LEVVs in the last mile

Creating a vehicle decision model for nuisance-poor parcel delivery for PostNL.

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Preface

This thesis concludes my six years of studying at the faculty of Industrial Design Engineering. When starting this project during a less strict COVID-policy I did not think the project topic to be as relevant as I think it is now. Walks through the city centre showed me the number of delivery vans rushing through the streets and parking everywhere to keep providing people with products they need. Hopefully, this project helps PostNL in reducing the pressure on the cities and the drivers.

Firstly, I would like to thank Marije Hakkert – Wichers from PostNL for giving me the opportunity to do this project and coaching me throughout. Your way of coaching made me realise a lot about personal points of improvement in my future professional life. Thank you for patiently repeating things for me when I did not understand. I admire your eye for detail, work-ethic and thoroughness in doing things. You telling me to stop thinking and start working has been the main reason for a successful outcome.

Secondly, a big thank you to Team Duurzaamheid for welcoming me into the team and a feeling of comfort from the start. Even though it was mostly digital, you have helped me a lot in providing me with information, listening to me explain the model and the non-work-related conversations. Especially Jorick for providing me with internal information and Ilonka for cycling through the cold with me.

Besides Marije I would like to thank the rest of the graduation board, Sicco Santema and Albert Plugge. Thank you for your coaching and your feedback during this project. Especially at the final phase of the project when I needed guidance on prioritisation. Even though I did not reach out for help that much, I appreciated it every time I received it. Your feedback has helped me create structure in the chaos that is in my mind.

Lastly I would like to thank Hans Doornink (for driving me), Robbert-Jan Joling, Eveline Frouws and Aart Vierhout for validating my design. Saskia van Dijk, Frits Lintelmeijer and Daan Grasveld, thank you the interviews. Bennie, Wahid, Bert and Ben, thanks for driving the LEVVs in Groningen.

Lastly, thank you to Willem and Gieneke Palthe for helping me with excel and spelling and the rest of the family and roommates for listening.

Executive summary

The e-commerce market is growing rapidly and PostNL continues to strive for delivery to the doorstep. The last mile of delivery is considered the most impactful part of the logistical chain. On top of environmental impact, the liveability of the city centre is challenged by bulky delivery vans rushing through narrow streets and blocking the way to deliver parcels in time. Municipalities have ambitions to expel unsustainable and big vehicles from their city centres, making it a pressing matter for PostNL to change its approach.

PostNL committed to deliver 100% emission-free and nuisance-poor in 25 Dutch city centres by 2025. Emission-free delivery is achieved through deploying an electric fleet, but nuisance-poor delivery asks for a strategy to reduce congestion and make traffic situations safer.

PostNL aims to deploy light electric vehicles (Licht Elektrisch VrachtVervoer in Dutch) in the last-mile but is unsure what type of LEVV vehicle must drive on what road type to optimally reduce nuisance. The vehicle options are a bike-type LEVV and a truck-type LEVV as PostNL is unsure which one to choose and by testing both a full coverage of street-types is possible.

This research showed what information must be gathered for PostNL to decide what vehicle would cause the least nuisance on a type of street. The information helps them create routes for a vehicle-type which would cause minimal nuisance, while still being efficient. The information is used to create a model of choice theory, which helps PostNL decide what LEVV should drive on what street to reduce nuisance. A roadmap shows how this model is digitised and automated to be future proof. Lastly, a communication strategy is made to make sure the system is communicated clearly along the process chain.

Desk research and interviews showed that by focusing on safety and congestion as nuisance, liveability is increased no matter the area within the city. The potential in reducing this nuisance while still being efficient was confirmed in a physical test with both LEVV-types compared to a traditional bus. Two vehicles were selected as models for the design (Fulpra Roll bike and CargoLEV truck).

A survey showed a higher satisfaction rate in customers who received their parcel through sustainable delivery, together with a high vehicle awareness this shows a potential benefit for PostNL in happy customers and reputation.

A first PDCA-cycle (Plan-Do-Check-Act) was used to build the reasoning for choosing one vehicle over the other. City centre streets were categorised into six archetypes, on which every vehicle was judged on its potential to reduce nuisance while parking and driving.

The theory states that if a vehicle can drive and park nuisance poorly, it is the most efficient one as it can move fast through traffic and find a parking space in front of the door of the delivery, reducing walking time.

The second PDCA-cycle showed how this theory can be made into a model of choice which can be used to create routes in all cities.

Weighing factors drop density, street direction, stratona weight and traffic intensity are needed for a weighted calculation to benefit important streets in the calculation and advice. The shape of this advice and how it must be communicated along the process chain concludes this cycle.

In the last design cycle a tactical roadmap is created that shows how the system evolves into an adaptive and pro-active route planning tool supported and improved by future road work data and driver feedback.

PostNL ended up with a substantiated theory on vehicle choice and a roll-out plan for using it. Another benefit of this research for PostNL, besides supporting LEVV implementation, is that it supports the argument within PostNL for the value of nuisance reduction as a main KPI besides efficiency.

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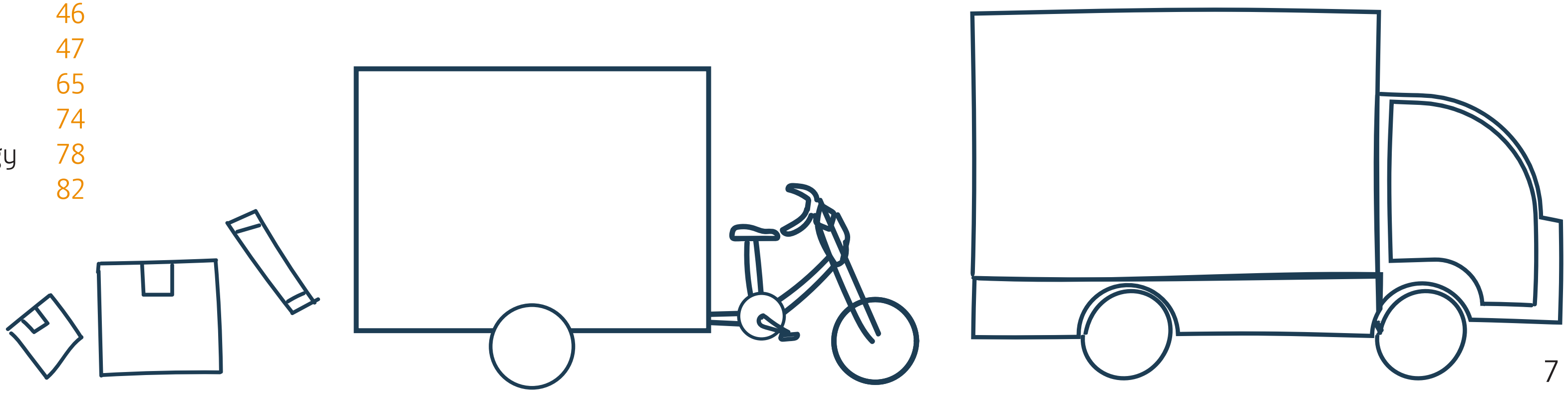

1. Introduction

The problem is introduced and the methodology used within this project to solve the assignement.

1.1 The assignment

This chapter introduces the problem PostNL is facing: a growing e-commerce market which increases the pressure on PostNL's process. This chapter is about how this pressure is increasing, and how PostNL wants to relieve the pressure on city centres. The chapter ends with the methodology used to create a theory on which PostNL can decide what vehicle to deploy to reduce nuisance caused by delivery vans.

Context

While the postal delivery has been shrinking in the Netherlands for years, the market for parcels is growing every year. While in 2017 the parcel volume totalled 420 million units per year (ACM, 2018), the year 2019 already showed that 576 million parcels switched owners (ACM, 2019). Due to the growth of the e-commerce market, the parcel volume is expected to keep growing the coming years.

In 2020 an explosion of the e-commerce market was caused by the global COVID pandemic keeping people indoors and relying on online shopping even more. In 2019 a total of 25,8 billion euros was spent on online purchases in the Netherlands, a growth of 4% compared to the year before (Welie, 2020a). This growth seems to be accelerating as the first half of 2020 already showed an increase of 22% (Welie, 2020b) in online purchases. All these online purchases need to be transported from A to B by a couple of big and smaller delivery companies in the Netherlands. This growth increases revenue for the logistical companies, but has its downsides for the climate in the city.

E-commerce will keep growing, and therefore the number of delivery vans too. More vans for distribution mean more vehicles inside the dense city centres. These vans cause congestion as they go from door to door without always being able to rely on free parking spots. Just by substituting fossil-fuelled vans for electric ones does not solve the problem of bulky vehicles driving through narrow streets.

Traffic not only negatively impacts a cities' liveability, but it also causes financial problems. In 2016 CROW estimated the costs resulting from this increasing congestion in Dutch cities. The traffic problem in the cities may lead to an economic damage of almost 1.7 billion euros in 2021 if this problem persists (Voerknecht, 2016)

Besides the last mile to delivery being the most cost-intensive part of the supply chain (Gevaers, Voorde, & Vanelslander, 2011) it also has relatively the biggest negative (environmental) impact compared to other parts (Nabot et al, 2016). Existing solutions are service points and lockers, where parcels are centralised for people to pick them up themselves. These measures reduce the distance a van must drive and significantly reduce vehicle movements through the city and also emissions if consumers come and collect them by foot or bike (Lange, 2020).

The challenge

Besides that of the environmental impact, PostNL recognises the problem of traditional delivery vans being too big and heavy to manoeuvre through the small streets of historical centres. The little space available for delivery vans causes congestion by the vans driving too slow or parking halfway on the road, so others cannot pass. PostNL formulates 'creating better interactions with customers' as one of its most important functions, so it worries that its operations inside the city centres negatively impact the experienced liveability and the happiness of the people there. More information on the company and its motivations can be found in appendix A1.

With the signing of GreenDealZES, PostNL's aspires to deliver zero-emission and nuisance-poor in city centres by 2025. To be able to achieve these goals of zero-emission and low nuisance last- mile, PostNL believes there is an opportunity in implementing a new kind of vehicle in the last mile of the parcel routes: Light-Electric-Freight-Vehicles.

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From now on they will be referred to as LEVVs (in Dutch: 'Licht Elektrisch Vracht Vervoer').

Literature shows that logistical service providers are focusing on applying new technology to improve the customer journey of both e-retailers and e-customers. The experience a customer has is based on multiple touchpoints with the provider. Both customers and non-customers encounter PostNL's vehicles making for many touchpoints which can impact their association with the company negatively. Increasing control over these touchpoints will result in performance improvements for the company (Lemon & Verhoef, 2016).

PostNL believes that by implementing LEVVs in the last mile it is assumed to solve problems for both road users and PostNL-drivers. Main problems being congestion, emissions, smell and noise.

PostNL believes that a varied fleet is key to keep delivering efficiently. PostNL sees opportunities for a bike-type LEVV and truck-type LEVV but is unsure of what type of vehicle to deploy on what route.

The assignment for this report is to find a way to help PostNL decide what delivery route should be driven by what kind of LEVV in order to minimise nuisance.

PostNL is planning on testing and deploying smaller vehicles before 2025 to make sure its ambition is realised. This means that the scope for this project is a design to be used as soon as possible, with a vision on how it could be developed in the future.
The final deliverables will consist of the following things:

1. A model of choice for LEVV vehicles.
2. A communication strategy for successful implementation.
3. A short-term roadmap on future development of the model.

The assignment:

Design a model of choice which helps PostNL decide what LEVV should drive on a certain street-type to minimise nuisance.

1.2 The methodology

This chapter shows how the project was structured and which design method was used to create the theory of the model of choice, the communication strategy and the roadmap.

Methodology

A 'model' must be created, which means that in the end it has to function. The model works if a substantiated choice can be made on vehicle deployment on a delivery route and if the model is usable for the people who need to use it. Simply put, information is put in and a result comes out. An important question to be answered is:

"What information is necessary to decide what LEVV should be deployed on a street?"

Figure 1 shows the first part of method used to create the final design. This project follows the first loop of a general design thinking methodology of image (empathise and define). First the problem is analysed and understood, then the design challenge is posed with design criteria framing the solution space.

This is followed up in the design phase by a PDCA-cycle approach (Deming, 1993). These PDCA-approaches replace the standard ideate, prototype and test phases as there is not a big brainstorm applied to find multiple solutions. The solution simply must work, which is the focus of a PDCA-cycle.

The PDCA-circle image 2 is a circular, iterative approach where a Plan is made on the best strategy. The plan is then executed in the Do-phase, after which it is 'Checked' by evaluation and accepted if satisfied. If the design is not acceptable the Act-phase is used to either pivot or return to the drawing board and repeat the process.

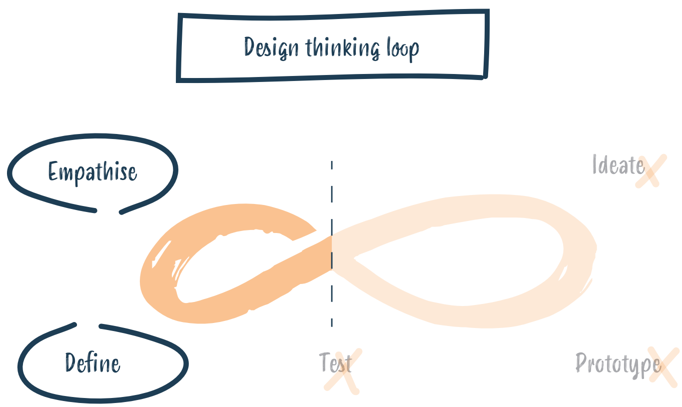

Figure 1: the classic design thinking loop.

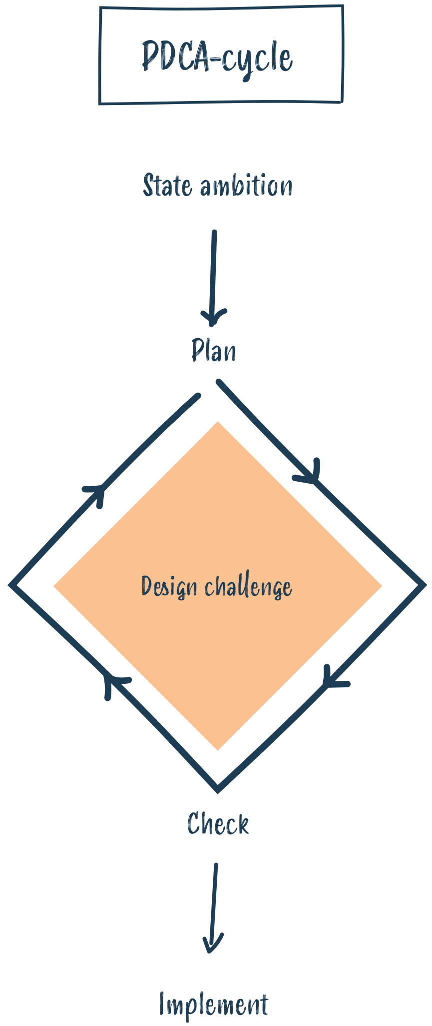

Figure 2: PDCA-cycle by Deming.

Report structure

Figure 3 shows the approach taken in this report. It starts off with an analysis part where questions are answered first in order to define the criteria the design must comply to in order to be successful for PostNL.

The research questions are answered in this order:

1. Can LEVVs reduce nuisance?
2. What type of nuisance could LEVVs reduce?
3. What vehicles are suitable for the process?

The design criteria resulting from this are stated, which helps frame the design challenge. The multiple facets of the final designs are created through design cycles. The final designs are presented in the design phase. First a road categorisation is made in the first one, whereafter existing routes are analysed on street build-up which finalises the model of choice which is supported by a roadmap for digitisation and a communication strategy for smooth implementation.

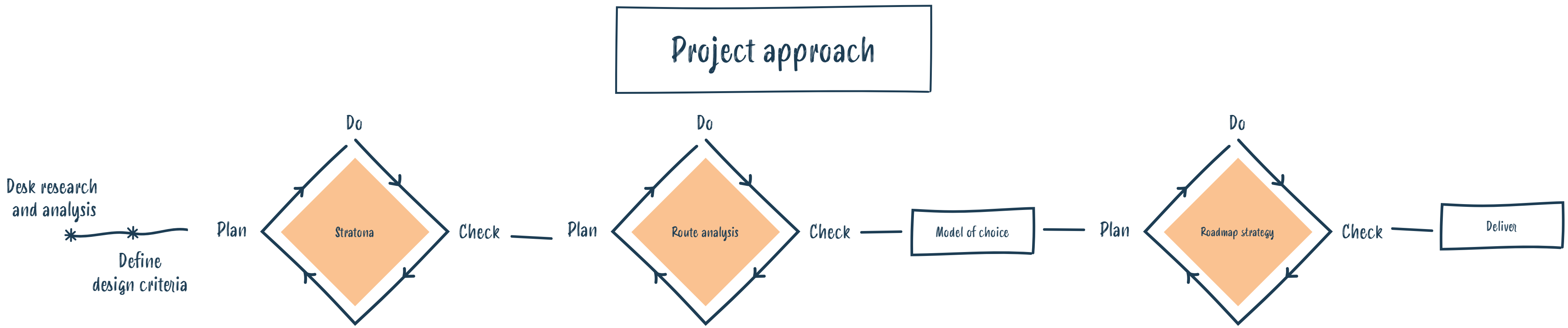

Figure 3: specific design approach used in this project.

1

Analysis phase

First the playing field and the players must be analysed to find out who is affected by the current situation and who can benefit from the outcome of this project. The players are the ones who experience the nuisance which threatens the liveability of the city. Research is done on what urban liveability entails exactly to find focus points which LEVVs could have a positive impact on. This is done to enrich what PostNL defines as nuisance.

This phase ends with a thorough analysis and selection of potential vehicles. First the feasibility and viability of the delivery process with LEVV-vehicles is tested. Customers are questioned in a survey on vehicle preference and drivers questioned on their experience using LEVVs on a real delivery route.

Finally, two vehicles are chosen as archetypes for the design of the model.

2

Define phase

In this short chapter the research from the previous phase is used to state design criteria. These criteria are used to frame the solution space and to be able to evaluate the design on feasibility, viability and desirability afterwards. These criteria form the basis of the next phase where they will act as guidelines to help follow the best direction to solve the problem.

3

Design phase

Following the PDCA-cycle approach, three design cycles are done to design the model of choice.

In the first cycle a collection of street-archetypes is created which act as blueprints to base the choice of vehicle is made and make sure the theory applies to all city centres. The second cycle decides how this theory is put into a model which helps PostNL decide what vehicle to deploy on what route. Within this cycle a communication strategy is created to help translate the output of the model into clear information along the chain of people executing the delivery process.

The last design cycle is used to create a roadmap on how the model is turned into a digital system and can be developed to its full potential.

4

Discussion phase

The last chapter acts as a reflection where the impact on PostNL is discussed. The design and its impact are evaluated on the trifecta of feasibility, viability and desirability. The report finishes with limitations to this research, advice on further research and contribution to literature.

Throughout this report some terminology will be used that may be unknown to readers. Some expressions will be particular to the culture within the company of PostNL, and some terms have a certain meaning within this project but another one in other regular situations. To be clear from the start a sum up of all important terminology is provided in appendix A2.

2. Analysis

This chapter contains analyses of the context and the players to find out where LEVVs are going to operate. Who are the players who are affected by the current nuisance and who are interested in a successful project? The relation between nuisance and how it affects liveability is studied, resulting in nuisance-factors which can be relieved by LEVV-implementation. By evaluating existing LEVV-types, all information is acquired to start answering the question on how exactly LEVVs should be implemented to reduce the nuisance.

2.1 The playing field

What is the context of the challenge?

The city centre

The ambition PostNL made to GreenDealZES was to realise zero-emission and nuisance-poor delivery in twenty-five Dutch city centres. But what does PostNL consider to be a city centre and where lies the border?

This can be traced to the time where cities were surrounded by city walls. Cities did not allow for buildings to be constructed outside of the city walls. This meant that within the city they had to build compactly and space efficient. Old city centres are typically made up of narrow streets and canals with stone bridges. After the cities allowed to break down the city walls, a new way of urban planning emerged for the space outside the walls. This resulted in a different kind of street structure that is more spacious with wider streets.

Why only the inner cities?

1 The streets are narrow and density of residents is high, making for an easily congested area.

2 Old city centres are difficult for drivers to manoeuvre through and room for parking is scarce.

3 The cities foundation is suffering from the heavy and constant traffic, especially bridges.

4 Municipalities are banning unsustainable vehicles from the city centre and creating environmental zones.

The cities

The final twenty-five cities were selected by PostNL itself, based on number of inhabitants, potential to make it more sustainable. This first ambition is a first step in the ambition for 2030, to deliver the last mile emission-free (figure 4)

All these cities have somehow presented their ambitions and roll-out of their regulations regarding zero-emission zones inside the city. The sooner these zones are installed, the more pressing the need for PostNL to make sure they comply to the city's rules and will be able to run the process efficiently.

The twenty-five cities are not mentioned in this report as the final selection is dynamic. The choice of city may change after this project.

Appendix A3 shows a picture of Arnhem where the city centre is distinguished from the area around it.

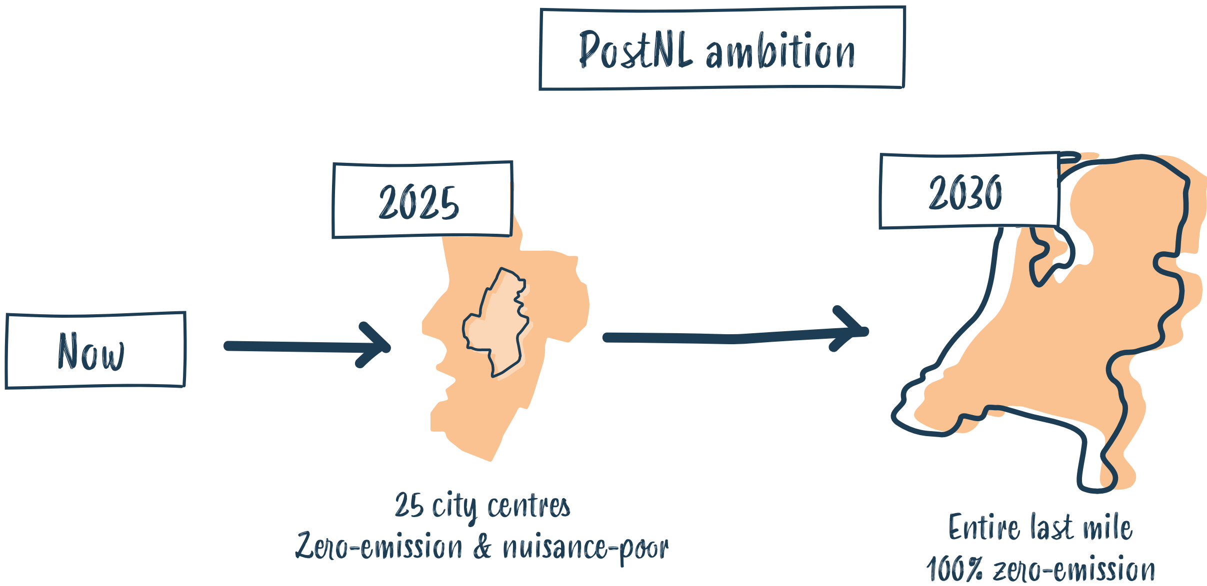

Figure 4: PostNLs last mile impact ambitions for the coming years.

2.2 The players

Who is the target group that experiences the nuisance? And who have interest in the outcome of the design?

Target groups

The outcome of a brainstorm within PostNL (figure 5) helped find what players are affected negatively by the current process with delivery vans and what players benefit from a successful nuisance poor LEVV process. This brainstorm was done on finding players for another similar project PostNL is working on, but they apply to this project. These players are mapped on different levels according to their relationship to the problem and the solution design. Four categories can be distinguished:

Problem owners
groups which experience nuisance from delivery vans directly.
Problem solvers
groups which are responsible for creating the new process with LEVVs.
Problem enthusiasts
groups which have an interest in helping to realize the LEVV process.
The competition
PostNL's direct competition who strive for the same success.

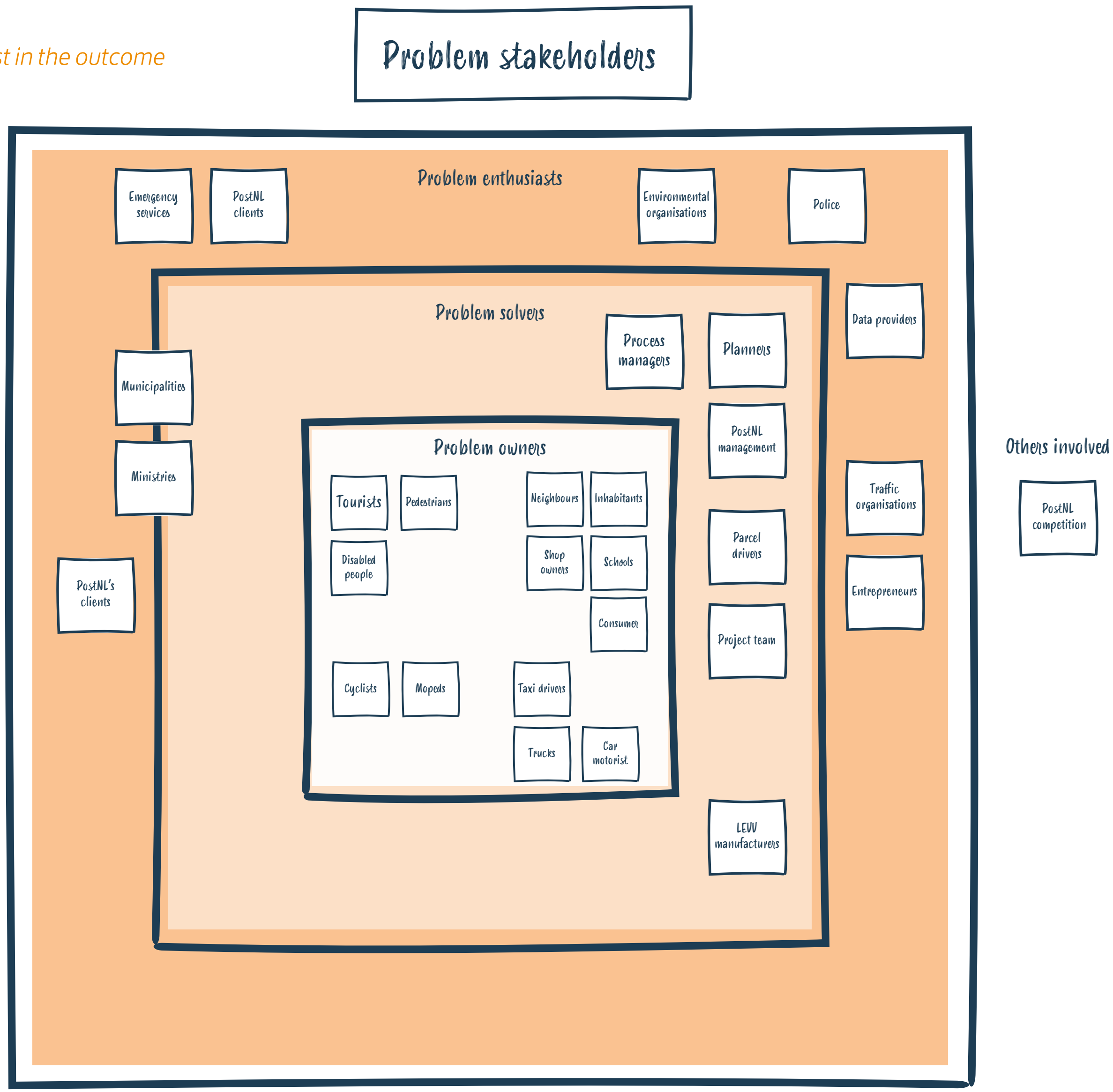

Figure 5: grid with different stakeholders of a successful LEVV implementation.

Problem owners

Both consumers of PostNL and non-consumers fall under this category. Everyone who moves around in the city centre is impacted by the traditional van and is part of this target group. The nuisance experienced by this group is what must be solved by the deployment of the LEVVs. Its perception of nuisance decides what nuisance factors must be focused on when choosing a vehicle for a particular road.

Problem solvers

Both consumers of PostNL and non-consumers fall under this category. Everyone who moves around in the city centre is impacted by the traditional van and is part of this target group. The nuisance experienced by this group is what must be solved by the deployment of the LEVVs. Its perception of nuisance decides what nuisance factors must be focused on when choosing a vehicle for a particular road.

Firstly, the design must work, generate an advice and be usable to the end-user.
If people are sure that the advice on vehicle deployment will reduce nuisance optimally, it is a feasible design. It is a viable design if there are no extreme unforeseen costs. Since this project is not directly revenue driven, this will suffice. The model is desirable if all players along the process chain are pleased with the design and can use it.

Problem enthusiasts

This project contributes to an improvement to the liveability of the city which is in line with ambitions of stakeholders in this group. All could benefit from the reduction of nuisance and can become valuable contributors or partners to this cause.

The competition

Not directly a target group, but competitors should not be forgotten as they can serve as inspiration. Appendix A4 shows a competition analysis on direct competition and what is happening in the field of parcel logistics. Big retailers H&M has closed a deal with Budbee a sustainable logistical company to deliver their products to consumers. These smaller companies use LEVVs and focus on efficiency while being sustainable by design. This is a valued trait to big retailers making it rewarding to use sustainable vehicles in the last mile (Kroes, 2021).

As this project is not directly focused on creating a competitive advantage but together creating a better environment for everyone, there is no focus in beating the competition so the role of the competition is not taken into consideration within this project.

2.3 Nuisance definition

Nuisance for PostNL

When is something considered nuisance according to PostNL? And what nuisance is caused by its big vans? The company mainly sees congestion as blocking fellow traffic participants from a smooth journey. The company came up with the following definition:

"Urban congestion is nuisance caused by interrupting the way of other road users with a PostNL vehicle."

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Literature teaches us a lot about congestion in traffic, but it is limited to road capacity and delays through transportation of people. Before only research was done on nuisance caused by delivery vehicles on main road, but in-depth research on a solution for congestion in city centres has not been explored yet, and might be more complex due to variety in street situations and traffic regimes.

PostNL came up with a way to look at nuisance. Nuisance can be determined by a simple equation:

Nuisance = Impact / Happiness

The degree of nuisance is determined both by subjective happiness (someones mood) and the impact of the nuisance (time waiting). (see example in figure 6)

If people are fond of LEVVs it would mean that the nuisance caused by them should be experienced as less impactful. Using LEVVs, PostNL could improve customer association making the nuisance they cause less impactful.

Besides improving customers perception, LEVVs can actually reduce nuisance. In order to do so, attention must be paid to making sure a LEVV can park in places where no other traffic participants can be hindered or by avoiding busy streets.

Besides congestion there are more ways PostNL's vehicles cause nuisance. Logical ones are noise and stench, being all forms of nuisance which can be perceived and experienced. Other causes of nuisance like particulate matter are not experienced by people.

PostNL stated that they felt like the liveability and happiness of people inside the city is negatively influenced by the many delivery vehicles congesting the roads. It is interesting to know what exactly liveable city entails and what other nuisance it is threatened by. A LEVV could be the solution to other nuisance sources, which is investigated in the next chapter.

Nuisance = Impact / Happiness

For example, when a person gets stuck behind a parked Albert Heijn delivery van he or she might be annoyed and unhappy. When that same person is stuck behind a van of the same size but from a more 'likeable' company like Coolblue, the impact seems lower. In the same situation the impact differs due to a certain state of mind.

Figure 6: formula and explanation through example.

2.4 Liveability

Nuisance causes unhappiness, making a city less liveable. For PostNL, congestion is the main motivation to invest in substituting hindering vans for smaller vehicles, and what the model should focus on. The phenomenon liveability is explored to widen the view on the other factors that make a city less liveable, on which LEVVs can have a positive impact.

Interviews

Two experts were questioned in a semi-structured interview on their perception on urban liveability and how LEVVs might improve it. This input was used to find other factors, besides environmental impact and congestion reduction, which a LEVV might influence positively by behaving a certain way or simply by choosing the right LEVV. Lintelmeijer is a former councillor on culture, traffic and heritage and advisor for GreenDealZes. The other expert is Van Dijk, policy advisor for the municipality of Amsterdam. The interview guide can be found in appendix A5. The analysis on liveability consists of interviews and desk research.

What is liveability?

What liveability entails exactly is something that changes with the time. In the 19th and 20th century the biological definition of liveability was most important: battling diseases and epidemics, which now seems like a reoccurring matter. Human needs for a happy life change over time as externalities change. Reducing the impact of these externalities create a liveable space. For example, bad air quality asks for cleaner air. When looking at the basic theory on the hierarchy of needs in Maslow's pyramid in figure 7, the sense of safety is what is the most basic after the basic necessities to survive (Maslow, 1986).

Many definitions have been given to the term liveability. Some examples are as simple as 'the appreciation of the living environment as experienced by inhabitants' (Marsman & Leidelmeijer, 2001).

The way Duyvendak and Veldboer (2000) put it: 'it is not about average income, but about connectedness in the neighbourhood, well-being, and social networks. One vows for focusing on the quality of the environment and the other about social connectedness. Both definitions show that liveability is experienced subjectively. One might find a space or situation liveable where the other might not, making it about perception.

Lintelmeijer projects his definition on current times and sees liveability as intrinsic, the quality of the physical space affecting it most. He stresses the subjectivity of liveability, and advices to find a focus factor which objectively improves liveability, which cannot be denied due to perception.

It is dangerous to generalise how liveability is experienced and could be improved for an entire city. Research by Marsman & Leidelmeijer (2001) states that when analysing problems in local neighbourhoods it is a misconception that findings and conclusions found in one neighbourhood apply toother neighbourhoods. There is no one-dimensional general satisfaction factor, but it can be separated into at least two dimensions, general satisfaction (which can apply to all areas) and specific satisfaction (which differs per area).

To make sure the LEVVs impact liveability for everyone, a nuisance factor must be chosen which is general and unanimously recognised as a threat to liveability.

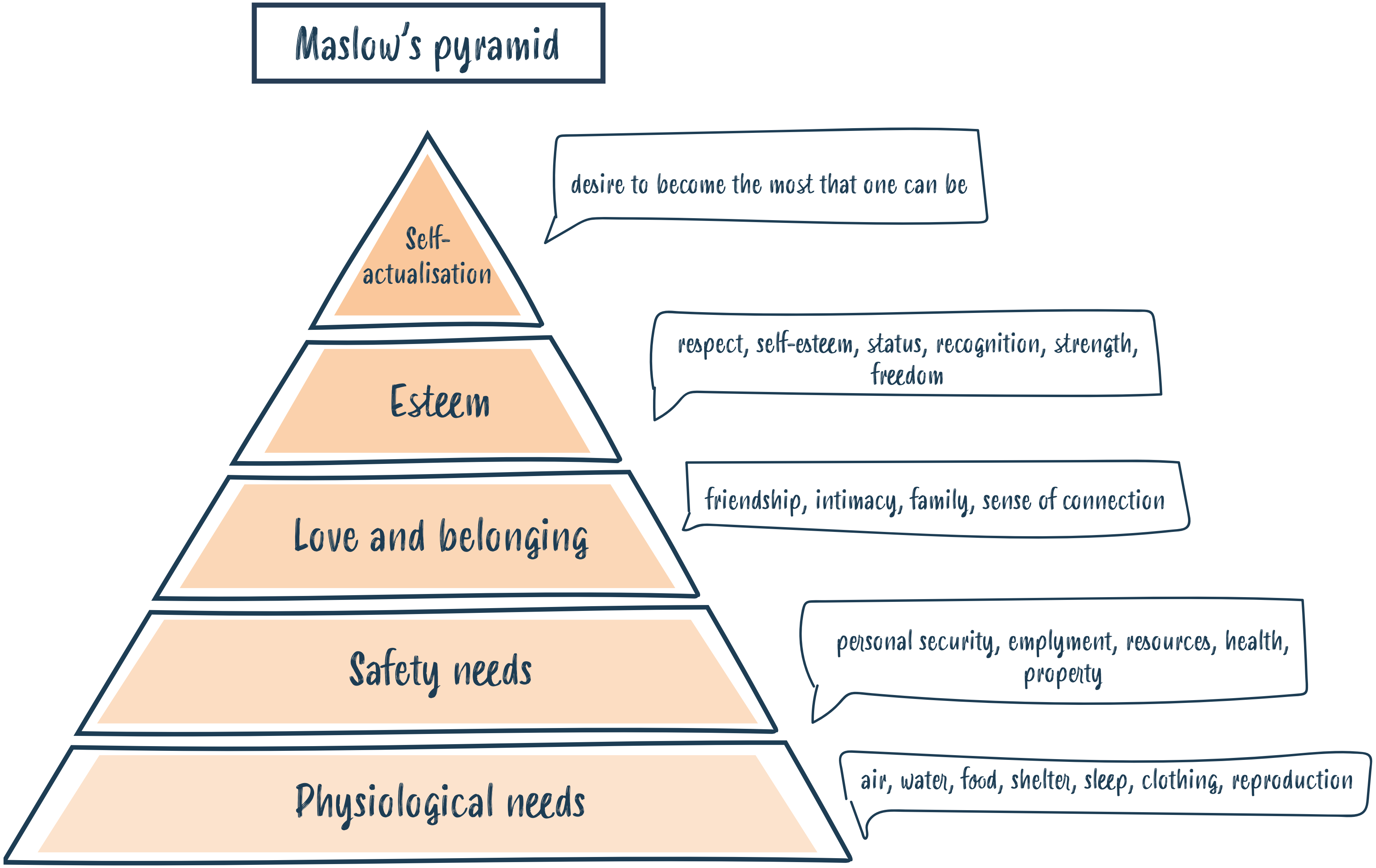


Figure 7: Maslow's pyramid.

Liveability per area

Every year the Leefbarometer, an initiative of the Dutch Ministry of Internal Affairs, studies the liveability score nationwide. What stands out is that in the city centres, where the score on amenities is high, the sense of safety is lowest compared to areas around it. This means that city centres score lower on liveability than surrounding areas (Leefbarometer, 2018)

Regarding the definition of safety, the Leefbarometer does not specifically mention traffic nuisance, but this does not mean it might not contribute to a sense of unsafety or that it might negatively impact the experience of the physical environment.

Municipal ambitions

Lintelmeijer states that when looking at current municipal ambitions in the Netherlands, the same focus points from still stand from the year 2000, where Al Gore formulated goals to improve urban liveability. There has been a shift though in mentality on how mobility should be managed. Gore plead for preservation of green spaces, easing congestion and restoring sense of community. In 2014 the focus shifted from spatial quality to spatial liveability, looking at the space first and then deciding what modalities would fit instead of modality driven design of spaces.

When looking at the assignment, “decide on what vehicle to deploy on what road to decrease nuisance and in result improve liveability”, this is in line with the zeitgeist now and happening in all city contexts unanimously.

Environmental zones inside the city and remodelling the street structure favouring smaller modalities are an example of how municipalities are trying to improve these things.

Impact PostNL

Delivery vans pose a threat to the feeling of safety on the street. The growth of volume to be delivered results in drivers working at a higher pace, violating traffic rules and taking risks. (Fleetnews, 2020) They block streets and do not improve the experience of the physical environment. These vans also contribute to the experience of traffic in urban areas, which can negatively influence social connectedness between people living in the same streets (Hart, 2008).

Van Dijk sees the LEVV as a useful tool to improve safety in traffic and liveability but worries about the regulations on these vehicles being unclear, resulting in many varieties of LEVVs in traffic, creating an even more busy and chaotic street. She sees an increase of individual modalities as a result of COVID-19, making public transportation unattractive. This increase causes streets to become even busier.

Municipalities want to regulate public space as little as possible to save space, but this means that PostNL needs to decide on using the best vehicle and clearly determine driver behaviour. Traffic safety is a factor which concerns all road users and unanimously considered a threat to a liveable public space. Improving traffic safety impacts both traffic participants and the PostNL drivers.

Conclusion liveability

- Liveability can be experienced both **objectively and subjectively**, and **general and specific**.
- To improve liveability for all areas, **a general nuisance** should be focused on reducing.
- Besides the previously stated nuisance factors, **traffic safety** is a factor which LEVVs can improve.
- City centres will **expel cars** soon, making a speedy **change in modality a pressing mattev** for PostNL.
- Municipalities will not adapt their public space to serve vehicles, **vehicles must adapt to the public space.**
- When wanting to improve liveability in an area, **decide on what vehicle to deploy there by looking at the space first**.

Nuisance to be reduced with LEVVs:

1. Congestion reduction
2. Traffic safety

2.5 The liveable street

Street features

The ANWB report 'Verkeer in de stad', shows an approach to creating street layouts which provide enough space, contribute to safer traffic and make spaces pleasant to live in. By categorising vehicle types on speed and weight the report (of ANWB) aims to create street layouts which improve flow and safety. A balance between participating in traffic and residing in the area is pursued (ANWB, 2020).

This approach shares the ambition at PostNL wanting to create a liveable area but still focusing on making sure the city is accessible to vehicles.

When designing a safe space where traffic can flow smoothly, attention must be paid to:

These factors can be used to categorise streets and judge the vehicles on nuisance free driving and parking.

1. What traffic rules apply there.
2. The mixing of different vehicles based on weight and speed.
3. How wide the domains should be to give vehicles space.
4. How much traffic moves through that area.


Street analysis factors
Parking potential
Traffic regime
Domain width
Traffic mixing
Traffic intensity

2.6 The LEVVs

Nuisance causes unhappiness, making a city less liveable. For PostNL, congestion is the main motivation to invest in substituting hindering vans for smaller vehicles, and what the model should focus on. The phenomenon liveability is explored to widen the view on the other factors that make a city less liveable, on which LEVVs can have a positive impact.

History

LEVVs have been around for a longer time than one might think. In the 1950's a Dutch company named Spijkstaal made electric milk and bread trucks to deliver from door to door. The rise of the supermarkets put an end to further innovation on these vehicles. Since 2011 the LEVV has made a comeback with a bigger range of and diversity in models (LEVV-NL, 2017). Companies like Urban Arrow, Easy Go Electric and Stint Urban Mobility have realised that the biggest potential lies in the transport of goods.

In 2010, regulations allowed small vehicles with a maximum speed of 25 km/h to access the bike lane without requiring European approval of the vehicle, no driver's license, and no helmet. Since then, some regulations have changed on regulations in Dutch cities. Drivers' licenses are needed for motorised vehicles (if not categorised as bicycle), and the city of Amsterdam does not allow 25 km/h mopeds to drive on the bike lane and drive without a helmet (NOS, 2019).

The changing regulations and varying policies between areas on LEVVs show a lack of judgement on how these vehicles should be regulated. The growing offering of LEVV-types leads to discussion on rules of admission, position on road segments and charging standards. To facilitate this growth the discussion takes a prominent position in political agendas, which is important to keep an eye on when deciding on what vehicle to deploy where. Expert van Dijk points out during an interview that to be launched European legislation will clear things up around how these vehicles should be regulated.

What is a LEVV?

Optically there are three known types of LEVVs (LEVV-LOGIC, 2017):

1. Electric motorised cargo bikes with pedals.
2. Electric motorised cargo vehicles, without pedals (stints, cargo mopeds).
3. Compact distribution vehicles with electric drive.

PostNL wishes to examine potential vehicles in the categories one and three, as the distinction between both is biggest and their position on the road differs (see figure 8).

Three types of LEVVs

	e-cargo bikes with pedals	e-cargo vehicle, without pedals	e-truck
			
Domain	Drive on bicycle lane Park on sidewalk	Drive on bicycle lane & road Park on sidewalk	Drive on road Park on parking spot
Speed	27 km/h no licens plate	25 km/h - blue license plate 45 km/h - yellow license plate	45+ km/h - yellow license plate
Net weightcap.	50 - 350 kg	100 - 500 kg	300 - 1000 kg
Brands	centaur cargo, cyclesparks, urban arrow, velove, fulpra, rytle	cargobee, ebretti, elveco, govecs, stint, tripl	electrocar, factory, tuktuk, eco-mobiliteit, aixam, addax
Max. speed	No plate. max 25 km/h	max. 25 km/h	no max speed

Figure 8: three types of LEVVs.

Which rules apply?

The Dutch RVV (Reglement Verkeersregels en Verkeerstekens) contain the regulations for different kinds of vehicles. For different types of LEVVs different regulations apply on what domain-type they must drive. According to the regulations the three categories must comply to the following rules:

1. Cargo bikes with pedals.
   a. Drive on the bicycle lane.
   b. Park on the sidewalk.

2. Electric motorised vehicles without pedals.
   a. Allowed to drive on bicycle lane if less wide than 0,75 meter.
   b. Park on the sidewalk.

3. Truck-type LEVVs.
   a. Drive on the road.
   b. Park in parking spots.

These three different categories optically can vary in maximum driving speed. The Netherlands distinguishes two types of license plates that match the maximum speed a vehicle is allowed to drive. A blue license plate means a maximum speed of 25 kilometres per hour and a yellow plate a speed of 45 kilometres per hour or faster. Blue plated vehicles may drive on the bicycle lane, but yellow plates must drive on the normal road. The speed of electric bikes is limited to 27 kilometres per hour without them needing a license plate.

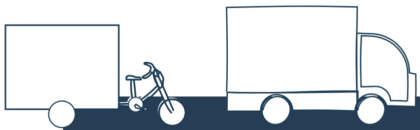
The assignment is to find a way to decide if on a street PostNL should deploy a truck-type LEVV or a bicycle-type LEVV. To be more specific, to decide whether a drive-way vehicle or bicycle lane vehicle would cause the least nuisance.

As mentioned before, the regulations regarding different types of vehicles are vague and changing constantly. When investing in vehicles PostNL wants to be sure that the vehicles are approved, clearly regulated and safe for use. PostNL wants to stay close to common vehicle types by sticking to an electric cargo-bike and a cargo-truck. The bike-type vehicle is restricted to a maximum speed of 27 kilometres per hour and the truck-type is bound to a yellow license plate, not having a maximum allowed speed. An example of differences in rules between municipalities is Amsterdam not allowing blue-plated vehicles on the bicycle lane, whereas other cities do allow it.

General benefits of LEVVs

According to The Hogeschool of Amsterdam's (LEVV-LOGIC, 2017) extensive research on LEVVs these are the advantages and disadvantages of using a LEVV in a delivery process compared to traditional delivery vans. D. Grasveld from online supermarket Picnic, reflects and adds on these advantages and disadvantages with his experience with LEVVs in their daily process. A summary of relevant pros and cons are presented in figure 9.

These advantages and disadvantages do not apply to both LEVV-types though, some discrepancies are important to mention.



LEVV pros and cons

1. LEVVs have **more routing options** in the centre because of bicycle lanes and one-way streets.
2. LEVVs are **smaller** and have **more parking opportunities** out of the way of others.
3. LEVVs are considered **less of a threat** to traffic users.

1. Usage of LEVVs demands a **new way of route-planning.**
2. **Traffic** rules for LEVVs are **inconsistent** among different cities and enforced to varying degrees.
3. LEVVs can carry **less volume** than a traditional van.
4. (New) drivers must be **trained.**

Figure 9: pros and cons of delivery with LEVVs.

More routing options and parking opportunities

The first one is that truck-types do not necessarily have more routing options than a bus, as they must comply to the same rules of a van, which means that they cannot enter one-way streets both ways and cannot use bicycle lanes. So, the truck-types will mostly use the same route as traditional vans.

Unlike bike-type LEVVs, truck-type LEVVs may not be parked on the sidewalk. Although, as they are typically smaller than a bus it means that they can easily park on the side of the road without blocking the way.

Grasveld values this advantage as the distance between the parked vehicle and the front door is minimised, reducing the time the vehicle stands still, and the chance of reducing nuisance while parked.

In highly regulated areas the truck-type is bound to parking spots or loading and unloading places.

Attention must be paid to what the road looks like and its features to estimate if a truck-type LEVV can be parked there free of nuisance and without being fined.

Sometimes cities exempt certain types of vehicles, but this varies per city and the level of exemption is inconsistent. Besides this, these exemptions must be bought per vehicle. For this project it is assumed that there are no exemptions for traffic rules and drivers stick to the rules.

Safer in traffic

The LEVVs operate on different domains, meaning they are mixed with different kinds of traffic users. The type of domain determines what vehicles drive there. When claiming that a LEVV is safer than a bus, attention must be paid who the LEVV could come into contact with. A bus might never enter a pedestrian area, where a LEVV might, potentially causing an unsafe situation. Also, the busier the street, the more people could be hindered by a vehicle.

When projecting this onto nuisance, attention must be paid to the participants sharing the domain with the LEVV. Together with the features of that domain, like street width or curb-height, it decides if driving there with a certain LEVV is safe.

Driving training

Grasveld stresses the importance their LEVVs have on their reputation. Picnic's drivers are the faces of the company and their driving behaviour decides if the customers associate their service with the vision of Picnic, to be a family friendly proposition.

Picnic drivers receive training before being allowed to drive the LEVV. Monthly, their driving behaviour is judged by a digital driving coach, which is a tracker installed in the vehicle which measures speed and turns. Feedback is given back to the driver to improve his driving behaviour.

A truck-type LEVV resembles a traditional van but a bike-type LEVV asks for physical effort. The bike-type must follow different traffic rules and is mixed with different kinds of participants. Making sure the driver and those around him are safe, training is needed.

New route planning

Main differences between delivering by a van and a LEVV are:

1. the need for a city hub as LEVVs cannot drive on the motorway (depots are typically located outside the city centre)

2. the difference in trunk volume, the way of driving the vehicle and the sorting process at the depot, which must be done by someone other than the delivery driver.

What this process looks like is discussed in the next chapter.

2.7 The LEVV process

This chapter presents the newly designed process for LEVV delivery. The viability of this process is tested in Groningen to find out how efficient it is compared to delivery with traditional van. A bike-type and truck-type LEVV were tested on nuisance reduction compared to a van. These tests show if delivery with a LEVV would not negatively impact PostNL's service and if the assumption is true that LEVVs reduce nuisance. By observing and measuring the LEVVs in process, much can be learned on how the vehicles behave in the real context of the city.

The new process

Figure 10 shows the new LEVV process. The biggest difference of the current process is the way the parcels are sorted. The person sorting the parcels at the depot is not the one delivering them from the hub. PostNL came up with a system with rolling containers with numbered shelves. Parcels on the conveyor belt are scanned and a handling projector projects a code onto the parcel which matches the code of the shelf. A list will help the LEVV driver locate the parcel easily, having to look through only a couple of parcels instead of all of them. This does require a strict route indication which needs to be followed by the delivery driver.

Another difference is that a LEVV must reload two to three times during the delivery route to deliver all the parcels of that day. By sorting the parcels into the special rolling containers this part of the process is just a matter of swapping the rolling containers at the hub.

1. The daily volume to be delivered by a LEVV is the same as that of a van (around 200 parcels per day).
2. One LEVV will replace one bus in the city centre.
3. The driver does not have to break traffic rules.
4. It needs to be as efficient, or more efficient than the current process.
5. Big parcels will still be delivered by one bigger vehicle.
6. A driver will park as close to the door as possible.
7. The vehicles do not require an exemption for city centres.
8. The vehicle is containerised (an entire rolling container can be put in).
9. The safety and comfort of the drivers must be guaranteed.
10. Drivers are trained on the process and on driving the vehicles.

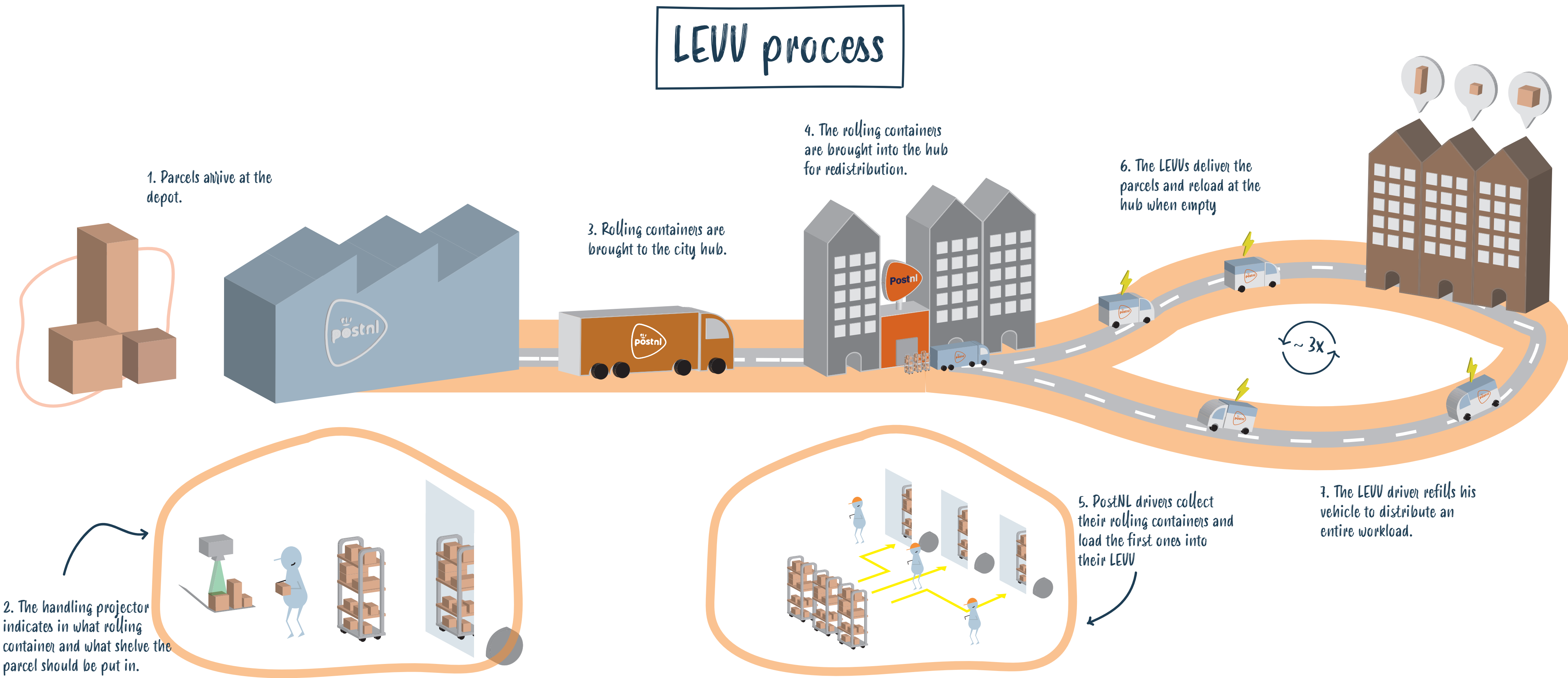


Figure 10: the designed process with LEVVs.

Figure 11: nuwiel bike-type LEVV (property of Nuwiel)

Figure 12: goupil truck-type LEVV.

Figure 13: traditional Mercedes Sprinter van.

Groningen test-case

Over a timespan of seven days distribution tests were done in the centre of Groningen with three vehicles (figure 11, 12 and 13). One driver drove all vehicles on the same delivery route in the city over multiple days. A traditional van, a Goupil (Electrocar) and a Nüwiel bicycle.

The goal of this test is to find out

1. How much efficiency is won or lost compared to a van?
2. How do they perform on reducing congestion, compared to a van and each other?
3. What are the differences between a truck-type and bicycle-type along the entire process?
4. What is the employee's experience and what alterations are needed?

Efficiency analysis

The way the time was measured was done the same for every vehicle in the test. Set-up and pictures of the test can be found in appendix A6.

Sorting

The handling projector and special containers were not available for the test but sorting them by hand into containers at the depot already saved time as the deliverer did not have to re-sort them at the hub. He just needed to take the parcels from a rolling container and put them into the LEVV.

Delivering

The results showed that during delivery (the part between the first stop and de last stop of a trip) the number of stops per hour increased by almost 25% when driving a LEVV compared to a traditional van. Both the truck-type and the bike-type had a higher performance rate (figure 14).

Overall

When looking at an entire trip plus the time it takes to go from and return to the city hub, the number of stops per hour of a LEVV equalled that of a van
The efficiency of the LEVV in terms of stops per hour equalled that of a van when taking the activities at the hub.

If during the test the LEVVs had been containerised, it was calculated that it would have increased the total efficiency of the LEVVs by 9.5% compared to a traditional van (loading and delivering). The driver would win time at the loading process.

The time lost in the phase prior to the delivery trips and reloading is made up by the vehicle being able to move faster through traffic, park closer to the door and the parcels being sorted efficiently.

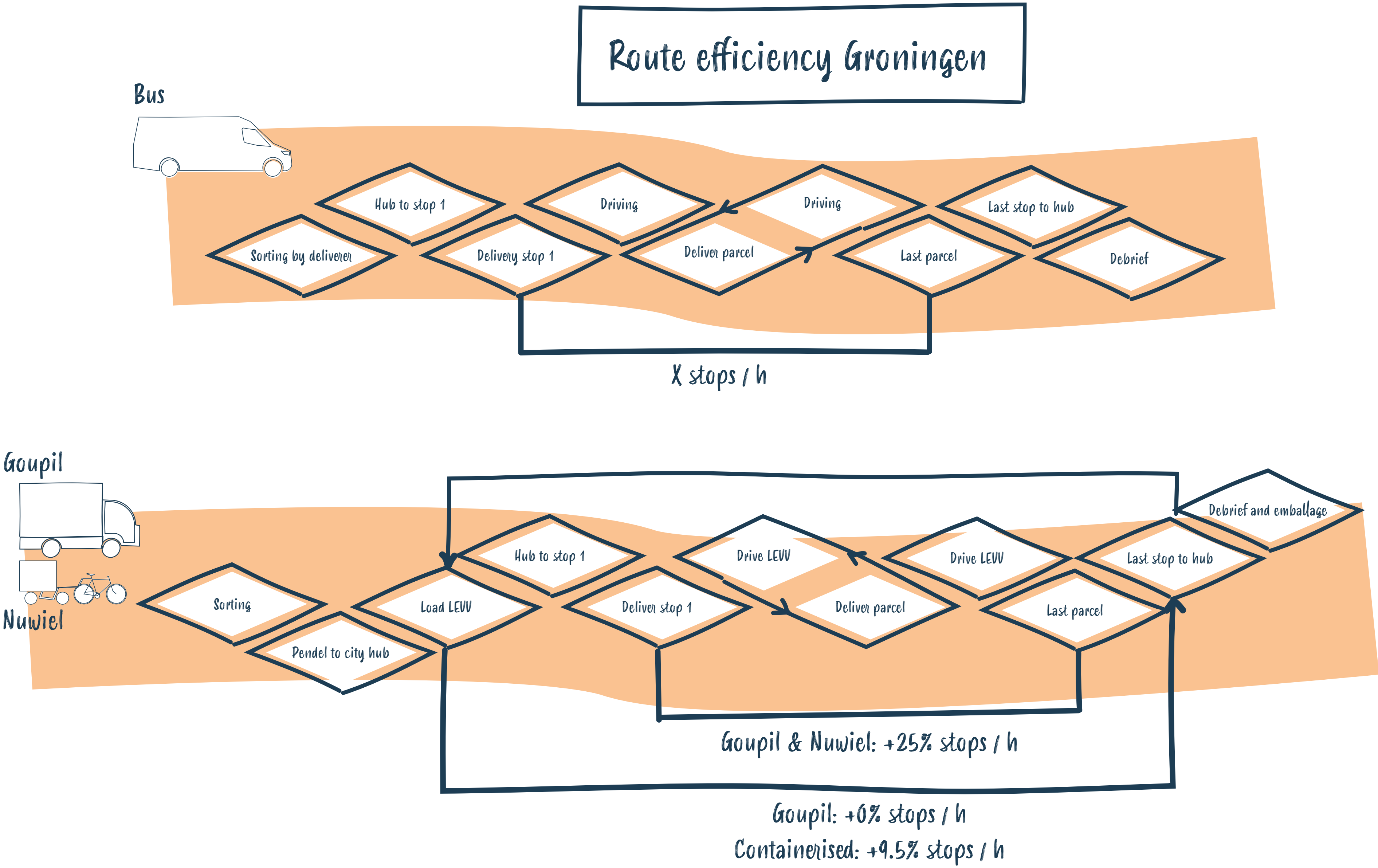


Figure 14: efficiency of bus and LEVVs compared along the process.

"When delivering with a van it hinders other road users 4 to 5 times more than a LEVV."

"Congestion caused by a van typically lasts longer than nuisance caused by a LEVV."

Congestion analysis

The vehicles were followed along the delivery route and observed during parking and driving. At every parking action, the situation was assessed on (potential) nuisance experienced or caused by the PostNL driver. The full set-up can be found in appendix A6 and more observations in appendix A7.

Figure 15 shows three situations in the same exact stop along the parcel route in Groningen. The width of the vehicle is responsible for a big portion of hindrance. The acquired data from the test in Groningen showed that when delivering with a van it hinders other road users 4 to 5 times more than a LEVV. This means that if a LEVV is used, less individuals get stuck behind or are delayed by a vehicle of PostNL.

The analysis shows that when delivering with a LEVV, more parking actions in total were done. This can be explained by the advantage of a LEVV being able to park close to the front door of the delivery without blocking the way. Traditional vans are reliant on tactical parking places from where multiple stops are done. This means that more stops are done from a single parking action and a longer parking time. On top of that, the driver must walk from the bus to the door, which costs time. Safely can be assumed that when a van is parked and causes hindrance, the hindrance will last longer compared to when someone is hindered by a LEVV. To conclude, a LEVV causes less nuisance when parking compared to a bus. A LEVV can easily park out of the way and close the front door of the delivery. If a LEVV would cause nuisance, it would last less long than when a bus would cause it.

Figure 15: three test vehicles at the same parking spot in the Zwanenstraat in Groningen.

Driver experience

To be able to make a smooth transition from van to LEVV, the wants and needs of the drivers should be taken into consideration. Drivers were asked to talk about their experience on the process, the difference between the vehicles, the benefits and disadvantages of the LEVVs. What must be done for them to swap their van for a LEVV? Details and the interview guide can be found in appendix A8.

Switching modalities affects the way they work, their efficiency and the comfort in driving and delivering parcels. Comfort is one of the most important values as the driver's work is physically challenging. Listening to their insights can create a more favourable process for the drivers and a bigger chance of employee acceptance.

Driving & Parking

1. LEVVs allow easier manoeuvring through the city, there are more routing and parking options.
2. The smaller vehicle with lower driver's seat made the drivers feel like less of a threat to the safety of others.

Process

1. Containerisation is a must for the process to work as without it means more handling.
2. Reloading makes for a variation in work, which drivers enjoy.
3. They think a new type of employee is needed for the bicycle-type vehicle.

Vehicle

1. Handling parcels with a LEVV is easier and faster with a LEVV compared to a bus.
2. The closer to a van the LEVV seems, the more likely they are to swap.
3. Delivering exclusively by bicycle-type LEVVs is not a preferred option.
4. Only if they can alternate between other modalities.
5. The truck-type needs upgrades on comfort, cabin size and power steering.
6. Bad weather conditions may be a bottleneck for willingness of driving a bicycle-type of LEVV.
7. The Goupil does not have power steering, making it tiresome for drivers.

Customer response

1. The more 'open' the vehicle the more positive the responses.
2. People like the aspects of sustainability, safety and noise reduction.
3. Stores are happy that their store fronts are not blocked when using a LEVV.

Conclusion

The employees are happy with the current way of working and do not directly experience trouble with finding parking spots or causing hindrance as they are used to the fact that this happens in urban contexts. They do realise that using smaller vehicles could help them cause less congestion and contribute to a safer place for other road users. A trade-off is made constantly by drivers between efficiency and nuisance-free driving and parking. They do believe a LEVV will help them in to reduce nuisance.

Although LEVVs might help them reduce nuisance, the biggest bottleneck for drivers is the comfort of the vehicles. Both vehicles were considered uncomfortable or malfunctioning on critical factors.

Drivers enjoy structure and repetition, helping them deliver efficiently. A LEVV means a change in structure, and a new way of working to adapt to. A LEVV being uncomfortable will decrease the satisfaction of the driver, which makes comfort a priority when choosing LEVVs for deployment.

2.8 The customer satisfaction survey

A total of 24.372 people responded to the digital customer satisfaction survey of PostNL. For the first time the people were asked about delivery vehicle preference. This short chapter discusses the results and conclusions of the survey. The relevant questions asked are presented in appendix A9.

Survey analysis

Awareness

From the total group of respondents that personally accepted the parcel (16.785) 72% is certain what type of vehicle had delivered their parcel. You could say that 7 in 10 customers are aware of the type of vehicle, figure 16.

Preference

Of the 33% (figure 17) saying they prefer a vehicle-type the biggest portion prefers an electric van. Motivations for preferring a sustainable solution, besides sustainability, are noise reduction, smell reduction and less use of space.

Of that group (with a preference) 10% states it prefers smaller electric vehicles, while these are not yet widely visible in the streets. The survey shows that these respondents show a lower overall satisfaction rate than other consumers. This shows a promise for the LEVVs in a way that there is already demand for a smaller type of modality and a happier customer if it receives service with LEVVs.

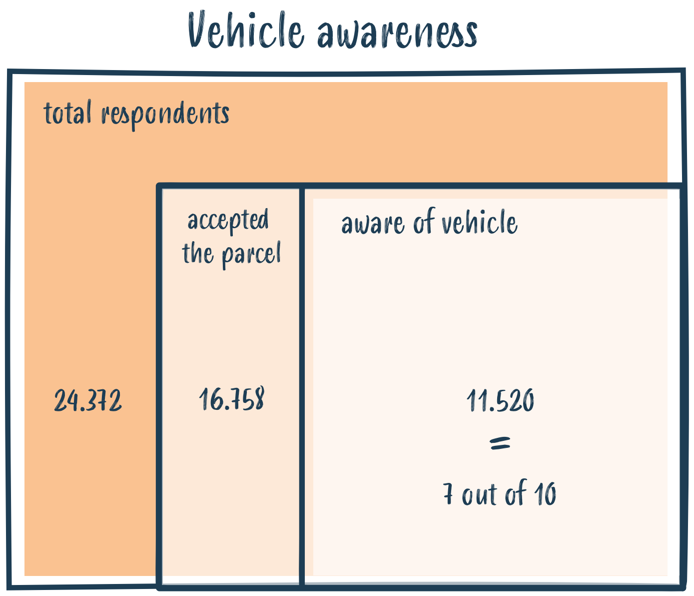


Figure 16: results vehicle awareness under PostNL customers.

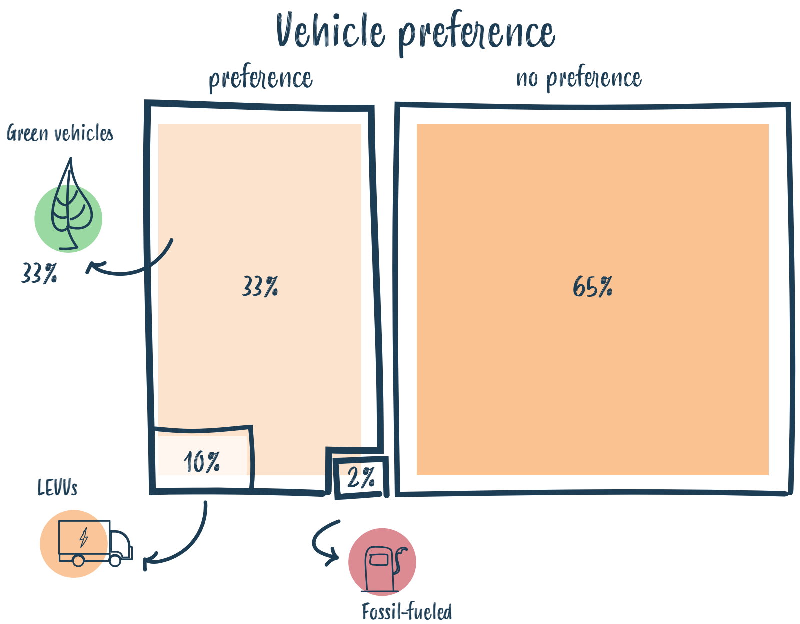


Figure 17: results vehicle preferenceunder PostNL customers.

A small group prefers diesel type of vans as they find them more reliable, cheaper and comfortable. They do not believe the range of electric vehicles to be sufficient to deliver the whole route.

What must be realised is the fact that the respondents live in different contexts, rural and urban. This project focuses on the city centre though. Of the group living in urban areas 47% shows a preference for sustainable delivery (figure 18).

Satisfaction along journey

Respondents that are not aware of the type of vehicle show a lower score on satisfaction over the entire customer journey than respondents that know the vehicle type. Also, respondents that know their delivery was done by a sustainable vehicle are more satisfied than people who are unaware of how the vehicle is powered.

Consumers with a preference for sustainable delivery who know that their delivery was indeed sustainable are more satisfied with PostNL's service than people that are unaware of or do not receive service by electric vehicles.

Conclusion

People who receive sustainable delivery are in theory happier customers, but they must be aware of it (figure 19). By being present and visible in the streets, awareness can be created. Even better would be if smaller vehicles could do the job as a part of the respondents that prefer sustainable delivery already prefer LEVVs. The fact that almost half of 'urban respondents' prefer sustainable delivery supports the case of desirability of the deployment of LEVVs in city centres. Do note that electric vans also fall under this category.

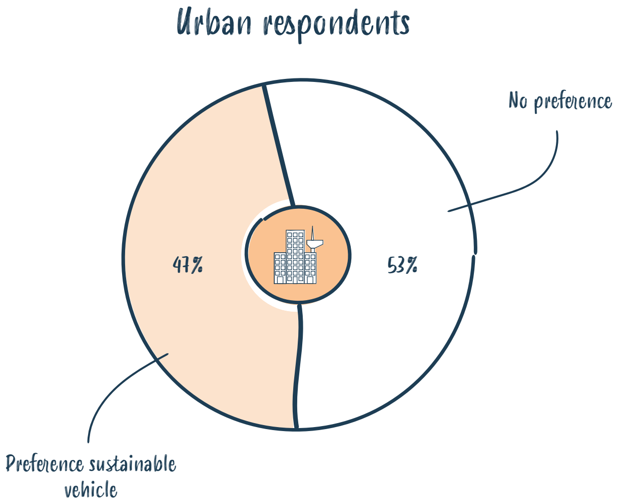


Figure 18: vehicle preference among urban respondents.

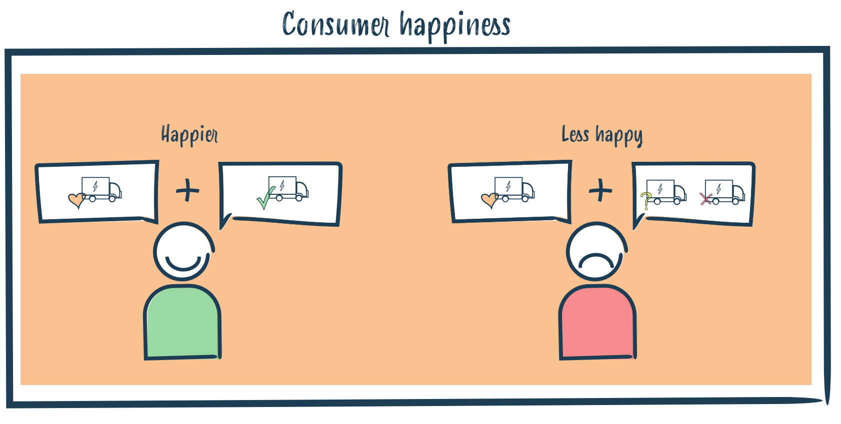


Figure 19: customer happiness affected by vehicle preference.

Interim conclusion

- The two LEVV-types to be considered are a **bicycle-lane vehicle and a driveway-vehicle.**
- The LEVV process is **viable and feasible.**
- **LEVVs reduce congestion** along the delivery route.
- **Traffic mixing** per domain is an **important** factor to decide if a LEVV can drive nuisance free there.
- **Comfort** is a vital feature which should be judged when choosing the vehicles.
- The more **visible** the LEVV, the **more satisfied** the urban customer.

2.9 Vehicle archetypes

This chapter explains how the vehicles are chosen which will serve as archetype vehicles the model will be designed on. PostNL has already decided on what vehicles they will use for the pilot, but this part shows what demands the vehicle must meet and what elements of the vehicle are important for making a choice between two vehicles.

Vehicle demands

For a new vehicle type to be accepted on to the road certificates are needed which are acquired through examination. It must meet European requirements (EG-guidelines) categorised in a vehicle category. This can be done through the Rijks Dienst voor het Wegverkeer, the Dutch Vehicle Authority, which examines the vehicles. Vehicles that are not licensed, are not taken into the consideration.

A list of requirements which must be met by the vehicle to be considered are stated in appendix A10. PostNL made a shortlist on potential vehicles based on their width and availability:

Reasons why vehicle types are not suitable.

1. Cannot be containerised.
2. Has too little volume capacity.
3. Looks unstable
4. Is too wide or too long.

Looking at what the other logistical companies are doing shows what PostNL does not want in their vehicles.

DHL uses street scooters which are electric truck-type LEVVs (see figure 20). This vehicle is as wide as a car and not containerised. The length does not give it the perks that a smaller LEVV would have. PostNL wants to leverage a narrow vehicle's width to increase passing potential and finding parking spots. This means that they want to find a containerised vehicle which is as narrow as possible.

A motorised cargo bike used by DPD (figure 21) is not an option for PostNL as it is not containerised. Besides this, the driver needs to wear a helmet and cannot drive on the bicycle lane. As this vehicle must drive on the road, it is compared to a truck-type vehicle which has a roof to shelter it from the weather.

Shortlist vehicles

The preferred vehicle will merely serve as an example used to create the decision model. The design of the decision model will be applicable to bike-type and truck-type LEVVs in general. If PostNL decides to deploy other vehicles, the model should still be useful.

The vehicle prototypes will provide specifications and attributes which are used to judge a vehicle in a certain context. Besides this, physical tests with chosen vehicles can be done to make sure the assumed qualities are valid. PostNL decided on two vehicles which are tested within a pilot and which will serve as archetypes for the model of choice.

Appendix A10 shows specifications of the chosen truck-type LEVV. The bike-type LEVV specifications are not available as the model is being designed and optimised at this point. Specifications of the bike-type might change after the model is made. Per vehicle the most relevant specifications are discussed:

Figure 20: DHL's street scooter (DHL, 2021).

Figure 21: DHL's cubicycle (DHL, 2021).

Figure 22: DPD's cargo bike without pedals (DPD, 2021).

Figure 23: Fulpra Roll.

Choice bicycle-LEVV

Within the project team a choice was made to go for the Fulpra Roll (figure 23) bike because of the following four reasons

1. The width of the bike is 1 meter. And the the size to volume-ratio of the Fulpra's container is optimal compared to other LEVV-bikes.
2. Containerisation and capacity are very important factors for an efficient process. The Fulpra Roll is already made to be containerised.
3. Dynteq closely followed the requirements demanded by PostNL, making sure the vehicle fits the wishes of PostNL.
4. Fulpra Rolls are produced in the Netherlands which makes supplier contact and shipping easier and also cheaper compared to the Rytle from Germany

Figre 24: CargoLEV

Choice truck-LEVV

Within the project team a choice was made to go for the CargoLEV (figure 24) truck because of the following four reasons

1. It is narrow, namely 128 centimetres.
2. The size and volume ratio is perfect compared to other vehicles within the same group.
3. It is containerised.
4. PostNL enjoys are good relationship with the importing company Electrocar. They already use the Goupil model, which is imported by Electrocar.

2.10 Problem definition

After the analysis phase what must be taken into the criteria in the define phase?

With these two models at hand, PostNL wants to know how it can reduce nuisance which is experienced universally as annoying, which can be solved by the use of smaller LEVVs. PostNL is unsure whether they need a vehicle which drives on the bicycle lane or the road. For both vehicle-types they need to know on what type of street would reduce nuisance best while still being able to deliver efficiently. For a vehicle to be part of the solution it must be containerised and narrow.

A street categorisation must be made first, on which PostNL can decide what vehicle they would deploy there. After this they must know what vehicle suits existing routes best so they can reduce the nuisance there to a maximum.

When PostNL knows what vehicle to deploy where, they need to make sure the process of LEVV delivery is understood by the people executing it. When this is clear a plan can be made on how this model of choice can create optimal routes for all city centres within the ambition of PostNL.

3. Define

To be able to create a model that is technically feasible, economically viable and desirable for the 'problem solvers' some scoping needs to be done and design rules formulated. After the design process the outcome must be challenged on the criteria stated here. By keeping these in mind the chance of success and satisfaction is maximised.

3.1 Design criteria

These are the criteria the model of choice and further development must consider when designing. The extent to which the final design meets the criteria decides the level of success for PostNL.

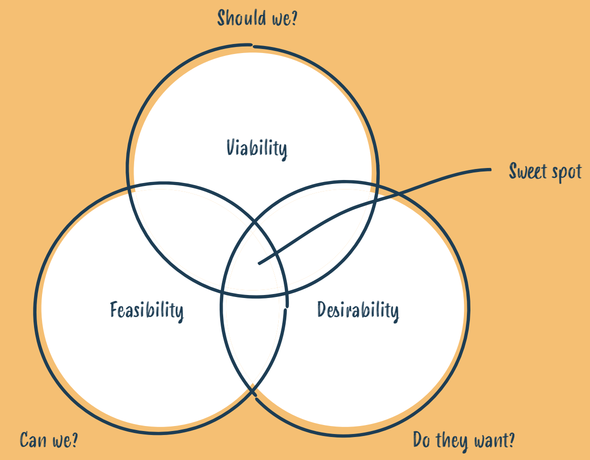


Figure 25: Feasibility, viability and desirability venndiagram.

Deliverables

- A **decision model** which shows what vehicle should drive on what road to minimise nuisance.
- A **strategy** on how to automate and digitise the model into a **system for analysis all cities.**
- A **roadmap** on how the system evolves in the future.
- A communication strategy which helps translating the model into a workable process.

Context

- The **current** defined **twenty-five cities** are within scope, the others are out.
- Everything **outside of the historical city** centre is **out of scope**.

Time planning

- The model must be **immediately usable.**
- The roadmap must lead up to **2025.**

Feasibility

- The model applies to **all truck-type and bicycle-type vehicles, i**f they meet requirements.
- The model tells PostNL **what vehicle** would cause the l**east nuisance on a street.**
- The model can be digitised and automated for all twenty-five city centres.
- The model is future proof.

Viability

- The model will **not increase costs** anywhere along the chain.
- The model must take **volume distribution** into consideration.
- The model must show PostNL the **impact of nuisance reduction**.

Desireability

- The output of the model can be **communicated easily along the process chain**.
- The model and its system must be **liked** by the **route planners and process managers**.

4. Design

After analysing the context and stating the design criteria for the design to be a success, two design cycles are done. This chapter shows how a first design cycle leads to a way of categorising streets and deciding on what vehicle preferences per category. In the second cycle the model of choice is designed which gives an advice on how, after which a third one helps create a plan to innovate the system and communicate along the PostNL process chain. The chapter starts off with a categorisation of streets which makes it possible to judge vehicles on predefined street profiles.

4.1 The stratonas

A city centre is made up out of many types of roads with all different features and characteristics. Things like bike-lanes, tramrails, narrow streets with parked cars and obstructions all influence the performance and potential of the vehicle on reducing nuisance. In this chapter city centres are analysed and existing streets are categorised on pre-defined factors. A choice is made on what vehicle suits what category best, with the aim on choosing the vehicle which would cause the least nuisance. These are then validated through physical tests and validation interviews with experts.

Road categorisation

PostNL wants to know on what street to deploy what kind of vehicle to minimise nuisance. To be able to answer that question, it must first become clear what kinds of streets one can find in the city centres. A categorisation must be made of streets after which a judgement can be made on what vehicle suits best. The idea is to find categories that cover all streets present in all twenty-five city centres.

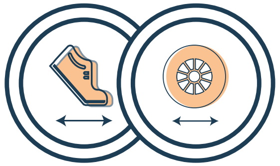
Every street-type category is judged on factors which make it possible to estimate if a LEVV-type would cause nuisance or experience nuisance.

Streets are analysed on five factors: traffic regime, traffic mixing, domain width, parking potential and traffic intensity.

The created categories are called 'stratonas', the street version of persona archetypes.

Traffic regime
What rules apply to that street? Who can drive where and at what speed? What is legal and what is illegal?

Traffic mixing
To what extent do vehicles share the same domain?



Domain width
How wide are streets and the sidewalks, how much room is there?

Parking potential
How many parking opportunities are there? Where could the LEVVs park?

Traffic intensity
Typically how busy is that street with what kind of road users?

Stratona

Strah-tow-na

noun

Stratonas are street archetypes which can be found in all Dutch city centres. The collection of stratonas represent a complete set of all existing streets in historical centres.

Digital street analysis

To find streets to categorise, firstly a truck-type LEVV was driven through the centre of Amsterdam to get a feeling of what streets are present, the size of the vehicle in traffic and what obstacles can be found. This helped in supporting personal assumptions when distinguishing streets digitally. Afterwards, seventeen city centres in total were analysed through Google Street view by judging them on the factors, screenshotting them and clustering them into groups. These were judged on the five factors (appendix B1) Six stratonas were created which are explained.

Vehicle preference

Per stratona it must be decided what the vehicle preference is that would cause the least nuisance. The archetypes and their specifications being those of a CargoLEV and a Fulpra Roll. When judging the street on a vehicle the following basic questions were asked and answers were motivated.

"Is the vehicle allowed to drive here? "

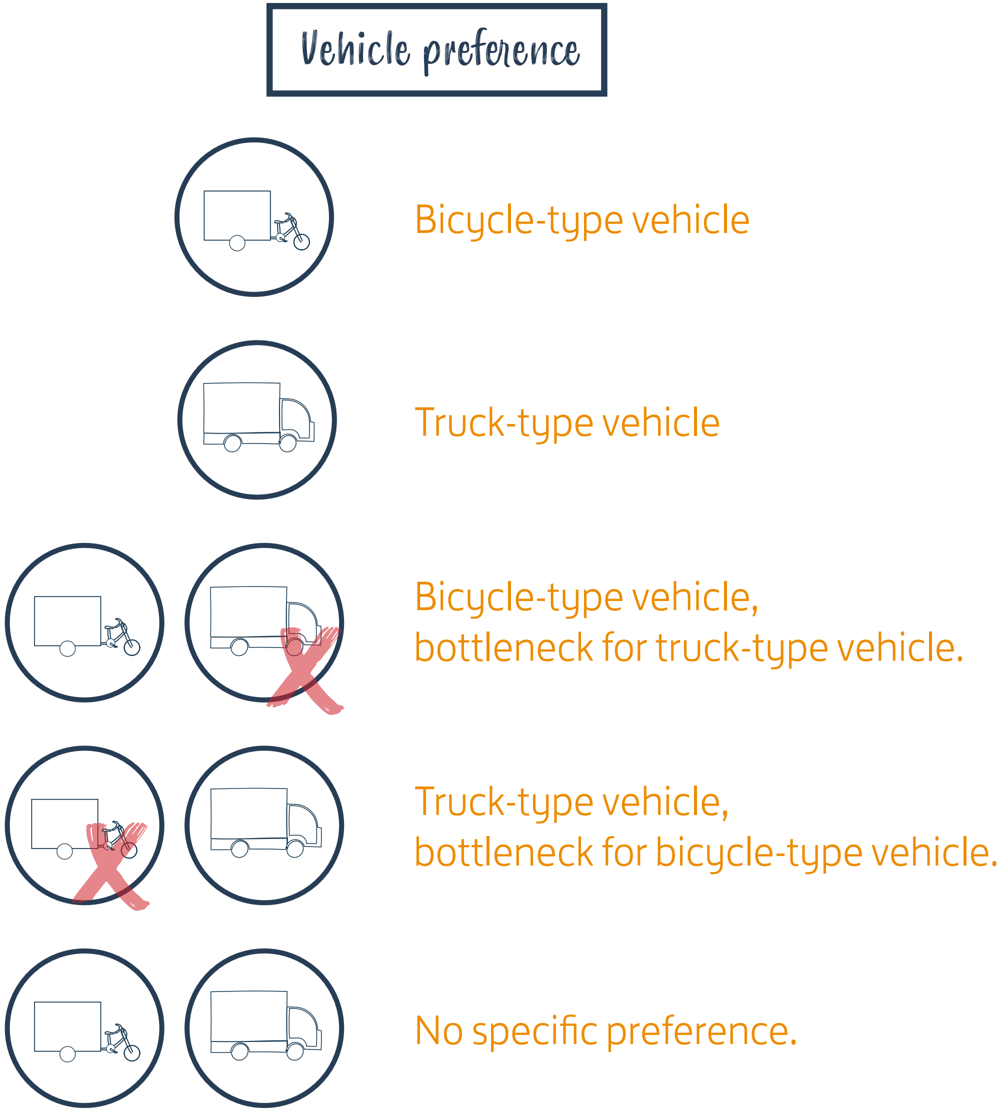
If this does not give a clear preference to one of the vehicles, then preference is based on the following question:

"What vehicle potentially causes the least nuisance while driving and parking?"

If no good reason can be found why one should be preferred over the other, then both vehicles are preferred.

If the law does not allow a vehicle type to drive on a stratona or if it would cause extreme nuisance, then this stratona counts as a bottleneck for that vehicle. This means that PostNL does not want this vehicle to drive here as it may be illegal or pose a threat to the safety of the driver or others.

The options for vehicle preference on the stratonas can be judged by the following options.



Stratona validation

A first validation study was done on saturation of street-types by digitally visiting random streets and trying to find new categories within the PostNL team.

A second validation study was done with four process managers from varying sorting depots. Examples of streets were taken from the city their depot operates in. Appendix B2 shows how the process managers were sensitised before judging the stratonas. Their input was used to finalise the stratona definitions and quotes are included.

Lastly, both vehicles were taken into the city and a real delivery route was driven. The aim was to compare the physical situation to the digital one and test the vehicles on the stratonas and adjust the stratonas accordingly. Appendix B2 shows the stratonas judged on the factors and a more detailed judgement on the experience with the vehicles on every stratona.

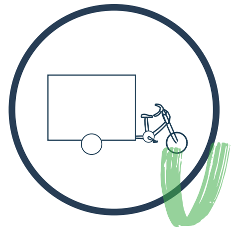
The stratonas

Six stratonas are presented and discussed on the stratona factors: traffic regime, traffic mixing, domain width, parking potential and traffic intensity. Each stratona is presented and the preference for a vehicle is substantiated.

The final stratonas:

1. Narrow one-way street with barriers
2. Bicycle lane
3. Pedestrian area
4. Narrow isolated bicycle lane
5. Mixed road
6. Sorted road

1. Narrow one-way street with barriers



Explanation

This stratona is commonly found in residential areas where obstructions like traffic bollards, street elevations, canals, houses, parked cars, and other obstacles make it difficult to find a parking spot out of the way of others.

If the street has obstructions and the domain is less wide than 320 centimeters (figure , it is considered narrow in this stratona. The width of a Bike-type LEVV (100 cm) + average width of a delivery van (200 cm) + room to safely pass (20 cm) (Theory recommends passing other traffic leaving 1.5 meters of space in between to guarantee safety, this is not realistic in this stratona though. (Mijnrijschool, 2021).

This stratona distinguishes itself from the mixed road stratona by its road being narrow. Typically, if there are a lot of parking spots free for use, and parked cars do not form a barrier, then it is not considered to be this stratona.

There is no bottleneck here for truck-type vehicles as they can operate here legally. There is no direct safety hazard for others and if operated carefully they could prevent congestion from happening.

1. Parking on a parking spot or behind the barriers is not always an option. So, the vehicle should be as narrow as possible to be parked on the side and passable by others.

2. Can enter the street both ways, truck-types cannot. Safest option for others (pedestrians and cyclists) in highly mixed situation, as speed is slow.

3. If there is room then a bike may park on the sidewalk, truck-types may not.

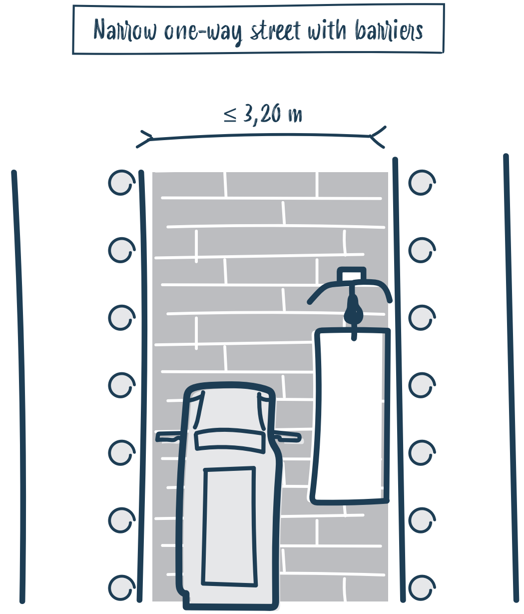


Figure 26: illustration of width NOB stratona.

"If this street was any wider I would have said both vehicles as they could comfortably park on the side of the road. I know streets with similar features that are wider."

- Process manager Elst

Figure 27: Prinsestraat Den Haag

Figure 28: Delftsevaart Rotterdam

Objects keeping vehicles from parking on the sidewalk.

Two-way for cyclists, vehicle must be as narrow as possible to leave room to pass.

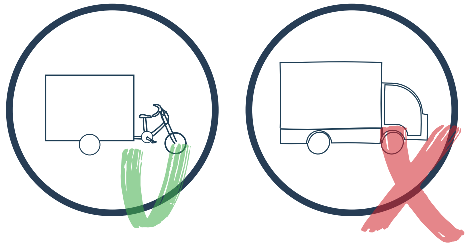
Consistently parked cars force LEVUs to park on the road, or between the bollards if possible.

Even with a bike only other cyclists and mopeds could pass.

Figure 29: Sarphatipark Amsterdam

Figure 30: Vinkenstraat Amsterdam

2. Bicycle lane



Explanation

The bicycle lane is an easy decision as regulations do not allow truck-type vehicles on this domain. One might argue that there are versions where cars may enter ('car as guest-roads' in Dutch), where cars have to adapt their behaviour to that of cyclists. These are still considered as a bicycle lane stratona as the dominant vehicles there are bicycles.

Entry to bicycle lanes is often blocked by traffic bollards, making it difficult for a truck-type to even enter.

A bicycle-type vehicle is the preferred vehicle simply because the rules do not allow cars on there. So, there is a bottleneck for truck-type vehicles.

CargoLEV cannot use opportunity to drive through and has to reroute.

Figure 31: Spui Amsterdam

Figure 32: Oosterdok Amsterdam

Traffic bollards block entry for CargoLEVs.

No motorised vehicles can enter, an electric Fulpra is allowed, or can be taken by the hand.

Cars-as-guests road, where the cyclist is the dominant vehicle type.

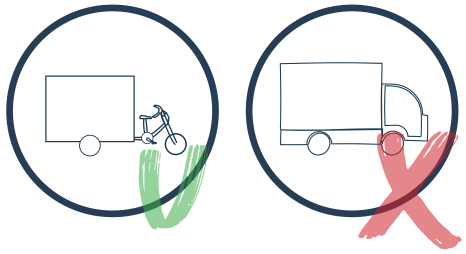
Old driveway turned into a bicycle lane

Figure 33: Vughterstraat Den Bosch

Figure 34: Sarphatistraat Amsterdam

Perfect example of municipal ambition to reduce motorised traffic from centre.

3. Pedestrian area



Explanation

Pedestrian areas often lie in the very center of the inner city and are meant for shopping and recreation. Entrances of pedestrian areas are often blocked by (dynamic) traffic bollards making sure vehicles (without exemption) do not enter the street.

A truck-type vehicle is not allowed inside pedestrian areas unless they have a waiver to enter. But for this model, it is not seen as an option. So, a pedestrian area is considered a bottleneck for truck-type vehicles.

1. It can be taken through the street by hand (walking assist), which is safer.
2. Regulations often allow cyclists to enter, either riding or by the hand.
3. They are smaller than truck-types and can move through small streets.
4. Less of a threat to pedestrians as its smaller and more 'open' as PostNL drivers experienced.

Figure 35: Beursplein Rotterdam

Driving any vehicle in a busy pedestrian area is a bad idea.

Traffic bollards often keep vehicles from entering

Figure 37 Mazelaarstraat Dordrecht

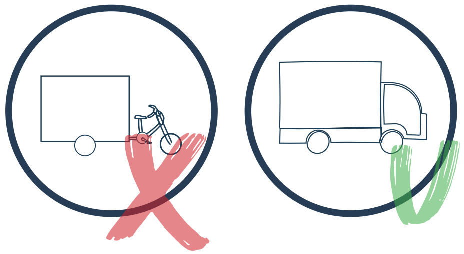
Figure 36: Nieuwstad Groningen

Pedestrian areas are sometimes combined with tram lines. A tram-domain and sidewalk is what they are made up of.

Fulpra Roll can be taken by the hand.

Figure 38 Leidseplein Amsterdam

4. Narrow isolated bicycle lane



Explanation

This stratona is characterised by a bicycle lane strip which is isolated from the driveway through either obstacles, or pavement. Accessing or crossing one lane from the other is not possible. These roads are designed to isolate fast traffic from slower traffic, creating a safer situation. The bicycle lanes in this stratona are narrow.

When is an isolated bicycle lane narrow enough to be this stratona? The bike-type LEVV is 100 centimeters wide, and the maximum allowed width of a regular bike is 75 centimeters. Traffic organisations advice leaving 25 centimeters of room for overtaking and for oncoming cyclists. If added up, if an isolated bicycle lane is less than 200 centimeters wide, it is this stratona. (Fietsersbond, unk.)

Driving a bike-type LEVV on a narrow and busy bicycle lane makes it is unsafe as cyclists cannot pass, move at different speeds and cannot oversee what is happening in front of them due to the container blocking their view.

The unsafe situations a cargo bike would cause on this road results in a bottleneck for bike-type LEVVs. Therefore, the preferred vehicle is a truck-type LEVV, which drives on the driveway and parks on parking spots or at street corners. Most of the time the speed limit on the driveway makes it unsafe to park on the side of the road.

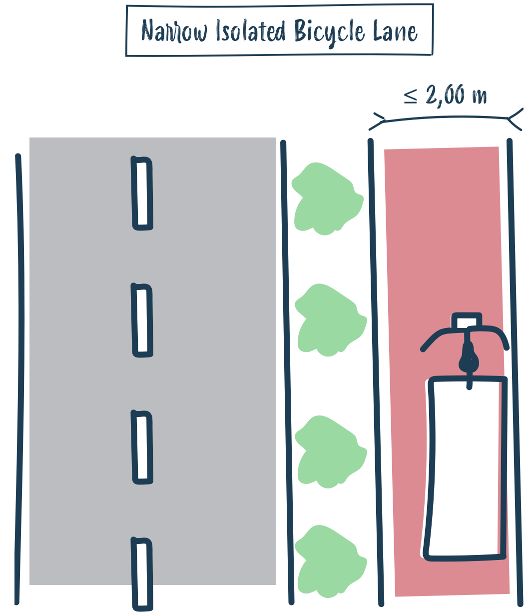


Figure 39: illustration of width NIBL stratona.

"Well this bicycle lane is quite narrow, if it were busy it would be too wide to pass or for others to pass. A truck-type would be better, but it will have to behave the same way as a traditional bus."

- Process manager Nieuwegein

Figure 40: Spuistraat Amsterdam

Figure 41: Stationsstraat Apeldoorn

The space between the isolated streets may function as parking opportunities

Biking on a narrow bicycle lane will not allow for overtaking or to be overtaken.

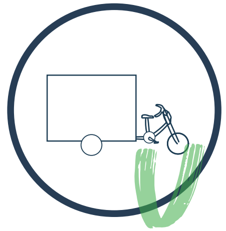
The nuisance caused on the bicycle-lane is more important than easy parking on the sidewalk

Two isolated narrow bike lanes are separated, resulting in two narrow domains.

Figure 42:Plantage middenlaan Amsterdam

Figure 43: Coolsingel Rotterdam

5. Mixed road



Explanation

The least organised stratona is this one. There is little indication on the road on where different vehicles should drive. All traffic users drive on the same domain, resulting in a highly mixed traffic situation.

About the width, this stratona often is wide enough for a LEVV to be parked on the side of the road. A mixed road can be enclosed by barriers, which makes it resemble a narrow one-way street with barriers, but if the street is wide enough (> 3 meters) than there is enough space for a LEVV to park on the side of the road, nuisance free. This stratona comes in both a one-way street as a two-way street. Regarding safety and congestion, there is not really a difference between the two vehicle-types

Both vehicles can operate here nuisance-free as the street is wide enough. There is no reason why one should be excluded from operating here.

Figure 44: Oude Ebbingestraat Groningen

Figure 45: Griftstraat Apeldoorn

All vehicles share the same domain, except pedestrians

If there is no parking opportunity and the road is wide enough, parking on the side is possible.

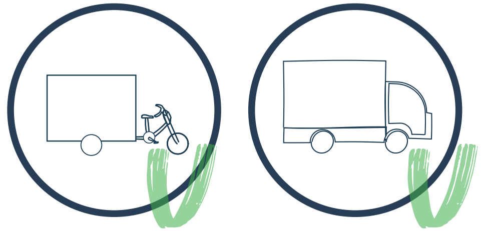
The same obstacles as a NOB, but drive domain is wide enough to park on the side without blocking the way.

Some are one-way streets, but it has parking opportunities and is wide enough to park on the side.

Figure 46: Scheltussingel Amersfoort

Figure 47: Prinsengracht Amsterdam

6. Sorted road



Explanation

This is a road where all vehicles are sorted neatly into domains without any physical isolation. This indicates a low mixing of traffic but possible unsafe situations for both vehicles as no barrier separates them. A truck-type must cross the bike lane in order to park and is reliant on a free parking spot or out of the way of cyclists. The same goes for bicycle-type trucks, they are reliant on parking spots but may be parked on the sidewalk neatly. Both a truck and a bike-type LEVV can cause nuisance in their own way as the bicycle lane is narrow and parking there will force cyclists to swerve onto the car domain.

So, it is recommended for both vehicles to behave like a traditional van and park in strategic places on street corners or parking spots. Following regulations there is not a reason to exclude a vehicle from this street, both are preferred.

"Crossing the bicycle lane with a car can cause tricky situations but standing still on a narrow bicycle lane can too. Parked cars can make it difficult to enter the sidewalk anyway, so I do not have a preference.

- Process manager Nieuwegein

Figure 48: Sint Walburgstraat Groningen

All road users are neatly organised.

The parked cars may force the LEVVs to park on street corners.

Figure 50: Karel Doormanstraat Rotterdam

Figure 49: Rokin Amsterdam

A LEVV must act the same way as a bus to not cause nuisance.

Parking on the narrow bicycle lane forces cyclists to cross the drive domain.

Figure 51: Kruisplein Rotterdam

Interim conclusion

These six stratonas are what all city centers are built up out of. These stratonas allow for analysing bigger areas within the centers to in the end decide what parcel route should be driven by what vehicle. Not all streets look exactly like the examples given but can always be matched under a stratona category based on the five factors.

Now PostNL knows what type of streets the cities are made of and they know on what street they must deploy what vehicle. If a delivery route is driven in the centre, a vehicle will come across all these different stratonas.

In theory nuisance can be minimised by having vehicles drive on stratonas where they are preferred. This way the vehicle can come as close to the front door as possible without causing nuisance. By analysing existing delivery routes on their stratona build up, an advice can be generated on what vehicle could access the most streets and cause the least nuisance in the process.

While the decision model is built on existing routes, this does not mean that in reality a LEVV will replace a van and drive the exact same route. New routes will be formed based on the theory and model which is presented in the next chapter.

4.2 The model of choice

This chapter represents the second design cycle and focuses on how the stratonas are plotted onto existing routes to find out what vehicle would fit a route best. This is the first step in analysing all city centres and the basis on what nuisance-poor LEVV routes can be built. A calculation is done to find out what the stratona build up says about what vehicle should deliver on that area. The cycle ends with a communication strategy, which shows how the output of the model is presented along the process chain.

Delivery route analysis

Current delivery routes are analysed per streets on what stratona they are. This part is done in five steps.

These five steps are used to create the first MVP (minimal viable product) for the model of vehicle choice.

1 Current delivery areas within the historical city centre are identified.

2 A list of streets from within that delivery area is acquired through the process manager from the depot delivering that region.

3 With Google Street view every street within that route is analysed on what stratona it is.

4 The stratonas are visualised onto a map of the area.

5 A calculation is done and an advice is given.

Step 1: Model delivery areas

Two randomly chosen routes within Arnhem and Utrecht were analysed. These cities were chosen as PostNL is planning on piloting LEVV delivery in one of these cities.

Figures 52 and 53 show the two existing routes inside the centres of all cities. These routes were picked randomly. These screenshots were taken from a PostNL program called Routemaker, which is used to visualize a collection of zip-codes from that delivery route into a coloured-in area. Every delivery route is covered by a single bus.

Step 2: Stop list

Two randomly chosen routes within Arnhem and Utrecht were analysed. These cities were chosen as PostNL is planning on piloting LEVV delivery in one of these cities.

These routes were picked randomly. These screenshots were taken from a PostNL program called Routemaker, which is used to visualize a collection of zip-codes from that delivery route into a coloured-in area. Every delivery route is covered by a single bus.

Step 3: Google Street View

Automatic identification of stratonas does not exist yet, making it impossible to digitally identify what street is what stratona. So, this must be done by hand. Google Street view is used to manually go through the city and determine the stratona. These are then visualised by tracing the street on a map and assigning different colors to different stratonas, image 54 and 55. Not only the type of stratona is determined but also traffic rules like one-way and two-way streets and their direction, by creating arrows (one-way).

All streets and their stratonas were numbered for both routes, figures 56 and 57, and listed into an excel sheet. This sheet will help create an overview of the analysis and serve as a database for extra information.

Sometimes one street can exist of two different stratonas. These will then be judged as two separate streets.

What Google Street view shows might not be true for the situation present day. Some streets had pictures taken in 2014, these were checked by looking for information on renovations online.

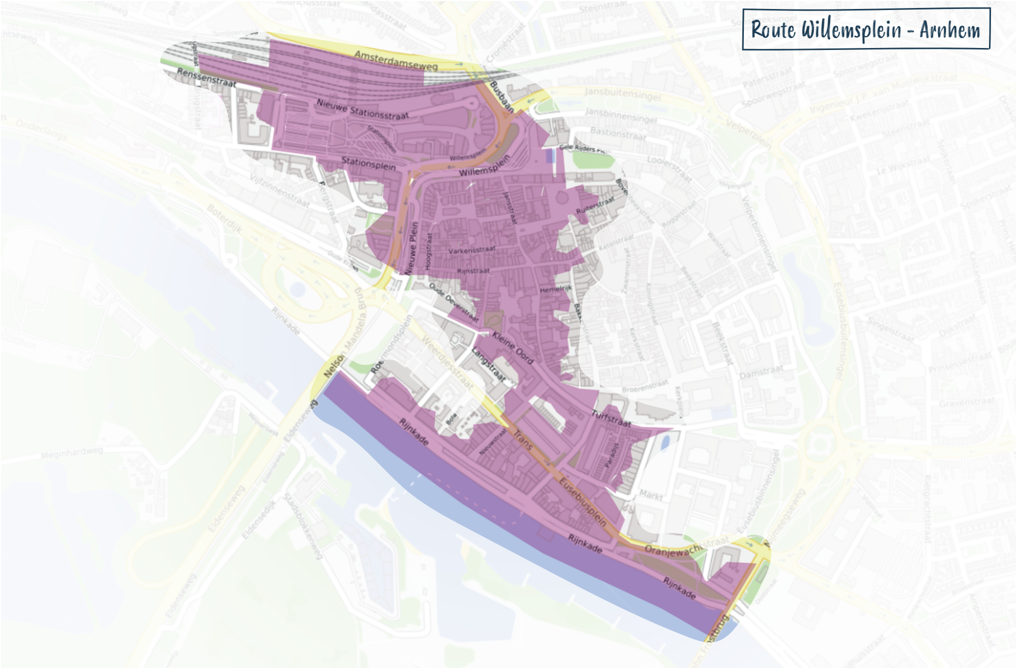


Figure 52: route Willemsplein in Arnhem.

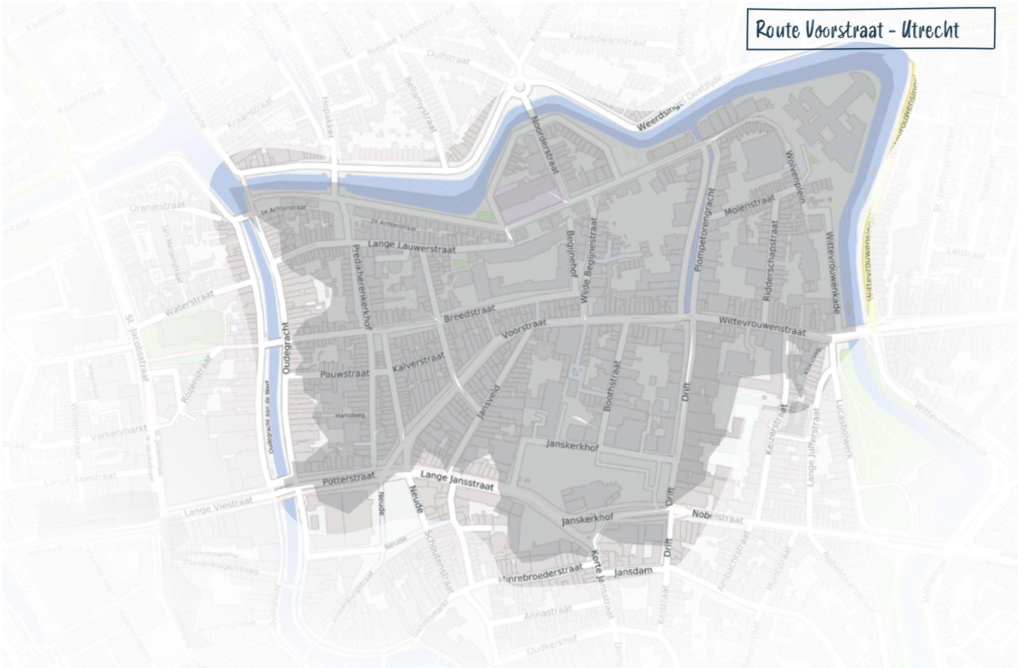


Figure 53: route Voorstraat in Utrecht.

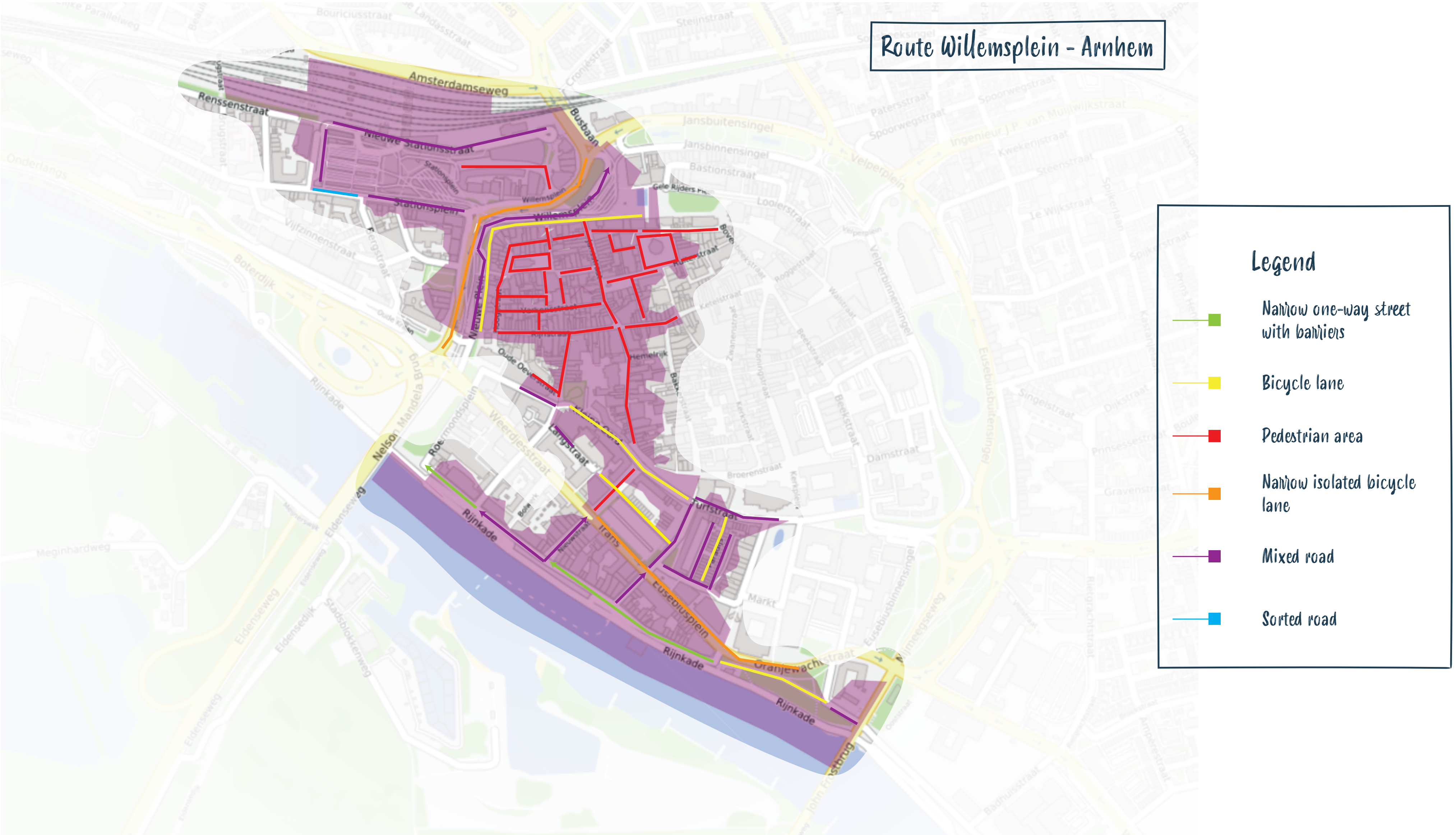


Figure 54: analysed route Willemsplein with stratona legend.

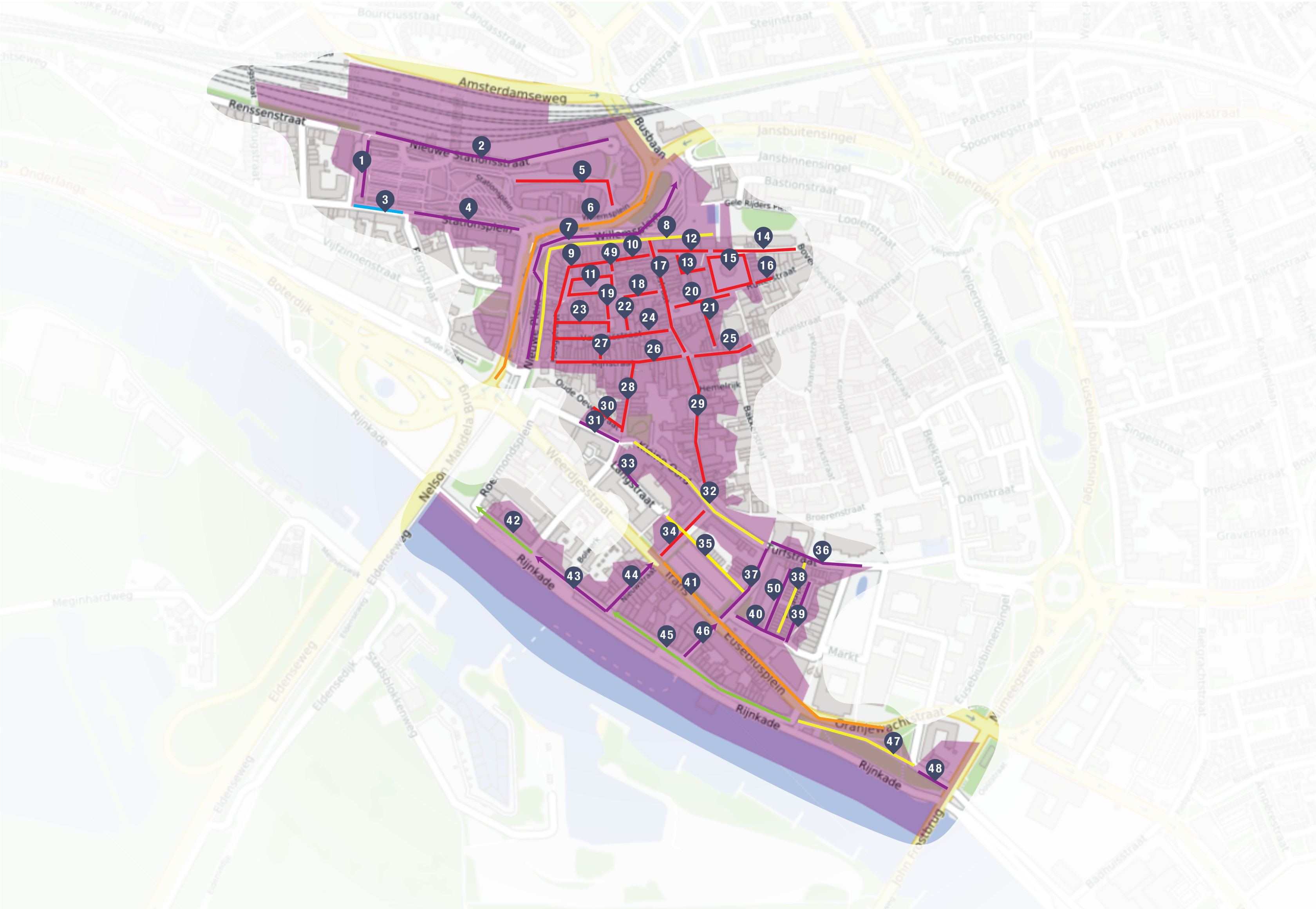


Figure 55: analysed route Willemsplein with streets numbered.

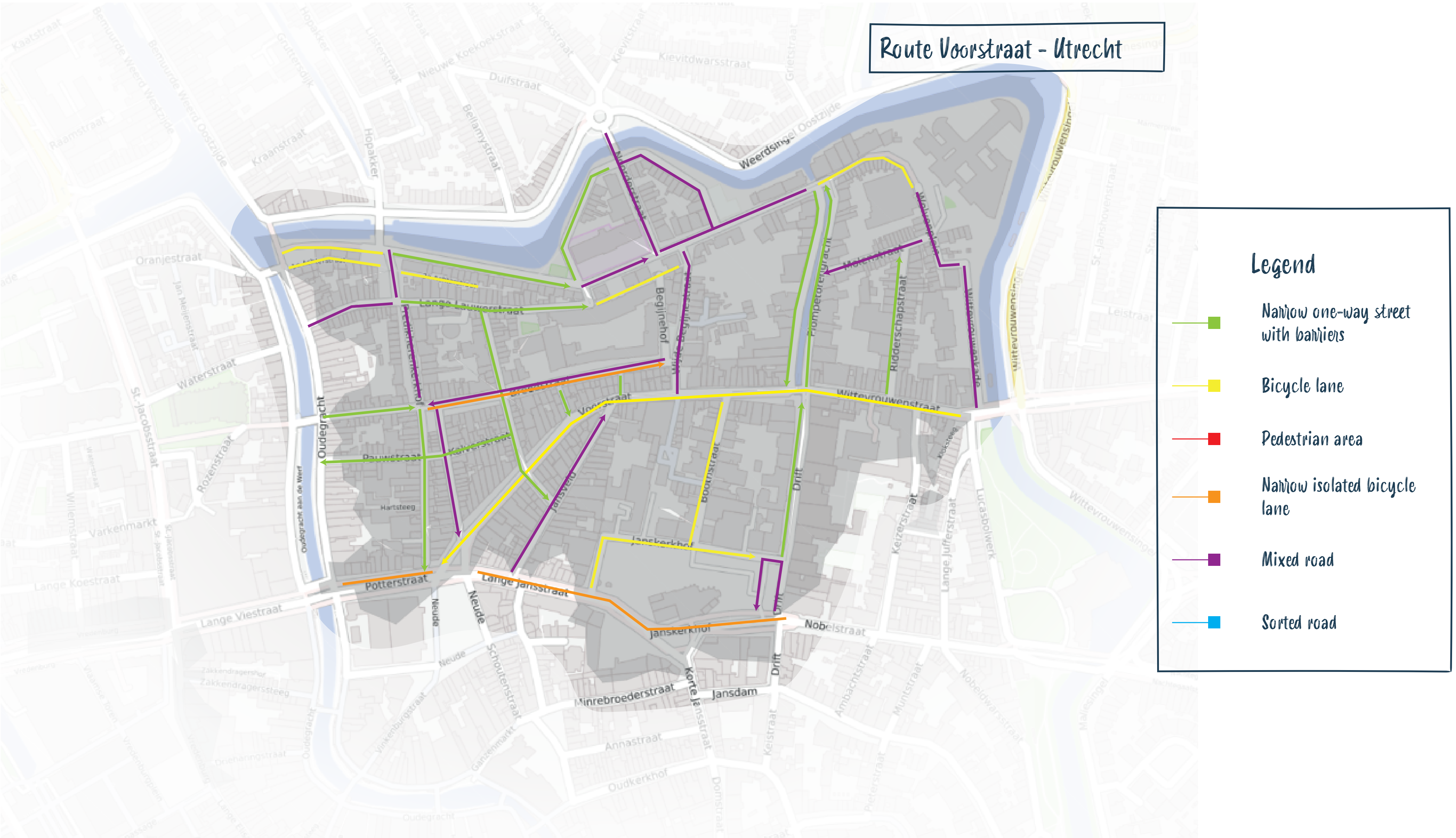


Figure 56: analysed route Voorstraat without streets numbered.

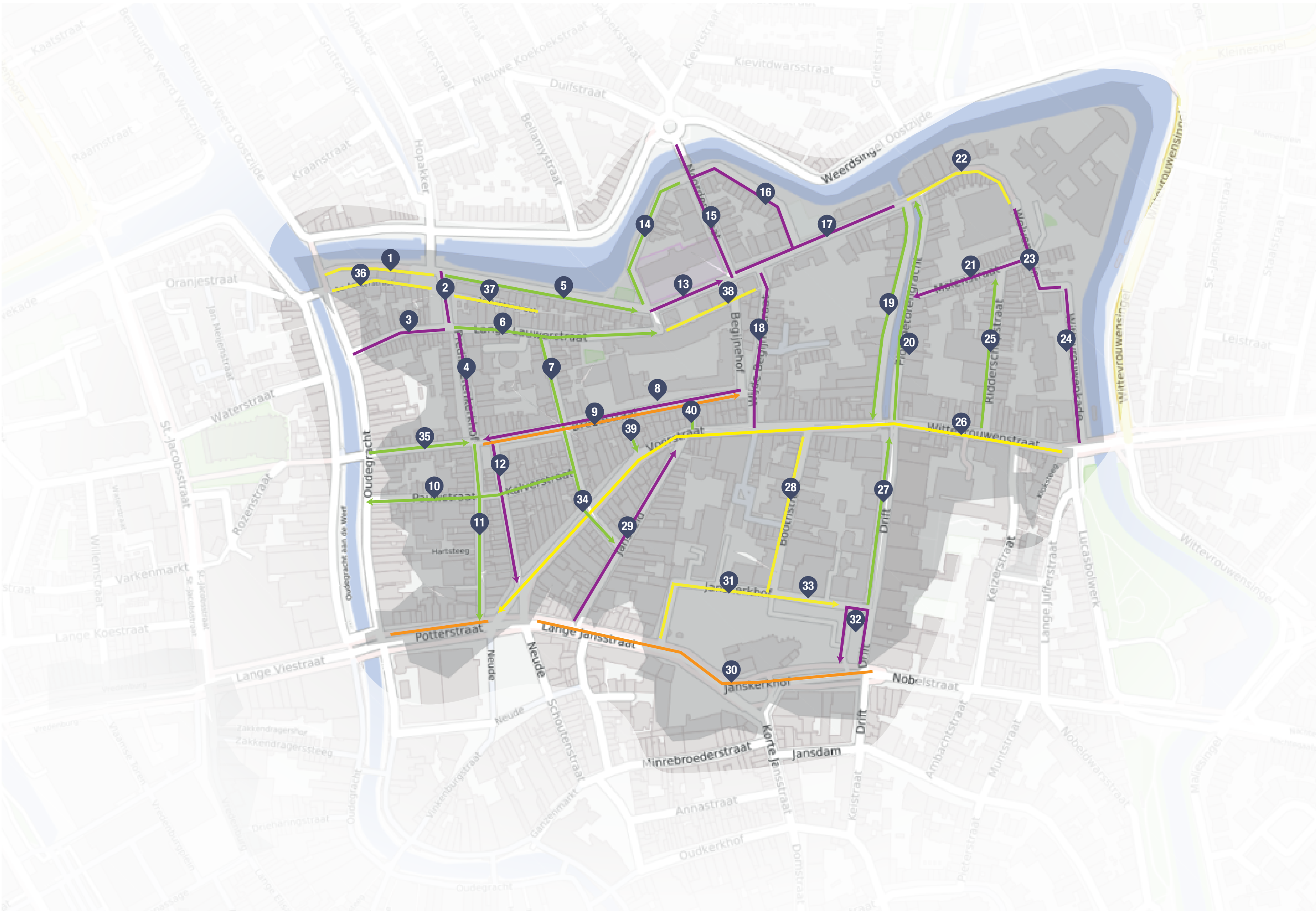


Figure 57: analysed route Voorstraat with streets numbered.

Step 4: Calculation and advice

After all streets were analysed on statonas and numbered they were put into a spreadsheet (table 1).

The streets were judged on the stratonas and coded with letters A to E, table 2. Every stratona has one or more preferred vehicles which were coded either A (bike-type), B (truck-type) or AB (no preference). No stratona was given the code D, as during the validation session this stratona was merged with another.

With this knowledge two things can be said:

1. The stratona distribution within this area.
2. What vehicle fits this area best and would cause the least nuisance.

This can simply be done by counting what percentage of all streets is attributed to a bicycle-type LEVV and what to a truck-type. The stratonas without a preference attributed to the score of both vehicles equally.

For the area Willemsplein the distribution is:

79% for the bike-type LEVV and 21% for the truck-type LEVV.

For the area Voorstraat in Utrecht the distribution is:

76% for the bike-type LEVV and 24% for the truck-type LEVV.

In both areas it is clear the bike-type LEVV would be able to cause the least nuisance and have the most routing options. The advice here would be to deploy a bike-type LEVV on that route.

The excel-sheet is presented in appendix B3.

Table 1: Basis of excel-sheet for calculation.

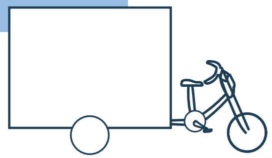
Street name	Street number	Stratona	Preference
Stationsplein-West	1	B	A
Nieuwe Stationsstraat	2	F	AB
Utrechtsestraat	3	G	AB
Stationsplein	4	F	AB
Oude Stationsstraat	5	C	A
Nieuwe plein	6	E	B
Willemsplein	7	F	AB
Gele Rijders plein	8	B	A

Table 2: stratona with their code and preferred vehicle-type(s)

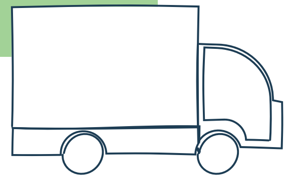
Stratona	Code	Preference
NOB	A	A
BL	B	A
PA	C	A
NIBL	E	B
MR	F	AB
SR	G	AB

Route Willemsplein - Arnhem

79%

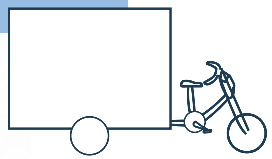


21%

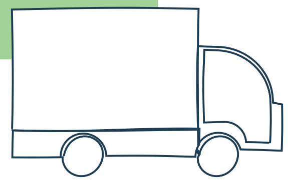


Route Voorstraat - Utrecht

81%



18%



4.3 The weighing factors

This chapter shows how weighing factors are determined and how these are scaled.

Weighing factors

By calculating the advice for what vehicle to deploy like this all streets in the equation are deemed as equally important, which is unrealistic knowing that for instance the street lengths differ, and the time spent in one street may be longer than in another. It must be explored what streets along the area are more important to the driver. Weighing factors need to be added to the calculation to go from a more quantitative calculation (how many streets) to a more qualitative calculation (what street should weigh more in the consideration?).

An important street will receive a higher total score and drive up the argument for one vehicle type. For example, a street is more important when there are many parcels to be delivered there.

Stratona

Within three stratonas (bicycle lane, pedestrian area and narrow isolated bicycle lane) there is a bottleneck for a certain type of LEVV. Either a vehicle cannot operate somewhere as the traffic regime will not allow it or it would cause nuisance in a certain way. Driving on this stratona with that vehicle could cause problems for the driver as he/she must break rules, reroute or walk a distance to the front door. This street, if present within the area, should weigh heavier in the equation to the benefit of the preferred vehicle-type there. This means that the three stratonas BL, PA and NIBL all weigh heavier in the equation.

Drop density

When dividing the street length by the average number of stops, the drop density is calculated. Drop density being the distance between two consecutive stops. The smaller the drop density, the more parcels per meter must be delivered.

Traffic intensity

The more traffic on the road, the bigger the chance of a PostNL encountering other traffic users and blocking their way (or be blocked). If a street typically has no traffic passing through, the chance of causing nuisance is small compared to a busy street. Tools like Google traffic show the typical traffic intensity of cars on all streets. The model requires data about traffic of all sorts, motorised and not motorised, covering all stratonas.

The more intense the traffic in a street is, the more important it is that the vehicle causing the least nuisance is driven there.

Street direction

An important difference between the two types of vehicles is that a bike-type LEVV may enter streets in both directions, where truck-types are not allowed. This is a big benefit to bike-types as there are more route planning options for them.

If a non-preferred vehicle is bound to a one-way rule, and the preferred one is not, then this road should weigh heavier to the benefit of the vehicle that can enter both ways. To make it simpler an example is given:

The street in question is the stratona 'narrow one-way street with barriers', where a bicycle-type is preferred. The bicycle may enter the street both ways, whereas the truck-type may not. This means that, besides driving nuisance-poor, driving a bicycle-type vehicle has more options to drive the quickest route.

The stratona where there is no preference for a vehicle too receives the extra weight, but this is distributed equally over both vehicles, so it will not matter in the end.

Calculation

Street	Direction	Stratona	Dropdensity	Traffic intensity	Weighed score
Stationsplein	1	0	4,5	1,5	7
Oude Stationsstraat	1	2	3,5	1	7,5
Nieuwe plein	1	2	4	1	8

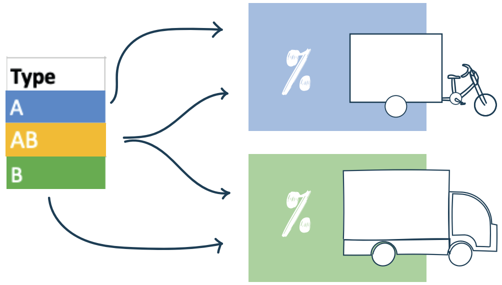


Figure 59: calculation method.

Scaling

The more traffic on the road, the bigger the chance of a PostNL encountering other traffic users and blocking their way (or be blocked). If a street typically has no traffic passing through, the chance of causing nuisance is small compared to a busy street. Tools like Google traffic show the typical traffic intensity of cars on all streets. The model requires data about traffic of all sorts, motorised and not motorised, covering all stratonas.

The more intense the traffic in a street is, the more important it is that the vehicle causing the least nuisance is driven there.

So, how do you decide on what weighing factor should weigh the most in the consideration? How do all factors add up to a final score and advice?

Factors 'stratona' and 'street direction' are static, which means their impact on nuisance potential is absolute, while traffic intensity and drop density are dynamic and can fluctuate.

Example: if a street is very busy and a lot of stops need to be delivered there, it is very important that the preferred vehicle drives there as it would cause the least nuisance. If a street is not very busy and only a single parcel must be delivered there, the chance of any vehicle causing nuisance is small.

Because of this, it is important to make a clear distinction between streets within the area based on traffic intensity and stratona value, resulting in scaled scoring.

The initial weighing factors taken into the equation are presented in figure 58. Figure 59 shows how the distribution is calculated. By simple addition. This way of calulation is used as multiplying would result in a score of zero if one street would score zero on one of the weighing factors.

Within Willemsplein the street Rijnkade 4 is both estimated and experienced as the most important street as it has a high drop density. It is a bicycle lane, where only a bike-type should drive, making it contribute heavily to the advantage of the bike-type.

The munterstraat is the least important as there are hardly no parcels to deliver there. It is a no-preference stratona but mostly used to pass through. For these reasons PostNL does not want this route to weigh the same as the Rijnkade.

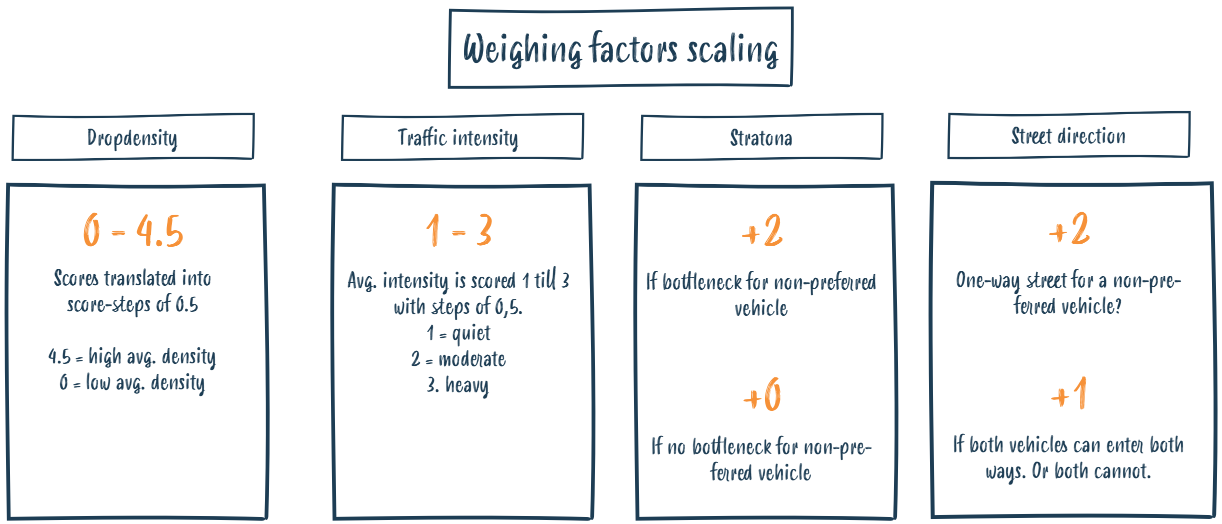


Figure 58: weighing factors and their scaling.

Final advice

With the weighing factors and their scaling complete and validated an advice can be given on what vehicle suits that delivery route best. For both areas nuisance would be reduced the most when driving a bike-type vehicle.

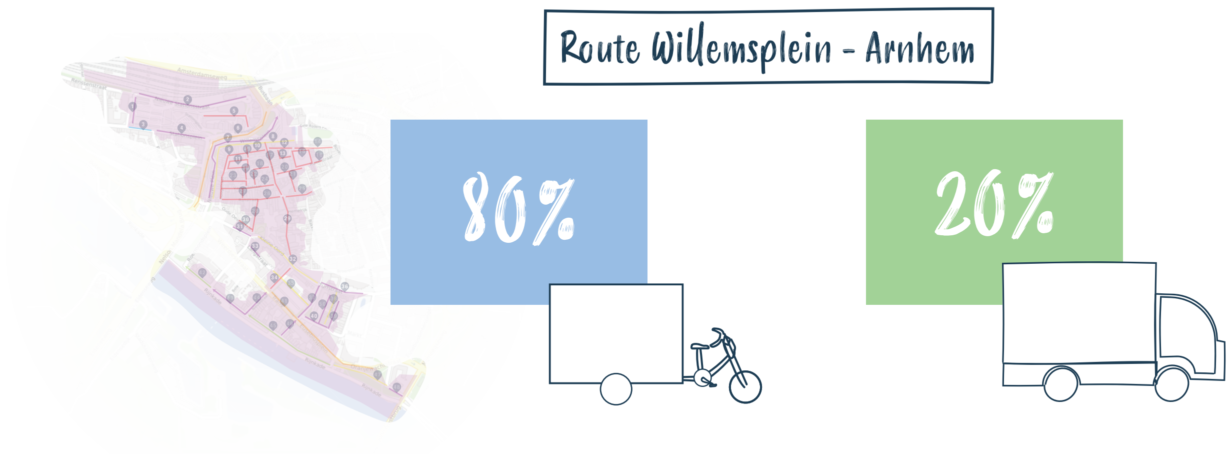
For Willemsplein Arnhem the percentage distribution shows a

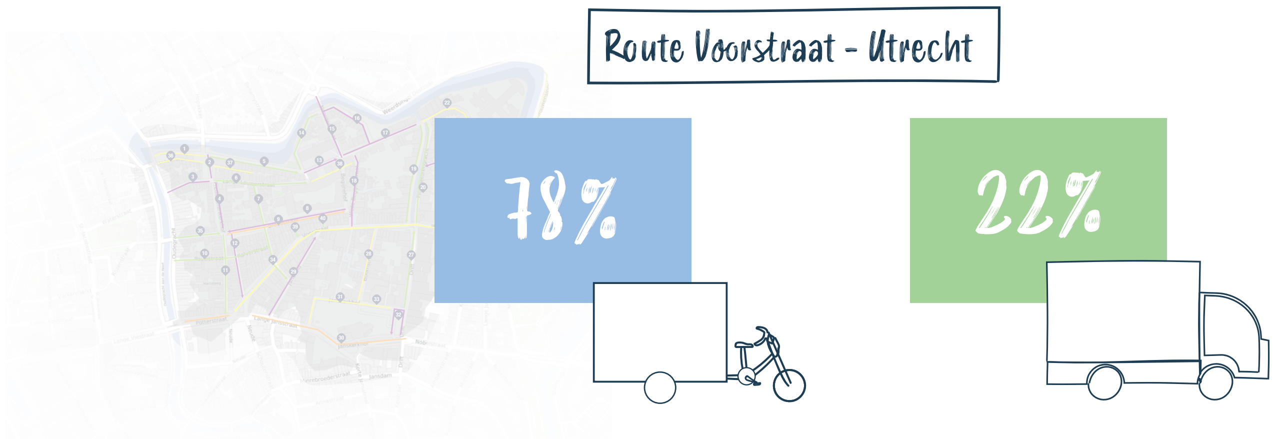
80% fit with a bicycle-type LEVV and a 20% fit with the truck-type LEVV.

This can be attributed to the big pedestrian area and one the most important roads being either a bicycle stratona or a stratona without a preference.

For Voorstraat Utrecht the the percentage distribution shows a.

78% fit with a bicycle-type LEVV and 22% fit with a truck-type LEVV.





Conclusion

This design cycle showed how existing delivery areas can be analysed and streets within an area can be translated into stratonas. This analysis shows an overview of a route and what vehicle would perform best on reducing nuisance while still using all streets to their potential. By adding weighing factors, streets which are deemed more important weigh more in the calculation of scores, strengthening the argument for the preferred vehicle in the entire area.

What this means for PostNL is that they can now safely calculate and substantiate their choice for a vehicle per area.

Interim discussion

Stratona

The stratona of a street was analysed through Google Street view, width of the street cannot be estimated through a screen, resulting in some streets being considered a bike-type street which might be a truck-type street. It is expected that if digitally the streets can be analysed on stratonas, the final distribution would differ from the one presented here.

Streets could also be redesigned without being updated in Google street view; this information must be up to date.

Weighing factors

As COVID-19 drives up volume numbers for PostNL, the average volumes per street data used for calculating drop density are not realistic for the future.

Calculation

One might think, why does the advice stay the same and why is it for both areas extremely to the advantage of the bike-type LEVV?

One reason is the ambitions of municipalities to create a bike-friendly centre, which is acted upon by remodeling streets. In the area Voorstraat, the most important street was recently converted from a narrow isolated bicycle track into a wide bicycle lane.

The other reason is that the area Willemsplein to a large extent is a pedestrian area.

In this calculation the vehicles are set against each other, creating a notion that a vehicle is very unsuitable for that area. Looking at the build-up, many streets do not prefer a vehicle-type. When analysing entire centres and building new routes for the LEVVs, it is better to know what percentage of that area can be covered by a LEVV. What would happen is that the analysis would show what percentage of that area can be driven by a LEVV, keeping options open and giving more freedom to the route planner.

Figure 60 shows what the distribution would look like if this way of calculation was applied on Willemsplein.

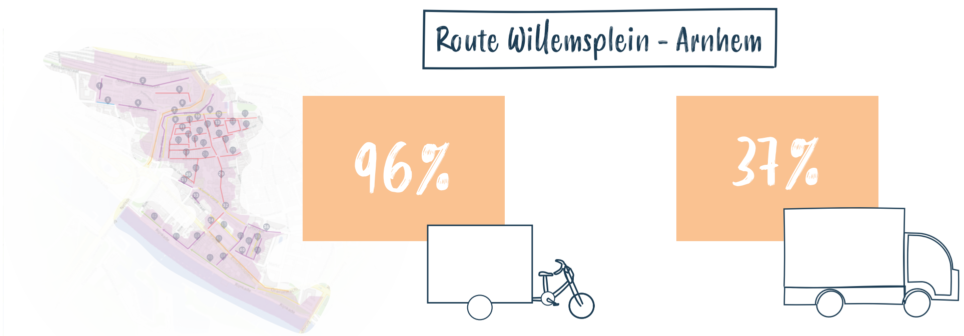


Figure 60: outcome analysis with alternative calculation.

4.4 The communication strategy

The system must be built and all the people along the chain will have their responsibilities to make the process work. But how should the output of the system be communicated along the chain of the process? This chapter shows how verbally and visually the output of the system is translated into information which process managers can use to run the LEVV operation.

Communication strategy

Three validation interviews were held with four process managers from different PostNL depots. The goal of the interview was to find out how the advice resulting from the street analysis could be communicated to them and people planning the routes.

The questioned that needed answering were:

1. In what shape should the result of the city centre analysis be presented to you?
2. What details are necessary for a planner to work with it?
3. How do you increase the chance of acceptance within the process staff?

Validation analysis and advice

The analysis of the existing routes in Utrecht and Arnhem were presented to the process managers and they were asked to judge, based on their knowledge about the area, if the advice and conclusion from the analysis are true. When asked why they though the distribution leaned to the advantage of a bike-type LEVV, they mentioned the trend of municipalities rearranging the street layout to cater to cyclists more. Moreover, they understand the benefits that bike-type vehicles can have, so the fact that the ratio favored the bike-type strongly was to their liking.

Communication plan

This strategy focuses on how the communication flow runs along the chain of implementation. The communication chain can be split up into phases.

The steps are presented below and a communication flowchart is presented in figure 70.

1. Analysis – Route generation
2. Synthesis – Optimise routes and manage process
3. Action - Deliver parcels
4. Feedback - Give feedback on experience

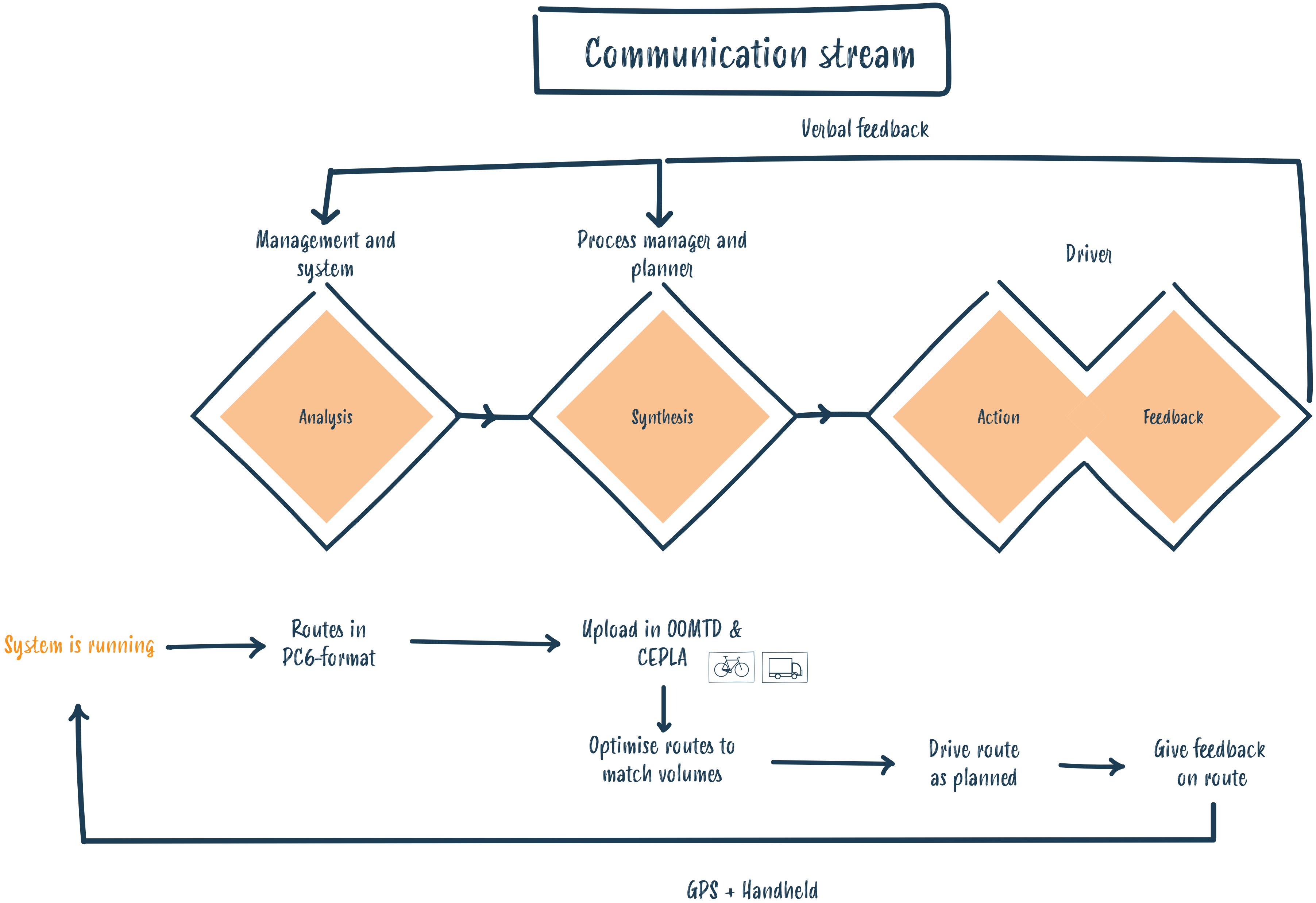


Figure 70: Flowchart of communication stream along the process chain.

Analysis

The programmer uses theory and data from internal and external sources to create a visual map based on the model of choice and creates nuisance-poor routes for LEVV vehicles.

These routes are expressed in a post-code (zip code of postal code?) list. These lists are then communicated to the process manager in the shape of an excel sheet. Some explanation will have to be done, so when offering the advice, they will go through it together and find out if the routes are indeed valid and realistic.

When asked how many times a process manager would like to receive new advice in the form of routes, they answered that standardising the process is key to an efficient process. This means that the process today should be the same as every following day. Only if routes are found to be inefficient or something inside the route demands a different vehicle-type, new routes should be communicated.

So only when something in the street context has changed or a discrepancy between the route and the real situation makes for a bad route, new routes will be generated and implemented.

Synthesis

The process manager receives the post-code files and a visualization from the routes plotted on a map for reference. The post-code files are uploaded into a program called OOMTD/CEPLA, which works as a database with information on volumes and other relevant information. These programs allow for post-codes (zip codes of postal codes?) to be transferred from one route to another one to match volumes and spread the workload evenly between drivers.

An indication of what vehicle matches what route can be made clear by a simple icon in CEPLA and OOMTD. Process managers do not need this indication, but it could be useful for others or new planners.

Action

The most important part of the success of LEVV delivery is the route that a driver should follow. The system is designed so the parcels are sorted into the right section of a specific rolling container. The person sorting the parcels is not the one that delivers them, which means a clear and easy communication method is needed for a driver to find the parcels inside the vehicle. This is done by creating a route and providing a list to the driver, every stop telling him in what section to find the parcel.

A strong advice from the process managers is to give as little flexibility in driving the route as possible. If a driver would follow the directions the system would give him, this would mean the performance on nuisance reduction would be optimised.

Feedback

A struggle that process managers deal with is the discrepancies between theory and practice. They say that a computer can calculate things very well, but it never fully matches reality. Therefore, they plea for a feedback system which can enrich and improve the systems' match to the real situation.

The process managers do recognise that in the pilot phase, the automation of feedback is not crucial, so through interviews, surveys or just conversations process managers should be able to receive feedback from their drivers about the route.

Small problems can be solved by changing the route by the planners themselves, but feedback should also be shared with the programmer of the analysis system.

When the pilot is successful and the LEVVs spread to other cities, there is room for automating feedback. GPS-feedback from the vehicles can teach the system a lot about the drivers' behaviour and how routes can be adjusted to their behaviour. By creating software built into the handheld computers (which drivers use to follow the route and collect signatures), simple questions about the route negative externalities (road work, new traffic rules, obstacles) can be indicated which helps to enrich the system and plan better routes.

Daily route changes can be made resulting from this feedback, so a connection to the system is needed and to the daily planners.

4.5 The roadmap

A strategy in the shape of a tactical roadmap shows PostNL what data to acquire and what steps need to be taken in order to develop an adaptive and proactive route planning system

Analysis

In the book Design Roadmapping (Simonse, 2017), a roadmap is defined as a visual portray of design innovation elements plotted on a timeline. Elements such as user values, new products and services but also market segments, technology applications and touchpoints. This roadmap will use the format and parts of the standard tactical roadmap but will focus on what is happening along the process of implementing LEVVs and how the model is digitised and automated for it to be fully functional and usable for planners. In the validation interviews together with the process managers this route was set out.

At the end of the horizon an adaptive system and successful implementation of LEVVs is expected. The steps to be taken to reach that goal are spread out over three horizons. (2021, 2022-2024 and 2025). This roadmap shows

1. How the roll-out of the LEVV-process progresses.
    a. What steps must be taken by the PostNL teams along the chain.
2. How the system is enriched and what resources are needed.
3. Who the partners are to deliver the resources.

'The system'

What exactly is meant when talking about 'the system'?

The system is a program which visualises all information about the city into a visual map for analysis and generation of routes. The system shows static and dynamic data which help create nuisance- poor and efficient routes for LEVVs.

Reading manual

To best understand the roadmap it is advised to start at the top from the horizon and work down until the bottom is reached. Afterwards start with the second horizon and so on.

The different coloured rectangles and arrows, figure 71, represent a different activity and stream.

In appendix B4 shows a more elaborate explanation on what is happening in every horizon. This part shows some overlap with the communication strategy.

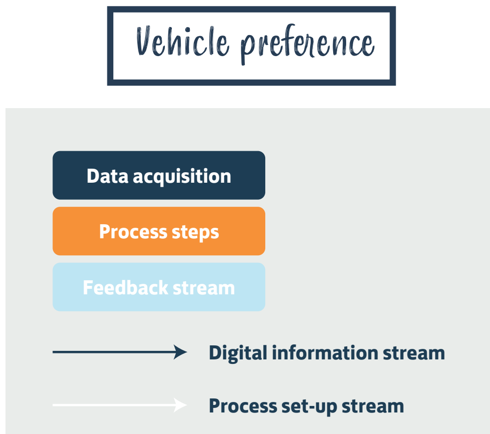
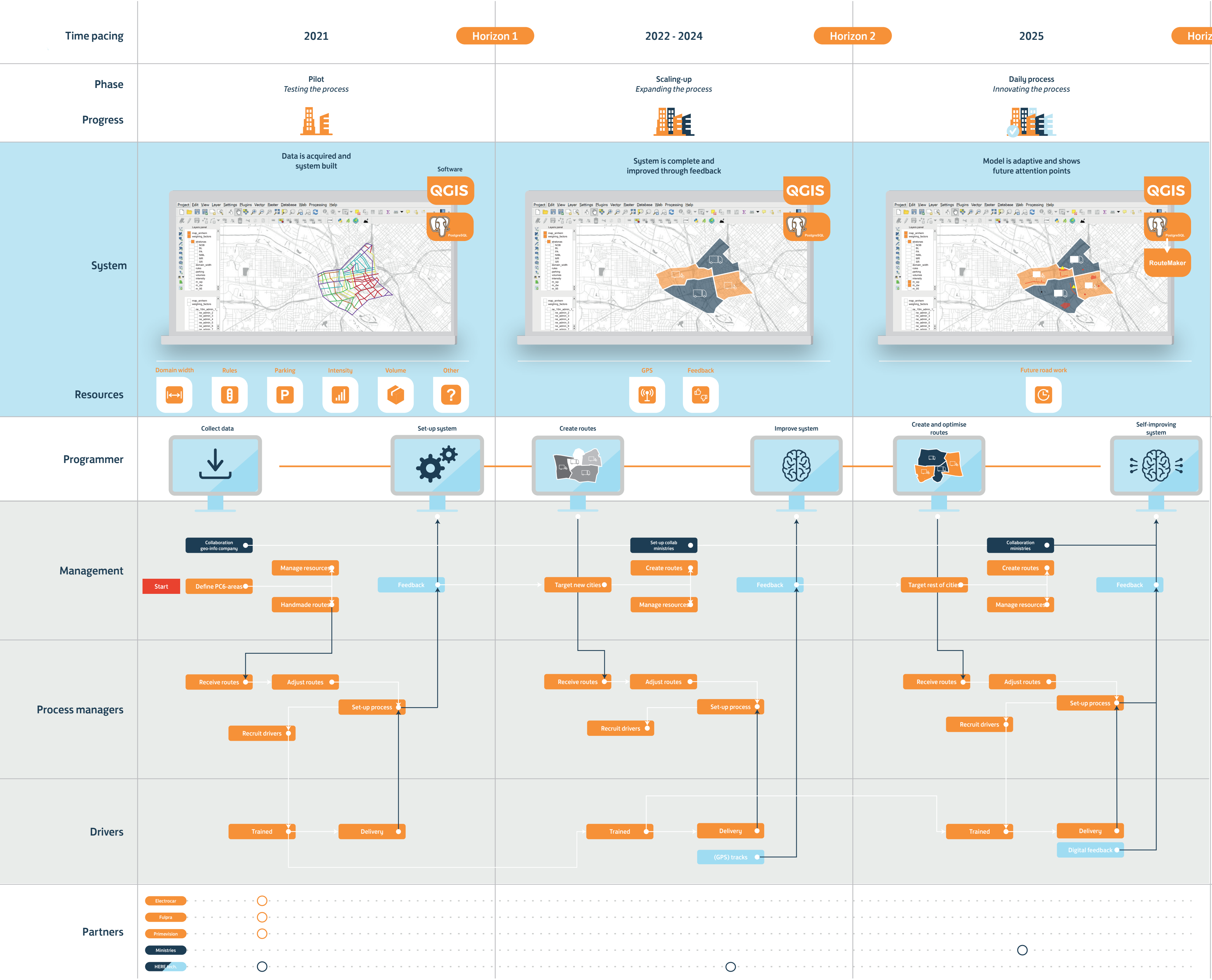
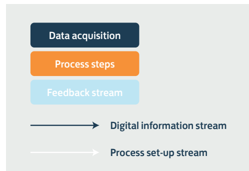


Figure71: Roadmap legend



In 2030 PostNL's LEVV planning model is adaptive and predictive. PostNL works together with ministries to shape the city to optimise nuisance free delivery.

Multimodal planning is not restricted to the city center anymore.



Horizon I

The analysis of the pilot-cities can be done by hand in the same way the routes Willemsplein and Voorstraat were done. During this pilot phase, the system is built internally at PostNL and necessary data is acquired to analyse the streets on stratonas. This static data for example, street width and length and traffic rules can be acquired freely or through a geo-information company. Dynamic data, like parcel volumes per street, is data known to PostNL. Traffic data can be acquired through a geo-information company like HERE.

Free software QGIS is used to build the map resembling the one presented in paragraph 4.2. Feedback from the drivers and process managers is used to optimise the process and apply in other cities.

QGIS is supported by a program PostgreSQL, a relational database where the data can be stored and used for storing data and calculating the advice. The vehicle companies are the ones that will give basic training on how to use the vehicles so new drivers can be safe and confident on the new LEVVs.

Horizon II

This phase counts as the 'scaling-up' phase and takes two years as it is working up to a situation where LEVVs are implemented in all twenty- five cities. LEVVs will be implemented in different cities incrementally, as the process must be set up for every city and resources must be acquired. The system created nuisance poor and efficient routes.

Where the quality of the routes was only commented on by verbal feedback, now also through digital feedback. By installing 'driving coaches' in the vehicles GPS-tracks can be analysed to judge performance on nuisance reduction and efficient driving. This feedback can be used to learn about the relationship between routes and the way they are driven.

New drivers are trained by experienced LEVV drivers from other cities. These know the ins and outs of using a LEVV along the delivery route.

Horizon III

The year is 2025 and all twenty-five cities are taken over by LEVV vehicles. The process works and LEVV delivery has been normalised. The system has constantly improved and is now on the verge of becoming adaptive, which means that it will improve itself through receiving digital feedback from drivers and the driving coach.

Where feedback was given verbally before, now drivers receive basic questions about their route on their hand-held devices. Along and after the route simple yes/no questions about the physical route driven are answered to help the system remove discrepancies between the digital map and the real context and create better routes.

The system is linked to the ministries' database[1] which shows upcoming street remodeling which may cause a need for route optimisation. This information could have an impact which requires completely new routes or small adjustments to the daily route. For this it is important that a program accessible to the process managers and planners also shows this information.

Future vision

The roadmap works towards a future vision where the system is adaptive and predictive as it connects information sources to pro-actively make changes in routing plans. The system learns about driver behaviour in relation to the streets and creates efficient routes which optimally reduce nuisance.

[1]In a session about creating a tool to measure congestion, the deputy of the Dutch Ministry of Infrastructure showed interest in connecting databases so PostNL can see what planned road work will impact the route of LEVV drivers.

5. Discussion

In this final chapter the conclusion of the entire process is presented and how the solution contributes to the aspects of feasibility, viability and desirability. How did this project contribute to scientific research and what has limited this project? Advice is given on what further research can be done to substantiate the success of using LEVVs. Lastly, a personal reflection on the project is given.

5.1 The conclusion

So what was done and what is the end result?

Conclusion

The assignment PostNL posed was to help them come up with a model which helps them decide what LEVV vehicle should be deployed in order to reduce nuisance. The seemingly simple question that needed answering was the following one:

"What information is necessary to decide on what LEVV should be deployed on a street?"

A quite broad question where multiple little questions helped find the answers.

"What is nuisance and who experiences it?"

The target group for nuisance reduction is different from the target group the design must accustom to. The model is designed to benefit the problem owners while supporting the problem solvers in reducing nuisance. It has done so, as the needs of the problem owners were taken as basis for the design. Every decision made was based on the question if it would reduce congestion or create a safe space.

The problem enthusiasts can benefit from a reduction of nuisance and turned out to be useful for turning the model into a system.

Interviews and desk research showed the focus there is from within municipalities to reduce it and increase liveability. Liveability is something valued differently per area and can be objective or subjective. Because PostNL wants to improve liveability in the entire city centre, the focus must be put on nuisance which is recognizable and experienced as such in every area, in all twenty-five cities.

Because the LEVV-benefits sustainability, noise reduction and smell reduction are evident, the focus factors for the model were set on: congestion and safety. All LEVVs are sustainable, noise and smell reducing, but congestion and safety depend on how the vehicle behaves in traffic. This is where a distinction between two vehicles was made.

"What vehicles would be suitable for the process and nuisance reduction?"

Firstly, it had to be proven that LEVV delivery indeed were feasible and viable. This project confirmed that the LEVVs reduce congestion while being as, or even more efficient than a traditional bus. Because designed process asked for specific qualities in vehicles, only a couple of vehicles were deemed fit. The final vehicle had to fit the requirements, while still being comfortable and safe for the drivers. Attention must be paid to comfort because drivers indicated that this will affect their willingness to adopt LEVVs. The Fulpra roll (bike-type) and CargoLEV (truck-type) were chosen as archetype vehicles as they have best volume/size ratio and are containerised.

Both a bike-type and truck-type are used because PostNL believes in a varied fleet and pleads for a bike-type and truck-type LEVV. They drive on different domain-types which means that makes sure that all types of streets can be accessed and nuisance can be reduced by matching the vehicle to the street.

"What is the context the LEVVs must operate in?"

Street archetypes were made that can be found in all twenty-five cities. PostNL wants to know on what type of street they should deploy what vehicle. Six so-called stratonas were created based on factors traffic rules, traffic mixing, domain width, parking potential and traffic intensity. Because every city centre is made up out of just these 6 archetypes, a judgement can be made on what vehicle would cause the least nuisance in every street, in every city.

The six final stratonas are called:

1. Narrow one-way street with barriers
2. Bicycle lane
3. Pedestrian area
4. Narrow isolated bicycle lane
5. Mixed road
6. Sorted road

Together with the PostNL team and process managers at the depots, these were tested on saturation, and judgement on vehicle preference was validated with both. By running them by different people along the chain, small adjustments were made to make sure all stratonas were complete.

The theoretical groundwork being:

The model of choice is based on the notion that if as many streets as possible are driven and delivered by the preferred vehicle, nuisance would be reduced to a maximum and liveability will improve.

A delivery route consists of multiple stratonas which have different preferences. To decide what vehicle would fit that route best in optimally reducing nuisance while still being efficient a calculation was done

Because not all streets are accessed as frequently and extensively as others some streets should weigh heavier in the consideration. A street where vehicle-choice has the biggest impact on nuisance, should weigh more in the vehicle consideration.

These important streets (and their preferred vehicles) are favored in the calculation by applying weighing factors because they help in creating efficient routes (if a preferred vehicle can drive on its stratona, it can reach the front door more easily, reducing walking time).
Bottleneck stratonas for either vehicle should weigh beneficial to the preferred vehicle to make sure that vehicle drives up the argument for that vehicle. All weighing factors are:

1. Drop density (avg. parcels/m)
2. Street direction (one-way or two-way)
3. Stratona (bottleneck or not?)
4. Traffic intensity (avg. movements per day)

Testing the route with LEVVs gave an impression on important streets within the analysed routes. This helped finding a realistic hierarchy and calibrating the streets accordingly.

Because a choice must be made per route and not per street the advice was given on a vehicle through a percentage distribution. This was calculated by summing up the vehicle arguments for every street present and multiplying them by the weighing factors.

The two routes analysed in Arnhem and Utrecht both showed a strong advice to deploy a bike-type LEVV. This can be explained by the trends of car-free centres and big pedestrian areas.

This analysis strategy forms the basis of a practical strategy to build a system which can generate new routes according to the model.

"How to turn the model into a system which helps create new routes?"

All data on stratonas and weighing factors must be acquired and combined in a system which creates a visual map generate efficient and minimal-nuisance routes for all cities within scope. This data can be acquired through open-source information and geo-information companies like HERE technologies. Internally PostNL has people to build the system.

"How is the model communicated"

The system must create routes which can be altered by process managers to distribute volumes. Because repetition and structure make for an efficient process, only new routes must be created and communicated when necessary. They are necessary when vehicles cannot operate somewhere due to external factors or volumes that cannot be handled anymore.

Feedback is given to everyone along the chain to optimize the process. This feedback is automated and digitised as more cities have deployed LEVVs.

"How can the system evolve to reach its full potential and what does it need?"

The roadmap shows how the model must be developed to in the end become a system which adapts to changing contexts and learns about driver behaviour to optimise routes. Because municipalities are working on reducing traffic in the centres by regulating or remodeling, the system must be able to adapt to these ‘obstacles’ by optimising routes.

The further time advances the more automised the feedback to the system is. The roadmap ends at a point where the system shows information on planned road work, helping PostNL and process managers to pro-actively create new routes.

5.2 Feasibility, Viability & Desireability

The criteria are repeated and reflected on to discuss the extent to which the model is feasible, viable and desireable.

Feasibility

- The model applies to **all truck-type and bicycle-type vehicles**, if they meet requirements.
- The model tells PostNL **what vehicle** would cause the **least nuisance on a street.**
- The model can be digitised and automated for all twenty-five city centres.
- The model is future proof.

Feasibility discussion

A feasible design strengthens your business. In this specific project the design is feasible if PostNL is able to technically build the system. This report has designed the groundwork and theory for the system. What could challenge the feasibility is the acquisition of necessary data and the capacity to build the design. The easier and cheaper the information can be acquired the more feasible the system.

A design is most feasible when it builds on strengths of a company. Reduction of nuisance is not yet one of them. As the system progresses, much more can be learned about how LEVVs cause and reduce nuisance by the digital feedback coming from the vehicles and the drivers.

This feedback can teach PostNL more about nuisance and how it can reduce it. By choosing two vehicle types and only using their specifications on width and containerisation, it can safely be said that the model applies to all LEVV-types (bikes and trucks), if they are narrow enough.

The stratonas showed that a categorisation of streets can be made which apply to all city centres. By estimating, testing and validating the vehicles on these streets, a judgement was made on what vehicle would cause the least nuisance.

These stratona profiles support the possibility of creating a model which can analyse all city centres and recommend a vehicle for existing routes or create new ones. By constantly adding feedback from practice and new information this system can be better at creating nuisance-poor and efficient routes. This way the system adapts to the changes in street structure and become pro-active by using data on future roadwork.

Viability

- The model will **not increase costs** anywhere along the chain.
- The model must take **volume distribution** into consideration.
- The model must show PostNL the **impact of nuisance reduction**.

Viability discussion

Nuisance reduction cannot be translated into revenue or cost reduction directly. But there are other reasons why this design and the system are a viable strategy.

But the ambition that PostNL has is substantiated by showing how LEVV deployment can be as or even more efficient than a bus in the centre. On the KPI's efficiency and customer happiness LEVVs have been proven beneficial over traditional vans, increasing happiness within the urban consumer. This model clears the way for PostNL to manage and act upon nuisance-reduction as a KPI.

When looking at the future, PostNL must pivot as cities are banning big vehicles from their centres through either regulations or road planning. If PostNL does not change its vehicles here soon, costs will be made on exemptions or by an inefficient, rushed transition.

The model and its theory do not cost any money, the system to be built to support and implement the model does. A mix between free open-source geo-information and vehicle tracking-data is what make up the costs. The model can use free software at the beginning, but when optimised it will surely use self-built or paid software.

Process managers worry that with growing volumes, the LEVVs cannot handle the number of parcels to be delivered. The efficiency test showed that when using centralised hubs, the LEVVs can be more efficient than busses, the LEVV delivered the exact same workload. The test showed that LEVVs can withstand volume growth better than busses. The preferred vehicle will drive a more efficient route due to it being nuisance poor in combination with said LEVV.

Desireability

- The output of the model can be **communicated easily along the process chain**.
- The model and its system must be **liked** by the **route planners and process managers**.

Desirability discussion

When the model and its drivers were presented to process managers and planners they responded enthusiastic. The way that the solution was made visual helped them understand the theory on what vehicle to choose. They were shown analyses of their own context of operations which helped them provide comments which brought theory and practice closer to each other.

The claims made about the area were confirmed or denied by them, reshaping the model to its final form. By doing this the process managers and planners got to shape the final model (adding weighing factors) and how the output (routes) can best be communicated to them. This gave that desired 'invented here' effect, which supports the chance of adoption.

5.3 Further discussion

This chapter discusses what things can be researched by PostNL to make the case even stronger for LEVVs. Advice is given for LEVV implementations. The limitations show what could have been done better in this project. What gap in the literature did this research fill? The authors personal reflection on the project finalises this report.

Recommendations for further research

This project has shown opportunities and threats which require further investigation.

Calculation
A new way of calculating the advice was proposed in chapter 4.3, by combining this calculation and enriching the stratonas from surrounding areas, multimodal planning can be done with other vehicles added to the mix. This way of approaching the distribution opens up nuisance reduction across the entire country. A centralised route planning tool will be the result.

Route planning
Now routes are divided over multiple trips, this means that planners can be more flexible in deploying vehicles. Where they were limited to a single route per vehicle, they can now plan three to four routes per vehicle. The potential can be researched and what benefits is may have for nuisance reduction and efficiency.

Congestion metric
If congestion is made measurable, the implications can be translated into financial impact. The effect of this model and the system can then be determined and performance on reduction can be improved.

Consumer interest
This project was the start of identifying what nuisance is and how LEVVs can reduce it. The effect on customers has not been investigated as the vehicles must be experienced first. Safety and congestion were the first factors which were considered broad enough to apply to all areas within the city centers.

Packaging
Growing volumes form a threat to LEVVs as big parcels will simply not fit. By optimizing packaging of parcels, the number of parcels that into a LEVVs increase.

Amazon
What does sustainability and nuisance reduction mean to a big potential client like Amazon. Could a streamlined LEVV process be an interesting proposition for Amazon and bind them as a client?

Advice to PostNL

Along the entire process of LEVV implementation some points of interest must be considered as they pose a threat to a successful implementation.

New employees
Vehicles resembling the vehicle drivers are comfortable with have a higher adoption rate. From the interviews it became clear that drivers are not motivated to substitute their van for a bike-type LEVV. The discrepancy between a van and a bike-type LEVV is too big for them. Bad weather and physical effort are other reasons

The recommendation is to recruit bike drivers from a different target group. Options are the Deliveroo type driver, young and flexible and people without driver's licenses.

Extra vehicles
Make sure a back-up vehicle is present at the city hubs. Process managers worry that with increasing and fluctuating volumes they occasionally need an extra vehicle to distribute workloads.

Vehicle specs
When optimizing the vehicles, make sure that the vehicle can be locked easily when stepping on and off. Constantly having to unlock and start the vehicle takes too much time and effort, resulting in drivers not wanting to take the vehicles to every front door.

Limitations

The model was created to be as close to the real situation as possible. But some things were left out of the scope which impact the feasibility of the model.

Hubs

Hub location was not considered in this report, while it can have a big impact on the distance a LEVV must drive from the hub to the first stop. What the effect is of hub location is, is still unclear.

Volume increase

The increase in number of parcels for PostNL was not taken into the consideration. Numbers on average volumes for the drop density calculation are not representative for the future. Process managers worry that LEVVs and their limited capacity will not be able to handle extreme volume fluctuations.

COVID-19 situation vs. normal situation

This project was done mostly during a hard lockdown, which means that some assumptions could not be tested in the real situation. Streets were quiet, resulting in not seeing the LEVVs move during an extreme situation. Weighing factors will need adjusting once the situation resembles how it used to be.

Vehicle capacity

The Fulpra Roll and the CargoLEV differ in container capacity. A difference in loading capacity was not considered in the calculation as it will become important when new routes are built.

Route analyses

The two routes analysed, were both convincingly bike-type routes. No route was analysed which advised to use a truck-type LEVV. This could mean either that the stratonas and weighing factors are favoring bike-types too much, or that a truck-type might never be the superior to the bike in nuisance reduction.

Varying regulations

The city of Amsterdam is an example of a municipality that makes its own rules according to motorised vehicles (NOS, 2019) (mopeds on the driveway with a helmet). It is unclear how they will assess the cargo bikes and what rules will apply to them in Amsterdam. This might mean that a Fulpra must drive on the main road, making the model irrelevant.

Novelty of research

From a scientific point of view there needs to be a gap in the literature for this research to be novel and to be sure the subject has not been explored yet.

This research was intended to find a way for PostNL to substantiate their choice for a LEVV-type. PostNL was given a way to make a choice based on what vehicle would cause the least nuisance in a certain context.

The entire context was categorised into street archetypes which all streets within city centres are part of. A judgement between two LEVV-types has never been made on the basis of nuisance reduction. No research exists which helps find the potential nuisance reduction a vehicle can achieve by comparing them in different contexts.

Previous research (LEVV-LOGIC, 2018) on LEVVs shows the potential that cargo bikes have in urban contexts, focusing on operating performance and comfort for the driver, without comparing two types of vehicles and reducing nuisance.

Knowledge to be acquired here is the positive impact LEVVs can have on the livability of the city and a strategy in behaviour by LEVV drivers in order to maximise this positive impact.

Previous research, resembling this, has shown the impact of regular traffic on livability (Floor, 2020) and the effect of traffic regulation by municipalities (Flämig & Wolff, 2016).

Personal reflection

Learning goals

In the design brief I stated that I thought finding the 'why' was an important part of this project as it usually is in strategic design projects. Why is PostNL doing this? As the project progressed, I realised that the why did not matter that much in answering the question PostNL posed. Instead of finding the competitive advantage of LEVVs and finding different ways to tackle this problem, it turned out to be a matter of doing. Finding the 'why' did not contribute to the model of choice. What I have learned from this is that not all questions need to be challenged. The ambitions of a company can be sufficient proof that the driver behind the question is valid.

I had hoped to learn programming and build an MVP to be tested. Within the time this was an unrealistic ambition. What I did make is a roadmap as a recipe to build the system. Not have I learned to write code, but I did learn about geo-information and how this data works.
This ambition to get better at UX-design was associated with the programming. Both ambitions were not realised sadly.

I do believe that I have made a complex multi-faceted problem into a simple solution by scoping effectively. The final design shows PostNL exactly what information is necessary to find an answer to their question. I feel like in the end I have given them more than they initially asked for. I brought the model of choice to a level where not only can they substantiate their vehicle choice, they now know how to combine nuisance reduction with efficient routes and a plan to make it into a multimodal planning system.

Experience at PostNL

The reason for wanting to graduate at a corporate company was to experience if it would suit me as a strategic designer. For a whole 2 weeks I was allowed to go to the office after which the lockdown kept us at home. I aimed for bringing creativity to the table and using the team to find a solution. Not being at the office impacted my ambition to contact and involve people into my project. The virtual distance created a social distance between me and the team increasing the threshold to contact someone without being prepared and concise.

This notion was invalid as the team is very welcoming, helpful, dedicated and enthusiastic. They really made an effort to make me feel part of the team. From day one I felt like I could speak my mind, which is something I value in teams.

The coaching I received was always on point, no-nonsense and critical. Marije was constructive in her criticism and complimentary at the same time. Her feedback was valuable and will help me in professional life after graduation.

Process

I was looking for the 'why' of this challenge to halfway find out that the method I thought that I was applying turned out to be the wrong one. An action based method (PCDA-circle) turned out be the strategy which I had applied throughout the project. The old method caused me to feel restricted by the structure of the old method.

It is more important to work towards a solution with a non-typical design method than re-striction yourself to rules of a method as you think it is what is expected from you.

My ambition was to become better in applying methodologies, but found out that not every question can be answered by using a prefabricated methodology.

Regarding the entire process and how I experienced it, the advice after the mid-term meeting helped my find the confidence to take decisions and rely on your own assumptions instead of finding hard proof for every step you take. I went from a philosophical mindset to a get to work mindset.

5.4 Sources

So what was done and what is the end result?

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