered reliable so they can contribute to the knowledge base.



Figure 2: Design Science Research. Taken from Hevner et al. 2004

To ensure that design science research is both relevant and rigorous, Hevner et al. (2004) have devised seven criteria that can be followed by researchers. These guidelines are derived from the idea that knowledge and understanding of a problem are gained through the design and application of an artifact (guideline 1). This artifact can be a model, a method, an experiment, or a construct. Importantly this artifact has to be designed with a specific purpose and domain in mind for which it will be relevant (guideline 2). To ensure that this artifact is useful it has to be evaluated rigorously through a proven methodology (guideline 3). Also important is that the artifact is innovative, it needs to solve a problem that either has not been solved before or do it in a new more efficient way (guideline 4). This establishes that the process is design research and not simply design. Research implies that the process needs to be replicable, which means that the design science research must apply rigorous methodology throughout the process (guideline 5). This process is a search process where the designer must use all available tools to reach the goals that have been set forth (guideline 6). When finally, the goal is reached, the results of the research have to be communicated effectively, making it accessible to both technical audiences (from the knowledge base) and to a managerial audience (the environment) (guideline 7).

There are different methods to formalize and operationalize design science research. By following these methods, the researchers ensure the rigor and validity of their research. What follows is a quick overview of a few different methodologies.



Figure 3:The Design Cycle by Eekels and Rozenburg 1991

The design cycle proposed by Eekels and Rozenburg (1991) shown in figure 3 was originally proposed for research in the field of engineering but can be employed in a variety of fields. The method begins with the definition of the problem which is the unsatisfactory situation which has to be transformed into a more satisfactory one. After identifying the problem and what needs to be changed the next step is analysis. In this step the researcher analyses the current environment, the situation that needs to be changed. This is done through both direct observation of the situation and through theoretical research in literature. Through these means, the research hopes to attain an understanding of the facts as they are in the present and the possible solutions that the design could strive towards. From this analysis, a list of requirements, specifying what criteria need to be met to make a successful design are constructed. From these requirements the next step, synthesis is performed. In the synthesis step, the researcher must consider the entire landscape to truly understand what the problems are and the path to a solution. By combining everything that the researcher has learned, a tentative design proposal is made. In the fourth step, this design is then tested, through simulation. This simulation should predict the behaviours of the final design, though the researcher must keep in mind that no simulation will be wholly accurate. It results in a conditional prediction which is evaluated in the next step. In this step, the prediction is compared to the requirements that were produced after the analysis step in the cycle. This comparison will then result in a decision on whether the design fulfilled these requirements and can be considered a success. If the design does not fulfil enough of the requirements the research moves back to an earlier stage to retrace some of the steps and attempt an improved design. While this design cycle by Eekels and Rozenburg (1991) is somewhat broad, it can be adapted to better fit a specific situation when necessary.

2.2.3 Action Research

The goal of action research is to solve and explain problems that are found in a system, attempting to generate knowledge both for practical application and to increase the knowledge base. According to MacColl et al. (2005), action research consists of two parts "collaborative analysis by the participants, leading to the formulation of theory; followed by collaborative change with studying of results". The researcher takes an active role in the study and collaborates with the system that is being analysed. For a study to be action research, the researcher needs to take a non-trivial action that will have a noticeable effect on the system (Dresch et al. 20014). Through the action part of action research, practical solutions are generated, while the research practice is about creating knowledge about practice (Mcniff and Whitehead, 2016).

According to (Coughlan & Coghlan, 2002) to properly conduct action research, three steps need to be taken. These steps need to be implemented in the design of the experiment. Any provisional and final experiment design will need to fulfil and be able to answer the steps outlined below:

- 1. Pre-Step:
 - a. Why is the Living Lab project desirable, and what are the forces driving the need for action?
 - b. Why is this worth studying?
- 2. Main Steps:
 - a. Data Gathering
 - b. Data Feedback
 - c. Data Analysis
 - d. Action Planning
 - e. Implementation

- f. Evaluation
- 3. Meta Step: Monitoring
 - a. Can be considered a meta-step. It occurs throughout the whole cycle (and all subsequent cycles). By constantly monitoring throughout the six other steps, and questioning assumptions and what is happening, it can encourage continuous learning.

2.3 Living Lab

Living labs are an emerging concept where private companies, public bodies, and individuals collaborate to test out and validate new concepts in a real-life environment (Niitamo et al., 2006). The idea behind Living Labs is to aim for innovation that leads to usable products and services (Eriksson et al. 2005). The concept was initially started by William Mitchell at MIT to observe the living behaviours of people living in smart homes for a time and has grown from there. It has developed into both an environment and an approach that "facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values." (Bergvall-Kåreborn et al., 2009).

According to Bergvall-Kåreborn et al., (2009), there are five components and five principles that make up a Living Lab and will be explained in the following paragraph and seen in figure 4. The five components are:

- *ICT & Infrastructure:* The technologies that enable different parties to share and collaborate.
- *Management:* The ownership, organization, and policy of a Living Lab that is usually run by researchers.
- *Partners & Users:* Each bringing their own knowledge, expertise, and expectations to the Living Lab.
- *Research:* The learning and evaluation of different concepts in the Living Lab, which should contribute to both practice and the theoretical knowledge base.
- *Approach:* These are the methods and techniques that are generated by the Living Lab environment

The first principle of a Living Lab should be *openness*. Openness in the sense of knowledge sharing between different parties, and an open mindset to attempting different approaches. This leads to more collaboration and the development of new ideas as different perspectives are gathered. A second principle is *influence*, the influence of different stakeholders who are rarely involved in the innovation process. End users are encouraged to have a larger say and influence of proceeding to improve the technical aspect of the end product and because users should have a right to have a say in the technology they will be using. *Realism* is the third principle. It emphasizes that all activities in the Living Lab should be carried out in an as natural and realistic manner as possible. This generates results that are also valid in the real world. *Value* is an important principle, that is divided into economic, business, and consumer value. Economic value can be measured through the innovative output for each stakeholder that holds economic value to their organization. The business value relates to the more intangible yields from the Living Lab, like intellectual property and new relationships. Lastly, consumer value is the extra value that consumers perceive in the improved products and services offered to them. The last principle is *sustainability*. This refers to the responsibility that the Living Lab holds to the wider community it inhabits. Its responsibility to create new relationships and new knowledge that contributes to societal needs. It is

also vital that the Living Lab takes responsibility for its environmental, social, and economic effects on its surroundings.

2.3.1 City Logistics Living Labs

Like other Living Labs, the objective of a city logistics Living Lab is to encourage collaboration between authorities, industry, and academia. Bolstering relationships between these stakeholders and the implementation of "sustainable logistics measures along with monitoring and evaluation tools to enhance freight policy in urban area" (Nesterova et al., 2017). For a city logistics Living Lab the set-up has to fulfil three important conditions according to Quak et al. (2015). *Inclusiveness* where the different relevant stakeholders are connected, and each has a similar awareness of the problems facing them and possible solutions. *Anticipatory capability*, the ability to predict the effects through simulation, gaming, or other forms of analysis. *Responsiveness*, measuring the impacts, and having the ability to together react with a potential solution.

To ensure that these conditions are fulfilled and that the city logistics Living Lab is a success, some elements need to be present according to Nesterova et al. (2017). There needs to be political commitment in the form of solid plans and measures to support the city logistics Living Lab. These can provide guidance of where efforts need to be concentrated and can help the Living Lab run smoother. Stakeholder cooperation needs to be encouraged, as more involvement from different parties at different stages of the lab, results in increased benefits for all. This requires a platform or mechanism that promotes regular cooperation and communication between the stakeholders. If this includes enough stakeholders it builds trust and results in common solutions and improves the system (Nesterova and Quak, 2016). It is also important to know what is happening in the city logistics Living Lab. Constant measuring and analysis of data are needed to make the best decisions. As discussed previously gathering data is difficult in city logistics due to the variety of stakeholders and their unwillingness to share data. By using technological advancements in real-time traffic and air quality measures and the increased trust and cooperation between stakeholders in Living Labs, the availability of data should improve. Lastly, city logistics Living Labs need to be an iterative learning process, with a consistent knowledge transfer. Nestrova and Quak (2016) explain how a "cyclical approach is in the foundation of Living Lab methodology." Where solutions can be tested, measured, evaluated, adjusted, and tried again, creating knowledge at each iteration, as illustrated in figure 5. This incorporates knowledge and feedback from all the different stakeholders, and in turn, generates knowledge for each as well.



Figure 4: Example of an Iterative process that could be used in a Living lab

2.4 Minimum Viable Product

Minimum viable product is defined by Ries (2009) as "a version of a new product, which allows a team to collect the maximum amount of validated learning about customers with the least effort". It has different definitions in literature but is usually defined along the lines of being an iterative process that is based on continuous feedback from early adaptors (Lenarduzzi and Taibi, 2016). By using a minimum viable product, companies can collect data about an early version of their product while generating revenue. A minimal viable product needs to have the minimum features possible to still be viable as a product for the customers. By following this strategy companies can gain high returns with minimal risks. The returns a company can gain are that they can test the product out, gather customer feedback, identify the most viable features by repeating the process multiple times. Meanwhile, the company is also selling products that would add revenue which would usually not be collected if the company waited to release the product with all of its planned features ready.

When planning to use a minimum viable product strategy in a product release, a few steps should be taken. The product owner should have a clear idea of what the value proposition is on a business level, but be ready to reinterpret how that value changes on different technical details (Munch et al., 2013). This allows for iterative testing of the value proposition through small changes in the product. The product starts at its most basic 'down-scoped' version possible. This is then released to an audience that is not involved with the project, for them to use and evaluate. This feedback is then considered as the product is slightly improved. This new and improved version is again released, this process is repeated iteratively until a product is reached that is considered complete. This process can be very beneficial for the right product, but there are many products where adding new features and releasing them multiple times can be damaging. It is important to consider whether a product benefits from being produced in a Minimal viable product fashion before starting the process (Munch et al., 2013). Specifically, a Living Lab could benefit from the advantages of following the minimum viable product approach as it benefits from the minimized risks as well as the iterative testing and the customer feedback.

3. Methodology

This chapter will outline how the Living Lab experiment will be designed. It uses the theory gained from the literature review in chapter 2. Starting with the outline of the experiment design, the section explains the design theories that are used and how they will be implemented throughout the thesis. Focusing on the design cycle whose format the thesis mostly follows. The chapter will then proceed to explain the practicalities of the design, describing how the relevant data will be collected through meetings and interviews with stakeholders. Concluding with how the design will be validated and evaluated.

3.1 Experiment Design Outline

A theoretically backed research methodology and approach are necessary for the design of an experiment. It helps ensure that valid and reliable results can be taken from the Living Lab. It also establishes a framework for a design that can reach the objectives that have been set forth. The Den Haag Living Lab is a particular experiment that requires a mix of methodologies. A 'case study' research methodology will be used to frame the research while Action research philosophy will inform the experiment to encourage critical reflection of how the actions taken by the experiment affect the experiment and its subjects. The main approach however will follow Design Science research methodology. This approach will guide the steps on how to prepare for and design a successful experiment and will be the approach that is focused on the most.

3.1.1 Case Study Frame

As the wording of the 'Den Haag case' implies, the experiment can be taken as a case study; an in-depth and detailed examination of a particular case. In a case study, a subject (the case itself) and object (analytical focus through which the subject is viewed) must be defined clearly and distinctively to allow for proper research. The subject of our case is the Den Haag urban freight system. It has hard geographical boundaries of the city limits and time boundaries defined by the timing of the Living Lab. The choice of the subject is outside of the scope of this work but could be considered to be due to *local knowledge*, the proximity of Den Haag to TUDelft would have been considered. The object of the case study, the analytical focus of it, would be the '*Effects of introducing a platform that connects various logistics services, including crowd-shipping to deliver packages*' which is what the experiment wants to look into.

Following the approach of Thomas (2011) of his typology of case studies, the Den Haag case study can be categorized as shown in figure 6. As discussed previously the subject is chosen due to local knowledge instead of it being a key, or outlier example of an urban freight system. The purpose of the case study is intrinsic (Stake, 2005)) as we are concentrating on Den Haag itself and not on what happens beyond the case. It has an evaluative purpose as the Living Lab will be testing a solution (the logistics platforms of Nimber and the other stakeholders) and assessing its effect on the urban freight system of Den Haag.



Figure 5: Den Haag case study, adapted from Thomas (2011)

The approach will be that of theory testing. The experiment will assess the validity and scope conditions of different theories on how the platform can and will affect the Den Haag urban freight system (George & Bennett, 2006). Lastly, we have to decide on what sort of process will be followed. When Lead is seen as a whole, there could be an argument to claim that there are multiple subjects (the different cities' urban freight systems) that will be compared. Yet for the thesis, the focus will be completely on one single subject (Den Haag), with little concern given to the other Living Labs. This leads to a single study, which will be comparing the subject over time and thus a diachronic single process. Comparing the freight system before the introduction of the platforms to afterwards.

3.1.2 Design Science Research

The case study framework is needed to give structure to the living lab. The design science approach will help develop an experiment design. The idea behind design science is not only to explain or to increase knowledge (about how the design is created) but more to improve the performance of the process of designing as well as the final solution (Aken, 2004). The idea is not necessarily to come up with the perfect solution, but a satisfactory solution (Simon, 1996), as an optimal solution rarely exists when applied to the real world. In design science, research usually starts from the need to design an artifact (something man-made, interface between inner environment and outer environment (Dresch, Lacerda, & Antunes, 2014))in this case, an experiment design. This research should be grounded in scientific methods, but design science also requires some creative thinking.

To guide design science research, Hevner et al. (2004) came up with seven criteria that should be followed by prospective researchers. This is an overview of how these criteria will be followed in this research presented in the figure below:

Design an artifact	• Design of the Den Haag City Logistics Living Lab experiment
Problem relevance	 Problems of efficiency, traffic, pollution in Den Haag city logsitics system Problems of designing a city logistics living lab while keeping stakeholders satisfied
Design evaluation	 Experiment design will be validated through stakeholder feedback Experiment design will be compared with design requirements
Research contribution	 Contribution to the workings of the LEAD experiment Contribution to stakeholders' undesrtanding of the Den Haag parcel business
Research rigor	• Following Design science research, case study, and action research methodologies to ensure research rigor
Design as a research process	 Using documentary, bibliographic, and interview data to construct and evaluate the experiment
Communication of the research	• Writing a thesis and presenting in a way that both technical committee and other stakeholders are well informed and satisfied

To conduct research based on design science, different methods from different areas can be looked at. By taking a more general method, like the design cycle proposed by Eekels and Roozenburg (1991) that was discussed in the previous chapter (2), it can be tweaked to be used for our specific case. What follows is a short overview of how this design cycle would look:

- **Problem:** Starting with the function of the experiment, what do we want the experiment to do/what do we want to learn?
 - The main purpose is to evaluate the effects and possibilities of connecting different lastmile logistics services and platforms to create an interconnected open platform. To do this the platforms need to be implemented in a realistic manner and the right data needs to be measurable.
- **Analysis:** Analyse the current situation from both a practical and theoretical perspective. Investigate what solutions have been attempted and which could be possible in this environment.
 - Perform literature research to delve into three topics. Firstly, the topic of city logistics to be able to properly analyse the circumstances in Den Haag, secondly the topic of Living Labs to understand what needs to be designed. And lastly, experiment design and previous city logistics experiments to consider what has already been done and what directions look promising.
 - Analyse the current situation of the Den Haag Living Lab through stakeholder analysis and mapping, and business model canvases of the relevant stakeholders.
- **Requirements:** The performance specifications need to be formulated, what criteria should the design meet to be considered successful?
 - The criteria of the experiment will be set by the stakeholder involved. This will be done through discussions held with different stakeholders. This means that discussions and interviews need to be held with the different stakeholders (Nimber, Next2, Den Haag municipality, TUDelft/LEAD, and others). This can reveal what they each expect from the experiment. These expectations need to be converted into KPIs which could be measured

(measurability is also a responsibility of the stakeholders and would need to be discussed with them as well) to give clearer results.

- **Synthesis:** Coalesce the concepts considered previously: all of the literature research, the stakeholder opinions and requirements, and the original design purpose to get a vision of how the design should look. What it needs to include and what problems the design will attempt to solve.
 - This entails combining the literature research done on city logistics and Living Labs and combine it with the knowledge gained from analysing the stakeholders and their needs, objectives, and capabilities that they have discussed during the data collection.
- Provisional Solution: A provisional design proposal needs to be generated.
 - At this point, creativity is needed. By looking at the desired functionalities of the experiment, comparing to what is possible and realistic an experiment design is made.
 - This design should outline how the experiment is going to be conducted. Delineating the roles that the different stakeholders will have to perform. It will also lay out what needs to be measured, how it is to be measured, and by whom.
 - It will also explain how the gathered data is to be analysed, through which methods. And how to use the analysed data to evaluate the success of the experiment to each stakeholder.
- **Simulation/Testing:** The design won't be tested but instead using reasoning and discussion with the stakeholders, an idea of how the design would potentially perform is formed. This will lead to us being able to have some expectations and predictions of how this experiment design would perform when carried out.
- **Evaluation:** These expectations of the design then need to be compared with the criteria set in the performance specifications step. This comparison will be evaluated by the researcher and the stakeholders to judge where the design meets the criteria and where it would fail.
- **Decision:** After this evaluation, it will be decided whether the stakeholders and project owners are satisfied with this experiment design and move on to fine-tune it, or whether it is better to go back to a new and improved provisional design which would go through the last few steps again. It could also be that through this process we learn that some of the criteria are unrealistic or incompatible, which would mean we would have another discussion with the stakeholders to see where we could compromise.

This design cycle is chosen because of its flexibility. It allows the design to conform to the needs of this specific scenario. Yet different research design methodologies can also be borrowed from to sustain the Eekels and Roozenburg design cycle. The soft design science research method proposed by Baskerville et al. (2009) can help come up with provisional solutions by keeping the 'real world' and the 'design thinking' world separate. The method of (Gregor & Jones, 2007) can help by specifying design theory, which would help as we see how the Den Haag experiment design adds knowledge and fills a knowledge gap. Though this method was developed for information systems, it can be adapted for the city logistics field.

3.1.3 Action Research

Action research is characterized by being participative, being concurrent with action, and being research in action, not about action. In the Living Lab, the stakeholders involved with the planning of the experiment will also be participating in the experiment. The action (introduction of platforms) will be done concurrently with the research, the effects of which will be studied. This makes it clear that the planned

experiment can also be considered action research. As many of the stakeholders will be interacting, cooperating, and are themselves members of the system being analysed, special caution needs to be taken.

As the researcher takes the role of Living Lab owner, they will be in charge of organizing, conducting, and monitoring the Living Lab experiment. This means that they are in direct contact and will heavily influence all of the activities of the Living Lab, so the research needs to be aware of how their actions are affecting the study. In chapter 2, it is explained how steps need to be taken when conducting action research. The step that needs to be taken into account while the research is ongoing is the meta step of monitoring. The researcher must continually be monitoring the process of the Living Lab, inquiring on what is happening, how the process is being conducted, and what assumptions are being taken. While other stakeholders might be focused on the practical side of the Living Lab, the researcher must also monitor the learning process and ensure that all the possible knowledge gained is documented and communicated to those that might need it.

3.1.4 Final Methodology Mix

As has been discussed in the previous sections, the final experiment design methodology is a combination of the three methodologies described. The design cycle described in section 3.1.2 will be the main guide to design the Living Lab experiment and will be used to structure the thesis. This is reflected in Experiment Design component of the thesis that closely follows the design cycle structure in its formatting. The case study described in section 3.1.1 is used as a framework, to establish the limits of what is of interest and how the design will be approached. From the action research methodology described in section 3.1.3, the main interest is in the monitoring step. This will ensure that the knowledge created while following the design cycle is captured.

This mix of methodologies was chosen due to the needs of the thesis and the experiment. For the thesis there needs to be a clear and rigorous methodology that is replicable by future researchers in City Logistics Living Labs. For the experiment the methodology needs to result in a working, realistic design for the living lab that takes into account the objectives of the various stakeholders involved. This is why the design cycle was taken as the main pillar of the methodology. It is a proven design methodology that has been used for years. Which means it is possible to replicate it while it has shown evidence that it can deliver a working final design. Yet this methodology by itself is not enough for the needs of the thesis and the experiment. Action research is incorporated to ensure that knowledge is created and captured throughout the process. This is necessary as the thesis relies on learning from the process itself to answer the research question stated in 1.6. Lastly, due to the complexities of the thesis and the experiment overlapping, it is important to clearly define what is part of the experiment and what is outside of the scope. This is why the case study framework is also included in the final methodology. It helps the researcher clearly define what is part of the thesis and the experiment design process, what is part of the thesis and what is outside of the scope. Summary of the thesis and what is outside of the scope completely.

3.2 Data Collection

A work method is the steps taken to reach the goal of the thesis, it is important that it is well structured and properly followed, as this provides transparency in the process and makes it replicable. While the general research approach has already been explained, the work method explains how data is gathered and analysed. As explained previously this paper will follow a mixed approach combining Case Study, Action, and Design Science research. While the first two approaches are used mostly to frame the work and ensure it is done properly, it is Design Science research that will guide the actual work done in designing the Living Lab experiment.

The data gathering is first done through a literature review of the topics of interest; city logistics; research methodology; design methodology; Living Labs and experiments. Then data is gathered from the stakeholders through a combination of meetings and interviews. Meetings will be held where the stakeholders can all discuss their views of the experiments with each other, and where different aspects of the experiment can be agreed upon. Individual interviews will be held with the relevant stakeholders and will be one on one with the researcher to better explore the objectives and requirements of each stakeholder.

3.2.1 Meetings

While one of the goals of the meetings for the researcher is to collect data, it has to be kept in mind that this is not the overall goal of the scheduled meetings. A Living Lab is a collaborative effort. This means that there will be more back and forth discussion than a simple ask and response. The idea of these meetings is for all of the stakeholders to reach a common understanding together. The goal being that they create a shared awareness as discussed in section 2.1.2 and for them to start discussing potential solutions together. The function of the Living Lab owner is to lead these discussions while the researcher attempts to collect data through observation and interject when needed.

During these meetings, the researcher must take careful note of what is discussed. Registering the opinions of each stakeholder and the requirements and objectives that they express during these meetings. Even when a different approach is agreed upon it is important that the researcher documents what a stakeholder wanted to do differently and how come. This can give further illumination on the objectives of a stakeholder and what could be done to design a Living Lab experiment that is in their best interest. What is most important for the researcher in these meetings is to document any agreed solutions or possible solution ideas that are expressed in the meeting. As the concepts that are accepted by multiple stakeholders are important to include in any potential design.

These meetings also serve as valuable early validation points of potential design ideas. Having to individually check every concept with stakeholders at separate meetings will be very time intensive and tedious for stakeholders, especially private companies that have more pressing timing concerns. Having broad experiment designs to discuss during meetings is much more effective. This way the researcher and owner can get feedback from multiple stakeholders and discussion between the stakeholders can be held. This can develop into other possible solutions that come preapproved from the different stakeholders.

There are plans for a few different kinds of meetings. There will be a scheduled weekly meeting between members of the Municipality of den Haag and TUDelft. The purpose of these meetings will be mostly for organizing and planning the Living Lab administration. Organizing how to approach stakeholders and organize meetings and potential next steps. The second type of meetings will include a few additional stakeholders that have been part of the Living Lab since its inception (Next2Company, DHL until their departure, Nimber). During these meetings the actual Living Lab will be discussed, stakeholder views shared, and possible solutions discussed. The last type of meetings are workshops that include a higher variety of stakeholders. Including different organizations and individuals who have an interest in the Living Lab. This can be different employees of the municipality of Den Haag, private companies interested in joining the Living Lab, or companies and individuals that are simply interested in seeing how the Living

Lab could affect them. These meetings are a way to inform potential stakeholders about what's happening, gather data about the views and sentiments of potentially affected stakeholders, and possibly find new stakeholders to be involved in the Living Lab.

3.2.2 Interviews

Individual interviews with each relevant stakeholder are held and divided into different rounds. The first round will be unstructured interviews, where the subject of the Living Lab and each stakeholders' expectations, desires, and worries are discussed more broadly. Interviews allow for a more flexible instrument and can provide a greater understanding of the data (Saunders, Lewis, & Thornhill, 2009). It is also possible to observe the attitude of the interviewee towards the question, which is important in this case where the interview subjects are the stakeholders that determine the success of the experiment. There are possible disadvantages to interviews that the researcher must be aware of. For one communication can be difficult, and care needs to be taken that either the questions or the answers are not misunderstood. When an interview is held in person, there is also a chance that personal bias can be introduced by the researcher (Dresch et al., 2015). The interviewer might influence the interviewee due to the manner that the questions are asked or the reactions to previous answers. The researcher must take care to attempt to minimize these possibilities.

The purpose of these interviews depends on the stakeholder being interviewed. For some stakeholders, the purpose will be to gauge the interest of the stakeholder in the Living Lab, to learn about the stakeholders, and to understand the views they hold as parts of the Living Lab. From these interviews, the researcher should learn the objectives the stakeholder hopes to achieve through the Living Lab, their ability to measure different kinds of data if involved in the Living Lab, and what potential stumbling blocks they fear, that would cause them to leave the Living Lab or reject an experiment design. There are other stakeholders that are not expected to join the Living Lab but are interviewed for their insight and potential ways they can assist the Living Lab. From these interviews, the researcher should try to learn from the expertise of the stakeholders and use that knowledge to aid in the designing of the Living Lab experiment.

3.3 Evaluation and Validation

There will be two levels of evaluation for the thesis, firstly a validation of the design itself. Whether it has succeeded in fulfilling the requirements and satisfying the stakeholders. The other evaluation will be on how the process of designing itself went, and whether the research questions have been answered, and whether there has been a contribution to the knowledge base.

The validation of the experiment design is part of the design cycle discussed in sections 2.2.2 and 3.1.2. As the design cannot be tested or simulated, the validation must come from a comparison with the requirements and feedback from the stakeholders. The design needs to be compared with the requirements planted earlier in the design cycle, which were originally expressed by the stakeholders during the data collection. An evaluation will need to be made on whether the design fulfils enough of the requirements. Whether there are any critical requirements that are not realized by the experiment design and would cause the design to be considered inadequate. The stakeholder themselves must also express satisfaction with the experiment design. This can be validated either through their assertations during meetings, or during individual interviews if it is not clear from the meetings whether they are satisfied with the proposed experiment design. The researcher needs to get confirmation on whether the design matches the stakeholder's objectives, and they believe it is a realistic plan.

The evaluation of the thesis will be conducted individually. To ensure that the purpose of the experiment was achieved the researcher must answer the research question adequately and whether a contribution was made to the knowledge base. The researcher has to analyse the process they went through while designing the experiment. Evaluating whether they rigorously followed the theory-supported methodology to make the design replicable by others wanting to design a city logistics Living Lab. Concluding with a reflection of the process and suggestions on what could be done differently to improve it.

II. Experiment Design

4. Problem

With this chapter, the thesis initiates the experiment design part, which is modeled after the design cycle discussed previously in section 3.1.2. The design cycle begins with a problem that needs to be solved. This needs to be identified to define what the function of the eventual design will be. This problem and function of the design differ from the function of the thesis itself. The thesis aims to formalize a process through which a successful city logistics Living Lab can be designed. The aims of the design itself are independent of the thesis and rely on the problems that the Den Haag city logistics system is facing, and this is what will be discussed in this chapter.

Identifying the problem is the first step of the design cycle. In the design cycle, the problem is defined as the difference between the facts and our set of value-preferences regarding these facts. The purpose of the design cycle is to change this into a more satisfying situation. The facts in this situation are that the Den Haag city logistics system is dominated by conventional package delivery, and there is no experiment at the moment that is attempting a city logistics Living Lab.

The purpose of this experiment is to evaluate the effects and possibilities of introducing a new concept to the Den Haag city logistics environment. Specifically, the experiment is to evaluate the effects of introducing a platform that connects various logistics services in the Den Haag area. This platform would integrate various different logistics services like crowd-shipping, cycling couriers, parcel lockers, and mobility hubs. Through these concepts, the aim is to improve Den Haag city logistics and give the customers and residents in Den Haag a better service.

By introducing these concepts in a Living Lab environment, it will be possible to learn how these logistics services can perform not only in the Den Haag environment, but how they perform when connected together. This will give the stakeholders the opportunity to evaluate whether there is an added benefit to connecting their services and changing their business models to a more collaborative model. Simultaneously the learning goals of the Living Lab follow similar lines. Mainly, to learn the impact and potential of how different logistics platforms can be connected and collaborate for positive results.

These concepts will be implemented through a Living Lab ideal introduced in section 2.3. This entails that the concepts be introduced in a realistic way. Encouraging an open and sustainable process that can be used to create value for all the stakeholders involved. These stakeholders will include public bodies of the Den Haag municipality and private companies involved in the logistics fields. Each of these stakeholders will have their own objectives and reasons for joining the Living Lab, which will need to be managed and considered throughout the design process. Lastly, the end-users themselves can influence how the concepts are developed throughout the Living Lab, their feedback will drive how the Living Lab is run after the design is set.

At the end of the Living Lab, a few things are expected to be achieved. Primarily, the hope is that the Living Lab can prove to be a learning experience for all those involved. Where the stakeholders can learn from the project the benefits of collaboration and how to best organize their businesses to serve their customers in this new logistics environment. This means that accurate measurements need to be taken throughout the experiment. These will then need to be compared with the state of city logistics before

the Living Lab. Allowing conclusions and judgements to be made on the effects of the different concepts implemented and the way they have been introduced. The knowledge gained must also be shared between the stakeholders for further benefit to all involved. A secondary aim is that the collaboration between stakeholders (public and private) during the Living Lab grows to become alliances that flourish past the confines of the Living Lab. Lastly as mentioned before the aim is that the Living Lab will result in an improved parcel delivery service for the residents and businesses in the Den Haag area.

5. Analysis

To properly understand the problem, and what solutions are possible, a thorough analysis of the current situation needs to be made. This chapter will attempt to give an overview of how the den Haag city Logistics situation is, as well as an analysis of the stakeholders involved in the Living Lab at this point. The section begins with an overview of the relevant stakeholder. They are then mapped using a saliency model, which can help in the managing of the stakeholders. The important stakeholders will then be further analysed through a business canvas to further look into their business models. The chapter then takes a broader view and gives an overview of the den Haag city logistics system as it is.

5.1 Stakeholders

As stated, the stakeholders are important to the Living Lab and the ones that will define the requirements of the experiment design. They need to be well understood and well managed, which can be done through stakeholder analysis. First, the role of the Delft University of Technology needs to be defined. As the owner of the Living Lab, the University team will not be considered a stakeholder. Instead, they are responsible for managing the stakeholders and ensure that the experiment runs smoothly. As an academic organization, the university has a vested interest in the knowledge produced by the Living Lab as well as being responsible as a technical partner in developing the Digital Twin that will support the Living Lab.

The stakeholders can be divided into two groups, the partners of the Living Lab and the other stakeholders. The partners of the Living Lab are those that have been involved from the start of the project as well as being listed on the original LEAD documentation. The partners are involved with the planning through scheduled regular meetings where each step is discussed and decided upon together. The other stakeholders join later in the timeline of the project, and their involvement and commitment are more limited. These stakeholders participate through the workshops and one on one discussions, their final involvement depending on their interest in the Living Lab and the final design of the experiment.

5.1.1 Partners

Municipality of The Hague

The municipality of The Hague represents the city of The Hague, consisting of 555,000 people and 80 square kilometers. In the Living Lab, the municipality is there to advocate for the interests of the residents of the city and to ensure the smooth running of all public services. Represented in the Living Lab by Sven Mittertreiner, a strategic policy advisor at the city's mobility department.

Nimber

Nimber is a Norwegian crowd-shipping platform where "a community of amazing bringers utilise their spare capacity to solve the challenges of delivery" (Nimber, 2021). It matches 'senders' who want their packages delivered with 'bringers' that are either already headed in the direction of the package's destination or see it as a short detour worth making. The app lets the two users agree on a price, delivery time, and package dimensions during negotiations, usually resulting in lower prices than conventional delivery. The platform also provides services for businesses that need to follow a more rigid schedule by matching them with reliable bringers. These reliable bringers are not employees but trusted users who employ electric cars and preplanned routes to fulfill the clients' deliveries. In the Living Lab, Nimber is represented by Jackson Amankwah.

LEAD

The LEAD project is an EU-funded initiative that plans to create six Living Labs in different European cities with matching Digital Twins. The objective is to "address the requirements of the on-demand economy and the pressures caused by the increase of parcel deliveries while aligning competing interests and creating value for all different stakeholders." (Lead, 2021) The LEAD team manages the Living Labs, including the Den Haag case. While they are not involved in internal meetings with the other stakeholders, they give direction and structure to the Living Lab experiment through personal meetings with the TuDelft Living Lab team. In these meetings, Lead is represented by Carolina Cipres and Beatriz Royo.

Next2Company

Next2Company works with its clients to develop new innovative business models for them. With DHL Express they have developed a platform integrating Next2Company's front-end with part of the DHL platform. Resulting in a platform that mixes a point-to-point model with a milk run model with the idea to serve both businesses and customers in a local-to-local distribution network. This concept was tried out in Tilburg, but they now want to test it out on a larger scale, hence their involvement in The Hague. The Next2Company is represented by Jan Smit in the Living Lab.

With the exit of DHL from the Living Lab experiment, Next2Company has shifted focus to facilitating the integration of the different stakeholders' offerings and platforms.

DHL

DHL is an international courier service that delivers over 1.5 billion parcels per year (DHL WEBSITE). The company is committed to "Deliver Excellence in a Digital World" by focusing on Globalization, Digitalization, E-Commerce, and Sustainability. With this in mind, they partnered with Next2Company to develop the platform explained above. As a partner in the Living Lab, DHL hopes to test out this new platform through real cases in a bigger city like The Hague. DHL is represented by Henne de Jong, Retail Channel Manager at DHL Express.

During the project, DHL had to back out of the project, meaning that the Living Lab had to be restructured. A new courier service had to be found to work with the project and the experiment had to be designed around the other stakeholders, mainly another partner; Nimber.

5.1.2 Other Stakeholders

MyPup

MyPup is a company that installs lockers at offices or residential buildings. These offices or residential buildings hire MyPup to ensure that their employees and tenants are not bothered by multiple delivery personnel and instead have a single location to pick up their parcels. Instead of having multiple deliveries per day, all the packages meant for a client's building are sent instead towards the MyPup distribution point. They are then delivered on the same day at the lockers through the use of a single delivery trip.

Mobian

Mobian provides mobility hubs, where users can park their cars and continue a journey with a different mode, for example renting one of their e-bikes. Through their partnership with Docker that provides cargo bikes, Mobian is attempting to also move into the logistics market. They plan on opening three different hub locations in The Hague in the next year and see involvement with the Living Lab as a potential step forward in their logistics operations.
Hely

Hely has mobility hubs where they provide different forms of shared mobility from various suppliers, including Cargoroo bikes. They have two locations in Den Haag. Hely has been looking at how their mobility hubs can also host logistics services as they are interested in the synergies between mobility and logistics.

Cargoroo

Cargoroo rents out e-cargo bikes to provide a cost-efficient eco-friendly way of transporting cargo. They provide their bikes in various locations including in Hely hubs. The company wants to move into the logistics field and provide solutions for deliveries between SMEs and its customers (WORKSHOP). Taking part in the Living Lab can be seen as a path towards that goal.

Cycloon

Cycloon is a courier company that delivers mainly through bicycles. In collaboration with 'Fietskoeriers.nl' to deliver packages throughout the Netherlands. They partner with a more conventional courier service (DHL) to transport their packages from city to city. The packages reach a hub at the edge of the destination city, at which point they are transported using cargo bikes to their final destination. With the departure of DHL from the project, Cycloon can be an alternative to provide courier service in The Hague Living Lab.

DB Shenker

DB Shenker is a global logistics company that provides logistics services throughout the world. They could be interested in the Living Lab as they see the combination of the different aspects of the Living Lab (crowd-shipping, parcel lockers, city bikes, etc.) having extra possible added value.

Primevision

Primevision provides solutions in machine vision, recognition, and identification technologies. Their solutions help logistics companies making their delivery process safer, more efficient, more flexible, and deliver higher customer satisfaction.

CID residents

The residents of the CID area are already represented by the Den Haag Municipality. Yet it is important to keep in mind that their needs might not be well reflected by the municipality. As the Living Lab will involve and affect the residents of the area, their voice needs to be heard during the design of the experiment. They will be affected not only due to changing methods of deliveries but they might also be involved as crow-shippers in the experiment itself.

CID/Den Haag Retail

The retailers of The Hague should also be represented by the municipality in the Living Lab. Yet they too need to be involved in the Living Lab to establish a successful experiment. Retail partners are needed to provide some of the volume of packages necessary to carry out the Living Lab. To achieve this retailers need to feel comfortable and feel like the Living Lab is benefitting their businesses.

National Government

The national government is in a unique position. It is not necessarily interested or very aware of the project, thus has very little urgency and legitimacy. Yet as the Living Lab is being held in the Netherlands it still has the power to influence the project if there is a reason for it.

5.2 Stakeholder Mapping

When a large number of stakeholders are involved in a project, especially representing both public and private entities it can become difficult to manage. With each stakeholder having differing objectives it can be difficult to align all of their interests. To help manage this it can be helpful to map the stakeholders. While this does not ensure that each stakeholder's interests will be achieved, it does help to analyze the different stakeholders and ensure that all those affected will be considered.

5.2.1 Saliency Model

The saliency model of stakeholder mapping uses three attributes (power, legitimacy, and urgency) to generate a categorization of the different stakeholders. (Mitchell & Agle, 1997) This can provide an examination of how salient each stakeholder is towards the project and thus the degree to which priority can be given to competing claims. Giving an indication of the best way to manage these different stakeholders and combine their views into an acceptable list of requirements for the experiment design.

Power: Defined by Weber (1958) as "the probability that one actor within a social relationship would be in a position to carry out their own will despite resistance". In this case, it means a stakeholder that can get us to do something that we otherwise would not do. This can be done through; coercive power (force, violence, or restraint); utilitarian power (material or financial resources); and normative power (symbolic resources). Through these, a stakeholder can impose its will on the relationship.

Legitimacy: Suchman (1995) defines legitimacy as "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions". This is a very broad definition, which is necessary to delineate a nebulous term like legitimacy and helps with stakeholder mapping. It shows that legitimacy is concerned with a greater desirable social good that everyone works towards.

Urgency: Urgency exists when there is a time-sensitive aspect of the relationship and the relationship is important to the stakeholder. For a relationship where a time delay will negatively affect the stakeholder, thus urgent stakeholders call for immediate or at least fast attention and advancement.

These three attributes combined can define the salience of a stakeholder to an organization or a project. It can inform the manager of the project to what degree they need to give priority to the competing stakeholder claims. Yet a few things need to be kept in mind when considering this model. Firstly, these three attributes are not necessarily consistent and can change depending on the stakeholder, the relationship, or outside situations. Secondly, these can be considered more points of view than objective realities and the stakeholders themselves might see themselves very differently or might act in a different way than the model would imply. This needs to be considered to understand how best to manage the different stakeholders.



Figure 6: The Saliency Model of the Living Lab Stakeholders

Figure 7 shows the saliency model of the different stakeholders potentially involved at this point of the Living Lab. These can be divided into stakeholder classes which can give a better indication of how each of these stakeholders should be managed. The following section explains why each stakeholder is classified in their classes and how they should be managed. It is important to note that this is a snapchat of the stakeholder mapping at a certain moment. Over time stakeholders can gain and lose attributes causing them to shift stakeholder class. This would mean a different approach is necessary at that point.

5.2.2 Stakeholder Classes

Dormant Stakeholders

A dormant stakeholder has power but lacks urgency or legitimacy, so their power is not used. While dormant stakeholders have little interaction with the project, we should be aware of the possibility of dormant stakeholders becoming active as they could have a big impact. The *Dutch national government* in this case is a stakeholder that theoretically has plenty of power, but they have a legitimate claim to influence the project and no urgency to get involved.

Discretionary Stakeholders

Discretionary stakeholders have legitimacy but no power or urgency. There is no pressure for the project owner to involve these stakeholders, but they might choose to if it feels like the right thing to do. The *CID residents and retailers* do not have power in the project, but they have a legitimate claim that they will be affected by the Living Lab. They have no urgency as they are mostly not aware of the experiment, but if or when they become informed, these stakeholders might gain urgency and become dependent stakeholders.

Demanding Stakeholders

Demanding stakeholders are those with urgency but have no power or legitimacy. They will likely try to get involved or affect the project but do not have the means to achieve that at this time. The different logistics companies (*MyPup, Mobian, Cargoroo, Hely*) have urgency as they are private companies that have expressed interest in the Living Lab. As growing private companies, they are interested in fast expansion and want to act sooner rather than later. Yet at the moment they do not possess the power or legitimacy (due to a lack of contracts or agreements) to compel the project owner.

Dominant Stakeholders

With power and legitimacy, these stakeholders have a strong influence on the project. With legitimate claims and the power to act on them, it means that these stakeholders 'matter' to the project owner. The *Den Haag municipality* as the governing body of the area where the experiment will run has the power and legitimacy (also brought on through agreements with the project) to influence how the Living Lab is run. Due to the many voices and interests coming from the municipality, it can be argued that they can be seen as multiple stakeholders. Yet for practicality, they have been grouped as one important stakeholder that has many claims that need to be addressed.

Dependent Stakeholders

Dependent stakeholders have legitimate and urgent claims but may lack the power to carry out their will. They might need the help of other stakeholders to ensure that their interests are seen to. *Nimber and Cycloon* have urgency as private companies that want to grow their companies in a competitive marketplace. They also have the legitimacy that other logistics companies lack due to agreements reached with the project leadership. To keep the project running smoothly it is best to address the claims made by these stakeholders as it can disrupt the project otherwise.

Definitive Stakeholders

When a stakeholder has all three attributes it can be considered to have a very high salience and be part of the project's dominant coalition. The claims from these stakeholders need to be attended to immediately and with priority. *Lead* as the providers of funding and as the 'architects' of the project have the power and legitimacy to strongly influence the project. They also have the urgency of strict timelines they want to keep to which makes them definitive stakeholders. Next2Company can be considered definitive as they have legitimacy due to agreements with the project owners, the urgency of a private company that has already spend time on the project, and power due to their position of connecting the Living Lab with other necessary courier company stakeholders (like Cycloon).

Nonstakeholders

The rest of the stakeholders that do not have power, legitimacy, or urgency when it comes to the Den Haag Living Lab can be considered non-stakeholders. While it can be useful to hear their views on the project and consider their expertise, they do not need to be consulted when designing the experiment. It can be possible for these non-stakeholders to gain one or multiple of the attributes and would then need to be considered during the process.

5.3 Stakeholders and their current business models

The stakeholders that show a vested interest in the Living Lab and who are either *demanding, dependent*, or *dominant* stakeholders are further analysed through a business model canvas. The canvases were constructed from data gathered from both the interviews with the representatives of the different stakeholders, and from what is freely available on the websites of the different companies. The business model canvas tool allows for this gathered data to be organised and presented in a way that gives a clear overview of the main components of each business. This will give an analysis of the relevant stakeholders and a better understanding of their current business models. Through this, it can give an opportunity to see how these business models will fit or might need to be altered to fit into the Den Haag Living Lab.

As a Living Lab involves the stakeholders investing time, effort, and money into the project, it is important to analyse whether the private stakeholders' businesses could develop in this new environment. Using the business model canvases will allow for a breakdown of the different business models of the stakeholders involved. This breakdown provides two opportunities, first it gives insight into how to best design a Living Lab that considers the business models of the involved stakeholders. Ensuring that the design of the experiment does not clash with the existing business models of the participants. The second benefit of the business model canvases are that it can give a notion of how the business models of each stakeholder might need to be altered to benefit most from the eventual interconnected business model that the Living Lab is building towards.

5.3.1 Nimber

		Designed for:	Designed by:	Date:	Version:
Business Model C	anvas	Nimber	Mateo	12/01/21	1
 Key Partners Trusted bringers that can be counted on to deliver on a scheduled basis Online payment services Busines partners that use Nimber as delivery but are not customers 	 Key Activities Creating and mantaining the apps and website Coordinate between business clients and trusted bringers to ensure service Key Resources The platform and software behind it Technical employees that can maintain and develop the platform The Nimber brand 	 Value Propositions Sustainable deliveries Flexible deliveries (outside working hours or weekends) Cost efficient, price decided by sender Safe deliveries Customization, caters to senders exact needs Option to make money on existing trips (for bringers) 	Customer Relationships Bigger businesses that have scheduled deliveries with trusted bringers have a closer relationship that the company works with Most users do not have much contact with the company, only through the app and website. Channels Apps and website to communicate with users Direct communication with businesses that want to deliver and have trusted bringers Online advertisement in auction websites to market the service 	Customer Segme • Businesses I have their pr delivered to customers, t other busine individuals • Individuals tt send a pack want to do tt and sustaina • Individuals tt make some- money on th trips or as de couriers.	nts hat want to oducts heir e they sses or nat want to age and is cheaply bly hat want to watra eir planned dicated
Cost Structure Employee payroll Platform costs: developing Marketing costs: online ac Insurance costs 	g, mantaining, and cloud hosting se lvertisements	rvices Revenue Stre • Service through • Differer delivered	ams fee charged per delivery, as each the Nimber platform, a portion of v t set up can be made for business as	sender pays a certain a which goes to Nimber es with regularly schedu	mount Iled

Figure 7: Present Business Model Canvas of Nimber

The business Model canvas gives an overview of how Nimber is running its present business in Norway. From this, the interviews, and meetings with Nimber employees it can be seen that their business model

should translate well to the Dutch market and the Living Lab. Most of the aspects of the Nimber business can be directly transferred from their present way of doing things. The biggest difficulties that the Nimber model would face in the Living Lab would be the lack of supply and demand. In Norway, they have a pool of 'bringers' and a presence in the delivery market that attracts customers. In Den Haag, they would have neither. The Living Lab would have to ensure that it is possible for Nimber to attract potential bringers and for them to have a starting volume of deliveries to make the opportunity attractive for the Norwegian company. Another potential difficulty for the current Nimber business model is how dense the Den Haag area is compared to Norway. Nimber has found success in low density areas where there are few delivery alternatives, this is different to the high-density Den Haag market with a number of delivery alternatives. Nimber might have to find a different way to attract customers by focusing on niche delivery needs.

5.3.2 MyPup

The business model illustrated in the business model canvas would have to be altered for the Living Lab case. Instead of focusing on the building/office managers for closed contracts, MyPup would need to start opening their service. Opening certain lockers for the use of individuals who are not existing customers but who want to use the MyPup service. Also opening their lockers to the deliveries of Nimber and Cycloon couriers instead of exclusively their own. This would change various things about their business model, including the value propositions and their revenue stream. Instead of having the buildings as customers that pay a fee, MyPup could have revenue through individual deliveries that make use of their lockers. The Living Lab has to make it clear that by participating MyPup will become more efficient, offer a higher value service to their customers, and will be able to explore different possibilities in the market. This way MyPup could see participation in the Living Lab as worth the risk to change how they are presently operating.

Business Model Canvas		Designed for: MyPup		Designed by: Mateo	Date: 11/01/2021	Version: 1
Business model Key Partners • Delivery personell (Couriers) • Hub providers • Locker construction company • Electric vehicles provider • Package senders • Package receivers	 Key Activities Installation of lockers at customer buildings Mantaining the app and website Coordinating the receiving of packages and grouping them together to send to right building 	Value Propos • Less va infront c • Less de in buildi (security distracti • Employed distracta receivin package • Resider	sitions an congestion of building elivery personell ing foyer (y, practicality, ions) rees less eed at work from ng or picking up les ns/employees	 Customer Relationships Customers and users are different, which means different relationships for each group Users have MyPup app to communicate with company Customers have more direct relationship 	Customer Segmer Customers c companies o residential bu Each has diff needs and re both are look package deii solutions. Prr building man hires MyPup • Users are en	Its an be large r large ilidings. ierent quirements ing for very obably a age that aployees of
	 Key Resources Employees that can maintain the app and coordinate the package logistics Electric vehicles to deliver Lockers to deliver the packages 	do not h present delivery Environn friendly convent delivery Secure same da	ave to be at moment of (less limiting) mentally more than ional package delivery on the ay	Channels Apps and website to communicate with users Potential customers reached by word of mouth or advertisement (?) 	the companies and t residents inside the buildings	
Cost Structure Value driven Primary costs: Installation vehicles, employee payro	n of lockers, purchase (or leasing) o II, payment of couriers and hub ser	f electrical vices, platform	 Revenue Streat Main inclusion to have a secondar return or seco	ams come from customers (office and re the lockers service in their building ary income from users (office work excleance to encodific addresses who	esidential buildings) that lers and residents) who	pay a fee want to

Secondary costs: Marketing and advertisement

Figure 8: Present Business Model Canvas of MyPup

5.3.3 Mobian

		Designed for:		Designed by:	Date:	Version:
Business Model C	Canvas	Mobian		Mateo	14/01/21	1
 Key Partners Parking partners like hotels, airports and independent parking garages DOCKR electric cargo bike supplier Other bike suppliers Selling partners that offer the Mobian product 	 Key Activities Creating and mantaining the app and website Negotiate deals with suppliers and partners Setting up mobility hubs in appropriate apces 	Value Proposit More flex choices v Ease of t services can be u through c Safety at mind abc Sustaina bikes ins	tions ability and while travelling use, all are offered and nlocked nne app d peace of out your car bility of using tead of cars	Customer Relationships Direct relationships w businesses. Try to convince them directf why the Mobian servi is for them and how their employees will s the value. Indirect relationships with individuals, who use the website and a to communicate.	Customer Segm • Individuals coming fror and looking ce alternatives mobility ee • Businesses their emplo cargo bikes travelling th centres ins	ents who are n out of town j for ; in urban ; that want yees to use ; when rrough city tead of vans
	 Key Resources Hubs with equipment and at location with public transportation routes Contracts with partners Technical employees Data of their customers 			 Website to inform and advertise of different services offered and 1 communicate with current customers App to make reservations and payments Direct contact with business partners 	1 0	
 Cost Structure Employee payroll Platform costs: developing, mantaining, and cloud hosting services Parking space renting or ownership, depending on strategy 		rvices	Revenue Strea Individua Individua supliers) Subscrip Contract subscripi	Ims Ils paying for parking spaces Ils paying for renting of bikes (o tion with individuals who want f s with companys that pay fees ion like services	only a percentage as rest to regulary use their serv for their employees to ha	goes to bike ices ive

Figure 9: Present Business Model Canvas of Mobian

From the Mobian business model canvas, it can be seen that the main foci of the company do not lay in the logistics section. Instead focusing primarily on different mobility solutions. By participating in the Living Lab Mobian would need to shift its present-day business model. It can be a small change of simply giving their current customers extra services, like parcel pick-up and drop-off lockers, and the choice to deliver parcels for financial recompense. Or Mobian could shift their business model more markedly by embracing the logistics market and transforming their mobility hubs to full-fledged mobility and logistics hubs, where parcels can be delivered, picked up, but also offering cross-docking services and the rental of the material needed to fulfill these operations. By making it clear that Mobian has these different, potentially lucrative opportunities in the Living Lab they will be more encouraged to participate enthusiastically.

5.3.4 Cycloon

From the Cycloon business model canvas, it can be understood that Cycloon works relatively similarly to more conventional courier package delivery companies, but with a more social and environmentally conscious slant. They are mostly interested in delivering as many packages as possible in an efficient and environmentally friendly manner. Overall, their business model would not need to be altered much to suit the Living Lab. They would primarily be operating in the same way they do currently, but in closer collaboration with the partners of the Living Lab. Following Cycloon's company ideology, collaboration with other companies trying to deliver packages in a sustainable manner should be appealing enough for them to try joining the Living Lab.

		Designed for:	Designed by:	Date:	Version:
Business Model C	Canvas	Cycloon	Mateo	12/02/21	1
 Key Partners Large company clients for which different deliveries are handled Fielkoeriers.nl, cycling courier partnership with 20 cycling courier companies in the Netherlands Business Post, organization of different delivery companies that cooperate to further their reach and increase efficiency Social entrepeneurship partners that ensure Cycloon reaches their goal of socially concious delivery 	 Key Activities Delivering all incoming and outgoing mail for client companies Parcel deliveries throughout Netherlands Managing the delivery network with various partners and individual couriers. 	Value Propositions Sustainable del that is very environmentally concious with lin pollution Socially conciou delivery Fast and efficien courier service citly limits Reliable and hig 	yvery Relatively support relatively support face to face rel with individual mited deliveries Close relations larger clients w different servic nt offered and m cooperation is gh	ships erficial but lations clients for were less are ore needed.	gments Jals who want lies but are also are and imentally JS sees that have y needs that couriers are cally suited to ssees that want to
	 Key Resources Fleet of delivery bikes capable of carrying multiple packages efficiently Workpool of qualified delivery personell Technical employees Over 25 branches throughout the Netherlands 	quality service	Channels Website to info advertise of dif services offerer communicate v current custom Couriers meet customers in p during deliveria are the public to the company Direct contact business parth 	preservent to their to their the servent do and to with uers terson as and face of with uers	t a green image customers who sliver products to
Cost Structure Employee payroll Website costs: developing Materials (delivery bikes) Delivery costs when delivery 	g, mantaining, and cloud hosting se ered through partners	Rever • • •	tue Streams Companies that pay for full delive Individuals paying delivery of par Print and fulfilment services to fo orders	ery services cels or post r example prepare large ba	tches of webshop

Figure 10: Present Business Model Canvas of Cycloon

5.4 Next2Company - Connector

Next2Company is in a unique position in the Living Lab as a connector between the different stakeholders of the project. Both in a technological aspect but also in a business sense. Through their experience of developing new business models and their experience integrating logistics platforms, they are uniquely well suited for the purpose. They can draw from their experience with DHL in Tilburg for the platform. They have experience of the previously developed platform, which could take pick-up and delivery assignments, do the logistical planning, and provide the track and trace functionality for any delivery. As well as handling payment and account management for the different customers of DHL in Tilburg. This platform was considered a success when tested out, but for the Living Lab, a different concept is needed.

With four different stakeholders, each with their own platform, customers, and services, a connecting platform could be considered a daunting task. There are two possible alternatives to how this platform can be designed. One where each stakeholder would keep their platform which would be connected to the other platforms and the other option being where one platform is designed where all the services are offered. Figure 12 shows the less radical option. Where each stakeholder (in this example focusing on Nimber) would keep and maintain their own platform. Customers would directly their usual Nimber platform, but in the Living Lab, they would be offered additional services that would include the efforts of the other three stakeholders. Next2Company would be responsible for the connecting backend. They would keep the four respective platforms up to date on what their partners can offer to each customer. For example, Nimber would present a potential customer with the choice of delivery at a nearby MyPup locker. If this choice is taken by the customer, Next2Company would be responsible for the details of parcels delivery and eventual payment sharing between the companies. This approach would mean that each company is

able to independently manage their own platform in a way they believe their customers would appreciate while offering the services of the full Living Lab.



Figure 11: Example of each stakeholder with their own platform connected through Next2Company

The other approach would be to develop a Next2Company platform. This would be called something all the stakeholders agree with and is clear to the customers. The customers of the different stakeholders would all access this platform instead of the individual platforms of the different companies. A customer would immediately be given all of the options that the Living Lab can offer through the Next2Company platform. After they have made their choice and filled in the details this can be communicated with the other platforms to know what is needed from them. Figure 13 shows a first impression of what Next2Company visualizes as the architecture of the proposal (does not include Mobian yet as they are planned to join the Living Lab in the last step). From this figure, it can be seen that there will be constant communication and confirmations between the platform (called Next2Delivery in this figure N2D) and the platforms from the three other companies. The N2D platform will take care of most of the functionalities that are needed in a logistics platform (Orders, Invoices, Track & Trace, customer support, etc.) while the three companies can concentrate on fulfilling their role and communicating with the N2D platform. This approach would take more time and effort as a new platform would have to be developed and the communications between the new platform and the existing ones would need to be established. Yet it would give potential customers of the Living Lab in Den Haag a one-stop-shop for all of their logistics needs. Having one platform where everything goes through it could keep things more organized and streamline the whole process.

A combination of the two approaches could also be attempted. Following this course would mean starting the Living Lab with the first approach, where each stakeholder keeps their own platform, and slowly progress towards the second approach of a single integrated platform. This follows the minimum viable product approach that was introduced in section 2.4. Introducing a new product, in this case, the

connected platforms and improving it through different iterations throughout the Living Lab. Depending on the feedback from customers and stakeholders this will eventually lead to a single integrated platform or another solution that results from the knowledge gained throughout the different iterations of the Living Lab.



Figure 12: First impressions of an integrated Living Lab platform

5.5 Den Haag City Logistics

The municipality of den Haag has a population of 550,000 people that covers 80 square kilometers of area, resulting in a density of 6,500 people per square kilometer (CBS). It has an extensive public transportation network to serve this high-density population. With 12 tramlines, 10 bus lines, and 6 night bus lines operated by HTM personenvervoer, transporting 280,000 passengers a day in the Den Haag region (HTM Personenvervoer N.V, 2020). This shows a robust public transportation network in the city. Yet only 10% of the population use public transportation as their main transportation mode, with roughly 40% of the population taking the car (Mobiliteitsbeeld, 2019). This is reflected in figure 14 from the government's mobility report. The Den Haag area has very low accessibility through by car, but high accessibility through public transportation.



Figure 13: Taken from mobiliteitsbeeld 2019 and Den Haag Duurzame Dialoog

This lack of accessibility is both a problem for the city logistics of den Haag, but also partially caused by the system. Figures show that on average trucks delivering or picking up items in den Haag drive 500,000 kilometers every day, while delivery vans do 3,000,000 kilometers every day. This huge amount of vehicle kilometers is a problem for the city of den Haag. While logistics related to construction were the biggest causes for worries, employees of the municipality ranked the delivery of packages as the third most urgent carrier problem that the municipality needs to address, as shown in figure 14. This combination of low accessibility through road, with high accessibility through public transportation is the perfect setting to introduce a crowd-shipping concept. Which relies on individuals, biking, walking, and taking public transportation instead of using delivery vans to transport packages.

6. Requirements

During the requirements phase of the design, the performance specifications need to be formulated. At the end of the section, it should be possible to understand what criteria the design should meet to be considered successful. In this experiment, the criteria will be set by the stakeholders involved. In a Living Lab, the concepts of openness and the empowerment of users is important to the success of the Living Lab (Bergvall-Kåreborn et al, 2009). A Living Lab should attempt to gather as many different perspectives as possible and empower the stakeholders and users involved to garner the creativity of the user community. Only by involving the stakeholders early in an open design process is it possible to ensure that they become and remain engaged with the experiment.

To achieve this the different stakeholders will be involved in planning meetings, workshops, and personal discussions to better foster cooperation. These conversations can reveal what each stakeholder expects from the experiments through their personal objectives and how they can get involved in the Living Lab. These objectives will then be converted into KPIs which can be measured during the experiment and will define the requirements of the design. This will result in an experiment where all (or the most possible) stakeholders can reach their stated objectives. Where they can use the results of their measurements to evaluate the success of the Living Lab. This is an iterative process, where the requirements that have been produced are checked with the stakeholders so they can be changed when necessary.

6.1 Stakeholder Objectives

The objectives of each stakeholder were explored through their involvement in the workshops, the planning meetings, and the one-on-one discussions, these can be found in Appendix I. From these conversations, the main objectives of each stakeholder were extracted and summarized in table 2.

Stakeholder	Objectives
LEAD	 Environmental improvements of air quality, noise pollution, and lower energy consumption.
	 Improved quality of life in neighborhoods and improved job quality in the last mile sector.
	 Economic improvement for the logistics operators through more efficient deliveries (lower cost, lower delivery time, higher reliability). Economic improvement for retailers through increased sales
Next2Company	 To test out a local-to-local distribution network in Den Haag. Should be a self-standing network where packages can be sent and received on the same day or the next day serving B2B, B2C, and C2C. To know what different services need to be offered to these three distinct groups. Determine what kind of demand there is in these three groups. To connect different services through their software To gain knowledge through which Next2Company can eventually profit from a new logistics business model that relies on interconnected platforms.

Table 2: Stakeholder Objectives

Den Haag	• See it as an entrance to see what is possible on the logistics topic (it is still
Municipality	understaffed), could be a springboard to taking a bigger interest in the
	logistics field.
	• Lower emissions resulting in cleaner air and better air quality through the
	use of fewer delivery vans and greener modes.
	• Encourage alternative transport modes especially biking and walking inside
	the city center.
	 More efficient urban logistics to alleviate traffic and the constant delivery
	vans outside companies and large residential buildings.
	 Ensure the testing does not have a negative impact on citizens and their
	guality of life, preferably improve the guality of life for residents involved.
Nimber	Test out their platform in a different market than Oslo/Norway to see
	what differences they would need to consider.
	 Increase their number of users and deliveries, directly increasing revenue
	and profits.
	• Experiment with the use of lockers and how it could be beneficial to them
Cycloon	Increased revenue and profits
,	• Growth
	Make parcel delivery more sustainable
MyPup	• To see how they can integrate their lockers with different services.
7 - 1-	 To increase the number of locations (clients) and thus increase revenue.
	 Test out how potential customers would react to having lockers at a hub
	compared to at their home (willingness to pick up parcels vs willingness to
	pav)
Mobian	Want to increase the number of hubs that they operate, resulting in higher
	revenue.
	 Increase the occupancy rate of their parking spots and rented bike,
	increasing their profits.
	 Interested in user cases and data of their target audience and how to
	reach them.
	• In search of courier partners that could work cooperatively with their hubs
	by using their parking spaces and renting their cargo bikes.
	 Increasing their added value to customers by offering more services in
	their hubs.
Cargoroo	• To grow and have a higher occupancy rate, increasing revenue and profits.
	 To find partners in the retail and logistics branches that they could rent
	their bikes out to.
	• To become a 'player' in the logistics between SMEs and customers (B2C).
Hely	Increasing revenue and sales
	• Finding synergies between mobility and logistics hubs, where one can
	work as a mix for both functions.
Local Residents*	Reduce traffic and delivery vans outside their building.
*Through	Lower cost of deliveries.
research instead	Quicker and more reliable deliveries.
of interviews	 Improved quality of life in the neighborhood.
Local Retailers*	Cheaper, more reliable, and quicker deliveries.

*Through	•	More delivery options.
research instead	•	Increased sales (more revenue).
of interviews	•	Consistent 'story' of delivery.

6.2 Stakeholder Criteria

The choice of the criteria is based on the identified stakeholders' objectives above, while also keeping in mind possible experiment designs. Table 3 shows the different criteria with which stakeholders have expressed interest in these concepts.

Criteria	LEAD	D. Haag	Nimber	Cycloon	MyPup	N2C	Mobian	CID
Air Quality & pollution	Х	Х						Х
Energy Consumption	Х	Х		Х				
Door to Door delivery cost	Х		Х	Х	Х	Х		Х
Door to Door delivery time	Х		Х					Х
Delivery Reliability	Х		Х	Х	Х	Х		Х
Quality of Life	Х	Х						Х
# Of Deliveries	Х		Х	Х		Х		
Delivery van Km	Х	Х						Х
Target user's data			Х	Х	Х	Х	Х	
User case data			Х	Х	Х	Х	Х	
# Of Users			Х	Х				
# Of Locations (hubs)					Х		Х	
Effect of Locker location			Х		Х			
Gained Partnerships	Х		Х	Х	Х	Х	Х	
Gained Knowledge	Х	Х	Х	Х	Х	Х	Х	
Occupancy Rate of					Х		Х	
equipment								<u> </u>

Table 3: Stakeholder Criteria

6.3 Indicators

The criteria that have been listed in table 3 need to become operationalized by constructing metrics that can be expressed in the form of KPIs. These indicators need to reflect the criteria so that it is possible to measure whether or at least to what extend the experiment contributes to each criterion. This provides a calibration to judge how the Living Lab is performing compared to the present-day setting, or the 'do nothing scenario'. These indicators are usually quantitative and need to be measurable. This means that they not only need to be possible to measure but the Living Lab needs to realistically be capable of measuring these indicators accurately. There can be multiple KPIs for a single criterion, while a single KPI can also help measure multiple criteria, it is not a one-to-one system. Table 4 shows the criteria, and which indicators will be used to measure the criteria.

Table 4: Indicators needed to measure the various criteria.

Criteria	Indicators
Air Quality & pollution	CO2 emissions
	Particulate matter
	Volatile Organic Compounds
	 Nitrogen Oxides (NOx)

	Carbon Monoxide (CO)
Energy Consumption	kWh per average delivery.
Door to Door delivery cost	Average delivery cost
Door to Door delivery time	Average time for delivery
Delivery Reliability	 Percentage of deliveries that arrive at the right place and the right time.
Quality of Life	 Mix of air quality, noise quality, traffic stats
Number of Deliveries	 Number of deliveries through the new platform
Cost of Deliveries	 Average cost of package delivery
Delivery van Km	 Average number of van Km per delivery
Number of users	 Number of people that have used the platform
Number of hubs	Number of new hubs opened
Effect of Locker location	 Willingness to pay for door delivery compared to locker distance from home/work
Occupancy Rate of equipment	Average percentage of equipment in use per day
Gained Partnerships	 Number of partnerships created between stakeholders due to Living Lab involvement

6.4 Design Requirements

The indicators listed in table 4 are those that need to be measured throughout the experiment. They reflect the objectives of the different stakeholders involved in the Living Lab. Without these indicators being measured it would be impossible to determine whether the Living Lab is a success or not. It would not be possible to determine what effects the Living Lab has had on city logistics, and what effects the different concepts have had on the system. The final design must reflect this by clearly stating how all of these indicators will be measured, as well as by whom they will be measured and calculated when necessary.

There are some objectives that the stakeholders have expressed which are not reflected on the list of criteria above. These are the more intangible objectives, whose success is not possible to measure through an indicator. These objectives are related to the knowledge generated through the process of the Living Lab and the collaboration between the stakeholders. First of all, the stakeholders all want to test out their concepts and business models through the Living Lab. They are interested in how their concepts and models could work in a new city logistics paradigm of interconnectedness. They want to know what to expect if they alter their business models and attempt to find new streams of revenue through the opportunities offered in the Living Lab. The only way for these organizations to gain this knowledge is for them to go through the experience of a realistic test case. To achieve this the Living Lab design must be as realistic as possible, imitating how these concepts would work in the real world. This means making the Living Lab a success in terms of end-user engagement. This culminates in another requirement for the Living Lab design, which is broader; that the design enables a realistic Living Lab where stakeholders can learn from how their potential end customers react to the development of new concepts.

The last objectives from the stakeholders that have not been listed yet are the more specific knowledge gain objectives. These include user case data and target user data. Again, these are not objectives that will be measured through an indicator in the Living Lab. Instead, these rely on the collaboration and sharing of knowledge of the different stakeholders. They each have knowledge and expertise that others might be lacking or want to have. By encouraging collaboration and open knowledge sharing these

objectives can be fulfilled. The Living Lab must encourage all stakeholders to be as open as possible within the confines of proper care for the privacy of their users.

7. Synthesis

The synthesis is the last step before the design is made. This chapter will coalesce all of the concepts that have been discussed in previous chapters to try to set up a design that will be considered successful.

7.1 Stakeholders

In section 5.2.2 the stakeholders were divided into different classes, to determine how they should be managed for the benefit of the Living Lab. This can help to give a ranking of which objectives and ultimately indicators might need to be prioritized in case that they cannot all be fulfilled. In table 5 the relevant stakeholders are shown and their influence on the Living Lab. This is determined as those with power having the most influence, those with legitimacy having middling influence, and those with only urgency having the least influence. From the saliency model, it follows that definitive and dominant stakeholders (Next2Company and Den Haag Municipality) are the most important to keep satisfied as they have the highest amount of influence in the project. Dependent stakeholders like Nimber and Cyloon have middling influence. Lastly, demanding stakeholders like MyPup and Mobian have the least amount of influence on the Living Lab and thus are prioritized less than the other stakeholders mentioned previously. It has to be clear that all stakeholders are important to this Living Lab, and the success of the experiment is reliant on all of these stakeholders validating the design.

Table 5: Influence level of involved stakeholders

Most Influence	Middle Influence	Lesser Influence
 Next2Company 	Nimber	 MyPup
 Den Haag municipality 	Cycloon	 Mobian

7.2 Measurements

The requirements chapter (6) of the thesis concludes with table 4 that lists all of the criteria important to the different stakeholders, and the indicators that could be used to assess whether these criteria are being fulfilled. These key performance indicators will need to be measured throughout the experiment. The results of which can be used to evaluate the efficacy of the experiment. They can be used to measure whether the goals that the stakeholders were hoping to achieve through the Living Lab were reached. These indicators were focused into a list of KPIs which are shown in table 6.

To make a ranking of what indicators need to be prioritized, the indicators are highlighted to reflect which stakeholder group's objectives are reflected by which indicator. This means that the indicators highlighted in green are only of interest to less influential stakeholders. The indicators highlighted in yellow are of interest to middle influence stakeholders while the red highlighted indicators are of interest to the most influential stakeholders. Some indicators reflect the objectives of multiple stakeholders, in this case, they were highlighted to reflect the stakeholder with higher influence. By organizing the indicators in this manner, it can help during the design if a choice needs to be made between measuring two different indicators. This gives a starting guide on how to proceed. Though as the Living Lab relies on good collaboration and the participation of all stakeholders, the objectives expressed by any of these stakeholders should not be ignored.

		Stakeholders						
	KPIs	Most Influence		Middle Influence		Less Influence		
		Next2Company	Den Haag	Nimber	Cycloon	MyPup	Mobian	
	Change in CO2 emissions		Х					
	Change in VOC emissions		Х					
	Change in Nox emissions		Х					
SIG	Change in CO emissions		Х					
ityl	Change in decibels of noise pollution		Х					
iori	Change in kilowatt-hour/delivery		Х					
h Pr	Change in % of on time deliveries	Х		Х	Х	Х		
Lig I	Number of deliveries through LL platform	Х		Х	Х			
_	Change in van Km in municipality/delivery		Х					
	Quality of life change customers/residents		Х					
	Number of partnerships created at the LL	Х		Х	Х	Х	Х	
	Change in cost of average delivery			Х	Х	Х		
Mid Prior	Change in time of average delivery			Х		Х		
	Change in % of equipment use at hubs						Х	
	Change in % of lockers used					Х		
Low Prior	WTP door delivery vs. lockers at hub					Х		

Table 6: The criteria and interested stakeholders.

These indicators still need to be organized in a format that makes it clear who is responsible for measuring, calculating, and compiling the measurements. As has been discussed in section 2.1.4 data collection in city logistics can be very complicated. The two suggestions to improve this data collection were the use of technology and the collaboration between stakeholders. As collaboration between stakeholders is vital to the importance of the labs, it is practical to also have collaboration in the measurements of the Living Lab. This can be another step to open knowledge sharing between stakeholders. Table 7 shows the different KPIs, how they are going to be calculated and measured, and by whom. The table gives a good basis for how each of the indicators should be measured, and who will be responsible for these measurements. As it is a Living Lab it is expected that the different stakeholders collaborate and share their knowledge, while the owners, TUDelft, coalesce the different measurements given by the stakeholders and make the calculations when needed.

There are still some aspects of the measurements which are left unclear due to uncertainties about the practicalities and details of the experiment. One of which is how some of the measurements for conventional package delivery will be made. Due to the loss of DHL as a stakeholder, the Living Lab does not include a courier with this data freely available. Instead, there are a few options that can be kept open. The first option is Cycloon, which is also a courier service, which could have the data either available through previous research of their competition and their industry, or it could be available to them through their alliance of Fietskoeriers.nl, a collaboration of 30 bike courier companies. A group like this should have data on conventional package deliveries through vans. If this option does not work, it will have to be done through research and calculation. This implies that the project owners will have to commit time spend finding data on conventional van delivery and applying it to the Den Haag case. The last option is to use the Den Haag municipality's influence. While the current data team at the den Haag municipality does not have this level of detail on the current city logistics system in the city. There is the option that they can investigate how packages are delivered in the city at this moment and share some of the data with the Living Lab team. With this data, it will be possible to create a baseline of the current situation of conventional parcel delivery in Den Haag. This will then be used to compare it with the newer data

measured throughout the experiment to be able to evaluate the effects of the Living Lab on the various criteria.

Table 7: KPIs of the Living Lab detailing who will be responsible for measuring them and how this will be done

KPIs	Measure/Calculate	Who measures and how?
	Calculated: Obtain the CO2 emission	Nimber: Ask bringers through which transportation mode they deliver which
Change in CO2	used in conventional package deliveries	packages Cycloon: Measure how much of the delivery process is done through
Emissions	and compare it to the total amount	which mode. TuDelft: Using these measurements calculate C02 emissions
	emitted through the LL method	considering transportation mode and distances covered
Change in Volatile	Calculated: Obtain the VOC emission	Nimber: Ask bringers through which transportation mode they deliver which
Organic	used in conventional package deliveries	packages Cycloon: Measure how much of the delivery process is done through
Compounds	and compare it to the total amount	which mode. TuDelft: Using these measurements calculate VOC emissions
emission	emitted through the LL method	considering transportation mode and distances covered
Change in Nitrogen	Calculated: Obtain the NOx emission	Nimber: Ask bringers through which transportation mode they deliver which
	used in conventional package deliveries	packages Cycloon: Measure how much of the delivery process is done through
emissions	and compare it to the total amount	which mode. TuDelft: Using these measurements calculate NOx emissions
emissions	emitted through the LL method	considering transportation mode and distances covered
Change in Carbon	Calculated: Obtain the CO emission	Nimber: Ask bringers through which transportation mode they deliver which
Monovide	used in conventional package deliveries	packages Cycloon: Measure how much of the delivery process is done through
emissions	and compare it to the total amount	which mode. TuDelft: Using these measurements calculate CO emissions
	emitted through the LL method	considering transportation mode and distances covered
	Calculated: Obtain the Decibel noise pollution emitted in conventional package deliveries and compare it to the total amount emitted through the LL method	Nimber: Ask bringers through which transportation mode they deliver which
		packages Cycloon: Measure how much of the delivery process is done through
Change in Decibel		which mode. TuDelft: Using these measurements calculate Decibel noise
of Noise Pollution		emitted considering transportation modes used in different areas.
		Municipality: Could use a decibel meter in specific areas that are most
		affected by the LL to compare noise level before and after LL implementations
	Calculated: Obtain the kWh of the	Nimber: Ask bringers through which transportation mode they deliver which
Change in kWh per average delivery	average delivery of conventional	packages Cycloon: Measure how much of the delivery process is done through
	package delivery and compare it to the	which mode. TuDelft: Using these measurements calculate kWh consumed
	amount through the LL method.	considering transportation modes and the distances covered.
	Obtain current costs of Den Haag inner-	TuDelft calculates average LL Delivery Cost= Costs of Nimber bringers + Costs
Change in cost of	city deliveries and compare to the	of Cycloon deliveries + Costs of MyPup locker rentals + Costs of Mobian/Hely
average delivery	amount measured for the average	hub fees + Costs of Dockr/Cargoroo rentals + Costs of Next2Company
	delivery in the LL	platform / total number of deliveries.

Change in average time of delivery	Obtain current delivery times for inner- city Den Haag conventional package deliveries and compare to delivery times in LL	Nimber bringers and Cycloon couriers can give accurate time measurements of how long from picking up a package to delivery. TuDelft can gather this data and compare it to that obtained
Percentage of deliveries that arrive at the agreed upon time and place in proper condition	Measure the number of deliveries that are considered 'reliable'	Through the data given by Nimber and Cycloon couriers and data from customers using Next2Company's platform. TuDelft can calculate how many of the deliveries were a success and which percentage did not arrive properly
Number of crowd- shipping deliveries rejected	Measure the number of deliveries that are put up by senders but are not picked up by any bringer.	Nimber/Next2Company can track how many requests for a delivery have been input by potential senders that were not matched with any bringers
Number of deliveries through the new platform	Measure the number of deliveries every week through the new platform.	Next2Company should be able to easily access this data of how many deliveries and how many customers are using the platform.
Average number of van Km in Den Haag per delivery	Measure the number of van Kilometers in Den Haag city limits and divide it by the number of deliveries.	Nimber can gather whether bringers are using vans (or other vehicles) to deliver which packages and Cycloon measure how many kilometers of van distance are used in each delivery. TuDelft can calculate an average per delivery and compare it to conventional Den Haag deliveries
Change in percentage of equipment use per day	Measure the percentage of how much the hubs different equipment is being used and compare to before the experiment	Mobian can measure how much of their assets are being used by either different bringers and couriers or others due to the LL and see how much that adds to their usual asset usage.
Quality of life (- pollution)	Attempt to measure through different tools, through surveys, and measuring pedestrian access to hubs/ car ownership	Den Haag can administer surveys in the neighborhood of hubs, to get an impression of how a hub has affected their QoL. They can also measure pedestrian access to hubs and car ownership in the neighborhood to see what effects the LL has. Nimber and Next2Company can administer surveys of their users to measure how their quality of life has been affected
Customer's willingness to pay for door delivery	Measure whether/how much customers are willing to pay more for door deliveries than locker deliveries,	Next2Company can give the option of MyPup locker deliveries at a hub instead of door deliveries at a lower cost and compare how many customers go for a locker solution and at what price. Can also compare locker deliveries at work to locker deliveries at neighborhood hub for different prices

compared to a locker at a hub	possibly through a stated preference survey	
Number of partnerships created between stakeholders due to LL involvement	Measure how much cooperation the LL is stimulating	TuDelft can oversee how many different stakeholders work together, and form lasting partnerships that go beyond the limits of the LL
Change in amount of locker use	Measure whether the LL encourages locker use	MyPup can compare the number of lockers being used per day in the LL compared to the amount used before the LL was implemented

7.3 Minimal Viable Product

The minimal viable product process is described in section 2.4 and could be applied for the design of the Living Lab experiment. To do this, the most basic form of the experiment needs to be implemented first. The success of the first design will be measured through the relevant criteria listed in table 4. With this feedback, the product owner can alter the second design accordingly. Components of the experiment can be removed that were deemed to have a negative effect on the KPIs. The second design should only add the minimum extra value to the first design so that it can be tested with the end customers before more features are added. In the case of the Den Haag Living Lab, this would mean introducing an additional logistics service for the second iteration. This process is then repeated two more times till the final design is reached and the services of all of the involved stakeholders are included.

This process is illustrated in Figure 15. In this figure it shows the possible iterations for the Den Haag Living Lab. Here the first iteration will have only one logistics service included, the crowd-shipping of Nimber. After the first iteration has been completed and evaluated a second iteration can begin. This one would include one extra service, namely the cycling couriers of Cycloon which would be included through the connector: Next2Company. By following this process it is ensured that only a single new element is introduced every iteration, making it possible to measure and evaluate the effect of each service independently. By conducting the experiment also has the option to change the planned design between loops in case of negative results in one of the earlier iterative loops. This gives flexibility to the design as it is not locked in. If all of the concepts were introduced together, or without feedback loops between them, an erroneously introduced concept could affect the testing and feedback for the other platforms. Instead, using the MVP approach each service will be added in a different loop while giving the experiment the flexibility to change if needed.



Figure 14: MVP of the Den Haag LL

7.4 Living Lab Business Case

7.4.1 Value Proposition

When conceiving whether a business is possible in a certain situation a few things need to be looked at. One of the most important is having a value proposition. Which is what value will be delivered by this new business venture. This needs to be something that the customer can benefit from and needs to be communicated clearly. To have a unifying strategy, the Living Lab needs a unified value proposition. From the business model canvases shown previously of the participating companies, it is clear that they each have their own, differing value proposition. By developing a new value proposition, it can be a big step to effective cooperation between the stakeholders. To do this a builder model like Barnes, Blake, & Pinder (2009) can be used. Which consists of six stages that are expound on in the next section.

- 1. What market segment or clients will be targeted?
 - The market will be geographically limited to clients in Den Haag. Targeting those with unconventional delivery needs as it will be difficult to compete for efficiency with the traditional courier services.
- 2. What is the current situation for this market segment, what value are they currently receiving?
 - Currently, it can be difficult and expensive to deliver certain packages. This includes those of unusual size or a large weight that not all couriers can transport. It also includes parcels with specific delivery instructions. For example, those that need special care like flowers or medicine or even packages that need to arrive at a specific time. All of these parcels are difficult for traditional courier services to deliver and thus end up being expensive.
- 3. Define what offerings mix the Living Lab provides.
 - The living lab will offer personalized sustainable delivery with a variety of additional possible services. With each different stakeholder bringing unique services to the table (Crowd-shipping, Lockers, Mobility hubs, etc.)
- 4. Asses the value this offering gives the customers.
 - The Living Lab offers negotiable prices and delivery flexibility depending on what the customer exactly needs. As the pricing is done for specifically the request of each customer, and with the option to negotiate it makes sure that the value of the service matches the cost to the customer. While ensuring that this is done in a sustainable manner.
- 5. <u>What alternatives are there in the market?</u>
 - There are a variety of conventional delivery services like PostNL and DHL which are very
 efficient but are not as flexible in their delivery services. There are also unconventional
 delivery services like Parcls, ViaTim, and Red Je Pakketje which each have a unique
 offering, but none have the options that the Living Lab offers with four different
 participants.
- 6. <u>Can this be backed with evidence?</u>
 - Most of what has been stated in this model can be backed up with proof to substantiate the value proposition. Yet there are a few assumptions, especially about the demand for this kind of service, that have been made, but this is partially the reason for the Living Lab. To test out whether these assumptions and this business strategy can work in Den Haag.

This model ultimately leads to the value proposition: "For Den Haag clients that need to ship their unconventional packages, LL is a platform that provides personalized local to local sustainable deliveries. Unlike the likes of PostNL and DHL, LL offers clients the chance to negotiate prices for a variety of delivery services through crowd-shipping and cycling couriers that deliver and pick up at private addresses and lockers throughout the city."

7.4.2 Alterations to Current Business Models

The value proposition that was developed in the previous section is a new one and not something that the current business models of the stakeholders necessarily strive towards. To ensure that the experiment proceeds smoothly, it is important that all of the stakeholders have business models that can collaborate towards the same goals. This means that some of these companies need to make alterations to their current business models mapped out in section 5.3 to effectively participate in the Living Lab.

The core business models of Next2Company, Nimber, and Cycloon should not need to be changed too much to fit into the Living Lab business model. Cycloon will be fulfilling a very similar function to what they do currently. Serving as couriers that deliver parcels. The difference will be in that they might be expected to do extra services, like picking up and dropping off from lockers. Similarly, Nimber will still operate as a middleman matching paying customers with bringers that are willing to pick up and drop off parcels in specified locations. The difference for these businesses will be how they collaborate. While in their current forms Nimber and Cycloon already collaborate with various other firms, in the Living Lab this will be an even tighter collaboration, where they might need to be open to sharing costs and revenues. The companies need to be ready for this collaboration, and agreements need to be made between the active participants on how exactly the deliveries will work. In terms of technologically, logistically, and financially. This will require negotiations and contracts to have a clear foundation of the collaborations.

MyPup's current business relies on fixed fees from clients for the use of the lockers for their employees or residents. In the Living Lab, this is not the case. As the Living Lab will focus on individual deliveries, MyPup will not be getting a similar fixed client fee for their participation in the Living Lab. Instead, MyPup will have to open its lockers to the couriers of Nimber and Cycloon, and the potential customers of the Living Lab. Collecting revenue by charging a fee for the use of a locker or by collecting a fraction of the amount that Nimber and Cycloon customers are paying.

Mobian's role in the Living Lab is still vague as they have not been as active in the discussions and meetings as the other stakeholders. Their current business model focuses primarily on different mobility solutions. Mobian would need to shift its current business model. It can be a small change of simply giving their current customers extra services, like parcel pick-up and drop-off lockers, and the choice to deliver parcels for financial recompense. Or Mobian could shift their business model more markedly by embracing the logistics market and transforming their mobility hubs to fully-fledged mobility and logistics hubs, where parcels can be delivered, picked up, but also offering cross-docking services and the rental of the material needed to fulfill these operations. Mobian's current revenue comes from either individuals that use their mobility services or companies that have contracts that allow their employees access to Mobian's mobility services. A similar concept could be followed for their inclusion in the Living Lab. With logistics services being offered to individuals for a price, or logistics companies (including the other Living Lab stakeholders) paying to base some of their services in the Mobian hubs.

An overview of this new business model for the Living Lab can be seen in figure 15. A business model canvas has been created giving an overview of how the Living Lab could run as a business made up of the different stakeholders involved in the experiment. It would not necessarily replace how the companies involved are currently doing business, but only give an idea of how the business model would look for the Living Lab. The canvas can be used as a jumping-off point where the different factors of the business model are organized and made accessible. This will make the discussions and planning of the commercial side of the Living Lab easier and more structured.

		Designed for:		Designed by:	Date:	Version:
Business Model C	Canvas	Living Lab De	n Haag	Mateo	10/05/21	2
 Key Partners Those included in the LL are: Nimber, MyPup, Cycloon, Mobian, Next2Company, Municipality of Den Haag, and TUDelft Partners to the LL stakeholders le: Nimber bringers, Dockr for Mobian. Online services for payment and platform hosting Online marketplace websites 	Key Activities Creating and martialing the LL platform Coordinate the information flows and requests between stakeholders/platforms Collaborate on governance rules on how the LL will operate Key Resources The platforms, connectors and software behind it	 Value Propositions Sustainable deliveries Flexible deliveries (outside working hours or weekends) Cost efficient, price open to negotiations Safe deliveries Variety of possible logistics services like locker pick up and drop off, crowdshipping and access to logistics hubs 		Customer Relationships • Businesses with unconventional deliver needs build up a good relationship through negotiations and regul deliveries • Most users do not haw much contact with the LL, only through the LI app or the app of one the stakeholders Channels • Either the LL platform through the individual platforms of the	Customer Segments Businesses in den H that want to have the products delivered to their local customers but have troubles wit conventional delivery methods Individuals that want send a package and want to do this chear sustainably and/or through a locker pick Individuals who have parcels they want to deliver but does not	nts in den Haag have their ivered to istomers, ubles with I delivery hat want to age and nis cheaply, and/or cker pick up vho have want to oes not fit
	 The collaboration between companies to offer complementary products, superior to the competition Expertise and assets from a wider pool of logistical stakeholders in the LL 			 Direct communication with businesses that want to deliver through the LL Online advertisement in auction websites to market the service 	within conve delivery con Individuals t make some money on th trips or as d couriers.	 within conventional delivery confines. Individuals that want to make some extra money on their planned trips or as dedicated couriers.
Cost Structure Employee payroll and payment for 'bringers' services Platform costs: developing, mantaining, and cloud hosting services Costs of connecting platforms and services, transaction costs, coordination costs, etc. Marketing costs: online advertisements Insurance costs		Revenue Strea Delivery the rever agreed/r Equipme process what is u	the, as each sender pays a cert nue of which is divided between tegotiated between them nt use fee of the use of lockers of delivery or independently, rev used and agreements between s	ain amount through the L the stakeholders as and other hub equipment enue again divided depe takeholders	L platform, , be it in the nding on	

Figure 15: Business Model Canvas of the Living Lab den Haag

7.4.3 Risk Analysis

When starting a project like the Living Lab it is a good idea to conduct a risk analysis. This identifies and weighs the different possibilities that may jeopardize the Living Lab. After having assessed what could potentially go wrong and stop the project from reaching its goal, measures can be developed to address these potential risks. By doing this the project will have a higher chance of being successful.

Risk Matrix

1	Limited locker locations	Not enough bringers to deliver	Lack of supply, low parcel volume
1	Inefficiencies due to low clients/ parcels density	Covid related delays	Disagreements between stakeholders
Probability	Lack of interest in variety of services	Costs higher than customers willingness to pay	Data breach
		Lack of locker or hub space	Platform's connection issues

Impact

Figure 16: Risk Matrix of the Living Lab Business Case

To frame the risk analysis a risk matrix is employed. This is a tool to organize the different potential risks in a way where they can be judged to see what needs to be addressed most urgently. In figure 16 we can see the risk matrix for the Den Haag Living Lab. It goes from low-risk possibilities, where the probability of it happening is low and its potential impact is also low to high-risk possibilities that are more likely to happen and would have an appreciatively bigger negative impact. This risk matrix shows the main risks that have been considered, but it is by no means an exhaustive list of everything that can go wrong in the project. While it is impossible to be prepared for any eventuality, developing some preventive measures on the more severe risks will set the project up for success.

7.4.4 Risk Prevention

The biggest risk identified through the risk matrix is that of a lack of demand for the service and thus a lack of parcel supply. Like any company, the stakeholders need customers to use and pay for their service for success. The fear is that, especially at the start of the project, there will be a very low volume of parcels which would mean the project never has the chance to get off the ground. Two approaches can be followed to try to limit this risk. First, a more immediate method is by directly attempting to get a 'seed' number of parcels. This would be enough parcels for the Living Lab to at least start functioning as the demand grows. This seed parcel volume can come from MyPup's existing Den Haag parcel volume that they are willing to have delivered through the Living Lab instead of their usual manner. Another source for these packages could be through the municipality of Den Haag, who is also a partner in the Living Lab.

Interdepartmental and even outgoing mail could be entrusted to the Living Lab to help get the process started. This could be the placeholder as the second approach to increase demand manifests itself.

The second approach would be by contacting other businesses that we believe would be interested in the service and pitching them the idea to get involved with the Living Lab. This would be companies that have a constant need for deliveries, specifically unconventional deliveries as mentioned earlier. This would include furniture stores whose furniture is too large and difficult for them to deliver themselves or flower stores that need to have special care taken of their fresh products. By contacting these types of businesses and having agreements in place for future deliveries it can limit the risk of not having enough demand at the start of the project. As the project matures the hope is that the volume of parcels grows more naturally, through word of mouth and intelligent marketing decisions, like promoting deliveries in secondhand web shops (Marktplaats.nl).

The second biggest risk is the other side of the same coin, if the package volume is there, there is the risk that not enough bringers are available to properly deliver the parcels. As this only really affects Nimber, it can be considered a less impactful risk than the first one, yet with Nimber being a vital part of the project, not having the necessary bringers would cripple the Living Lab. At the beginning of the Living Lab, a careful balance needs to be found between the number of bringers and the volume of parcels, if there are too many bringers then they will not have enough parcels to deliver and will lose interest in being involved with Nimber. If there are not enough bringers the parcels will not be delivered on time and customers will be less likely to turn to the Living Lab for the delivery needs. To attract bringers the right people need to be targeted. For deliveries within the city of Den Haag, students would be the best segment to concentrate on. With multiple universities in Den Haag and the neighboring towns of Delft and Leiden, there should be a large student population. They have excess free time, free or subsidized public transportation travel, are low on funds, and are capable of trying different things and learning quickly. These qualities make them perfect candidates to work as Nimber couriers, and thus it should be the segment targeted. This can be through bulletins on university campuses or through a small marketing campaign aimed directly at this audience. For deliveries originating in Den Haag and ending in the city outskirts or suburbs, another group can also be targeted. These are the daily commuters, as they are making this trip regardless, they can be more easily convinced to pick up and drop off a package on their way to work or home for a smaller fee. To target this segment would be more difficult but could be done by targeting them on their usual routes from work to home.

The last risk that will be discussed in depth is the risk of disagreement between the stakeholders. To have a successful Living Lab the different stakeholders all need to collaborate closely. If they start disagreeing or trying to pull the project in different directions it will be very difficult for the Living Lab to succeed. To limit the chances of this happening a few steps can be taken. First of all, the ideas and direction of the Living Lab need to be well planted in the beginning. This is also where this thesis comes in. It is the objective of the paper to identify what it would take to ensure that this project is a success and a large part of that is stakeholder management. As seen previously a lot of effort has been put into ensuring that each stakeholder's ideas and concerns are recognized and addressed. There also need to be discussions with all of the different stakeholders participating together, where they can each express their desires and doubts about the project. By encouraging this collaboration from early on, it is more likely that the stakeholders can work together and there are no surprises as the project develops.

The medium-level risks either have a lower impact or are less likely to happen than the high-risk cases, yet it is still important to address them. A limited number of locker locations means that it will limit how often the lockers service will be used and tested through the Living Lab. MyPup has made it clear that they are willing to install more locker services, especially in Mobian hubs which would increase the frequency that the lockers could be used in the Living Lab. Inefficiencies due to low client/parcel density ties into the low amount of demand that the Living Lab will face in the beginning. In the same way, as mentioned before through seeding the demand or by contacting other businesses the Living Lab hopes to increase the number of clients and parcels it will handle. Covid related delays have already affected the Living Lab as they have the rest of the world. By keeping a flexible schedule and planning that can deal with unexpected delays, the effect of covid can be minimized. There is a chance that the costs of the services are higher than customers are willing to pay. This can be either handled by increasing the efficiency of the services, or it could be taken as a sign that the business model proposed does not work and needs to be altered. A data breach is always possible and can be damaging when the platforms handle personal data. Following the GDPR, limiting the amount of personal data, and having good IT practices can all reduce the risk of a data breach. Lastly, platform connection issues can always happen. By having a reliable server and good responses to server and connection crashes the Living Lab can attempt to keep these risks to a minimum.

The risks are also being minimized by the experiment design following the minimum viable product methodology discussed in sections 2.4 and 7.3. If all of the services and stakeholders were introduced simultaneously all of the risks mentioned would be similarly introduced simultaneously and exacerbated due to the confusion. By slowly adding new features after every iteration has been fully tested, the risks are lessened considerably. The minimum viable product approach diminishes the complexity and thus the risk of the project by introducing the simplest value-adding features first. It gives those running the experiment the chance to fully understand the new features before introducing new ones. After every iteration, the stakeholders and the Living Lab owner can analyze how the experiment is going, through the measurements and observations. This can allow them to identify which risks are becoming more likely and gives them the chance to alter the design to minimize this risk in the following iteration.

8. Design

With the conclusions that were taken from the synthesis step of the design cycle, an experiment must be designed that will address the stipulated *problem* while fulfilling all of the *requirements*. This is the experiment design step that requires creativity. The desired functionalities of the experiments need to be examined and compared to what is realistic and possible given the different limitations. From this, a creative solution needs to be produced that will satisfy all or as many of the stakeholders as possible.

This design will outline how the experiment is going to be set up and conducted. Delineating the roles that the different stakeholders will be expected to perform throughout the experiment. It will also explain at what point the different stakeholders will be involved and how they are expected to be included in the Living Lab. It will outline how these stakeholders will interact with each other, explaining which tasks need to be carried out by each of the stakeholders. Through this, the following section will lay out what needs to be measured, how it is to be measured or calculated and by whom. As the experiment will be following the minimum viable product process the chapter will be divided into four different iterations, also referred to as loops, as new features are implemented at the start of each iteration. This will ensure that the Living Lab can begin its most simple form, before adding more stakeholders and developing different connections to eventually reach the goal of an open platform with full network integration.

8.1 Iteration 1 – Nimber



Price Negotiations / No bringers for request

Figure 17: Iteration 1 - Nimber is introduced

The first loop will only introduce the Nimber platform to the Den Haag municipality. The goal of this design is to have Nimber being used by a small number of customers in Den Haag in its most basic form. It would introduce the concept of crowd-shipping to the Den Haag package delivery market. Allowing for customerto-customer (C2C), business-to-customer (B2C), and government-to-government (G2G) deliveries to be made through crowd-shipping delivery. This is done when a 'sender' posts the details of the package they want delivered on the Nimber platform. One of the 'bringers' will then agree on the details of the delivery (price, time, location, and package) and perform the actual delivery. When the delivery is made a confirmation is sent to the Nimber platform, which then sends the agreed upon fee to the bringer. If no bringer is willing to deliver this package for the offered price, the request will be denied. As illustrated in figure 17. The Nimber platform is ready to introduce this service in the Netherlands on very short notice, as most of the platform would be identical or even scaled-down from their existing Oslo platform.

The biggest difficulty in this scenario is encouraging the actual use of the platform. Nimber does not have an established userbase in Den Haag and would need to start from the ground up. This would include finding both customers that want to deliver packages through Nimber but also people that want to become potential Nimber bringers. According to section 2.1.3, there is no simple way to solve this 'chicken and egg' situation, only by increasing the public acceptance of crowd-shipping will more people be willing to join. To encourage this, some form of marketing will need to be done. A similar strategy to the one originally used in Oslo can be employed. Using online advertisement on marketplace websites, like the Dutch Marktplaats.nl or Facebook's Marketplace. These websites have a built-in demand for the cheap movement of packages and could start channelling customers towards the Nimber platform.

Another approach from the Oslo Nimber operation can be adapted to increase package volume. By directly approaching businesses that regularly need packages delivered, these businesses can be convinced to use Nimber as their main delivery service. This would require some time to search for appropriate businesses and would require negotiations for agreeable terms to these companies. A simpler option might be the use of the Living Lab's current contacts within the Den Haag municipality. They could give the experiment access to some of the governmental parcel flow to seed the Living Lab. There would also be a need for trusted bringers, who could reliably deliver the agreed-upon packages at the scheduled times. This approach would ensure a minimum number of packages on a weekly basis that could jumpstart the experiment.

In this scenario, the stakeholders involved would be limited to Nimber, LEAD, the Den Haag municipality, and its residents and retailers. Though it is only the first step of the experiment, the proper indicators need to start being measured from the very beginning to know the effects of each scenario and how they influence the success of the experiment. Table 8 explains what needs to be measured and who is responsible, the general outline of how measurements will be done discussed in the Synthesis chapter (7) will still be followed. After a certain package volume has been established through the Nimber platform, and enough data has been collected to build solid feedback, the feedback can be used to inform the next loop.

КРІ	Stakeholder responsible
Change in Co2 emissions	Nimber - TuDelft
Change in VOC emissions	Nimber - TuDelft
Chang in NOx emissions	Nimber - TuDelft
Change in CO	Nimber - TuDelft
Change in decibels	Nimber - TuDelft - Municipality
Change in kWh per average delivery	Nimber - TuDelft

Table 8: Measurements in iteration 1

Change in cost of average delivery	Nimber - TuDelft
Change in average time of delivery	Nimber
Percentage of deliveries arriving on time	Nimber
Number of deliveries through the new platform	Nimber
Number of crowd-shipping deliveries rejected	Nimber
Average number of van Km in Den Haag per	Nimber – TuDelft
delivery	
Quality of life	Municipality
Number of partnerships created between	TuDelft
stakeholders	

8.2 Iteration 2 – Nimber, Cycloon, Next2Company

The second loop introduces the first connection between separate platforms. In this stage of the experiment, Nimber will be joined by Cycloon and Next2Company. Cycloon will function as bringers for the Nimber platform, with each Cycloon courier acting as a trusted bringer, that can deliver the scheduled packages reliably but also compete for any other packages on the Nimber platform. The design of this stage might be different in practice as feedback from the first loop should have been incorporated into the design.



Figure 18: Iteration 2 - Cycloon & Next2Company are introduced

Next2Company will be responsible for connecting these two platforms. Setting up an application programming interface (API) that will allow the two platforms to communicate and the two companies to work together. It will enable Nimber users to post package delivery details on their Nimber app that Cycloon would also be able to see and act upon if interested. For this to go smoothly the two companies

need to negotiate and discuss how the collaboration will work, whether Nimber still takes a cut if Cycloon delivers the packages, and/or whether Cycloon has any sort of priority over the conventional bringers. The deals that Nimber had formed with partnered companies can be shared with Cycloon, who can take over as trusted bringers, as their bike couriers are fully employed. This collaboration can be seen in figure 18, where the Cycloon couriers are seen as a subset inside of the bringers pool, who are mostly focused on the partnered businesses' deliveries.

Similar measurements would need to be taken in this scenario as in scenario 1. Table 9 lists the same indices as the first loop. The measurements would also need to be measured differently, as the contributions of Cycloon and Next2Company would include facets of the experiment that only they could measure. In scenario 2 there is an expectation that fewer delivery requests will be denied. Due to more consistent coverage of the Cycloon couriers, who should always be available to deliver packages at the right prices. Most of the measured indicators should improve, as having different and more couriers available should make the deliveries more efficient than when only using Nimber bringers. When the collaboration between the different parties has been established, measurements have been made and certain volumes of packages have been delivered the Living Lab could be ready to progress to the next loop of the Living Lab.

КРІ	Stakeholder responsible
Change in Co2 emissions	Nimber – TuDelft - Cycloon
Change in VOC emissions	Nimber – TuDelft - Cycloon
Chang in NOx emissions	Nimber - TuDelft - Cycloon
Change in CO	Nimber – TuDelft - Cycloon
Change in decibels	Nimber - TuDelft – Municipality - Cycloon
Change in kWh per average delivery	Nimber – TuDelft - Cycloon
Change in cost of average delivery	Nimber – TuDelft – Cycloon -Next2Company
Change in average time of delivery	Nimber - Cycloon
Percentage of deliveries arriving on time	Nimber - Cycloon – Next2Company
Number of deliveries through the new platform	Nimber – Next2Company
Number of crowd-shipping deliveries rejected	Nimber – Next2company
Average number of van Km in Den Haag per	Nimber – TuDelft
delivery	
Quality of life	Municipality
Number of partnerships created between	TuDelft
stakeholders	

Table 9: Measurements in Iteration 2

8.3 Iteration 3 – Nimber, Cycloon, Next2Company, MyPup

In scenario 3, MyPup and its package lockers are introduced to the Living Lab, starting the physical integration of the stakeholders, which up till now has been mostly digital. This means that Next2Company has to integrate the MyPup platform with the two previously connected platforms. The lockers will serve as separate pick-up or delivery points for both the customers as well as the bringers. This means that the lockers will have to be opened to the Cycloon and other Nimber bringers for them to be able to deliver and pick up the packages. Resulting in more flexibility for the users that have access to the MyPup service. At this point in the experiment, some of the lockers are meant exclusively for existing MyPup customers,

and not for other Nimber customers that do not have a MyPup connection. While there will be other locations that could be opened to non-MyPup customers. This would mean that Nimber users could also have their packages delivered to nearby MyPup locations or drop off the packages they want to send in one of their lockers. Integrating this platform will also increase the volume of packages substantially, as the current MyPup package volume gets added to the Living Lab. Again this design might be changed during the conducting of the Living Lab, depending on the measurements taken from the first two loops

MyPup lockers are currently used by either office or residential buildings that wish to have their packages delivered more sustainably and with less congestion and safety issues. With all of the building's packages arriving with a single courier every day, which arrives from their Den Hoorn distribution centre. In the Living Lab, this volume will be fulfilled by the Nimber-Cycloon alliance. Instead of using the delivery system they currently have in place, the MyPup packages will be gathered in the distribution centre outside of Den Haag, and then taken by Cycloon couriers into the city and their respective lockers. Any package that a MyPup customer wants to have returned, they will indicate in the MyPup platform. This will then get communicated with the Nimber platform, where its bringers can elect to pick up and deliver the particular package to its end destination. If no bringers are willing to fulfil this delivery, the regularly scheduled Cycloon courier will pick it up and either deliver the package to the end destination if viable or back to the distribution centre for further processing.



Figure 19: Iteration 3 - MyPup is introduced

In this scenario, all of the indicators measured previously will continue to be measured. Though MyPup will start contributing to some of these measurements as shown in table 10, as some of their packages will be included in the concepts of the 'average delivery'. A new measurement will be added, which considers the usage of the lockers, tracking the change in locker usage after MyPup is integrated into the Living Lab. Where it is expected to increase, as the service is improved by the collaboration with the other

stakeholders as well as due to the use of Nimber customers who want to use the service. The first effect that will be noticed by the involvement of MyPup will be an increase in package volume, as all of MyPup's Den Haag packages are added to the Living Lab. The efficiency of the average package delivery should also improve, as packages destined for lockers are consolidated and all delivered on a single trip. Lowering the average emissions, cost, and time it takes to deliver packages in the Living Lab scenario. Less crowd-shipping requests should also be denied, as with lockers, there is no need for a time window of when the package needs to be picked up or delivered. This opens the crowd-shipping requests to more bringers that are travelling at different times during the day. When this scenario has been established, with a certain MyPup package volume having been handled by the Nimber-Cycloon alliance, and enough measurements to provide feedback for the next loop the Living Lab can move on to the final scenario.

КРІ	Stakeholder responsible
Change in Co2 emissions	Nimber – TuDelft - Cycloon
Change in VOC emissions	Nimber – TuDelft - Cycloon
Chang in NOx emissions	Nimber - TuDelft - Cycloon
Change in CO	Nimber – TuDelft - Cycloon
Change in decibels	Nimber - TuDelft – Municipality - Cycloon
Change in kWh per average delivery	Nimber – TuDelft - Cycloon
Change in cost of average delivery	Nimber – TuDelft – Cycloon -Next2Company -
	МуРир
Change in average time of delivery	Nimber - Cycloon
Percentage of deliveries arriving on time	Nimber - Cycloon – Next2Company
Number of deliveries through the new platform	Nimber – Next2Company
Number of crowd-shipping deliveries rejected	Nimber – Next2company
Average number of van Km in Den Haag per	Nimber – TuDelft
delivery	
Quality of life	Municipality
Number of partnerships created between	TuDelft
stakeholders	
Customers willingness to pay for door delivery	Nimber - Next2Company - MyPup
compared to locker delivery	
Change in amount of locker use	МуРир

Table 10: Measurements in Iteration 3

8.4 Iteration 4 – Nimber, Cycloon, Next2Company, MyPup, Mobian

In the final loop, Mobian, a mobility hub company will be added to the Living Lab. On the level of digital integration, the Mobian platform needs to be connected with the Next2Company network that includes Nimber, Cycloon, and MyPup. Ensuring that the different platforms can communicate and collaborate to give their users the best experience. There will also be a higher level of physical integration, as different assets from MyPup and Cycloon can be housed in the mobility hubs. Allowing for better coverage and usage of these assets. A Mobian hub consists of a space, usually well connected to public transport, that includes different mobility services. Parking spaces to leave your vehicle, electrical (cargo)bikes from Dockr that can be rented on the app, and other vehicles that can be rented from the Mobian platform. The Living Lab will add a small group of MyPup lockers to the hubs, where users of the Living Labs will be

able to pick up and leave some of their packages. The hub can also be used by Cycloon, as it can integrate their national fietskoeriers network to consolidate in the Mobian hubs by parking their vans there and delivering the packages from there on bicycles. As with the other loops, this design could be different in practice, when the measurements from the first three loops have been evaluated and the design changed accordingly.

With a wall of MyPup lockers included in the Mobian hub, the lockers service will be available openly to other users and not exclusively those with existing MyPup contracts. This signifies that Nimber users will be able to specify whether they want to have their packages picked up and delivered at specific addresses, or whether they are open to having their package either delivered or picked up from a convenient locker location. This will allow for more flexibility in the service, as both senders and bringers can negotiate to see how much the extra distance and hassle to pick up a package at an address or at a hub is worth. It also gives existing MyPup users the flexibility to have packages of theirs delivered at either the locker they currently use at work or home, or to have it delivered at a Mobian hub if it is more convenient. They could also have their return packages picked up at a mobility hub instead of their usual lockers for a reduction on the delivery price they pay.



Figure 20: Iteration 4 - Mobian is introduced

Cycloon will also benefit from the Mobian integration, not only as Nimber bringers but also in their conventional business model. When Cycloon's electrical van carrying packages from outside Den Haag approaches the city, it will now have a choice on whether it goes to the conventional distribution centre at the city outskirts or to the mobility hub if it is more convenient. With the space to park the van and the availability of electrical cargo bikes, the Cycloon courier can use the hub as a small distribution centre. They can leave the van in the hub, transfer the appropriate packages to either the lockers for later pickup
or one of the available electrical cargo bikes, and use that to deliver the packages in the vicinity of the hub.

Mobian will benefit from this integration, as for one their service will be more valuable to their customers with the additional choices of dropping off or picking up packages at the locker walls at Mobians hub locations. Mobian customers that are travelling through the hub will also have the choice to make extra money or get discounts on their Mobian fees, by picking up packages from the lockers and dropping them off at an address on the way of their trip. Mobian could also increase their revenue due to the higher usage of their assets. With more people coming and going to drop off and pick up packages, their parking spots and rented bikes should have their usage rate increase. With Cycloon using the mobility hub as small distribution centres, their parking places and electrical cargo bikes should be used more often as well. To add more value to the Mobian hub and evolve it from a simple mobility hub to a community space a feature can be added to give a more personal touch. Experts believe that deliveries and locker pick-ups will lower the quality of life of people as they are such an impersonal activity (Interview Charlotte Appendix). If a small stand with someone that sells coffee and other refreshments is added, it gives people the face-to-face contact that they (subconsciously) crave. This will not only make the users happier adding value but could potentially serve Mobian as an extra revenue generation, if there is enough user volume to justify it.

This is the final loop that is planned in this experiment design. Depending on the measurements taken throughout the experiment and developments happening elsewhere, it is expected that the Living Lab keeps changing and growing. With new loops being added as new ways of integrating different concepts and adding value are found. Meanwhile, the measurements of this loop are those described in table 7 of chapter 7. As the final loop of the experiment, it is expected that all of the indicators improve throughout the experiment. Which would prove that the implementation of each concept was a success and gave added value to the end customers.

9. Validation

After a design has been made, the expected next step in the design cycle is testing or simulation. In this case, it is not possible to simulate or test out the design as would be preferred. To test out the Living Lab design would entail running through the whole experiment, or at least a considerable part of it. This would be prohibitively expensive in both time and money. There is no way to do a small mini–Living Lab to test out whether the ideas proposed previously would work. Simulation could be possible using the Digital Twin but is outside of the scope of this paper. Instead, the best way to establish that the experiment design is possible and realistic is to validate it through the stakeholders that would be involved. This was done through a combination of individual interviews and larger meetings with the involved parties. By presenting the design and experiment ideas in these sessions it gives a chance for the parties to give feedback on what they believe would work and what would need to be improved. The feedback given from these meetings has been summarized and presented in the following sections.

9.1 Design Feedback

Overall, the design was received positively. The idea of slowly adding more services to the experiment and the concept of collaboration between the stakeholders was especially seen as efficacious. The stakeholders were quick to jump on ideas where they believed collaboration between them and another company could be mutually beneficial. For example, Nimber was interested in how Cycloon could help in the last mile of B2C or B2B deliveries. Where the 'story' of the product and having reliable couriers is an important facet that they have struggled with before and where Cycloon excels. Cycloon on the other hand saw the benefit of having MyPup lockers to drop off packages as they felt their couriers were spending a lot of time inside buildings finding the right apartment. These types of mutually beneficial combinations are exactly what the Living Lab is trying to encourage. It was reassuring to see that these ideas were quickly picked up on by the stakeholders. Overall, they saw the design as a realistic way that the experiment could be performed to reach their individual goals.

There were also a few concerns about the design. On the technical side, it was about how the platforms could fit each other and communicate coming from Nimber, but Next2Company reassured that these issues could be solved relatively easily. Another technical concern was how the lockers could be accessed by Nimber and Cycloon couriers, but according to MyPup using a code was sufficient to open the lockers and no cumbersome exchange of keys would be needed. The main concern with the experiment design was the lack of a starting parcel flow. During the design stage, this was looked at as a risk but there was hope that some governmental flow could be secured by the Living Lab, but it was not possible. Instead, MyPup offered to have some of their Den Haag parcels be delivered by the Living Lab, as a starting point. Yet this is not enough for the experiment to function properly. Alternatively, the Living Lab plans to approach different businesses that might not be served well by the traditional courier services and attempt to entice some to give their parcel deliveries over to the Living Lab.

9.2 Measurements Feedback

Most of the stakeholders were less interested in the actual measurements of the Living Lab as they were in how it would operate. It seems that for some of the KPIs, accurate measurements will be a challenge, as the methodology is not in place to measure, and instead realistic estimates will have to be taken. For example, when trying to measure the changes in the different types of emissions, the experiment design puts the responsibility on Nimber and Cycloon to measure what their couriers emit during a delivery. For Nimber this is not possible, as they have no way of measuring or knowing it. At best Nimber bringers can input their mode of transportation and by using a projection of the route the bringer will take from pick up to delivery an estimate of their emissions can be made. Though it will be difficult to evaluate how accurate these estimates are and thus could bring into question any conclusions that are derived from the study, especially when it comes to the environmental benefit of crowd-shipping.

The other measurement that will be difficult to measure is the change in quality of life. The municipality is interested in knowing how the experiment will affect the quality of life of its residents and customers. It has proven difficult to find the right tool to measure this. From meetings with data and urban planning specialists of the Den Haag municipality, it has become clear that the municipality also struggles with calculating quality of life. According to the urban planning expert Charlotte Hilbrand, a lot of the quality-of-life impacts of an experiment like this are subconscious and thus very difficult to measure through a survey as was initially planned in the design. Instead, she says you have to look at the actions of the residents to see how they truly feel about crowd-shipping or a logistical hub in the neighborhood. For example, she suggested a way to measure how happy people are with a logistical hub in the neighborhood would be not only to see how often they visit it but how they do it, as walking or cycling towards it shows a higher level of ownership of the hub. These measurements are probably out of the scope of the Living Lab, and a simpler way will have to be studied.

The rest of the measurements were considered interesting and realistic to measure by the stakeholders asked. Next2Company did have an issue with some KPIs that they believed were missing. Mainly metrics on efficiency and knowledge. They would have liked the experiment design to also include some kind of measurement of the knowledge gained, to give a clear view of what the experiment is aiming to learn, and to be able to say at the end whether this was successful or not. As one of the main goals of the experiment is to foster cooperation between the stakeholders, this was attempted to be measured through the metric of 'number of partnerships created', but this could be seen as a relatively shallow measurement of the goal and lacks a measurement of what knowledge has been gained.

9.3 General Feedback

As was stated previously the general feedback of the design was positive. The stakeholders were satisfied with the design and believe that it would lead to a successful experiment. The design seemed to fulfill the main goals of the stakeholders. Which were primarily to test out new platforms, see how their services could collaborate with others, and grow, for the companies involved. While the municipality was primarily interested in a first step in seeing what is possible in the logistics field and to encourage alternative, more environmentally friendly transportation modes. The main negative feedback outside of the design and the measurements was a concern for how the collaboration would work. There was certain apprehension voiced during the feedback sessions as well as throughout the initial parts of the project of how well the different stakeholders could work together. Especially the companies have worries that the public participants of the project might not have the same priorities as the companies that have to always consider the profitability of the experiment. This needs to be considered throughout the actual operation of the experiment, as the private stakeholders might have a different level of urgency than say the municipality, and this contrast needs to be managed carefully. With the backing of the stakeholders, it can be expected that this experiment design would perform well if carried out as it is written at this time.

10. Design Evaluation

The final step in the design cycle is the evaluation of the design. In this step, the expectations of the design need to be compared with the criteria set earlier. This was partially done during the validation stage by the stakeholders, but the researcher himself must go through all of the objectives to see whether the design fulfills what it set out to do. The design requirements were summarized in section 6.4 and will outline the structure of the evaluation.

The first design requirement is that all of the criteria that were identified as interesting to the stakeholders be measured through the experiment. Of the 14 criteria that were originally listed the design attempts to measure them all during different parts of the experiment. Yet, from the stakeholder feedback, it has become apparent that 4 of those criteria will not be able to be measured accurately, and estimates will have to be made instead. These include: Air Quality & Pollution; Energy Consumption; Delivery van Kms; Quality of Life. The first three criteria will not be measurable because Nimber does not track its bringers' locations or mode of transportation. Due to privacy concerns, they are understandably unwilling to do so. Through projections and calculations relatively accurate estimates can be made, but it will be hard to evaluate how accurate these estimates are throughout the Living Lab. The experiment design is also unable to properly measure the quality of life impact that the Living Lab will have on residents and customers.

Without these measurements, it cannot be said that the experiment design manages to measure everything it set out to at the beginning. The measurement issues that these criteria face are not designbased. It is difficult to see how a different experiment design would enable the measurement of any of these criteria without taking a very different approach to the whole Living Lab. Unless Nimber is dropped and a crowd-shipping experiment is set up with couriers that are willing and open to share all of their data, the air quality, pollution, energy consumption, and delivery van kilometers will have to be calculated and estimated to a certain extent, regardless of how the Living Lab is designed. The quality of life could be measured superficially with surveys to the affected residents of Den Haag as was planned, but to accurately measure this criterion an expert would need to be included to advise every step of the way through the design and operation of this Living Lab. For these reasons another iteration of redesigning the experiment would not solve these problems, instead, these are some limitations that will have to be accepted within the Living Lab experiment design.

The second design requirement is the stakeholder objectives that were not reflected on the criteria to be measured. These are the intangible objectives related to the knowledge generated throughout the Living Lab and the collaboration between the stakeholders. The stakeholders all want to test out their concepts and business models through the Living Lab, and the design is supposed to give them the staging to do so. This would require the design to be possible to implement in the eyes of the stakeholders and give them the flexibility to test out the concepts they want to within the design. The only way to properly evaluate whether the design was successful in this is through the feedback given by the stakeholders themselves. This was covered in section 9, where it was stated that the stakeholders were in general happy with the design. Through the different one-on-one meetings and larger reunions, they communicated that they were pleased with the design and that they saw plenty of opportunities for their companies to reach their stated objectives through this design. With the approval of the stakeholders themselves, it can be concluded that the design was successful in fulfilling this requirement.

The last requirements of the design are the more specific knowledge gain objectives. These include user case data and target user data. The companies want to know more about their customers, how they use their service, and about their target market. While the experiment was not primarily designed around these objectives the idea is that through the experiment and through collaboration these goals can be achieved. The experiment gives the stakeholders the opportunity to see how their customers behavior when given the option for a wider variety of services. This way the stakeholders can assess what added value they can potentially offer their customers, not only in Den Haag but also use this knowledge for their customer base elsewhere. By sharing information about their customers (when privacy allows) the companies can better understand not only what their users desire in logistics services but also what other groups their companies can target. The design of the Living Lab encourages this collaboration and open sharing between stakeholders, which can lead to a better understanding of all of the companies' current users and a better understanding of their potential customer pool.

Overall, the design of the experiment can be said to have been a success. It is set up to measure all the desired criteria that are realistically possible to measure. It allows all of the different stakeholders to test out their concepts in a variety of manners and through a new business model. Lastly, the design also enables the stakeholders to learn more about their users and their potential target markets. By achieving these goals, the design can be considered to be a successful culmination of the design cycle.

III. Discussion

11. Conclusion

This section aims to discuss and conclude the study. Throughout the thesis, the process of designing the Living Lab has been followed. This process took roughly six months to see through, not including the writing. It was a collaborative effort with feedback and involvement from various people from TUDelft, the municipality of Den Haag, and the various companies involved. There were some difficulties throughout the process. One of them was Covid which limited face-to-face contact to strictly through video conferencing. Resulting in more difficult meetings and discussions. The departure of DHL from the project also left the project slightly lost and in need of a replacement and a new focus. Yet the designing of the Living Lab experiment went well. Common ground could be found between the stakeholders and their enthusiasm to work together made it easier to design an experiment with which they could all be satisfied.

This chapter contextualizes the findings of the thesis, both in the framework of the master's program as well as the wider research of the field. This will then lead to a discussion of the research questions set out in the introduction chapter at the beginning of the thesis. To conclude whether the thesis fulfilled its stated objectives.

11.1. Relevance to Management of Technology

This thesis was written for a Master of Science degree in Management of Technology (MoT). A programme that educates those with engineering Bachelor's degrees to understand technology as a corporate resource. The MoT Master promises to address these questions throughout the programme:

- What technologies do we need and when?
- Do we procure the technology we need with our own research capabilities, in collaboration with outside parties, or by acquiring it or licensing it from others?
- How can we use the abundant technological opportunities to affect our mission, objectives, and strategies?

While Living Labs were not a focus of the MoT curriculum, I feel that it is a uniquely well-suited tool to help answer these questions that stand at the base of the programme. Through a Living Lab, like the one designed in this thesis paper these questions can be answered for a variety of situations. In this particular case, the Living Lab seeks to test and answer whether the platform technologies introduced during the experiment are needed or wanted in Den Haag at this time. It shows that while different stakeholders might have a technology or capability that the others do not, it is through collaboration that the whole can become more than the sum of its parts. The Living Lab will test how introducing these new technologies and these new connected capabilities will affect the objectives and the business strategies of the companies involved. These are all concepts that routinely come up in most if not all of the MoT curriculum and reflect the themes of Technology, Innovation, and Commercialization that form the core of the study's programme.

For the more practical part of the thesis, there are also connections to the MoT Master. The concept of design that so much of the thesis focuses on is reflected in the courses *Integration Moment, Supply Chain Gaming, and Business Process Management and Technology.* In these courses we had assignments to

design different objects for different purposes, were they games to teach supply chain concepts or technology architectures to improve business processes. In all cases, the need for a design methodology was emphasized in the classroom and reflected in the work done in this thesis.

11.2. The Knowledge Gap

As mentioned earlier in the thesis, there is a lack of well-documented city logistics Living Lab examples in literature at the moment. While Living Labs have been done in the field of city logistics, the process of planning and designing these Living Labs has not been documented comprehensively. Instead, these previous city logistics Living Labs usually terminated the process at the end of the experiment, and the knowledge gained was not recorded and passed on (Quak et al. 2015). While these Living Labs might have helped gain knowledge about the city logistics problems that were being tested, very little of the process of designing such an experiment has been discussed in the theory. This knowledge gap means that it is difficult for researchers to improve on the process of designing such a Living Lab. In each case, the researcher must start either from Living Lab frameworks from another field or must use their own design process as was done in this thesis.

This thesis used a mix of substantiated design methodologies from design science research to provide a structured approach on how to design a city logistics Living Lab. Mainly based on the design cycle of Eekels and Rozenburg to give a structure on which to ground the design. The process was substantiated by case study methodology to frame the experiment and informed by action research. This led to a well-structured and clear design process.

Using the case study approach of Thomas (2011) gave the process a clear starting point. It made the boundaries and focus of the experiment explicit. Ensuring that the ultimate goal and limits of the Living Lab were always being considered. Action research informed the design process all the way through. It reminded the researcher of the importance of constantly monitoring and learning from the design process. Without which the focus of the researcher could have been shifted towards a more practical angle of only considering the demands of the stakeholders and not learning from and about the design process itself, which was part of the purpose of the thesis. These two concepts were used mostly as support to the main design methodology, which was the design cycle. The design cycle was followed step by step throughout the design of this Living Lab. It gave a clear path on what steps needed to be taken to design the best possible experiment. Each design cycle step is reflected in a chapter of this thesis making it clear how important it is to rigorously follow the design methodology. Which kept the process organized and streamlined.

By following these methodologies strictly, the researcher could ensure research rigor and enable others to follow this same process and expect a similar result. As this particular design process could be considered a success, future researchers planning to design a city logistics Living Lab can see this thesis as a frame of reference for their own process. This is the contribution of this thesis to the knowledge base. Instead of future city logistics Living Lab designers going in blind or having to adapt design methodologies from other fields, they can start working from a more appropriate foundation. With the hope that as more researchers design city logistics Living Labs and experience their successes and failures, they also add to this knowledge base and improve the understanding around designing Living Labs in the field of city logistics.

11.3 Research Questions

The intent of the thesis was to formalize an approach to designing a city logistics Living Lab. Following a rigorous scientific methodology of design that could be evaluated and replicated by others. This design was made with the specifics of the Den Haag Living Lab in mind. Including the objectives of these particular stakeholders and within the Den Haag context. Yet the purpose of the paper was for the process of actually designing the Living Lab to be generalizable in different logistical Living Lab contexts. From this follows that the main research question that this paper attempts to answer is:

How should a city logistics Living Lab experiment be designed to ensure that the stakeholders can consider it a success?

To help answer this question three sub-questions were formulated that could break down the main research question into more manageable parts. This section will attempt to answer the three, sub-research questions individually and then use these answers to address the main research question presented previously.

1. What characteristics does a successful city logistics Living Lab experiment contain?

The first sub-research question attempts to define what a successful city logistics Living Lab is. What are the typical characteristics that a Living Lab should contain that would benefit the experiment? Starting broadly the most important part of a Living Lab is the *collaboration* between the stakeholders, be they companies, authorities, academia, or the Living Lab users. The characteristics of openness and collaboration are the most important for a successful project. Another important characteristic is the *realness* of the Living Lab. It has to be realistic and natural and reflect the real world. While producing *value* for the stakeholders involved, be it new knowledge or relationships for the private companies or a better product for the consumers. The Living Lab must produce value for it to be considered a success. Lastly, the Living Lab needs to take *responsibility* for its environmental, social, and economic effects on its surroundings.

A City Logistics Living Lab (CLL) must contain all of these broad characteristics but has slightly different emphases. Collaboration is also vital in a CLL, especially the working together of the different companies from an early point in the planning process is important. With early collaboration, the different stakeholders, which might even be competitors, are more likely to be able to work together and settle their differences before they can affect the Living Lab. A platform needs to be provided for these discussions to take place, a mechanism that promotes communication between the stakeholders and the eventual development of trust and collaboration. In a CLLL there also needs to be an iterative factor to the project, where changes are made at the end of each iteration and the impacts of which are measured throughout the project. This was the CLLL can test out the different possible solutions and back up their findings with hard data. This is possible through a minimal viable product approach that was used in the Den Haag but can be done in other ways. A successful CLLL would fulfill the characteristics of a Living Lab of collaboration, realness, value, and responsibility while focusing on the specific CLLL characteristics mentioned above.

2. What process needs to be followed when designing a city logistics Living Lab?

During the designing of the Den Haag Living Lab, it became clear that there are two vital parts to designing a successful city logistics Living Lab. Close collaboration with the various stakeholders and a clear design

methodology are vital. Though the thesis did not evaluate which design methodology was best suited for a city logistics lab, it was found that strictly following an established design methodology enables the process. In this case, the design cycle of Eekels and Rozenburg was followed. This methodology worked well as it was broad enough to be adapted to the specific situation required for this Living Lab but still gave the process structure. By additionally using a case study outline it can give the Living Lab structure, and a standard to follow. This allows the researcher to keep the experiment design organized and on topic. Following the design cycle facilitates the researcher to better deal with unexpected problems. By following the steps of the design methodology, it is ensured that the design is progressing, and the researcher does not get waylaid by any of the possible problems. By following the design cycle, the researcher can ensure the rigor and validity of the research. This allows others to follow and reproduce the process and expect similar results.

Yet strictly follow the design process cannot go at the expense of the other important factors in designing a city logistics Living Lab. Mainly the process needs to be undertaken in close collaboration with the various stakeholders of the experiment. During each step of the process, the various stakeholders' inputs need to be sought out and considered before the next step of the design cycle can be taken. This holds true from the very start of the process. When the problem or the function of the experiment was defined it was done by considering what each stakeholder wished to get from the Living Lab. This concept needs to be kept at the forefront of each step of the design process. This is not a solitary activity, instead, it requires that the needs and desires of the different stakeholders influence each part of the design. At the end of the design, it is the other stakeholders that evaluate and validate the design. This means that if their needs are not met, the process needs to start over from a previous point, to arrange that the missing aspects of the design are fulfilled in the next iteration. For a successful city logistics Living Lab, strictly following a design methodology in collaboration with the relevant stakeholders is vital.

3. How do the stakeholder expectations translate to learning goals of the Living Lab, how can these be measured and evaluated?

As has been mentioned in both of the previous sub-research questions, collaboration with the stakeholders is of vital importance to the designing of a successful city logistics Living Lab. But how can this collaboration be reflected in the design of the Living Lab? To do so requires that the objectives and expectations that are expressed by the various stakeholders are translated into learning goals and concrete objectives that can be measured and evaluated during the experiment. The first step to do this is through discussion with representatives of the stakeholders. Personal meetings can be the most effective at this point. This is because the stakeholders might be more comfortable expressing themselves individually instead of in a group where there might be conflicting opinions. After getting a good idea of the objectives of the stakeholders involved in the project these need to be organized together into criteria that encompass the objectives. This final list of criteria needs to be converted into something that can be measured through the experiment. These measurements will allow the researcher and stakeholders to learn and evaluate the effects of the Living Lab. This can be done through performance indicators. These performance indicators are measurements that can evaluate the success of the Living Lab on the different criteria.

Determining the proper performance indicators can be a difficult procedure. They need to be able to accurately reflect the success of the experiment in the criteria they reflect. Yet it needs to be realistically possible to set up the experiment to measure these indicators. This means that while designing the

experiment it needs to be outlined how these measurements will be taken and who is responsible for these measurements. To accomplish this, again collaboration with the stakeholders is paramount. Firstly, the stakeholders need to agree that these indicators measure the success of the criteria they are interested in. Only then can it be evaluated with the stakeholders whether it will be possible to measure these indicators and whether those responsible for the measurements are willing and capable of doing this. Only when everyone agrees that the measurements will be possible and that they will measure what is needed can they be confirmed for the design.

How should a city logistics Living Lab experiment be designed to ensure that the stakeholders involved can achieve their objectives?

In conclusion, the three previous sub-questions can be used to finally answer the research question of the paper. The most important part of designing a city logistics Living Lab is the collaboration with the stakeholders. It is through discussions with and between the stakeholders that a successful design is conceived. By listening to what the stakeholders want and what they are willing or capable to do during the Living Lab is the best way to design a city logistics Living Lab that is realistic, responsible, and valuable. This needs to be supported by a robust theoretical backing. This includes rigorously following an established design methodology that can structure the whole process. As well as using theoretical backings for the design choices made throughout the design process. Any alterations made to the design need to be supported both by the expectations and capabilities of the stakeholders as well as by theoretical backing explaining the design choice. This means that while collaboration is vital, the design cannot be changed simply because a stakeholder wills it. The balance between finding what the theory states works best and what the stakeholders want is where the design should aim for. This will ensure the best chances that at the end of the process the stakeholders will see the design as a success.

12. Limitations and Reflection

In this chapter, the limitations of the design of the experiment and the paper as a whole are discussed as well as some of the reflections of how the process went. While some of the limitations of the design itself have been covered in the validation and evaluation section 9 and 10 there were other limitations that were not so much of the design but of how the design was conceived, which will be discussed. The limitations of the paper as a framework for other future logistics Living Labs are also expanded upon from chapter 11.

12.1 Limitations

The first main limitation of the design of the Living Lab is the fact that a Living Lab is a continuously developing and changing concept. This means that there is no necessarily final design of how the Living Lab should be performed over the next few years, as has been outlined in this paper. Instead, the Living Lab is expected to adapt to the circumstances and needs of its stakeholders and users. To establish a design for the experiment the researcher had to deviate from the constantly changing concepts of the Living Lab and pick a moment from where the design was set. This means that the design as presented now is not necessarily up to date with the latest discussions and decisions made by the stakeholders and owner of the Living Lab. It was necessary to decide on a cut-off point from which the Living Lab might start deviating from the experiment design. In this case, this cut-off point was the 5th of March meeting attended by the Living Lab owner, municipality, Next2Company, Nimber, Cycloon, and MyPup. Everything before this point was considered and included within the report and the design of the experiment. But the decisions and discussions that were held after this point were not incorporated into the design. This inevitably results in a deviation between the proposed design and reality. Even when new concepts were introduced during discussions while the design was being conceived, they could not be included, as this would lead to an endless updating of a design that would not be finished until after the Living Lab has run its course. While this is a limitation of designing a Living Lab in this manner, it makes it possible to have on paper a sketch of one possible direction that the Living Lab can take. This can give the Living Lab a general course to follow in the near future, while giving the opportunity to discuss what needs to be changed of the design in a structured manner.

Another limitation of the design was the lack of in-depth communication with some of the stakeholders, mainly Mobian and Cycloon. While Mobian is interested in participating in the Living Lab, the company felt that it was too early to become too involved at this point. They were still concentrating on growing the mobility side of the hub, believing that getting distracted by including logistics at this point was a bad idea. Mobian planned to open 3 hubs in Den Haag in the first half of 2021, only after these hubs were set up and operating as desired did Mobian have plans to expand into the logistics sector. This was reflected in the design where Mobian is only introduced in the final loop of the planned design, giving the experiment plenty of time to set up the other stakeholders before logistical hubs need to be included. The lack of interest from Mobian for the time being meant that contact was limited to two individual interviews Laurens Bushoff of Mobian and one workshop meeting. From these interactions, it was possible to glean the objectives, the measurements, and the capabilities of Mobian, but they were not able to validate the design. This is a limitation of the design as it means that it is not possible to say with conviction that the fourth loop of the Living Lab is possible, or whether the design as a whole fulfils the desires of the company. While the design meets the objectives that Mr. Bushoff gave during his interviews and the

design attempts to realistically take advantage of the logistical hubs of Mobian. It is not possible to say that the design has been validated thoroughly by all of the involved stakeholders.

The other stakeholder that had limited input on the experiment design was Cycloon. This came about because the original courier company involved, DHL, backed out during the early stages of the Living Lab planning. This meant that the Living Lab had to be organized primarily around Nimber and Next2Company instead of DHL and a different courier company needed to be found. Cycloon did not start participating in the Living Lab meetings until much later in proceedings. Throughout the planning stage of the Living Lab, the experiment was planned and designed with the understanding that a courier company would join, but it was simply a matter of which one. This means that while the experiment was designed with a courier company in mind from the beginning, Cycloon did not have a chance to offer their input on the design while it was being made. There were no individual interviews with the Cycloon representative, the company was only able to give an overall validation of the design during larger meetings where the other stakeholders were also present. This means that Cycloon was not able to give their individual opinion on the design, and were not able to influence how the experiment was designed. Instead, assumptions were made of what an environmentally and socially conscious courier company focused on cycling couriers would look for in a Living Lab of this kind and what objectives they would have when joining it. This is a clear limitation, as the design was not made with the company specifically in mind and thus could have potentially been made to better suit this stakeholder if another redesign was done.

12.2 Reflection

While the limitations dealt with the parts of the process that had possibly negative impact on the thesis, this reflection section broadly discusses how the project went and how the work methodology was followed. As has been mentioned before the project dynamics changed throughout the time spend designing the living lab, which also meant that the methodology had to be able to handle these changes.

The main change in the project was the departure of DHL which has been discussed previously, but the departure had impacts throughout the project. The focus of the project was changed. Originally the goals of the project were to create a local-to-local distribution network for DHL and a supply and demand matching platform to test out crowd-shipping with Nimber. These goals were changed and instead the focus became the connection of various logistics services on an open platform. This meant that the involvement of other logistics stakeholders became much more important, not only as a replacement for DHLs courier delivery/distribution capabilities but also as alternative logistics services that could be connected to Nimber's crowd-shipping service. With more different stakeholders involved in the project, it brought the concept of collaboration to the forefront of the project, the collaboration was straight forward as the objectives were also clearly defined. As more stakeholders joined the project, each with tenuous links to the project and different ill-defined objectives, communication, and collaboration with and between the different stakeholders became paramount.

With this change in focus, the design process, which had just begun when DHL left the project, also had to be altered. The methodology mix had already been put into place and was not reworked due to this change, instead the robustness of the methodology was proven as it showed that it was able to handle a change in focus and stakeholders. The case study framework had to be slightly reworked, as the focus of the project had been changed, yet for the rest, the boundaries of the experiment that had been defined were able to stay consistent. Some of the steps in the design cycle had to be altered, namely, the problem

(new focus); the analysis (different stakeholders to analyse); and the requirements (different objectives). Yet, the overall methodology mix stayed consistent.

Having the work methodology well defined early in the process made it possible to manage the changes in the project. By having clear boundaries and knowing what steps had to be followed made it possible to keep working on the design of the Living Lab, even when there were still uncertainties in the project. The fact that the methodology worked in spite of changes to the project when the process was already underway, and even helped keep the design process organized through these changes makes me believe that it is a robust methodology that would be replicable. While it is difficult to say what results another group of researchers would achieve following this methodology mix in a different project, I believe that by diligently following the methodology set out in chapter 3, a city logistics living lab designer would able to achieve their goals.

13. Future Research

This chapter will discuss the directions in which future research on this topic would be most beneficial when considering what has been done in this thesis. Part of the objective of this thesis was to benefit future research into city logistics Living Labs by providing a framework on which future Living Lab designs can be based. Yet this does not signify that future Living Labs should follow the same exact steps that were done in this thesis. There were things that could have been improved and other directions that researchers could focus on to improve both the process and the knowledge in the field. The thesis will then end with a short overview of what has been achieved through this work, and how it contributes in practice and in research.

13.1 Future Research

The mix of design methodologies in this thesis led to a successful Living Lab design. Yet the role of action research in the success of the design process is not readily apparent. In theory action research suits this project fully. As the researcher takes an active role in the study or design process and is attempting to gain knowledge from this process, action research is very suitable. Yet during the thesis, it was difficult to apply action research concepts directly, and instead, it was used as a supplementary tool to ensure that the researcher was consistently monitoring and learning throughout the process. While this contribution is valuable, action research has more to offer in the designing of city logistics Living Labs. It is uniquely suited as a methodology where practical solutions are generated while creating knowledge about the practice (Mcniff and Whitehead, 2016). In the future, action research can be investigated as the main design methodology to follow while designing a city logistics Living Lab instead of following the design cycle. While it may make the process more complex, action research could prove to be a valuable contributor to the process which was underutilized in this thesis.

The concept of crowd-shipping was introduced early in the thesis, and at some point was going to be a bigger focus of the study. Yet the thesis shifted more towards the concepts of different logistics services (including crowd-shipping) being offered on the same platform. The effects of crowd-shipping in particular were not looked at as much as was originally planned. Mostly the difficulties and advantages of crowd-shipping were investigated in this thesis, with the focus on how crowd-shipping would function in the Living Lab and in collaboration with the services from the other stakeholders. Yet crowd-shipping in particular, is an interesting topic that could use more research, especially through Living Labs. This thesis did not go in-depth into the different factors that can make a crowd-shipping service work, how it could benefit others and what can be done to promote its success. Especially the views of the customer and the courier on crowd-shipping were lacking during this thesis. Future research on how potential customers see crowd-shipping, what they see as attractive in the concept and what their fears are would be useful. The connection between customer and courier is also a potential source of future research, the concept of trust and negotiations between strangers could be interesting to look into. Lastly, future research on the couriers themselves, how they approach crowd-shipping, and what can be done to encourage more people into working as part-time couriers would be a worthy direction for future research.

Collaboration between stakeholders was emphasized throughout the thesis as the most important element in a successful city logistics Living Lab. The collaboration between stakeholders was highlighted and managed during the whole design process, and steps were taken to encourage collaboration between these stakeholders during the Living Lab itself. Yet the thesis did not have the scope to investigate the

concepts that are needed to promote collaboration past the design phase of the project. The governance rules to prevent and solve potential inter-stakeholder conflicts have not been studied in this thesis. In a Living Lab wither multiple stakeholders, some of which are competitors in other logistics markets, conflicts are likely to arise in a long-term project. Potential conflicts during the design phase were averted or solved through the use of stakeholder management and meetings between the interested parties. This might not suffice while the Living Lab is in operation, where problems of payments, invoices, customer services and many more could arise. Before this point, solid governance rules need to be discussed and agreed upon. This would most likely appear in the form of contracts that need to be negotiated between the stakeholders.

Future research is needed to see how these governance rules are best set up. The role of the researcher and the Living Lab owner in these negotiations and discussion is still unclear. There are doubts on how much influence the owner has and how/whether they should wield this influence. Weak or unfair governance rules can lead to conflicts that can derail a Living Lab. An important next step in future research would be studies on the best ways that a Living Lab owner can approach this. A similar study as this thesis could be formulated, where instead of attempting to satisfy the stakeholders through a Living Lab design, the researcher would endeavour to propose a set of governance rules. This could be in the form of Living Lab contracts that cover the most likely reasons for conflicts within a Living Lab and leave the stakeholders and Living Lab owner satisfied that any potential conflict can be solved through this framework.

13.2 Contributions

The contributions of this thesis could be divided into the practical contributions of the experiment design and the more theoretical contributions of the thesis overall. The practical contributions come from the actual work done for the Den Haag Living Lab. Primarily there is the final design presented in chapter 8, which can serve as the blueprint from which the living lab team can plan and organize the experiment. The design comes with recommendations of what the living lab owner has to focus on to ensure the smooth running of the project, primarily how important collaboration with the different stakeholders is. This collaboration has also been initiated, with these same stakeholders being involved in the process of the design, meaning that their objectives, views, and worries have been highlighted in the text and been considered during the design of the experiment. This information should make it easier for the living lab owner to be able to manage the stakeholders and lead the living lab to success.

The theoretical contributions of the thesis are in the city logistics fields. Specifically for other researchers in the field that want to design their own City Logistics Living Lab. This thesis serves as a blueprint for other researchers to work off of when they design their own experiment. The steps of the methodology that were taken are clearly explained and supported through literature. Throughout the thesis it is illustrated what exactly needs to be done to design a living lab in the city logistics field in which the stakeholders involved will each be able to reach the objectives they set out to achieve when joining the project.

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IV. Appendix

A1. A Selection of Meeting Notes

A1.1. November 19, (DHL drops out)

Mateo, Rodrigo, Lori, Ioanna, Sven, Jackson, Jan

- DHL Express drop out, slight opportunity of DHL Parcel Jan will know more in a week
- DPD looking at what they can offer, maybe as delivery organization in DEN HAAG
- PostNL is the third opportunity to look into
- Nimber difficulties
 - Attracting customers and drivers
 - Customer's through CID connections
 - Drivers maybe through bike courier company to pick up slack
- Using MyPup in combination with Nimber
 - These are lockers to solve 'the last meter problem', if involved could be interesting to incorporate with Nimbers work. (Will be at the workshop, perhaps left open till then)
- Jan will look at possible cycle couriers, has a list of startups that are involved in Den Haag
 - Lori suggests inviting multiple couriers to the workshop so they can all get involved in the pilot scheme (maybe some form of 'competition' or auction to see who will stay with the project?)
- Jan: Maybe start with a few businesses and then expand from there?
 - Or start with national retailers for their local deliveries
 - Or start with The Hague municipality for internal shipments (Sven will look into it)
- Start with business to business as it is the simplest format (known customers, more consistency and better data according to Jackson) and then use Nimber to connect these businesses either with bringers (crowd shipping) or with the cycling couriers discussed above.
- Idea is to start with this as a MVP for a couple of months and then see where else to go (C2C perhaps?)

A1.2. December 4 (Workshop Meeting)

- Lori Tavasszy (TuDelft)
 - Presentation:
 - Freight transport and Logistics
 - Trying to simulate demand, to help make decisions
- Rodrigo Tapia (TuDelft)
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 - Ioanna (TuDelft)
 - Works with LEAD
- Sven (DenHaag)
 - Presentation (through phones)
 - Den Haag has sustainability goals (cleaner airs, less traffic)

- Expected of 100.000 new citizens in the coming years, and not a lot of space, going to develop CID, ZKD where the project might be concentrated, but could be expanded to the whole city (especially the digital aspect)
- CID: New housing, between stations
- Want to know from other people how to implement the different aspects of smart mobility hubs (platforms, mobility hubs, etc.)
- Jackson (Nimber)
 - Company introduction
 - 100,000 deliveries, 8000 bringers
 - Both a website and app
 - Nimber Crowd: C2C, B2C (More free)
 - Nimber Business: B2C, B2B (Fixed fee, and fixed time and place, users have uniforms)
 - Has insurance up to 1000 Euros but you're allowed to ship whatever you want
- Jan (Next2Company)
 - Help business thrive, DHL
 - o Presentation
 - Inner city shipments are a large part of parcel shipments
 - These shipments carried out by traditional hub and spoke networks
 - Ambition to facilitate local shipments, reducing and optimizing physical flow of goods and lower emissions through smart logistics infrastructure. Integrating with domestic and international parcel business
 - Platform is a mix of point to point with route based logistics services
 - Value Proposition: nextDay/SameDay delivery, green transport, with fixed parcel dimensions and differentiated tariffs for service windows and depending on postcode
- Mirza Hotic (DenHaag CID Smart Mobility)
 - Program manager of smart mobility and logistics in CID and Binckhorst
 - Looking to participate in pilots of city logistics
 - Has plans and meetings on the setting up of different hubs (can't share details yet)
 - Excited to get it going, there is space to do pilots (not physical space)
- Jeroen Hutten (DenHaag CID)

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- Infrastructure projects and building projects
- The main aim of the study is low emissions, but there is a lack of space, especially in CID there's building in development that are very big and need a more efficient way to deliver goods to these big buildings. Maybe some sort of hub in the area or the building that could alleviate the traffic (IKEA/Picnic).
- Tom Broring (DenHaag economy/logistics)
 - Business areas to see how city logistics impacts it
 - The city is looking at how to give space to the complete chain of logistics (what is necessary for the size and function of the hubs in the chain). How would this project be connected with the physical hubs that are available in the city?

- Hans Lodder (DenHaag Data)
 - Specialized in traffic modeling
- Charlotte Hilebrand (DenHaag Spatial Planning) charlotte.hilbrand@denhaag.nl
 - Urban Planner, interface between mobility and urban planning. Interested in wider influence of hubs (livability of neighborhood)
 - Efficiëntie is een ding, maar ook de impact op de leefbaarheid. hoe kunnen zulke punten/hubs ingepast/gesitueerd worden, zodat ze bijdragen een leefbaarheid/sociale contacten/beperken overlast van aparte busjes die steeds de straat in komen, etc?
 - importent, especially in an area where people stay in a certain place for long, is to go from anonymous to rooted
- Luke van der Wardt (MyPup) lukevanderwardt@mypup.nl
 - Founder, they offer solutions for buildings and offices to give lockers for people to pick up
 - Currently have 20 pick up points (offices and residential locations)
 - The volumes can be shared
 - Target to grow in the city, to make it easier for employees and residents of the complexes to receive packages
 - Not exclusive to a carrier (multiusers) always add a service that they can consolidate in their own hub and can deliver parcels from ebikes
 - There could be connection with Nimber and Next2Company to maybe connect with MyPup. (Bringers could drop it off at the hub or at the lockers so that they don't need to find a specific time windows)
 - o Independent of courier companies
- Michael Baan (Hely)
 - Mobility service provider in shared mobility, have multiple hubs in Holland including the Hague
 - Do you already see initiatives where the city hubs for logistics also host other services?
 - Places where there could be synergy between mobility and logistics hubs. Are there hubs where there is a mix between the two functions?
 - Current NS stations are an example of these cases. (Mirza) They are looking at potential locations for hubs (mostly for mobility, but would be a logical mix to synergize with logistics)
- Michiel Oldenburg (Bereikbaar Haaglanden)
 - Is a logistics expert, main goal is to connect government with companies to do smart and cleaner logistics, could connect with others.
 - Nimber ('clones') attempts have been tried before in the Netherlands have failed
 - Should start small, (small area, with a few retailers, etc.) and then scale-up
 Where is the first mile in the presentations? They seem to concentrate on the last mile? (Lori says that if it's local to local first mile to last mile is the same but it will become clearer over time)
 - Different ideas: (1:02)
 - Garbage process of empty trucks being filled with garbage as they move
 - City Barge, garbage through the water

- Izipack: get your parcel at the public transport where you stop
- Fresh for restaurant logistics
- Parcls: The company I researched
- DHL: Freight bikes from city hub into the city
- PostNL: CityHubs in CID with cargo bikes
 - What kind of digital hub initiatives can be added
- Get connected with department of infrastructure (polswaak?)
- Look for loading infrastructure
- Hyperloop for CID (Starting for a Dutch initative)
- There is a waterway in the CID, could be a space saver and should be used to be efficient
- Ton Damen (Cargoroo)
 - E-cargo bike, active in Den Haag, and linked to Hely Hub
 - o Getting a better connection with smaller retailers, looking at local to local
 - Activation of current users (could be bringers?), don't want to just be suppliers of cargo bikes but also be a player in the logistics between the SME and customers, etc.
 - Would like to create a shared freight movement within the city
 - Hotspot in Amsterdam where logistical innovation is spread around the city through different hotspots (still in pre-concept spot) Want to be more than logistical hotspot.
 - Wants to do more and is enthusiastic about it
- Dimitri Karampelas (Db Shenker)
 - Lori was his supervisor
 - Seeing how DB Shenker could connect to the project
 - All system components (i.e. parcel lockers, crowd shipping, city bikes) are great individual improvements, but In combination there is a higher added-value. Of course as Diego mentioned, there is a challenge to connect them, but maybe this is the key to success
- Laurens Bushoff (Mobian)
 - Concept of mobility hubs (background in parking) trying to combine the two
 - Docker partnership to make it easier to rent a cargo bike in combination with a parking place at the edge of the city (through reservations). This keeps the city clear of logistics and delivery vans.
 - The location of the hubs is very important (for companies routing, but also for gov't to control traffic) is the hub located in such a spot that it is indeed time/cost saving??
 - What is the role of the municipality of placing the hubs? There is room needed to have space for all the activities. How do you mix the location with space
 - How to deal with public area vs. private area. Public areas you need a lot of regulations before a company can exploit its services. But private areas are more easy to find and organize and much faster because you are allowed quicker. Something to think about for logistics hubs.
- Ruud van Gils (DenHaag Data team)
 - Works in data gathering and delivery
- Norbert Nijhof(DenHaag Mobility)

- Program manager of parking, shared mobility and mobility hubs
- Valerio Gatta (Molde University/Roma University)
 - Representing living lab in Oslo, working with Nimber in crowdshipping
 - Likes the process, and will try something similar in the workshop in Oslo (January) The divergent and convergent ideas
 - o I agree that the main challenge is to connect different services...
- Merve (TuDelft)
 - Planning on doing the master's thesis in Lead project
- Diego Valdivia (Prime Vision)
 - New business development, software company facial recognition in logistics market
 - What's the strategy for data sharing?

Conclusions

- Physical hubs: Especially on space and how to connect these with the
- How to connect different services
 - Nimber, Cargoroo, Mypup, etc.
- o Difficult to look at infrastructure, keener to look at the services which will be important

Post-Workshop

- Jan: Should we look at enlarging the area of the experiment?
 - For Nimber maybe CID works fine
 - For Next2 and Cargaroo they want to include retail as well so maybe it needs to be bigger?
- o Lori: We should be looking at innovating not just being business development for Nimber
- o Jan: We should include MyPuP and maybe Hubbel?
 - Lori: There will be many different platforms and services. We should be above this, by connecting it instead.
- We can maybe concentrate connecting Nimber with Cargaroo (Hely) and MyPup?
 - Its better to have a vertical connection than horizontal, so maybe limiting to these will make it easier to get everyone to cooperate.
- Concentrate on the existing hubs.
- Need to see whether Jan can be involved and how he will be involved.
 - Probably not DHL, but maybe PostNL, Cyclone fietcourier, Hubble, etc.
 - Hopefully by next week he has a clearer idea of what is possible, discuss with IT to see if platform can be disconnected from DHL.
 - Maybe rotate to concentrate on helping Nimber with the vertical integration instead.
- Are the plans realistic for Jackson?
 - It depends on the data sharing; it can be a very fragile understanding. Needs common understanding there.

A1.3 December 16 (Post Workshop Meeting, Interviews summary)

Mobian:

- Reservation platform (app) for parking and they've added mobility (started with shuttle from parking to airport, then taxis for private rides). Started in other areas, experimenting with bikes and e-scooters (Docker) (Formula 1 Zandvoort)
- Plan to have 3 hubs in Den Haag by April 2021 (were delayed from 2020)
- Can integrate other types of mobilities and companies into their platform
- What they want:
 - Higher occupancy rate
 - More user data (both target audience and user case)
 - Looking for courier partners who will use the parking and bikes

MyPup

- Their clients are companies and apartment building that pay monthly fee to have lockers installed. MyPup receives all the packages at distribution center and then delivers them 'free' in one go to lockers same day
- Den Haag distribution is at a sheltered workshop (sociale werkplaats) where MyPup provides organization, electric vans and scooters but couriers are not employees
- Willing to open lockers to others and let other companies take care of the delivering and wiling to share data
- What they want:
 - More clients
 - Explore how lockers at a hub could work vs lockers at residential location (are people willing to walk or bike to hub to pick up package instead of pay more for home/office lockers)

DenHaag

- Charlotte (Strategic Advisor Urban Development)
 - o Positive effects on Pollution and Noise
 - Negative effects on social contact (worry that lockers/hubs will cut off the social contact that a lot of people overlook depending on how hub is designed)
- Mirza (Project Lead Smart Mobility & Logistics CID & Brinckhorst)
 - Still setting up his team, planning on properly getting started around March 2021
 - Job to find, evaluate and plan pilot programs in mobility and logistics
 - Works with Michiel Oldenburg who connects to different pilots
- Ruud (Data team member in Mobility department)
 - Actual measuring is usually outsourced to different firms
 - Work with data like:
 - Bike and road traffic (differentiated for 3 sizes)
 - Data at traffic lights
 - License plate data
 - Mobility style
 - o Usually work with a model to predict how traffic will react to different changes
 - Willing to share data and model (as far as it is allowed)

A1.4 January 29 (Living Lab participants meeting together)

Rodrigo, Ionna, Lori, Mateo, Sven, Jan, Jackson, Luke

- Facing the problem of not having enough supply of parcels to start the experiment, how could we solve that?
- MyPuP already has volume from werkze in Delft, and they would be happy for that volume to be taken over by someone (Nimber or Cycloon, but it is probably too far to bike from Den Hoorn to the different Den Haag locations)
- Internal gemeente parcels could also be used as volume, to start up the Nimber volume flows
 - Nimber needs to also get bringers, there will be difficulties there as it needs to be advertised and there need to be parcels to deliver (Chicken and egg situation)
- Nimber or Cycloon can also be used as delivery between lockers of MyPup, key would not be a problem
- Less of stepwise approach, maybe add MyPup + Cycloon earlier together as they are both 'existing' in Den Haag, unlike Nimber.
 - Jan+Luke will meet to discuss possibilities after the Jan+Cycloon meeting
- Risks and opportunities:
 - GDPR is a threat for open platform
 - Risks and opportunities per stakeholder can still be discussed individually
- Den Haag stadium hub, that can be used, it's being developed and used as a logistics hub, maybe we can get involved and it could add volume. Sven will look into it
- Lockers best placed in a roofed locations, due to rain/vandalism
 - Lockers in various locations around Den Haag, some of which could be open to the public
 - Lockers in a mobility hub seem like a good idea to Luke

A1.5 February 10 (Meeting with all companies including more Nimber members)

TuDelft: Lori, Rodrigo, Ioanna, Mateo

Next2Company: Jan, Thomas (project lead of next2delivery)

Nimber: Jackson, Georgia (tech), Jon Martin Trajford (managing director)

- Round of Introductions
- MVP steps comments:
 - Lori wants to stop for questions/comments?
 - Jon Martin: What is the timeline?
 - First it is a test, more of a technical nature.
 - It's more of a launching experiment than a complete roll out
 - The technical test can be done within 2 years.
 - The organizations can pick it up and go on
 - Jon: Technical part can be easy, but it's the community that needs to be made
 - \circ $\;$ Georgia: 1b to 2 is easy, what about 3, what do the parcel lockers mean $\;$
 - Lori: Having a connection between them, details to be discussed.

- Locker is a place where bringers can leave their package, as an alternative end point or pick-up point.
- Jan Smit: We will start specifying the interface of the systems. We have API of MyPup and will get it from Cycloon to make a data interface document together.
- Thomas: The technical part is dependent on for whom we will be doing it? Which clients which segments?
- Lori: What is the timeline?
 - It is a 3-year project, so we have at least 2 years roughly.
 - Ultimate vision is to have this connector to build between the many different platforms. This plan was made after DHL left the group, so specifications and objective are still vague/open.
- \circ $\;$ Jon Martin: What do you want to test? What do you want to answer?
 - Lori: The problem between the platforms is that they are not connected. We want to see how this plays out in real life when 2 separate platforms collaborate. Creating competition for an incumbent (Like DHL) through hyperconnectivity
- Jon Martin: Nimber is already combining with other companies, they have partners that can put things into the platform.
 - Connecting different local logistics networks/companies that can compete against a bigger company.
 - Jan: Do you have a functional description
 - Georgia: We have API documentation
 - Everybody's fixed on the price model, if you want to use spare capacity you have to look at another way (real time pricing, differential effort of extra effort or time)
- Which segments will the LL aim?
 - Jon Martin: Depends on the type of network you have?
 - Lori: CID Brinckhorst, B2B, and G2G?
 - We don't have a B2C community ready
 - The hague has a lot of governmental work
 - Jon: In Oslo logistics companies are good during the daytime, community is useful during the night.
 - Jan Smit: We should get an agreement for a certain volume from the Municipality for the pilot.
 - Often these are done over tender for long time contracts, so it needs to be looked at soon.
 - Thomas: Starting volume and name recognition are the most important to start.
 - Jon Martin: The community can deliver but depends on the deliveries. We tried to use commuters but pricing of packages were so low that people were not interested.
 - C2C is possible because there's a demand for more flexible delivery.
 - Lori: In conclusions this is still open but needs to be reconsidered with everyone.

- Resources and commercial presence/marketing?
 - Depends on what segments are aimed for the answer will be very different.
- Technical implementation challenges & road map
 - Jon Martin: The platform is already open, but it depends, we need to have volume and how are we going to work with Cycloon. Are they going to use our system, or the other way around? How are the lockers going to be used (who is getting info from whom?)?
 - Next2Company can make a first blueprint of the technical part, and an idea of business idea. We are all working from different business models and platforms, and we just design the interfaces to transfer the data and services.
 - Jon Martin: Should we be testing 1a/1b before we move on to the new steps?
 - The further levels are still a little vague. Want to concentrate the first steps first.
 - Jon Martin: With Nimber we have experienced how hard it is to grow the network without having the volume necessary (Tried it out in London). So they learned to work together with businesses from the start, as they can start with some volume and then keep it growing from there.
 - This is where G2G would come in.
 - Rodrigo: Does Nimber have any contacts that they can lean on?
 - Jon Martin: No, not aware of den Haag market.
 - Jon Martin: Interesting to test out lockers because they offer extra flexibility, especially looking at commuters which could be interesting.
 - Jon Martin: Interesting to see what inputs MyPup and Cycloon have. Try to see what services they are missing that Nimber could be included.
- Thomas: What is Nimbers focus right now in Oslo?
 - Jon Martin: Same day delivery, with electric cars up to 500Kg
 - Pilot with Ikea
 - Also, a pilot with micro-hub in the city
- Lori: Make sure that MyPup is also there for next meeting to discuss it all together. And check with the government for G2G flow.
- Jan: Cycloon is committed to joining, waiting for the local branch.
 - Managing partner will start a project team.
 - Hurdle: Budget, what kind of funding can cycloon get from central office. They will open a budget to get the local branch to open the pilot. Though they want to know the flows which we don't know and probably won't get high volumes in the first place. They don't have extra capacity (which shouldn't be a problem as we don't expect large volumes).

A1.6 February 19 (Finding a market for Nimber)

Rodrigo, Ioanna, Mateo, Sven, Jan, Thomas, Jon Martin, Jackson

Sven:

- Difficult to find flows, there is a logistics hub where PostNL/TNO take care of the work.
 - We could ask PostNL whether they are open to sharing some of the government load, perhaps non-standard parcels would be best.
- Inter-governmental flows are done in house, have their own sustainable couriers and unlikely to outsource.

• Could have a small pitch to try to convince them to agree for just the pilot (They are part of the project after all)

Jon Martin:

- Need to decide what it is we want to find out, what do we want to do?
 - Answer: How would a crowd-shipping platform work in Den Haag? (Jan)
- Need to find where Nimber can be useful, when you're delivering standard deliveries during the daytime, courier firms are a lot more efficient. At this point crowd-shipping is not viable as people are not willing to work for such small amounts.
- Could focus on commuters, but they expect some kind of revenue. The cost of a small parcel is too low to also include a big enough fee for the bringer.
 - Instead what should be focused on either big or unusual packages that normal courier services won't deliver or multiple smaller parcels that can bring the unit price down.
- The value proposition for some crowd-shipping is that if the bringer is a neighbor to the receiver it is cheaper to deliver. The bringer only needs to make a single journey to the destination, and doesn't have to go back like a conventional courier.

Possible Volume targets

- MyPup: 300 packages a day from den Hoorn to den Haag, willing to drop them off somewhere else for Cycloon/Nimber to do the distribution. As they are for lockers, the parcels will be 'conventional' and will probably better be delivered by Cycloon
- Secondhand stores Could be a very good combo, as what needs to be delivered is usually larger and customers are willing to pay a little bit extra. They also pick up items which could be included
 - Thomas connection with RataPlan and will contact them to see
 - o Ioanna connection with second hand clothing platform, will look into it
- Flowershops these require special care (water, immediate delivery and return if customer is not there) and has untapped potential that conventional courier companies are overlooking
 - Nimber has some experience in Oslo with this, though they focus on more rural areas as again in urban areas there are more efficient options
- Marktplaats Direct second hand dealings where customers are already interacting and need to pickup or deliver their products
 - Nimber works with one in Norway, when the customer's agree on a price there is a link to Nimber that can make it easy for them to have it delivered through the platform

For Bringers

- JM: rather already now the volume and area where we could have packages.
 - This way we can focus on where we need to get bringers and what type of bringers
 - If bringers appear before volume they will give up on app
- Students could be potential bringers, and are easy to motivate. There's plenty that go (usually on non corona days) everyday from Delft to Den Haag by OV or bike

A2. Individual Meeting Notes

These are the notes taken during various one on one meetings with relevant stakeholders to the Living Lab. These are not literal quotes but the notes of what I believed was relevant to the research. Many of these notes have been translated from Dutch as various of the meetings were originally held in Dutch.

A2.1 Meeting with Sven – Den Haag Mobility Department

What Does Den Haag expect and hope to get out of the Living Lab?

- To learn (department of mobility has no logistics people), see it as an entrance to see what's possible on the logistics topic. They don't have a 'logsitics person' and thus do not know much of the topic/don't know what to expect. He does think that having a bigger emphasis on logistics can help and this project could be the first step of the department taking a bigger notice of the logistics field.
- To improve urban logistics, want to have a cleaner city, lessen the traffic of mobility vans.
- Try to get people to bike and walk more in the city instead of using motorized vehicles (maybe through crowdshipping)

What worries do they have?

- Can't think of negative impacts of the LEAD project. In his view even if the pilot fails we can still learn from it, which would mean it was not a failure in his eyes.
- Why the project could fail: because users are not interested at all, so nobody signs up or is active. Meaning that nobody would use shared infrastructure or would sign up to deliver or receive crowd-shipped deliveries.
- First time in a EU project and in a Living Lab for the department, so doesn't know what to expect. Especially since they don't have Logistics experts in the department they don't know what to predict.

How do they think the effects of LL could be measured?

- Has to discuss it with colleague. There's a team of people that specialize on data, who have more knowledge, but he personally isn't confident in this area. He still needs to speak to them to at least get a grasp on what is being measured right now and what could be measured.
- Traffic Central monitors some places like busy intersections and there are some traffic lights that count the number of vehicles passing through.
 - Data team uses models more, so if he needs to know about the possible effects of a policy, he asks the data team and they can come up with models that show how the policy will affect traffic. Not sure where the data team gets their original number though.
 - For most of the big streets they have statistics of the average traffic flow over 24 hours.
 - He's not sure whether the logistics vehicles would have large noticeable impact on traffic statistics. Though he sees any decrease as an improvement/win.

A successful project in his eyes would mean:

- Making logistics more efficient in the city, especially if he can show that through the digital twins as well, he believes that he can go to his bosses happily
- Crowd-shipping has great potential, he really thinks that this option can help! Less movement of vans and trucks, or at least have them move to the outer rings of the city and have bikers or other more sustainable choices handle the deliveries within the city center

Personally – Works for 4 years in Den Haag municipality, 3.5 years in the mobility department.

- One of his passions is sustainability, wants to create a better cleaner world, in his personal life but also wants to have that in his work. So he is enthusiastic about the project.
- Lives above a busy intersection so he sees/experiences the traffic. Would be nice to be able to breath clean air through the window.
- Background Bachelor degree: 'Climate and Management' very broad degree about sustainability, includes climate aspects of: buildings, traffic, transportation, water management, etc.
- Work Mobility department. Work with traffic and also building permits looking at accessibility, like the parking for cars/bicycles, how entrances are connected to public roadways/transportation.

A2.2 Meeting with Jackson – Nimber

Where has it been introduced (Oslo)? Any employee drivers, or are all bringers crowd-shipped? Price difference with more conventional styles?

- All of Norway, mainly in Oslo
 - South Africa has same software.
- Sender goes into app, wants to send, and puts in the details of their parcel (size, weight, destination, time window, etc.)
- Bringer has different app, sees potential parcels that need delivering and can start negotiating with the sender
- B2C has electric cars and drivers. Combined routes for the 3 drivers
 - Drivers aren't employees, just trusted users,
- Companies not that open to crowd-shipping because of more rigid scheduling
 - And its better to take 1 driver for just one place to pick up
- A lot of data, on prices, deliveries
- Price is on average cheaper than conventional
 - The things that are posted are not urgent so they aren't willing to pay for the usual courier prices

What does Nimber expect and hope to get out of the Den Haag Living Lab?

- 2 different systems, and they are still growing adding new stuff, they want to try to see how else they can use their platform
 - Ikea pilot for example (delivery from IKEA)
 - Micro-hubs in Oslo, pick up products from outskirt to center, then B2C and C2C
- C2c is the easiest to test out.

- Not enough consistency, want to get more data, especially in a different country and culture than Norway
- B2C need to first talk to customers so it would be much more difficult

How do they think the effects of LL could be measured?

- Increase our numbers and get more data
- See whether others are different than Oslo?
- Number of users:
 - o Marketing necessary: facebook, markplaats (Norway version)

What worries do they have? Collaboration with DHL?

- DHL delivery hub
- Ready to collaborate
 - Share knowledge
- Psychology of the people affects C2C, need to know the people. They know the people of Oslo, price conscious and environmentally friendliness.
- Price of DHL is already very high
- Lockers are not sure.
 - \circ $\;$ Through the transport system, at the bus stops or close to it $\;$
 - Or centralized locker space for everyone.

A successful project in his eyes would mean:

• Have something that will work and get more customers simply. Get more profits. Something that they would want to be able to implement.

A2.3 Meeting with Ruud– Den Haag Data Team

What is the mobility data team?

- Mobility-data team (mobility has 70 people total) data has 5 people
- Don't have a measuring team anymore. Now that is outsourced (De verkeers tellers)

What is currently being measured by the Den Haag municipality? And what can be shared with the Living Lab?

- Driving traffic (traffic and biking)
- Floating car data
- VRI (traffic lights data)
- Lisence plata data.
- Mobility style research (to categorize what mobility style the people of different neighborhoods have) like ov vs biking vs car.
- Very open to sharing the data that they gather with interested parties.

A2.4 Meeting with Tom - Cargaroo

Quick explanation of how Cargoroo works and what he thought of the workshop meeting?

- Mas functioned company
 - To fill the gap of last mile of urban logistics through e-cargo bike
 - To facilitate a more livable city (focus on the people living on company)
 - Offering cargo bike to give another option (started in Haarlem)
 - More than 50 bikes operational in Den Haag want to reach 100
 - Being used a lot at very different times
 - \circ ~ Used to spend more time outside, and to replace cars
 - \circ $\;$ Have a lot of users data, how the bikes are used and where they are $\;$
 - o Going to Launch in Utrecht and Amsterdam (with 50 bikes)
 - Not only a bikes supplier, want to be an integrated part of logistics in the city
 - Working with the municipality to see where the need is, and what the needs are which could be solved by using bikes.
 - Not a free-floating system, instead a public space (permitted) where they park the bikes.
 - Want to know what their role is (what is the missing link that they are taking up), how they are changing the mindset of people and whether they are contributing in the livability of neighborhood, or street.
 - With this knowledge they can better implement in the new city
 - o 60% of users are families with young children, 15% use it for business
 - In the scope for this coming year, to focus more on SMEs
 - Bikes have to come back to their original locations (at the moment, they want to try out some drop off bikes)
 - Battery of bikes are replaced, (automated but manually)
 - \circ Bikes are locked 22:30 6:30
 - 2022 to have a more dynamic pricing model
 - \circ $\;$ Want to expand into the center, but waiting for public space to be opened
 - Pay just 1 cent to download and register

Would Cargoroo want to be part of the Living Lab, what would they hope to achieve, what are the goals?

- With the data of the existing fleets in Deng Haag they can contribute because they know when and where the bikes are used (and for some they can assume the purpose or at least assumptions of the trips)
- Also available through the Hely
- Also involved in a mobility hubs Interreg
- They have an open platform that they can incorporate with others, if they see the opportunities, and the objectives are aligned.

How could they see themselves working with other companies like Nimber or another (bike) courier services?

- That is something we can discuss, would need a viable business case to see how it is possible.
- They are a small company so they need to be very strict in what they can get involved with and need to be sure that it will help them reach their goals. So cooperation needs to be 'brutally honest'

- Needs to contribute to a livable city and it needs to be 'resourced'
- They want better utilization of their fleet in cities, a partnership could bring that to them.

What worries do they have?

- Not having a clear goal, but more a mutual outline of what the objectives are, making sure that everyone is on the same page.
 - Everyone could have their own agendas.
 - 0
- Difficult to synchronize all of the different stakeholders, (gov't, neighbourhood, corporations) because the smallest thing can cause a very long delay.
 - For example they tried to be part of 3 hubs in Amsterdam, everything was ready, but the local municipality didn't announce that the hub would be created, so they had a month delay. Second permit of pole announcement also didn't work so it caused 11 week delay at the end of the day.
 - It can ruin everyone's plans, so people need to be clear and try to avoid these things.

How do you think we could measure the effects of the LL?

- Car ownership in the neighbourhood (decrease in second car ownership)
 - Can be measured in a few different ways
- Through surveys, asking soft questions (quantitative and qualitative research)
 - Interviews of over an hour with people about the service and some about livability
- Mobielitijdsgeluk: everyone on a bike has an instant happiness
 - Having a cargo bike always at your service can increase your mobility satisfaction (though it is only part of the general)

A2.5 Meeting with Michael Hely

Quick explanation of how Hely works and what he thought of the workshop meeting?

- 30 locations in holland
 - 2 customer groups (inhabitants of large building and companies that wants to give shared mobility to their employees)
- Cars and ebikes using 1 app (Hely app)
- Subscriptions of 0 or 30 euros per month (then afterwards it becomes an hourly rate)

•

Would Hely want to be part of the Living Lab, what would they hope to achieve, what are the goals?

- In future developments a lot the design is in hubs with multi functions, and they are interested in being part of this development
- Want to grow their company and are interested in seeing their growth and the different opportunities for them

How could they see themselves working with other companies like Nimber or another (bike) courier services?

- They already work with different companies and believe they can collaborate with new ones
 - o Greenwheels
 - o M4h rotterdam

What worries do they have?

• We offer very different products, not sure if it would fit in the Living Lab

A2.6 Meeting with Laurens Mobian

Quick explanation of how Mobian works and what he thought of the workshop meeting?

- Enjoyed the workshop, a lot of good knowledge. How can we bring this in practice?
- Come from the airport industry, airport parking. Connect the different parking providers, internationally, push that offer to resellers (other websites to book). Has a booking tool where consumers can book and they push the products to resellers (to different parking spaces like Qpark). If you buy your holiday with a ticket with the airline you have an option to buy a parking space,
- Reservation platform for parking and they've added mobility (started with shuttle from parking to airport, then taxis for private rides). Started in other areas, experimenting with bikes (Formula 1 Zandvoort)
- Park and then take a bike (also offer step or e-scooter).
- Partnership with Docker for cargo bikes. They use smart lock to the bike which is unlocked with the app by reservation.
- Use the app to do the booking, all in 1.
- Roadmap: 3 pillars (travel, events, city-presence) so now concentrated on the city-presence (3 hubs in Amsterdam), want to open 20 locations in 4 cities by April 2021. Have 3 location in Den Haag

Would Mobian want to be part of the Living Lab, what would they hope to achieve, what are the goals?

- We have the solution for the parking and biking
- They need locations to put their parking space and their bikes, but should have 3 locations in Den Haag by summer 2021
- They want a higher occupancy rate
- Want to know data of users, what's the target audience and how to reach them. User case is very interesting for them as they want to know more.
- Looking for courier partners that are driving their van to the city and are willing to or have to switch to a cargo bike inside the city limits.

How could they see themselves working with other companies like Nimber or another (bike) courier services?

- They can help by finding hub locations (private locations so faster expansion)
- Integrating other types of mobility (want to work with others to increase occupancy rate), can be integrated through their technologies

What worries do they have?

- How do you bring this into practicality, everything is there (technology, mobility, regulations, etc) but a solution needs to be brought into practice when you start to prove the concept.
- High occupancy rate for the vehicles, so they don't want a lot of unused occupancy.
- Lack of speed of things happening.

A2.7 Meeting with Jan Smit – Next2Company

What exactly is Next2's role, how are they working with DHL and do they have the same goals?

• They have the same goals, they came up with the concept together and tried it out in Tilburg working with DHLexpress, now they want to try it out with a bigger scale and that is what they want from The Hague.

What will the developed platform do? There is a lot of talk of crowd shipping and shared infrastructure but will these be included?

- It is a temporary platform, that has been made integrating a Next2Company front end with part of a DHL platform. Idea is that it should work for the test, but through the test they want to find out how the platform is lacking, and what would need to be added to the platform to scale it.
- DHL platform is for a dedicated network, so it is either DHL that does the delivery or another party that they are working with. So, no crowd shipping, that is only Nimber.
- Made up of 2 logistics models, which they mix together:
 - Courier model, a direct approach where a courier picks up the package at an address and then gets delivered at the destination through courier
 - Milkrun model, a set route where DHL pick up packages at defined locations at specific times. In this way receiving and delivering packages.
 - Present models are courier model and/or hub. This is a different approach to local to local package deliveries.

What Does Next2 expect and hope to get out of the Living Lab?

- Main goal is to test out a local to local distribution network to see how it could work
 - Should be a self-standing network where packages can be send and received either on same day or next day delivery
 - Idea is to serve different group, B2B, B2C, and C2C
 - Want to see what (different) service needs to be offered to these 3 distinct groups to attract them
 - Want to determine what kind of demand there is in these 3 groups, and how to convince that current demand to change to their network

What worries do they have?

• They are a company and not researchers/academics, which means they don't have subsidies or government support. With a mixed group like this there is always the worry that the different parties want different things and the project gets derailed. Also they have to put in effort and time (working on paperwork, reading emails, etc.) which is not directly related to their goals, but more to the project as a whole which they could see as a 'waste'.
- Worries about the concept as a whole. With there being a mix of their local to local network ideas and the crowd-shipping/shared infrastructure ideas it could muddle the project. Still believes it is perfectly possible to make it all work together, but it is something that needs to be handled carefully.
- The difficulties of actually getting people to use the service. How do you get the present local 2 local demand to start using the DHL platform?
 - This means that market research and marketing need to be done to make it more likely to attract users.

How do they think the effects of LL could be measured?

- Proposes hypotheses to be then tested out.
- Can you convert the local to local demand to be used in your network.
 - This means that the current local to local demand would need to be known and then see what percentage or fraction actually starts using the DHL network.
- The test is only a success if the network and infrastructure necessary for this project can be introduced in such a way that a competitive market price can be set. The new approach needs to be cost effective.

A2.8 Meeting with Luke - MyPup

Quick explanation of how MyPup works and what he thought of the workshop meeting?

- Wasn't allowed to receive packages at the office (at ING) because of practicality, this is what inspired the start of the company.
- The difference with the older lockers is the use of hubs so it's only 1 van that arrives at the building. Instead of different vans at different times. Reducing the congestion on the street but more importantly for customers the congestion in front of the office or residential building of vans arriving throughout the day.
- In Amsterdam MyPup has their own hub, but they prefer the use of other hubs. So they see themselves more as a software company with lockers than an actual delivery company.
- In the Hague the delivery drivers they work with a Sociale Werkplaats. MyPup can provide the electric vans or scooters, but the people delivering them are not their employees.

Would MyPup want to be part of the Living Lab, what would they hope to achieve, what are the goals?

- They have lockers at offices and residential complexes, and they willing to share data about this (to see effects of having locker in a building)
- For an office to oblige it works better. For residential it has to be there from the start (works well with student) it's very hard to get an existing residential building to all start using and paying for the lockers.
- More locations to increase revenue is the ultimate goal.

How could they see themselves working with other companies like Nimber or another (bike) courier services?

• The lockers can be opened, so they can work together. Nimber can take over the deliveries, they just need to know for sure who is the one doing the deliveries.

- Willing to explore whether we can put lockers in a mobility hub to get customers going over there instead of the lockers always being at their place of work or office.
 - Would like to test how delivery at home vs going to the hub is seen by customers. The willingness to pay to have home delivery compared to delivery at a locker at a nearby hub.

What worries do they have?

- Not just e-commerce but also groceries and construction works.
- Not too many problems that they can foresee..
- Someone needs to take the lead and own the project, each commercial party would want to sell it's own thing. The interests need to be aligned and a party needs to ensure this.

How do you think we could measure the effects of the LL?

• Willing to share the information in the lab of the number of packages and what other data that they can.

A2.9 Meeting with Charlotte Den Haag Urban Planner

I understand that you are an urban planner, what exactly is your role in the Den Haag municipality?

- Strategic advisor urban development (planneloog)
- City and metropolis division (so city wide or regional issues)
 - o Specifically, mobility, and hubs. To look at wide impact
 - Shops have value, so replacement needs a social side
- Mobility hubs should have a social side to it, not be anonymous as it takes away from human happiness
 - \circ A locker by itself is very private where people have no interaction

Which effect do you see of a mobility or logistics hub on the livability of a neighbourhood?

- Pollution and noise
- Meetings are needed (how does this hub encourage meetings with people)
 - Maybe a café at the hub

How would you advise to measure the effects of a logistics hub on the quality of life (outside of pollution and traffic data)?

- Will think about it, not sure how to measure it.
- People might not be aware of what a local hub could contribute (it is subconscious), they don't see how it could help, so surveys might not help much.
- Looking at how people access to the hub (walking/biking is more personal, compared to a car) could tell whether they feel involved with the hub.
- Maybe try to combine it with other trips.

Do you know what the municipality measures at the moment and whether the Living Lab can get access to this data?

- Safety
- Public space quality (access, beauty, green, etc.)
- Number of functions (multifunctional)
- What is the range (scale of for how many neighborhoods or how many households)
- Busy with making a report of the effect of public spaces on quality of life
- Maybe measure walking traffic (compare anonymous to a more social hub)

You spoke briefly during the workshop about the effects of logistical hubs on sucial contacts, and how it is important to go from anonymous to rooted. Could you expand on that?

- Social contact is often underrated. She's worried that deliveries could replace shopping in the city which would have a negative effect. By having someone at the hub to talk to, even maybe a small café or something where neighbors can chat would really help out with this
- As mentioned before it comes from the anonymity of deliveries and especially lockers, you don't feel rooted in your community, which has a bigger negative effect than you would think

A2.10 Nimber Validation Meeting

Asked Jackson about the design first, then Nimber's ability to measure what's necessary and lastly overall impressions of the experiment and whether Nimber would be happy with it.

Design

- Loop 1
 - No real comments, Nimber completely ready for this step, just worried about both supply and demand side. How are we going to make sure we have a volume of packages to deliver and bringers to deliver them? (G2G?)
- Loop 2
 - This would be new for them as they don't have a Cycloon like delivery service working with them yet.
 - Not sure of how the practicalities could work, there has been discussion at Nimber on whether it is easier to simply register Cycloon as normal bringers or maybe integrate API)
 - Happy to have Cycloon there as it fixes the problems of the supply side, now only the demand side is a worry.
 - Cycloon could especially useful in the last mile part of Nimber for B2C or B2B, where the 'story' of the product is important. Cycloon bringers would probably be more disciplined and ready to present themselves and the products the right way. Example of recent valentines where they had to make sure the valentine presents were delivered 'nicely' not just dropped off at the doorstep.
- Loop 3
 - Nimber very happy to work with parcel lockers, thinks they have a great benefit to both companies' business models. Would work well in both first and last mile.
 - Would only work with non- physical keys to the locker (Pretty sure that is already the case)

- Nimber has some limited locker experience, especially picking up packages from a locker. To keep the Valentines example, the company left the packages in a locker in the weekend and bringers picked them up and delivered on Sunday.
- Locker location is very important for the added benefit of the concept. If the lockers are well located (in a central area, or a travel hub of some sort) bringers are much more likely to pick up or deliver a package on the way as they are already passing by that area. If the locker is out of the way bringers are a lot more hesitant to use it.
- Loop 4
 - Could be useful as a different place with lockers.
 - Some parcels are too big for lockers, a hub could be an appropriate place to 'act' as a locker where people/businesses can drop off their large packages (furniture, etc.) and the bringers can pick them up and deliver them. Especially if there is some sort of supervision at the hub (kiosk shop) it would be a very useful service.
 - Current bringers mostly have their own transportation so no need for electrical cargo bike rental
 - Parking could be useful as at least in Oslo Nimber has a few electrical 'back-up' vehicles in case that a bringer ends up being unreliable, the hubs would be an appropriate place to have such back-up vehicles

Measurements

- When registering bringers can input their mode of transportation, it is then encouraged to be input later when bank account and other extra info is required. But it is not compulsory, though most bringers do use it. Making it compulsory is difficult as it would impede in their principle of having the app be very easy to use and making it simple to start being a bringer.
 - Mode of transportation can often be deduced by type/size of parcel and pickup/delivery locations. (large parcels and long distances are usually cars or vans, etc.)
- No GPS tracking of route taken by the bringers, there would be privacy concerns and they don't think bringers would appreciate it. Though it has been discussed to implement this for trusted bringers who are carrying a business partners delivery. Instead, the starting address and end address are the only info available.
- Time taken to delivery is measured. There's confirmation when the package is picked-up and when it has been delivered.
- Reliability or number of late packages depends on the customers. When it is B2C or B2B there is a timeframe given and the delivery has to be done at the given time, this can be measured and collected. In C2C it is through personal agreements between the two parties, which can also be very flexible or changed last minute. This makes it impossible to track reliability unless there's specific complaints.
- Prices are kept track of very accurately, price that the sender offers to pay the bringer, the negotiations between two or more parties, and the price that is finally agreed upon for the delivery. (see data sheet for details)
- Jackson hasn't seen the data but it is possible to find the amount of parcels that get rejected, where no bringer is interested or no price can be agreed upon.
- WTP for different locations is not a feature they have at the moment in the Nimber app, but Jackson says it should be possible to create the software to give the users that option. This could

also simply be a feature where the sender get's a few choices of where they would like to send the parcel at different price points or not.

General Feedback

- Very happy with the design, believes that it would lead to a successful experiment.
- Fulfills Nimber's biggest goal which is simply to test out their platform in a different setting and in different systems. Believes that this will all be accomplished through the Den Haag Living Lab and will help the company as they grow.
- Biggest worry is about the demand market. Worried that there will not be enough packages to be delivered to make it a successful experiment, though the ideas of G2G and the MyPup volume does help.

A3. Further Diagrams

A3.1 Example of an Iteration 3 delivery with Cycloon courier





A3.2 Example of an Iteration 3 delivery with a Nimber courier