Appendices

In the report there is referred multiple times to the appendix for more information. Stated below is an overview of all appendices of this report.

Appendix 1:	Online user survey
Appendix 2:	Swapfiets helpdesk analysis
Appendix 3:	e-Kick test day
Appendix 4:	Berlin store visit
Appendix 5:	Berlin warehouse visit
Appendix 6:	Market analysis
Appendix 7:	Stakeholder analysis
Appendix 8:	Incorrect target group
Appendix 9:	List of requirements
Appendix 10:	Project brief
Appendix 11:	Sprint 1 Ergonomics
Appendix 12:	Sprint 2 Brakes
Appendix 13:	Sprint 3 Cable management
Appendix 14:	Sprint 4 Lock
Appendix 15:	Sprint 5 Kickstand
Appendix 16:	Sprint 6 Cable protection
Appendix 17:	Sprint 7 Charger plug
Appendix 18:	Sprint 8 Wiring to battery
Appendix 19:	Sprint 9 Loctite
Appendix 20:	Sprint 10 Charging feedback
Appendix 21:	Sprint 11 Cruise control
Appendix 22:	Strength and fatigue test e-Kick steer
Appendix 23:	Strength test e-Kick steer holder under angle

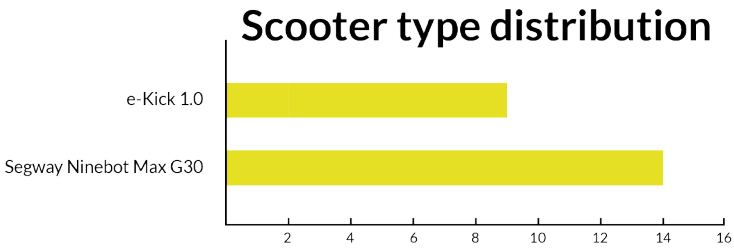
Appendix 1:
Online User Survey

Survey
All current e-Kick members were asked via email to respond to a survey made by Typeform including 6 multiple choice and 3 open questions shown below. 24 people responded.

Questions
Hi there, thanks for helping us improve our products! We would like to know your experience...
1 Which type of electric kick-scooter from Swapfiets do you have?
2 How often do you use your e-Kick?
3 How often do you charge your e-Kick?
4 Is the e-Kick your first electric kick-scooter?
5 Which option do you prefer?
6 Which option do you prefer?
7 What is causing you discomfort with the e-Kick?
8 What would your dream kick-scooter have that the e-Kick does not have?
9 Is there anything else we need to know about the e-Kick?
10 Can we personally contact you about your experience with the e-Kick for a follow-up survey? ...

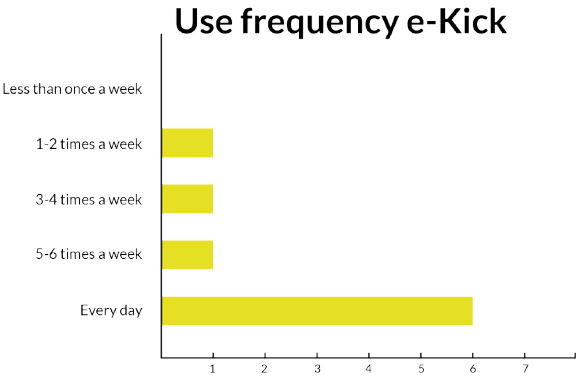
Results

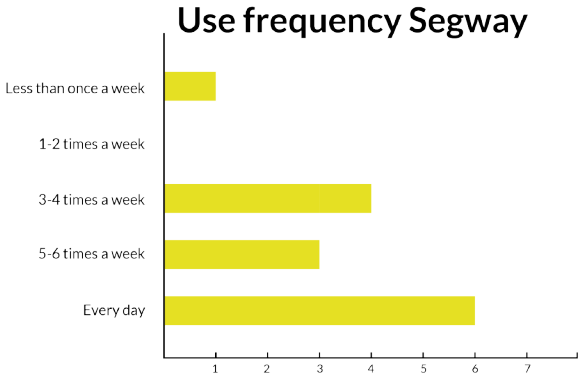
The raw data is added in an Excel file.
The type of electric kick-scooter is divided as shown in the graph above. The reason there are less e-Kicks than Segway models on the street is because of a tire issue that occurred for the e-Kick 1.0 resulting in a stop of handing out this type until this day.

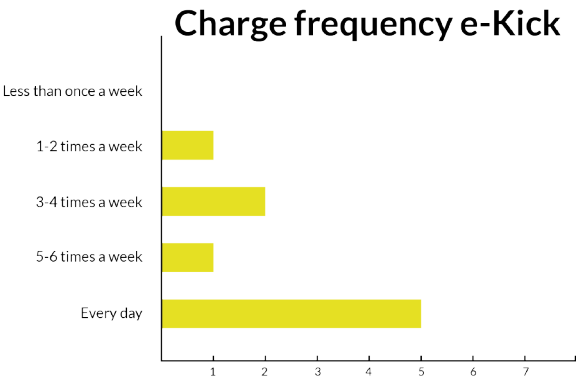


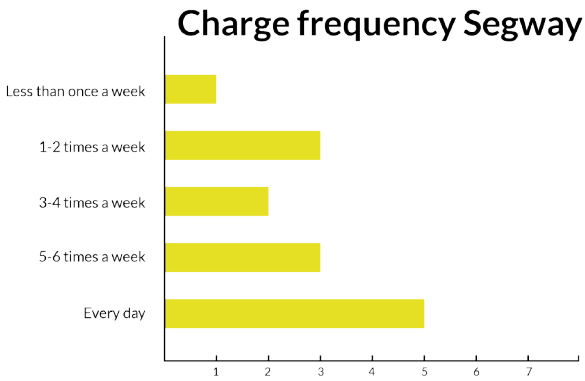
Looking at the use frequency of the two types almost the same pattern is shown. However, looking at the charging frequency of the two kick-scooter types, the e-Kick is charged more frequently. This is because the range of the Segway is 65 km versus the e-Kick with a range of 30 km. Small side note: this is the range the manufacturer claims under ideal circumstances. So in a low speed mode, low weight load and a smooth riding surface.

Range is a very important aspect for the user. Looking at the Weight versus Range graph, decreasing the range is never an option. But making it easy to carry is still a preferred improvement for the future e-Kick. It must be a solution where the e-Kick can be easily carried without decreasing the weight.



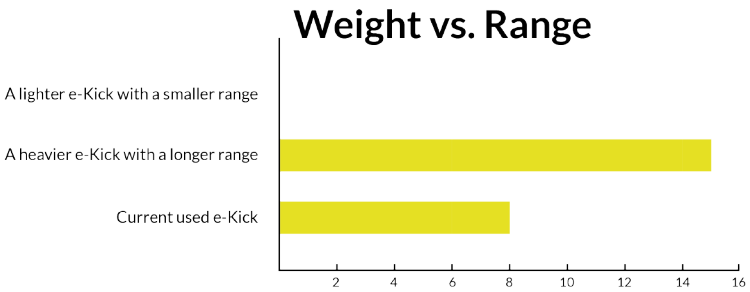


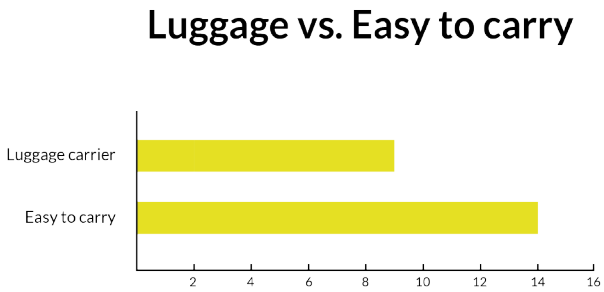




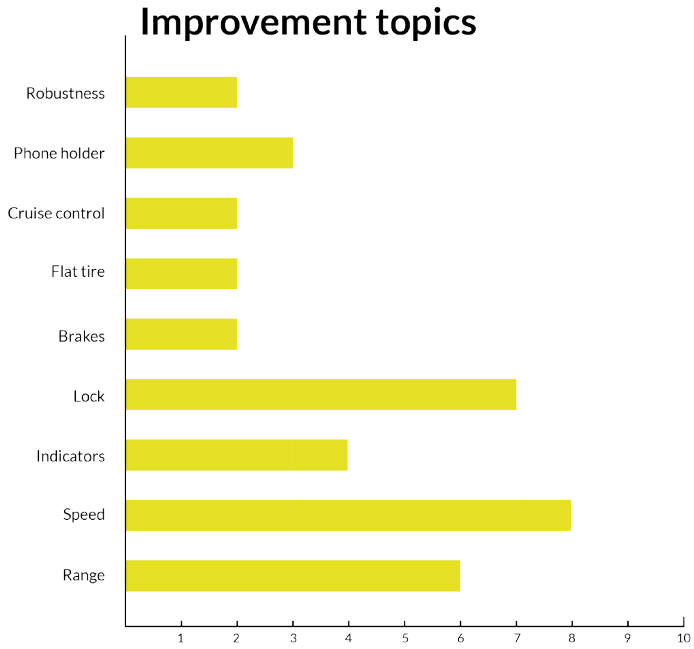
Based on 3 open questions about the improvement of the e-Kick and what features they are missing, most responses are clustered together in topics shown in the graph. The aspects mentioned most are discussed below.

Speed
8 of the participants of the survey want the kick-scooter to go faster. The current top speed is





20km/h and some are referring to 25km/h. This is not possible to change because of the German regulation(Bundesministerium der Justiz und für Verbraucherschutz, 2019). The maximum allowed speed for Light Electric Vehicles is 20km/h. However, a couple of them mentioned that the maximum speed is not constant. It fluctuates between 18 and 20 km/h which is not always the top speed.



Range
The range of the kick-scooters is too short according to 6 participants. 3 riding an e-Kick 1.0 and 3 riding a Segway. This is quite remarkable because the Segway is one of the best types available on the market according to range. This means that the customer just always wants more.

Lock
The lock was mentioned 7 times of which 4 referred to an electronic lock. The shared electric kick-scooter models in big cities have the option to lock and unlock via an app. This requires an IoT connection inside the kick-scooter.
The other people mentioned that the placing of the lock is not optimal and the constant bending while looking it was not great.

Indicators
The aspect 4 participants mentioned they miss, are indicators on the kick-scooter. Because it is not safe to drive with 1 hand, showing your direction in traffic is not possible. Adding indicator lights solves this according to the users.

Appendix 2: Swapfiets Helpdesk analysis

The Swapfiets helpdesk is constantly contacted by the customers if something is wrong with their product. The helpdesk documents all issues which are stored in a database I had access to. By analyzing all customer requests since january 2020 regarding the e-Kick, an overview of problems can be generated. **The raw data and the analysis is put in an Excel sheet added to this report.** The main insights from analysing 189 customer requests are shown below.

Responses	Unknown data
189	114
	60%

Lights	Flat tire	Wheel	Lock	Bel	Brake	Weird noise	Display	Battery	App	Screws loose
2	16	7	8	1	3	7	15	9	3	4
3%	21%	9%	11%	1%	4%	9%	20%	12%	4%	5%

Because some information is generated via the Swapfiets app and not everything is documented in the helpdesk, 60% of the data is not useful for this analysis. The percentages shown are based on the known data.

The main insight from this data is that there are 4 major issues with the e-Kick.
These issues are the tires, the lock, the display and the battery.

Flat tire
The majority of electric kick-scooter types Swapfiets currently uses is the Segway model. This model has pneumatic tires which give the user a comfortable ride and more grip in bad weather. The main disadvantage is that these run flat. Looking at the data, a big percentage of the kick-scooters coming back is because of the flat tires.

Lock
The lock whas the issue for a swap for 8 members, the main problem (6 out of 8) was the lock holder that broke off or came loose. This Means that the current lock attachment for the e-Kick is not of good quality.

Display
All cases that are clustered under the issue 'display' are because of an error code on the screen. This means that the kick-scooter has an internal error which blocks it from driving.
A potential cause is water damage.

Battery
Of the 9 battery cases, 6 swaps are because of the battery running empty fast. The other 3 are because the charger does not work. The manufacturer claims the e-Kick has a range of 30 km but this is under ideal circumstances. The customer is probably wrongly informed about the 'real' range which could lead to a reason for swapping the e-Kick.

Discussion
In this data it was not possible to see which type of kick-scooter the customer was using. Now all problems can not be directly linked to a kick-scooter type.

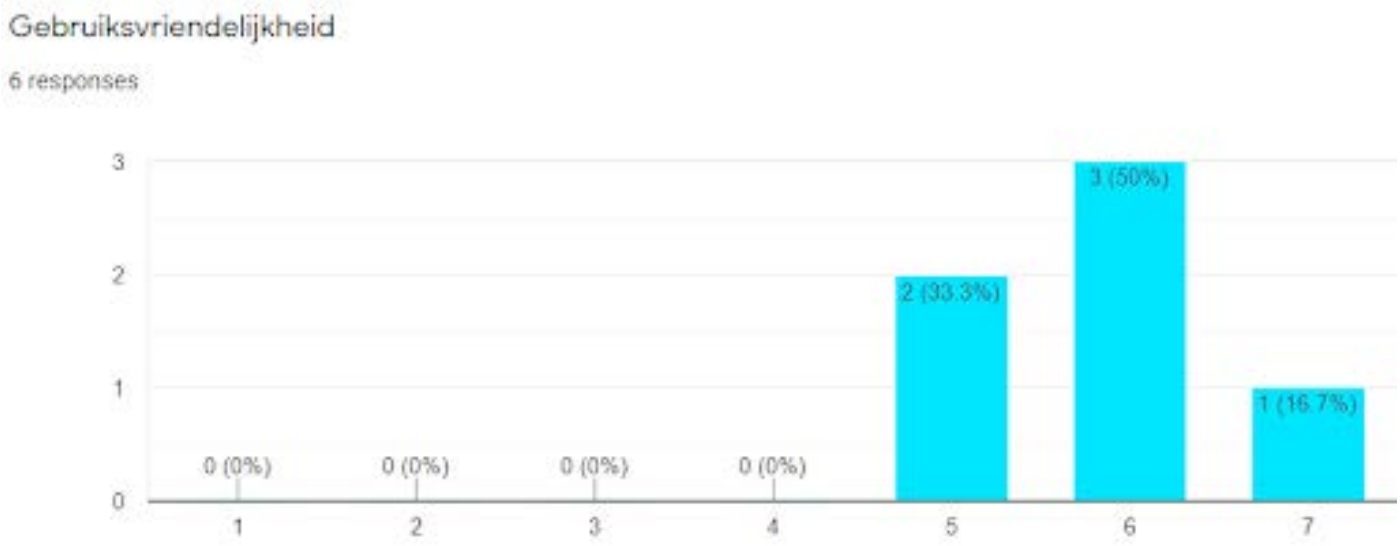
Appendix 3:
e-Kick Test Day

Date: 26-09-2020
Location: Bennekom (GLD)
Participants: 6 participants, male, age range 18-51 y/o

An e-Kick test day was conducted by testing 3 different types of electric kick-scooters. The test day consisted of two parts.

1. Short circuit of 200m test followed up with a short questionnaire.
2. Long cruise test of 5 km including obstacles like stairs and off road.

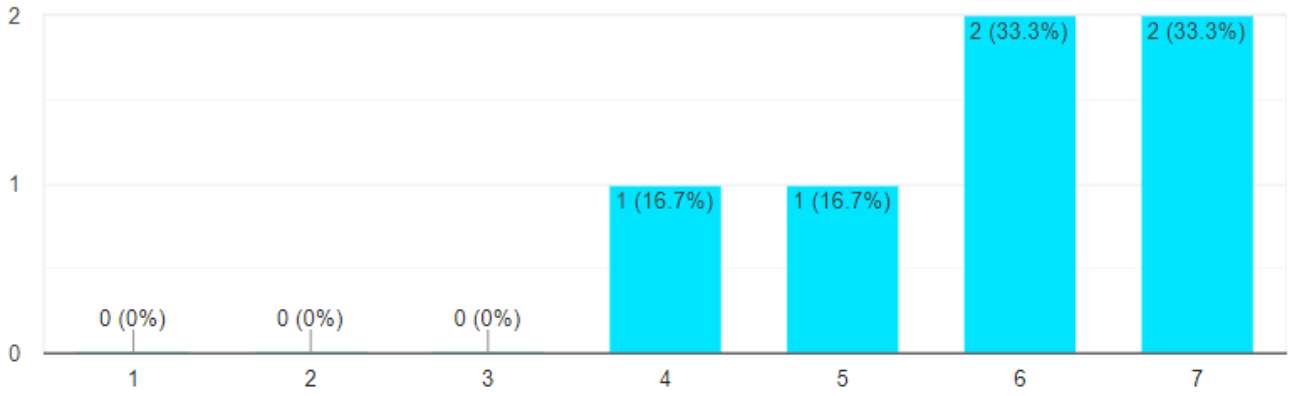
The results of the questionnaire are shown below



e-kick gaf me een veilig gevoel. ik kon het gelijk. ik kon er alles mee wat ik wilde	e-kick Als je weet hoe die werkt stelt het niks voor Eerste keer is onhandig Twee handremmen is prettig, Erg gebruiksvriendelijk	e-kick In 1 zin uitleggen wat je moet doen, dan is het duidelijk
e-kick prettig in gebruik paar dingen niet, die 3 standen zijn overbodig want je kan ook reguleren met de gashendel	segway es2 die standen zijn onduidelijk rem zoeken was lastig	segway ninebot max Moest ontdekken hoe die aanging Alles was duidelijk toen ik reed

Rij comfort

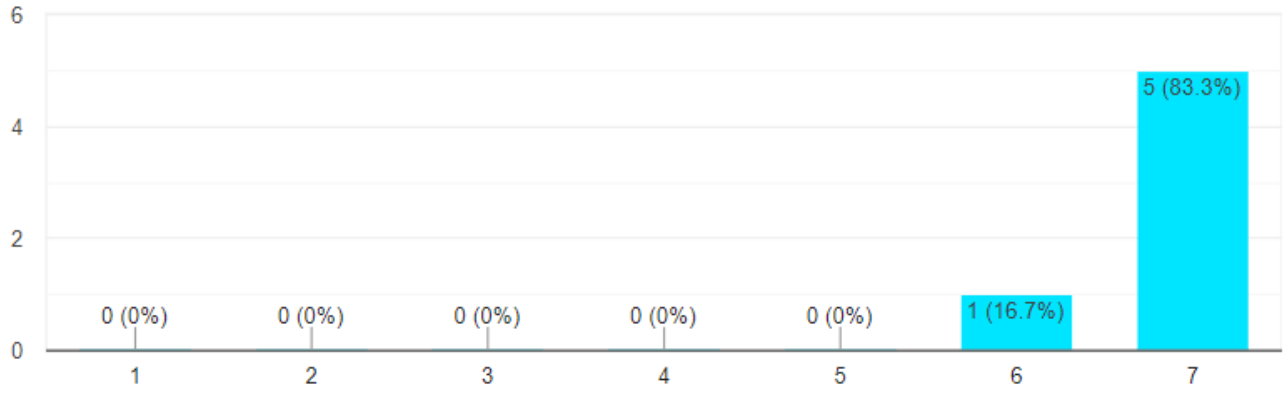
6 responses



e-Kick knopje inhouden vond ik stom, ga ik geen uur volhouden het knopje zit te ver.	e-kick nadeel is dat je krampachtig je stuur vasthoudt onderarmen voel je het trilt een beetje	e-kick banden te hard kiezen voor luchtbanden grotere banden iets meer comfort hij stuitert te veel
e-kick op de klinkertjes en bospaadje trilt hij wel je moet hem met 2 handen gebruiken	segway es2 heel onstabiel, het stuur harde banden remt erg hard vlieg over het stuur heen	segway ninebot max lekker degelijk communicatief, je weet wat er gebeurd

Veiligheid gevoel

6 responses



e-kick ultieme controle niet wankel deed wat ik wilde	e-kick ik voel me hartstikke veilig op dit ding 20 is hard genoeg, mag niet harder	e-kick met deze snelheid kom je niet in situaties die gevaarlijk zijn zou ze huren voor een citytrip of als ik in de stad ergens moet zijn
segway es2 hij doet wat die moet doen dat remmen is alleen lastig	segway ninebot max hij reageert gelijk, geen verrassingen	

Positieve punten	Negatieve punten
• Robuust • je hoeft niet te steppen, • erg gemakkelijk • is gewoon leuk • heel makkelijk overal komen • stoeprandjes gaat prima allebei de kanten op • dubbele handremmen is top • super praktisch • als ik hem bij een station zou kunnen lenen zou het top zijn • simpel • lekker compact • solide • reageert goed op wat je doet • remt goed • vering is goed voor een kleine step	• Gashendel voelt niet fijn • handvat is niet fijn • bediening was onduidelijk aan het begin • ik ging net steigeren, toen was ik bijna mn step kwijt • spatbord ging daardoor naar de filistijnen • door achteraandrijving ging ik steigeren • remmen zou ik lager willen, moet mn handen er overheen tillen • remmen zijn erg sterk • instabiele vorm bij de segway es2 • lubbertje bij de oplader zit niet goed dicht • als ik een stoeprand afrij, raak ik de bodem • ik zou de range willen weten, 5 streepjes geeft te weinig info

Aspecten die missen
• ik zag de lampen niet • iets grotere banden is comfortabeler • dit stuitert • steun voor een laptoptas zou handig zijn. • niet te veel ruimte innemen • Handremmen op de seway es2 • knopje moet bij de duim voor standen wisselen

After the first test and survey we went as a group touring in traffic to experience the kick-scooters for a longer distance. During this trip, multiple obstacles were encountered. After the trip, the participants were able to leave some overall comments on the electric kick-scooters.

e-Kick
• De boutjes op de achteras doen pijn bij het steppen. ze steken uit en dan kom ik er met mijn enkel tegenaan. • In het begin had ik moeite met hem aan krijgen maar na een kleine uitleg was alles duidelijk • op een brug trilde hij gigantisch door het ruwe oppervlak, je kon niks zien omdat je ogen mee trilden • cruise control zou handig zijn, als je remt schiet hij eraf • handremmen beter uitlijnen, ze moeten meer naar beneden gericht zijn. In het verlengde van je armen. • richting aangeven is wel een dingetje, gebruik je benen om die uit te steken.

Segway Ninebot ES2
• houding is sportief (voorover gebogen) • Iemand ging onderuit doordat voorwiel weg slipte in de bocht. • Het stuur is te smal, een breed stuur is veel comfortabeler • es2 is wel fijn omdat hij licht is

Seway Ninebot Max
• luchtbanden is wel comfortabeler vergeleken met die solid banden • luchtbanden zijn echt veel beter, veel meer comfort

Conclusion

On the 26th of September the e-Kick test day was organised in Bennekom Where 6 male participants with an age ranging from 18 to 51 tried 3 types of electric kick-scooter.
The test day consisted of two parts.
Short circuit of 200m test followed up with a short questionnaire.
Long cruise test of 5 km including obstacles like stairs and off road.

To see all data gathered that day see Appendix 3. The main findings of this test day are documented below:

Test 1

- For Ease of use the kick scooters scored on average a 5.8/7
- For Driving comfort the scooters scored on average a 5.8/7
- For Perception of safety the scooters scored on average 6.8/7

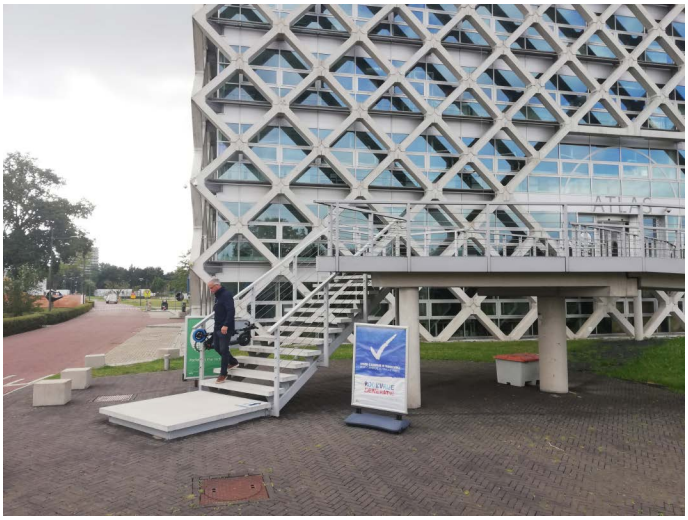
- The electric kick-scooters are perceived easy to use after a short introduction.
- Double handbrakes are preferred.
- Off Road on the e-Kick is not comfortable.
- Brakes are not ergonomically lined up with the arm on e-Kick.

Test 2

- The nuts on the rear axle hurt the ankles while kicking backwards.
- A cruise control would release the tension on the thumb.
- Showing the traffic where you are going is not possible with your hand, instead use your foot!
- The Segway Ninebot ES2 slipped away in a curb because of the front wheel drive
- The Pneumatic tires of the Segway Ninebot Max G30 were perceived way more comfortable compared with the solid tires of the e-Kick 1.0 and ES2

Discussion

The insights of this test day are based on users that are not an exact fit to the target group of the Swapfiets e-Kick. Next to that was the whole group inexperienced with the use of electric kick-scooters and had nothing to compare it with apart from the three scooter types available on the test day.
This will affect the viability of the insights which will be taken into account in the list of requirements shown in appendix 6.



Appendix 4:
Berlin store visit

To get in deeper insight in the Swapfiets workflow around the e-Kick I went to Berlin to speak to Swapfiets employees, experience the electric kick-scooter in the city and observe the workflow.
The two main researches done were interviewing the store lead about the users and getting insight in the repair of the e-Kick in the warehouse.
In this appendix the insights from these researches are documented.

I met with Hector who is store manager of Swapfiets in Berlin, he knows a lot about all customer interactions and about their visions on the Swapfiets products. And therefore also about the e-Kick.

Customers of an e-Kick
- The customers are as-is. They just get around
- Their main demand is range and speed
- They care more about having toys
- No bike users
- They use the e-kick as a status thing
- The target group is the same as the ones who buy it
- Hector thinks that this hype will disappear in 10 years
- The bike fanatics don't choose for the e-Kick, however they do like the e-Scoot.
- The regular e-Kick customer is quite aggressive, they don't make appointments and expect everything to go their way.
- They are not interested in the helmet, these are only the people for a bike.
- Balkan people is the target group

Use
- A lot of people expect to have a range of 30km if they use the sport mode. They are wrongly informed about the range of the e-Kick.
- Therefore they prefer the Ninebot because the range is way longer
- When getting the upgrade to a Power7 they ask where the power is, they don't understand the purpose of having a bike where you still have to cycle yourself.
- They take more advantage of the swapping service than the bike member. If it is dirty or not working slightly the same, they come for an exchange. The reasons are very small.
- Swap/customer/year is higher.
- People handed their e-Kick in after 3 weeks because they were bored or fed up with the bad quality.
- They don't understand that they have to pay for the minimum of a month even if they only used it for 2 or 3 weeks. They don't understand the subscription model.

General
- I helped about 50 people with an e-Kick
- According to Hector the following order of aspects are ranked to importance
  1 Range - 2 Speed - 3 Looks - 4 Comfort - 5 Weight
- The customer has now 2 options, the e-kick 1.0 and the Segway. This is not nice because they all prefer the Segway. Don't give them a choice.

Conclusion

Hector described the main e-Kick user as a person with a very aggressive personality.
People that don't make appointments and expect everything to go their way.
They use the e-Kick as a status symbol and are therefore demanding high specs.
This radical description Hector gave is used to create the persona of Gleb in the chapter User Analysis.

The main demand of the user is range and speed. Most of them are wrongly informed about the range of the e-Kick. The 30 km range we promise is not 30km if you only use the sport mode.

The Swap/customer/year is higher for the e-Kick compared with other Swapfiets products because the e-Kick users take more advantage of the swapping service. For a very small reason they demand a new e-Kick.

According to Hector, looking from a user perspective, the aspects of the e-Kick are ranked to importance from top (most important) to bottom (least important).

1. Range
2. Speed
3. Looks
4. Comfort
5. Weight

Appendix 5:
Berlin warehouse visit

In the warehouse I spoke to 2 mechanics experienced with electric kick-scooters and to the warehouse manager. Below are stated all the insights regarding the e-Kick.

Insights Jacko
Jacco is the mechanics chef at the Berlin warehouse.

e-Kick
- de banden zijn erg slecht,kijk maar naar sommige gescheurde
- Ze zijn ook niet goed uitgelijnd, foutje bij de machine die ze erop zet. Dit resulteert in een gehobbel bij het rijden wat het erg oncomfortabel maakt
- standaard heeft een plastic (of lage kwaliteit onderdeel) wat snel kapot gaat.
- hij is te goedkoop, de hele e-Kick
- als er iets aan het stuur vervangen moet worden wat aan het display vast zit (handrem of gashendel) gaat dit erg onhandig omdat de kabels erg kort zijn. het is een priegelwerk. Dit zorgt er ook voor dat het display er niet zomaar afgaat zonder het hele stuur te demonteren.
- de hendel om de e-Kick in te klappen is niet veilig, meerdere mensen uit de warehouse voorspellen dat members erop gaan staan tijdens het rijden
- De plastic afdichtklep op de laadpoort is slechte kwaliteit
- hij moet waterdicht zijn
- We moeten een bandenmachine hebben
- de dubbele voorrem is raar, Jacko ziet er het nut niet van in
- er moet zoiets zijn als de VanMoof politie, door een tracker erin te bouwen kan je ze allemaal terug vinden
- De moer van de achteras is veranderd naar maat 19 ipv 17 omdat het schroefdraad niet goed was, de nieuwe die we opgestuurd kregen waren een andere maat.
- we moeten de e-Kick onhackbaar maken. dit kan door simpelweg geen Bluetooth te gebruiken.
- Bij het wisselen van het achterspatbord is het lastig om het draadje van het achterlicht niet los te trekken. Deze zit vast met lijm ipv mechanische verbinding. Dit kan beter. Ook is het draad erg kort waardoor er weinig werk speling is.
- er moet locktight gebruikt worden voor alle boutjes, er trilt er nu nog wel eens eentje los
- alle stekker in het stuur naar de display (remmen, gashendel, koplamp) zijn te kort. valt lastig mee te werken.
- er zijn veel onnodige spareparts
- Het komt voor dat de gashendel stroef gaat omdat er water tussen komt. Hier gebruiken we siliconenspray(Syclon) voor, dit werkt goed voor plastic op plastic. (Zat nog niet in assortiment)
- e-Kick ladre was kapot na 2 weken, hij laadt gewoon niet.
- bij sommigen gaat de accu ook erg snel leeg

Segway Ninebot Max
- Wat we nu zelf repareren zijn de remmen, display, verlichting, schoonmaak. De rest besteden we uit aan roller Paradise
- er is al iemand binnen berlijn die 4 segways op zijn naam heeft staan en niet betaald
- voor de Segway Max is er een hacking app. deze zorgt ervoor dat je kan sjoemelen met de software en de locatie van de kick-scooter kan verplaatsen naar de US. Hierdoor is het snelheidslimiet veranderd naar 30km/h ipv 20km/h. We kunnen ze niet terugzetten zonder die hacking app. dus de gehackte segways kunnen we niet meer uitgeven want dat is gevaarlijk.
- Van de segways die uitgegeven zijn zijn er ongeveer 10% teruggekomen in 10 maanden.

- De segway Max is erg onderhoudsarm.
- wij halen de hoge druk spuit over elke vieze e-Kick/segway die we terugkrijgen.

Power7
- in Berlijn heb je allemaal 'Penners' die jatten alles, ze strippen fietsen en steps op onderdelen en verkopen deze weer. Een gevaar voor de Power7
- Als er zoveel pickups zijn in Berlijn staat straks de warehouse helemaal vol en is er geen plek meer voor alle Power7s

Insigths Jessi

Jessi is the warehouse manager of warehouse Berlin and responsible for the warehouse mechanics and logistics.

Power7/e-Scoot
- a competitor of the Power7 can be Dance, founded by the founders of soundcloud. looks like a very simple design but cheap.
- We use Roller Paradise for e-scoot repairs and for some of the Segway repairs.

e-Kick
- The speed limit at +- 20km/h is not constant, it fluctuates between 19 and 21.
- 50% of all e-Kick members don't pay
- The intake of the e-Kicks was a lot of work because the information for check in was not on the outside of the box, so we needed to open every box to look inside for the color and the frame number.
- There is not a really clear difference in placing the Broken and RTG in the warehouse

Segway Ninebot Max
- The segway folding mechanism breaks down because people don't properly use it. We need spare parts for this.
- The swapfiets bag with the charger and flyer in it, is getting very dirty while transporting it to the store. Maybe a black bag is a better option.
- A lot of members forget to bring their lock or charger at an exchange.

Insights Malcom

Malcom worked for 4 months in Malmo in Sweden for the company Circ. Circ was located there for 4 months. from beginning to end Malcom experienced a lot in the sharing business.

Circ scooter
- We worked with second hand kick-scooters from Portugal, so they were in used condition.
- The foot brake resulted in a worn out tire, it became flat on the top. Because it was a solid tire, it was not a really big problem.
- the front fork broke down often, it just snapped inside the steering column
- Also the front fork bent inwards. We used a simple tool with nuts and bolts to bend them back.
- The battery protection of the Circ was bad, the connection often had no connection of water came in and resulted in a shortcut. The repair was just making it dry again.
- A lot of bell broke down
- a main repair was the kickstand, it is exactly the same on the e-Kick. It opens up which result is the kickstand falling out.
- Rust was not on the bearings, but it was on the contact points of the battery which resulted in malfunctioning.
- Because of the battery mounted on the steering column, it was a bit unstable while parked and had an unpleasant driving experience
- There was a bolt inside the steering column that blocked the steering at 75 degrees. This was of bad quality so it broke down often.

e-Kick

- The e-Kick is quite heavy
- if you fold the e-Kick with the kickstand out, it is breaking it.
- The pedal of the folding mechanism needs to contain a rubber cover because it will harm the frame.
- it is important to protect all cables and connections, you don’t want any water coming in.
- the cables on small parts need to be short because it is easy to replace them.
- Battery charger point needs to be safe.
- Battery on the bottom is good for weight distribution.
- The cover for the battery needs improvement, it is now a simple piece of plastic.
- the rear light cable is fixed with glue, this is bad!
- some ideas for the lock: A plugin lock in the frame or a folding mechanism lock.

Conclusion

Below are stated all the insights regarding the e-Kick.

- The Kickstand is of bad quality. The plastic part wears out and results in malfunctioning shown in the picture. At Circ (a kick-scooter sharing company) they had a lot of broken kickstands of the same model.

- If something needs replacement on the steer or in the steering console the whole steer needs to be disassembled. Low quality, small cables insight a small steer takes a lot of effort and time.

- The plug cover for the charging port is of bad quality and falls off easily resulting in letting the charger port exposed to water and dirt.

- At Circ a lot of issues were because of water damage causing corrosion at connectors or shortcutting the whole system. This means all connectors must be protected against water. This also applies to the battery and charger plug.

- All bolts in the e-Kick are not tight enough. This must be solved not by over tightening them but by using Loctite.

- Some of the Segway models are hacked via Bluetooth. This can not happen to the e-Kick 1.0 because it has no Bluetooth connection.

- The double front brake at the e-Kick is very uncommon. Why not use a single front brake.

Appendix 6: Market analysis

Lime in Paris
According to the Annual report of Lim from 2018 and the Sustainability report for Paris in 2019 the following numbers show the Lime use in Paris.

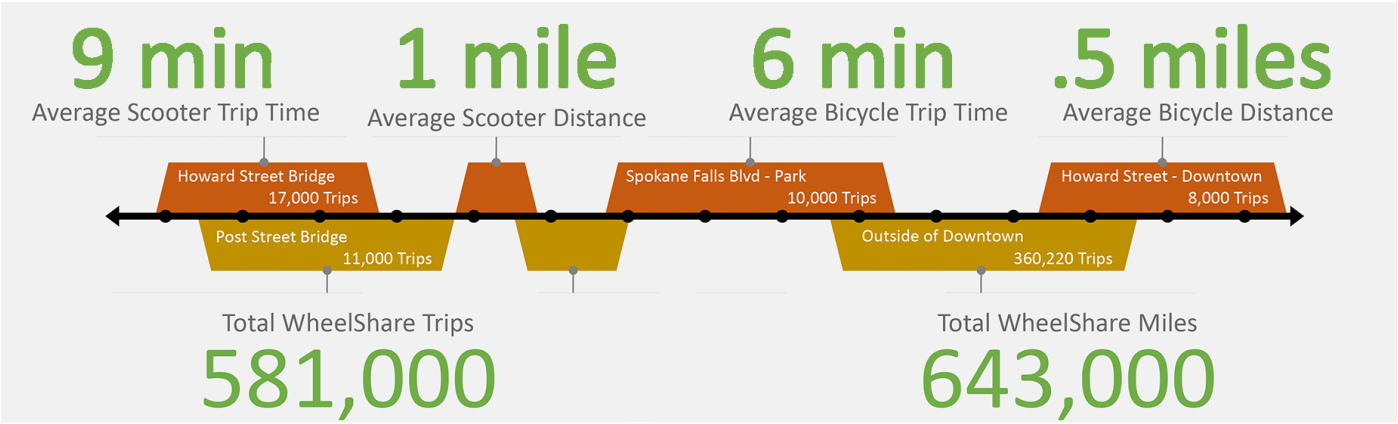
45% of Lime users in Paris use the Lime scooter for commuting.

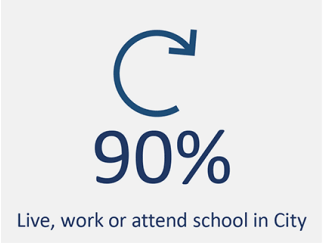
23% of trips were in combination with a different type of transportation of which 66% was public transport.

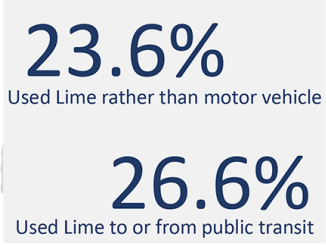
10% of all Lime trips resulted in not using a car which is 1.2 million trips in 2019.

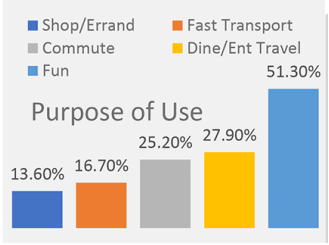
Bird
According to the Bird blog page the popularity of the scooter sharing industry grew 123% in the past year replacing other transportation types. These types are shown in the graph below (Bird, 2020).

Wheelshare program in Spokane
In the city Spokane (USA) a research was done in cooperation with Lime about the scooter usage. This resulted in a clear overview shown in the image below (Spokane's WheelShare program, 2020).









Appendix 7: Stakeholder Analysis

In this appendix all relevant stakeholders regarding the e-Kick 2.0 and 3.0 are described. They are analysed for their demands and motivations and how the project can benefit from all stakeholders while they benefit from the project.

SWAPFIETS

Who is this stakeholder?
Swapfiets is the world's first bicycle subscription service. For a fixed monthly fee, you get a Swapfiets bicycle. We make sure it always works.

If your Swapfiets breaks down, just call, email, Whatsapp us or use the Swapfiets app. We will come to you to fix your Swapfiets, wherever you are in the city.

If we can't fix your bicycle within 10 minutes, we will provide you with another working bicycle.

That's what we call Swapping.

The company Swapfiets is divided into multiple teams responsible for a certain operation part. For example you have Team Finance for financial business and Team Product for product management and optimization. This Team Product is involved most in the development of the e-Kick.

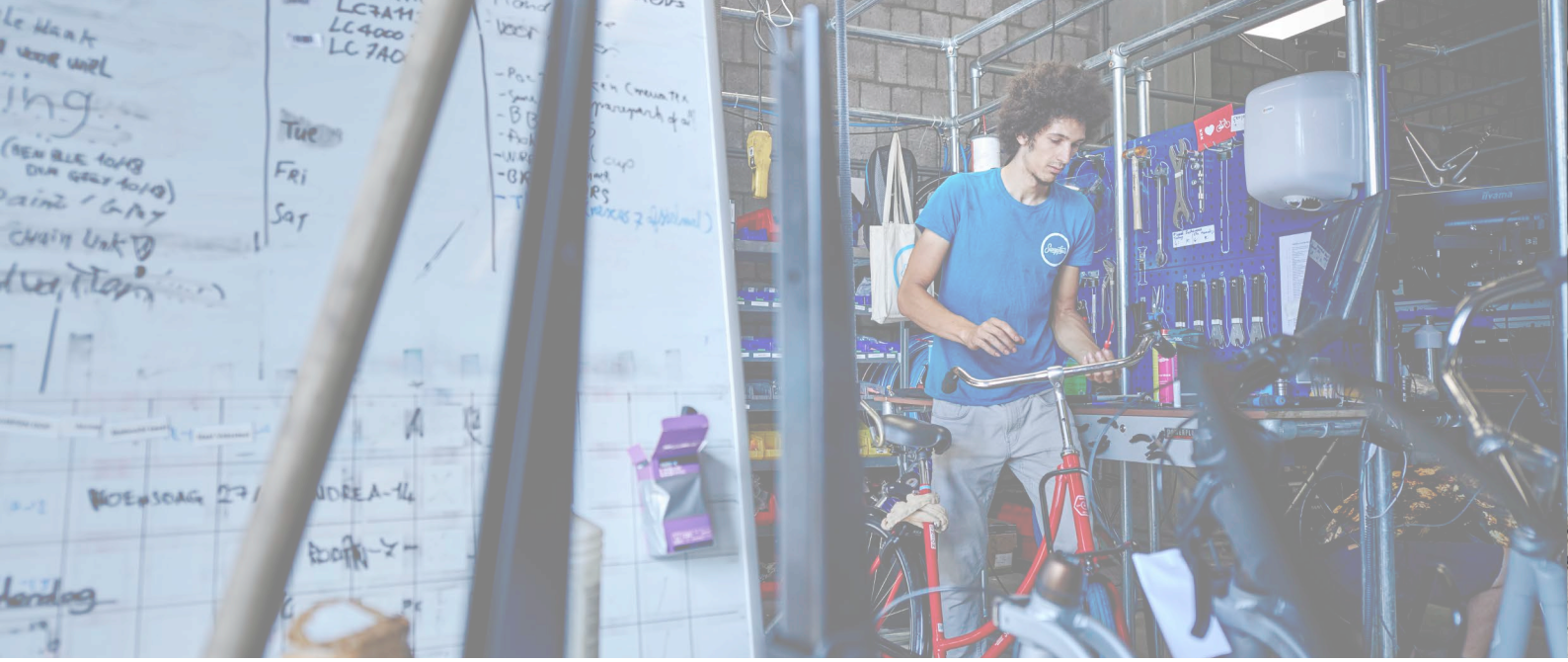
What motivates this stakeholder?
The purpose of Swapfiets is that they believe that a possession-to-use economy supports a more circular and smarter world.

The personality Swapfiets want to show to their customers is:
- Accessible
- Reliable
- Lively/Humor
- Distinctive
- Can-do mentality

The operations of the whole company need to run optimal around the products Swapfiets has. This means that the repairability is easy and the product life time and the product quality high. Swapfiets rates the quality of their products by analysing data of the amount of Swaps (events that the customer comes in contact with a Swapfiets employee). They want the Swaps per customer per year to be as low as possible. This means that if the Swap/Cust/Year is 1.5 for the Original1 bike, each year every Original1 bike will come back with a problem 1.5 times in a year. The goal for the e-Kick is to get the Swap/Cus/Year at 2.

What other priorities do they have, and how can we align our project with those priorities?
The Swapfiets approach of a new product introduction is fast. They invest in launching a pilot as fast as possible to gather data fast. For the e-Kick pilot Swapfiets placed 200 Segway models in Berlin just to see if it was successful. After seeing there was a high demand for this product, they introduced the e-Kick 1.0 in 5 big German cities. This means that the new product design of the e-Kick 2.0 needs to be fast and based on the insights of the running pilots.

Will this stakeholder likely have a positive view of our project? If not, what can we do about it?
If the new design suits Swapfiets brand personality and enhances the company workflow, the view is positive. Next to that the company needs eventually to make profit from their product which demands to keep prices low.



MECHANIC

Who is this stakeholder?
In every district Swapfiets is operating, a warehouse is located where all broken bikes/e-Kicks are repaired. This is done by the Swapfiets Mechanics. Most of them are full time employees working in their individual workstation (booth). They make all vehicles that enter the warehouse ready to go (RTG) again by checking, repairing, maintaining and replacing parts.

What motivates this stakeholder?
The Mechanics have a daily repair target of different assets. Their goal is to reach this target. They are motivated by variety in their work, so repairing different assets in a day is enhancing their working experience. Next to that the Mechanic likes to see a good and decent product, if the repairs are always because of a malfunctioning part, they ring the alarm at the Product team at HQ.

What other priorities do they have, and how can we align our project with those priorities?
They aim for a fast workflow. A set amount of time per repair focusses them on performing. If the new e-Kick design increases the repair time per asset their productivity will drop. So it is important that the analysis and repair is easy and spare parts accessible.

Will this stakeholder likely have a positive view of our project? If not, what can we do about it?
The Swapfiets Mechanic will be one of the first to detect design flaws. So if the new e-Kick version is causing work delay or complications they will definitely not have a positive view on the project. It is important to take this stakeholder group into account during the whole development process by asking their input and validation.

SWAPPER/STORE HERO

Who is this stakeholder?
The Swappers and Store heroes are the employees of Swapfiets who are in direct contact with the members. The Swappers drive around the city in the Swapcars delivering the Swap products and service directly to the customer. The Store hero also delivers the service and products only he does it out of the Swapstore which is located in the city centre.

What motivates this stakeholder?
The customer rating is very important within Swapfiets, currently it is 4,75/5. Being the face of the company for the members it is very important to keep them satisfied. Even if a bad thing happens to the Swapfiets product or the customer it is the job of the Swapper or Store hero to fix the problem and get the member back on the road again. Swapfiets is there to take away the effort you put into your bike.
The swappers benefit from a high quality product. If members come back frequently they will lose trust in the products which will make the Swappers job harder.

Next to that, easy fixes are carried out on the street or in the store to reduce the workload of the mechanics and filter simple problems at first member contact.

What other priorities do they have, and how can we align our project with those priorities?
The Swappers and store heroes need to ask the member what the problem is with their handed in product, this inventorisation is important information for the mechanic who is going to repair the product.
This means that easy inventorisation of problems of the e-Kick is important for the Swapper/Store hero.

Will this stakeholder likely have a positive view of our project? If not, what can we do about it?
If the product is functioning well and the Swapper/Store hero understands the product, handling it in front of the member is a lot easier. This will result in a positive view. However, if this new product attracts a different type of member who is harder to satisfy, the Swapper/Store hero will have a negative view on the target group and therefore on the e-Kick.

MANUFACTURER

Who is this stakeholder?
The current manufacturer of the e-Kick version 1 is located in China. They produce a lot of Light Electric Vehicles for the sharing markets. Kick-scooters, E-bikes and regular bikes are produced based on the customers order.
At the factory a lot of components are outsourced to other suppliers. Only the frame is produced at the factory after which all parts are assembled.

What motivates this stakeholder?
The Manufacturer wants to produce as many products as possible while satisfying the customer. So the standards for quality and safety are very important. They have their own design team who can design a product that satisfies all customer demands. Of course their main goal is to make profit from all this by keeping costs low and production high while making no mistakes.

What other priorities do they have, and how can we align our project with those priorities?
They like their own way of working, it is hard to convince them to approach their work differently. They claim that solutions are limitless as long as we specify our demands clearly. They never give no for an answer. So this means that if we send them a new e-Kick design, this needs to be worked out into detail. Otherwise they will do something different which is sometimes not a good option for the European markets.

Will this stakeholder likely have a positive view of our project? If not, what can we do about it?
The positive view on the project will come if Swapfiets orders a lot of new e-Kicks from them. Then it is their responsibility to deliver a product that conforms to all set requirements.

GOVERNMENT

Who is this stakeholder?
In every country Swapfiets operates in, the national government has laws that concern LEV's (Light Electric Vehicles). This is to keep a safe environment for their citizens. In a lot of big cities the municipality has a lot of influence on these rules. For example the city of Berlin has a parking restriction in certain areas for shared e-scooters.
So the stakeholder is the governmental deputy responsible for the city image of cities Swapfiets operates in or plans on operating in.

What motivates this stakeholder?
The safety of the citizens is number one priority. The vehicles that are allowed on the road must comply with strict regulations. The regulations used for the e-Kick are the german eKFV regulation. (Bundesministerium der Justiz und für Verbraucherschutz, 2019).

Next to that, most cities have sustainability goals set for the future. They want to reduce their emission and increase the use of renewable energy. Replacing car use with the use of LEV's is a potential solution and will contribute to the sustainable city goals. (Lime, 2019).
Also generating less waste is a goal for a lot of european cities. So sustainable handling of repairs and waste is important for Swapfiets

Looking at the UN's sustainable development goals, number 11.2 states that in 2030 sustainable transportation is accessible for everyone while improving safety. (SDG Nederland, 2020)

What other priorities do they have, and how can we align our project with those priorities?
A maximum speed of 20km/h.
Safety features like lights, reflectors and brakes.
Traffic laws refer to the e-Kick too.

Will this stakeholder likely have a positive view of our project? If not, what can we do about it?
If the e-Kick enhances the sustainable goals of the city and is safe for the civilians to use, the government will be positive.

Appendix 8:
Incorrect target group

GLEB

Gender: Male
Age: 29 y/o
Profession: Warehouse logistic operator

Personality: Straight forward/Direct
Imperious
Egocentric
Materialist

Values: Fast service
Self image
Cool looking product
The best specs

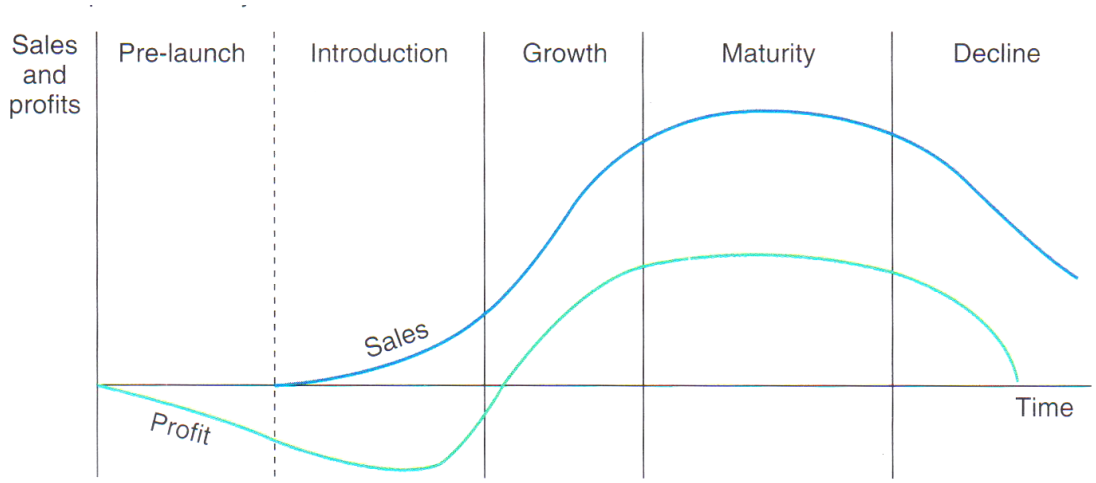
In this timeline you see a daily routine of Gleb. He goes to work by car and after getting home at the end of the day he uses his e-Kick for a fun ride around the park, drop by a bar and eventually rides home again. Depending on the length of the ride through the city or park, the estimated average daily travel distance by e-Kick is 12-20km.

The persona based on the stereotype the Berlin Store lead described is not an accurate image of the group Swapfiets wants to attract. This is because of the following arguments:

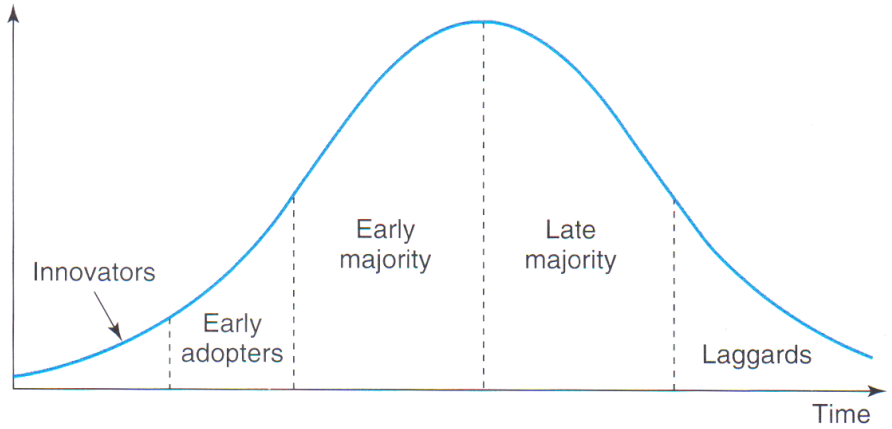
1. Hector described the average e-Kick customer of Berlin as a very aggressive person. This does not mean that every e-Kick user is aggressive. Getting in contact with such an aggressive person is likely to have a big influence on your perspective against the average e-Kick user. A single aggressive confrontation has more impact on your perspective than a couple of non aggressive confrontations (Jussim L. 2015).

2. According to the Berlin Swapfiets employees I spoke to in Berlin, there is a reason the customers are a stereotype. Berlin is a big city, and is seen differently than the rest of the German cities. The cultures and mentality is unique in this metropol. Because of this uniqueness it is not rational to base a persona on the average Berlin customer.

3. The third reason why the target group is not like the persona Gleb is because the market development of the electric kick-scooter is not jet in the stadium where the majority of the consumers are using the products. Looking at the graph we are still in the 'early adopters' phase. This means that the target group will change over time until it reaches the majority of the consumers (Evans & Foxall, 2009, pp. 346-351).



Diffusion of innovation: adopter categories



Appendix 9:
List of Requirements

The whole list is put in an PDF sheet added to this report.

Appendix 10: Project Brief

The Project brief is added as a PDF to this report.

Appendix 11:
Sprint 1 Ergonomics

Why
Firstly, the dimensions of the e-Kick need to be checked with the european P50 male standing posture.
Next to that, looking at the handbrakes and handlebars, some ergonomic improvements are necessary. Also is the shape of the steer straight and probably ergonomically shaped to the P50 end user.
Thirdly, the carrying of the e-Kick is not ideal. This needs a new design.

Goal
The height of the steer is suiting P50 male standing posture. The steer shape is ergonomically checked. The hand brakes and handlebars are ergonomically improved. The carrying is improved.
General ergonomics
The general dimensions of the e-Kick 1.0 are checked if they fit the body size of a P50 european male. Because the manufacturer is Chinese this could probably not be used as a design requirement.
Next to this, the safety of the user is checked to see whether the abrupt braking can lead to a fall or injuries.

How
- Using DiNED for the P50 male posture dimensions comparing it with the current e-Kick dimensions.
- Checking the balance and safety of the e-Kick.
- Making different steering shapes at TU Delft workshop.
- Testing and verifying the new dimensions and shapes with original e-Kick .

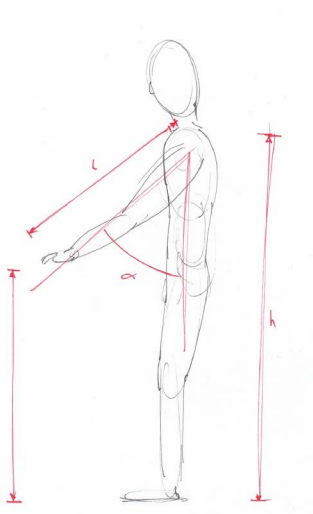
The Delft database DINED gives useful data for dimensions of the e-Kick:
- Shoulder height and arm length determine the steer height.
- Breadth over shoulders determine the steer width.

The actual height of the e-Kick steer is 970 mm from the standing plate. This results in an arm angle of 47 deg for P50 male. For P95 male the angle is 37 deg.

General ergonomics

A posture with slightly bended arms is better for the shoulders and neck. (Christiaans, 1998)

populations switch axis	Dutch adults 31–60, male		Dutch adults 20–30, male	
measures	mean	sd	mean	sd
Stature (mm)	1770	76	1848	80
Breadth over the elbows (mm)	502	38	488	36
Shoulder height (mm)	1457	73	1515	74
Arm length (mm)	746	47	763	43

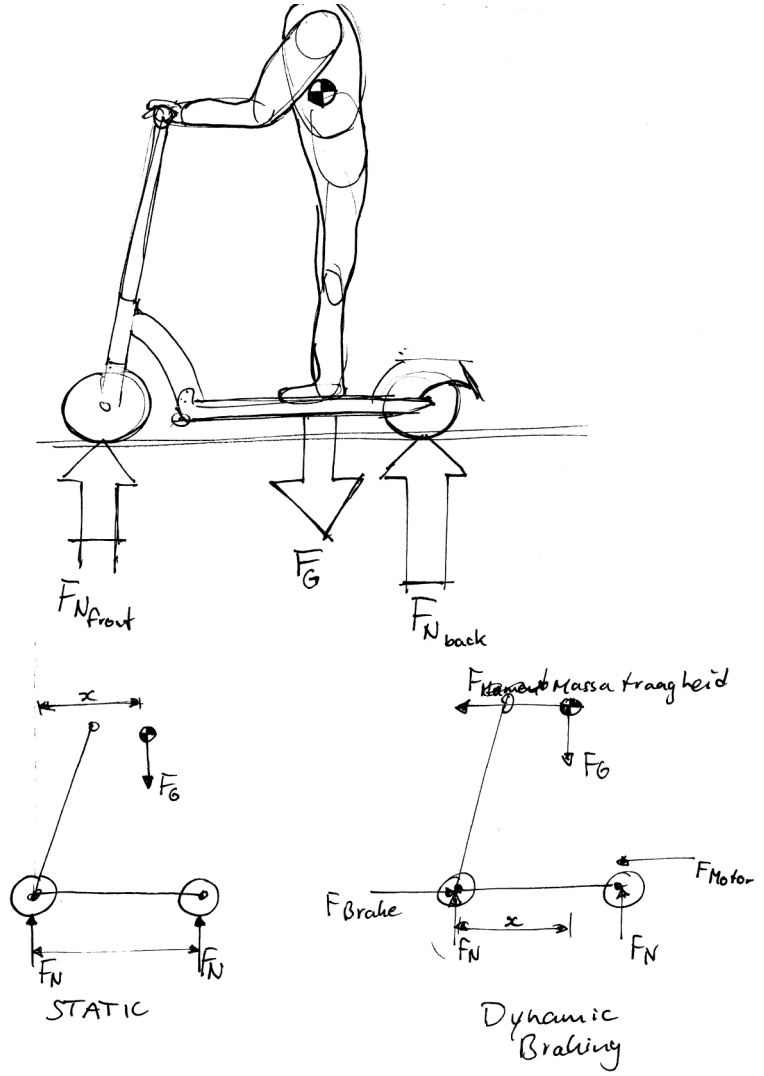


Arm angle	Steer height (mm)
40 deg	908
45 deg	952
50 deg	1000
60 deg	1109

Conclusion
The current height of the steer is not ergonomically uncomfortable for the P50-P95 European male. The e-Kick needs to be balanced out while driving, accelerating and braking. A simple free body

Balance and safety

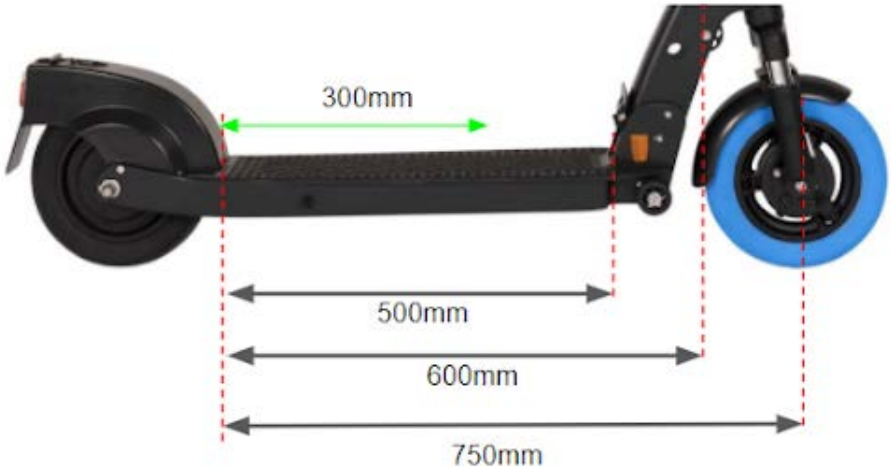
diagram is shown in the figure on the next page. It is important to keep the center of mass of the driver on the side of the rear wheel for a safe balance. If the center of mass is moved too close to the front wheel, braking or small obstacles can cause injuries by falling off the e-Kick.
The centre of gravity is not allowed to be on the first half of the baseplate, measuring from the steer. The green arrow in the figure on the next page shows the location the centre of gravity is allowed above.



IF DIMENTION x IS TOO SMALL THE DRIVER FLIPS OVER THE STEER WHILE BRAKING

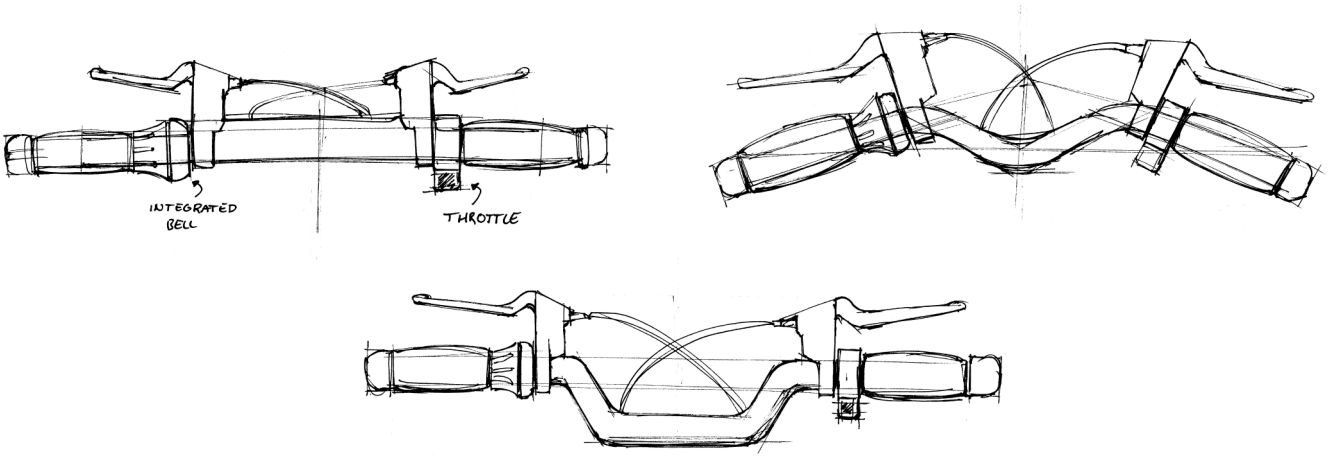
Conclusion

The users of the e-Kick need to be carefully instructed about keeping their center of mass above the rear half of the e-Kick. Driving with two feet next to each other is not safe. The perfect standing posture is standing as far back as possible on the foot board with your feet behind each other.



Steer shape

The steer of the e-Kick is straight. Unlike all bikes there is no bend in the handlebars. To validate if a bike-like shaped steer is better, a new steer is made in the TU Delft workshop which is used for user testing.



In figures below you see the new bike steer attached next to the old steer shape.

The user test is carried out with two different steer shapes on two different e-Kicks. The participants were asked which version they liked and why.

Test results

Participant no.	Preferred shape	Why?
1	Bended steer	Feels more natural
2	Bended steer	I don't know, it feels more natural
3	Straight steer	I like how it looks
4	Straight steer	It is more sporty, it suits the style
5	Straight steer	I feel like I have more control

Conclusion

The steer shape remains straight. The test did not point out that it was a promising change. Next to that is making a clean design of the steer harder when it is bent. To hide the cables on the inside of the steer is now almost impossible.

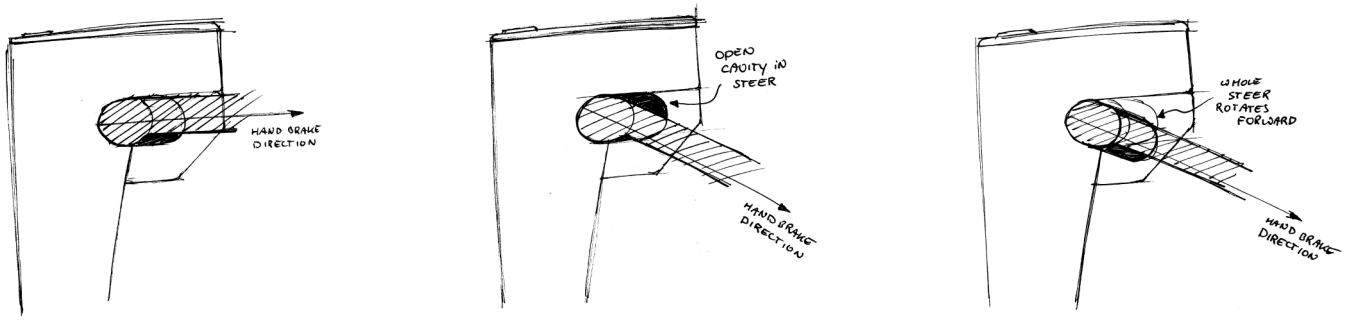
Hand brake angle

The angle of the hand brakes is not in line with the arms of the driver. This results in a bad reach for the brake. To improve the safety of the e-Kick, the angle needs to be adjusted and the brakes tilted downwards.

Looking at the image above, a slot is in the steering tube where the hand brakes slide into. This protects the wiring going from the brake to the display. But this prevents the possibility of adjusting the angle of the hand brakes.

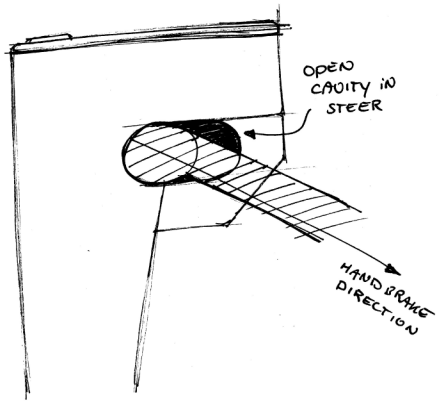
Problem

The steer has a slot for the handbrake, the slot angle needs to be adjusted in the steer design.



There are 2 main options to adjust the hand brake angle. Looking at the sketch above, the first sketch is the current solution with the hand brakes pointing forward. The second sketch shows the option of tilting the complete steer. The third sketch shows the tilting of the hand brakes by adjusting the slot inside the steer.

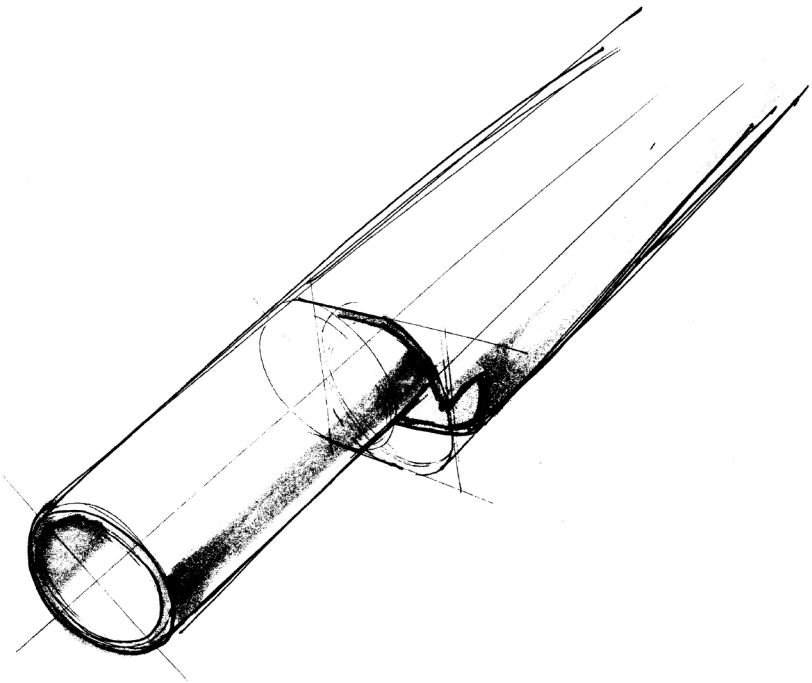
Option 1: tilt down hand brake angle



This option is made by machining a bigger slot for the handbrakes into the steer. Shown in the image below you can see the result.

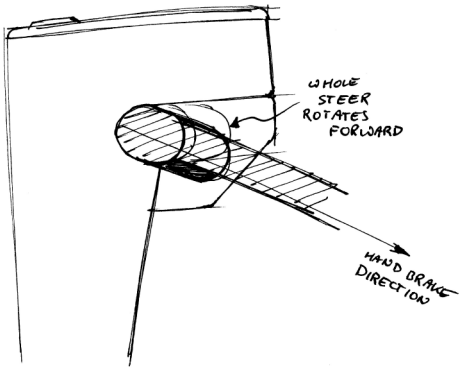
The result is for ergonomic purposes acceptable, but it looks not pleasing. The gap now visible impacts the aesthetics of the design and does not protect from water and dirt going into the steering tube.

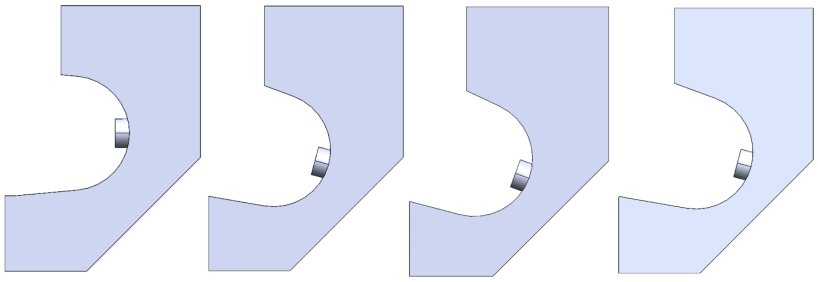
The new cut out slot for the handbrake looks like the sketch below.



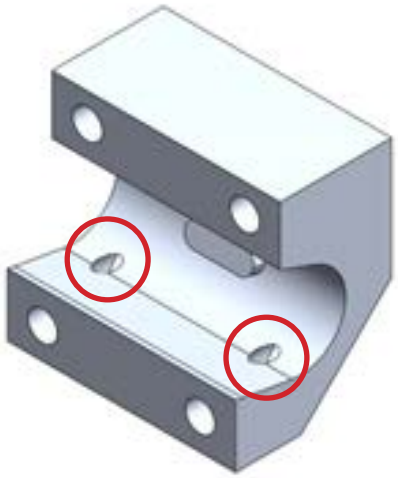
Option 2: tilt down the steer

To tilt down the steer angle, the casted aluminium part holding the steer in place needs adjustment.
With 3D modelling multiple 3D prints were made, having different angles for the steer.





By tilting down the contour of the steer, the bolt cavities open up (See figure below). This has influence on the strength of the part and now the steer is more exposed for dirt and water. According to the strength analysis in Appendix 23, the adjustment has no influence on the failure of the part.



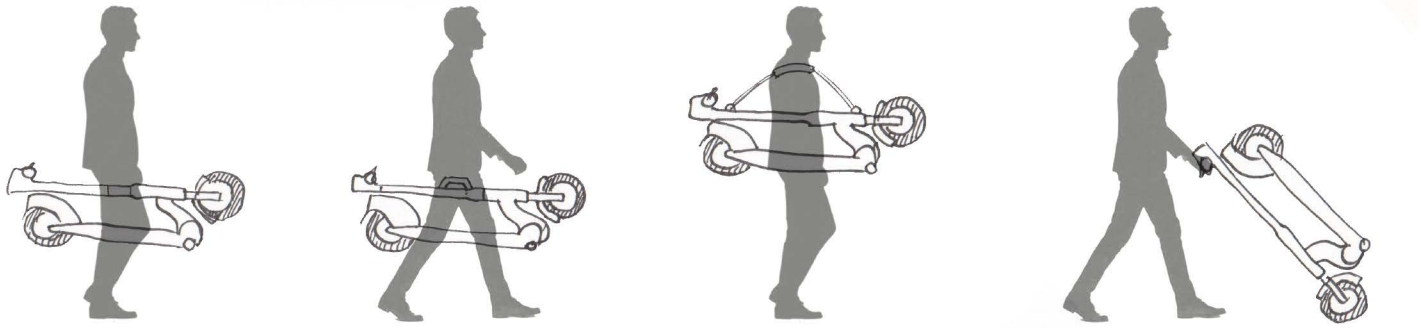
Conclusion
The best solution for this issue is to use a mix of both option 1 and option 2. The hand brakes itself will be tilted forward to an angle of 10 degrees. This limits the gap formation between the hand brake and the steer.
The whole steer will be tilted another 10 degrees by adjusting the small part locking the steer to the steering column.

However one important factor was not taken into account in this previous conclusion, the storage of the e-Kick.
Shown in the image below the current method for e-Kick storage in the Swapfiets warehouses is used. When tilting the angle of the hand brake too much down, the e-Kick will lean on the hand brakes when stored. This will lead to a breakdown of the part.
With live testing of hanging the e-Kick the maximum hand brake tilting angle is 10 degrees downwards. This leads to a new conclusion.

New Conclusion
Because of the tilting limitation of the storage method in the warehouse, the hand brakes are tilted down 10 degrees. This is done with the option 1 previously described. In the image below a render is shown of the new steer with the slots for the handbrake in.

Carrying

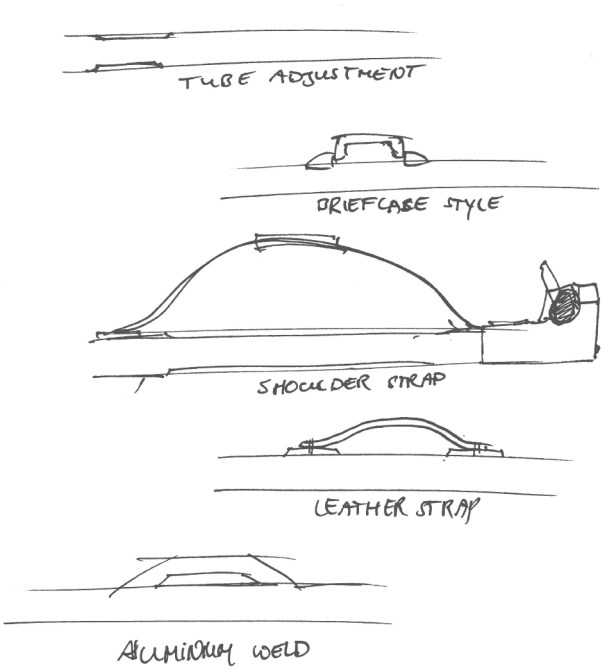
The e-Kick is with its 18 kg a quite heavy object. Because it is frequently taken into public transport and needs to be charged at home, the e-Kick needs to be carried sometimes. The current carrying of the e-Kick is not very ergonomically pleasing and needs improvement.



Solution

There are 3 viable solutions that can improve the carrying of the e-Kick which are shown in the sketch above.

- Carrying strap
- Grip
- Holding point indicator



Option 1

The first method is adding two rings attached to the steering pole. To this rings a carrying strap can be attached. However, looking at the user scenario approximately 95% of the time the e-Kick is used, the carrying strap is not necessary. Therefore the strap can be detached while riding.

+ Not visible when riding because it is detachable

- If the strap is left on the e-Kick, it can cause rattling noises
- If the strap is detached, it needs to be stored somewhere or taken along

Option 2
The second option is adding a grip to the steering pole, right above the center of mass of the e-Kick. This gives the user a better grip on the e-Kick because the grip has a smaller diameter than carrying it by holding the steering post.
Next to that can this option be combined with a lock idea where a new hole is created to loop the cable lock through.

+ Better grip
+ Possible to loop cable lock through
+ Balanced out above centre of mass

- Permanent om the frame
- Needs to be welded on for strong and safe grip
- Not for carrying with two hands

Option 3
The third option is to point out on the frame where to grab it by pointing out the centre of mass. This has no influence on the frame design and will only point user in the right direction

+ Minimal invasive design adjustment
+ Design looks opportunities

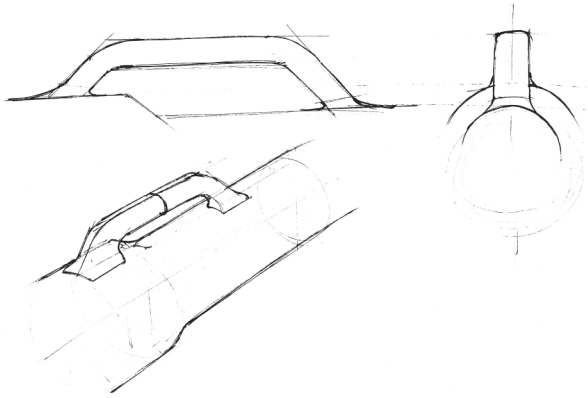
- Almost no change from original design
- Users don't need an indication for the centre of mass, they can feel it themselves.

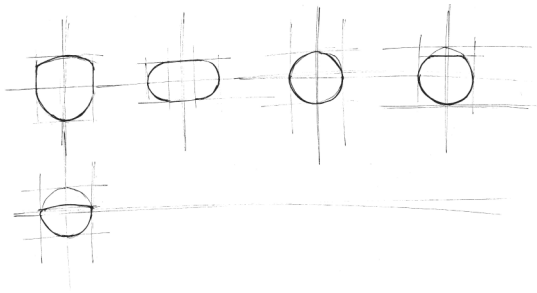
Design

The grip must fit balanced over the centre of mass of the e-Kick. A quick test prototype showed the location of the grip (See figure below).

The ergonomic shape of this handle bar is not comfortable at all. So a new iteration for the grip diameter is shown in the image next to it.

The ergonomics are desirable so now the design of the handlebar is important. It needs to blend in with the frame and does not interfere with other parts.





Based on the sketches above, multiple sizes are 3D modeled and 3D printed to test on the e-Kick.

Out of these different sizes the following conclusions were drawn:

- There needs to be enough space between the frame and the grip for your fingers
- The mechanic can still reach the bolts under the grip
- The lock needs to fit through

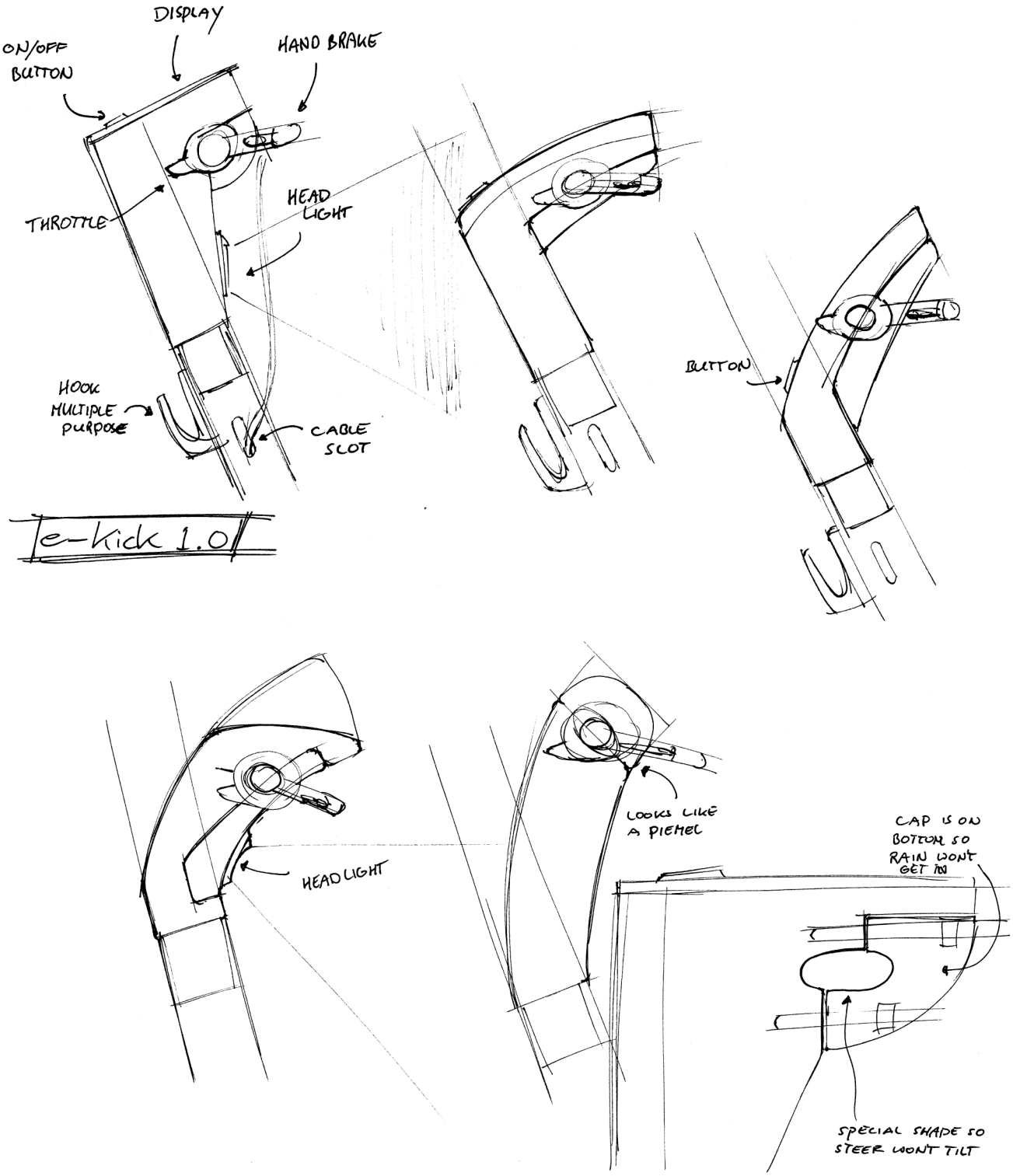
All of the requirements stated on the previous page were achieved as you can see in the pictures above. Below is the final design shown, made in Solidworks, ready to be manufactured and welded to the steering pole.

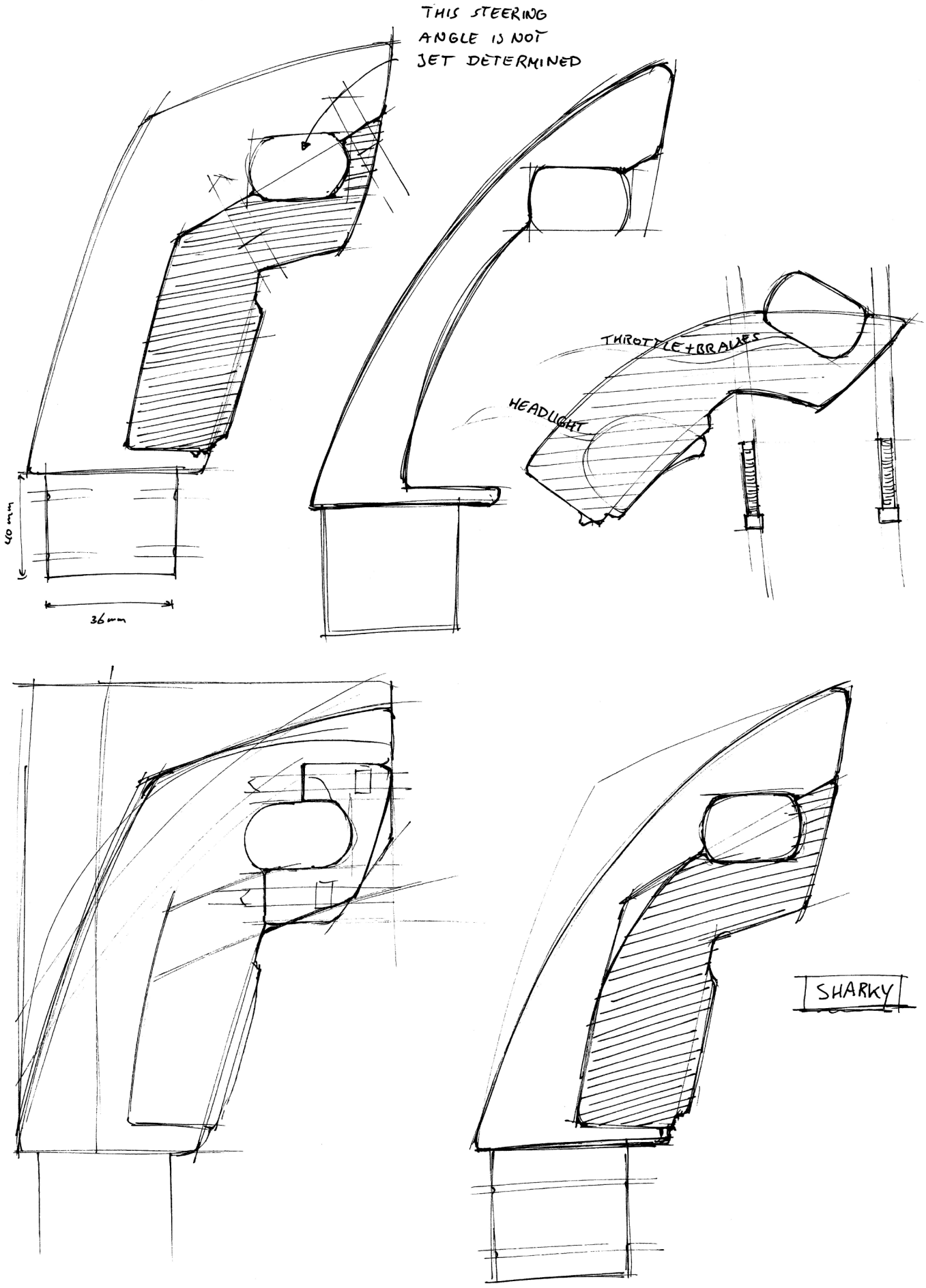
Next level

The previous iteration steps are not very invasive in the total design. Looking at a future model where a redesign is needed for the steering column, there are a lot of options possible.

Looking at the design process shown below the main advantages for a new development are:

- More space inside the steering column
- Better reach inside the column for repairability purposes
- More sporty look, targeting customers




THIS STEERING
ANGLE IS NOT
JET DETERMINED
THROTTLE+BRAKES
HEADLIGHT
40 mm
36 mm
SHARKY

Appendix 12:
Sprint 2 Brakes

By the order of the first batch of the e-Kick 1.0 Swapfiets demanded double handbrakes on the e-Kick. The standard model only had one handbrake which brakes mechanically front with a drum brake and electrically rear with an electrical brake on the rear wheel motor.
The demand of making the e-Kick with double hand brakes was solved in a weird way by the Chinese manufacturer. They added an extra handbrake which also led to a drum brake in the front wheel. This means that the left and the right handbrake both lead to an individual drum brake inside the front wheel. This is not the solution Swapfiets expected because of the standard front- rear brake separation used in bikes.

The braking on the e-Kick is quite strong and that is why Swapfiets employees inform the users about it when they first deliver the e-Kick. Is there a different braking method for the e-Kick that improves braking, is logical like the bike front/rear brake distribution and does not influence the current design too much?

There are multiple options which have 2 separate hand brakes:

Option 1:
1 drum brake front
1 drum brake rear
2 electrical brakes rear

Advantage:
- Same brake type front and rear
- Split hand brakes
- Option of adding cruise control

Challenge:
- Intern cable from front to rear
- Frame must be wider at rear

Option 2:
1 drum brake front
1 drum brake rear

Advantage:
- Same brake type front and rear
- Split hand brakes
- No electrical brakes result in steering console having less cables -> repairability improvement
- Cheaper handbrakes

Challenge:
- Intern cable from front to rear
- Frame must be wider at rear
- No software cruise control possible

Option 3: (Current solution)
2 drum brakes front
2 electrical brakes rear

Advantage:
- Original e-Kick 1.0 design
- No frame adjustments
- No brake cable to rear
- Option of adding cruise control

Challenge:
- No independent front and rear brake
- over designed front brake

Option 4:
1 drum brake front
2 electrical brakes rear

Advantage:
- Independent front and rear brake
- No frame adjustments
- Option of adding cruise control

Challenge:
- The haptic braking feedback differs between front and rear brake.

Option 5:
1 disc brake front
1 disk brake rear
2 electrical brakes rear

Advantage:
- reliable braking during bad weather
- Independent front and rear brake

Challenge:
- Needs a lot of maintenance
- The rear frame needs adjustment
- The front fork needs adjustment

Conclusion
Option 3 is chosen to be the best for the e-Kick 2.0. This is the same braking system the e-Kick 1.0 has.
The two best options are option 1 and 3. These two options are realistic to achieve and verified by the manufacturer. For option 1 the two main disadvantages are repairability and price. The repairability is not improved because of the extra cable added through the frame all the way from the handlebar to the rear wheel. Next to that, the price will be increased because of a new mould needed for the frame. The new rear wheel with the drum brake is wider and does not fit in the current frame.
For option 3 the main disadvantage is that it does not look logical to have two exact same front brakes working parallel. However the braking still works properly, the cable management is workable and the safety of the user is secured.
The investment money and repairability do not pay out the improvement of making the e-Kick more logical looking. Therefore the 3rd and original option stands.

Appendix 13:
Sprint 3 Cable management

There are three main problems occurring inside the steer relating to the cable management:
- Repairability
- Waterproofing
- Cable quality

Approach
- Analyse the current workflow for mechanics
- Create prototype in TU Delft workshop
- Validate with Swapfiets mechanics

Repairability

Problem:
The hole inside the steer is too small for our mechanics to work with, it is hard to lead the cable through.

The handlebars are hard to get off. This is because there is no closed cavity inside the steer to build up pressure for sliding the handlebars off easily. For bike steers this is possible.

Hard to get the cables through the steer. It is a small cavity where 2 cables must run parallel through.

Removing the heat shrink around the connectors is hard. Mainly because the hot glue added to the connectors melts to the heat shrink, making it stick to each other.

After reconnecting the cable connectors, the cable needs to slide back into the steer cavity. According to the Chinese manufacturer this goes easily without taking the steer off. But in this test it was not possible without taking the steer off again.

Solution
Make the hole bigger, this will have a minimal impact on the strength of the steer and will still meet the safety regulations (NEN, 2017). By analysing the strength via digital modelling, the hole can be made bigger (for strength analysis see Appendix 22).

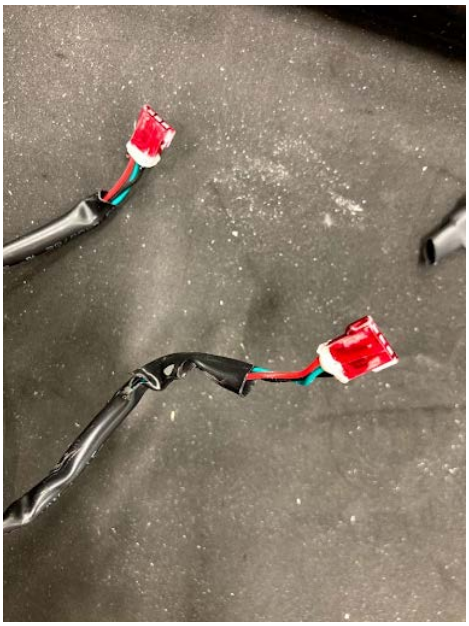
Validation
With a bigger hole for the cables to go through the mechanic has significantly better control over the cables. Now he can install everything faster.

Manufacturer response:
Suggest to remain the current one size as it's not easy for handlebar broken and this has been verified in all of our scooters. It's ok for operation if you can use a steel wire that can easier to hook out the wires. Pls refer to the attached videos for our operation.

In this video it shows that they guide the cables with a bicycle spoke. However, they only guide 1 single cable through the cavity, in the real design there are two cables parallel. According to the Chinese manufacturer this does not change the method. Using a spoke to guide the cables is a good option.

Cable connectors

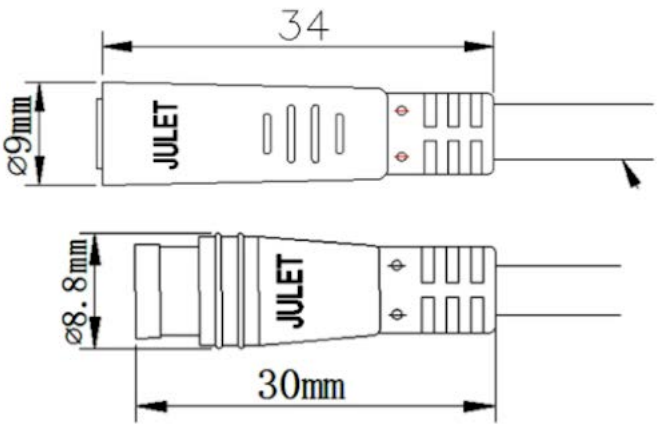
Looking at the current e-Kick 1.0 version, multiple connectors are not according to IP56 standards. These are the cable connectors inside the steer running from the brakes and throttle to the display and the cable connector connecting the rear light with the motor controller.



Looking at the first image you see a 3-pin connector used which is covered up with heat shrink for water and dust protection. The advantage of this connector is the size, it fits easily through the steering shaft. The disadvantage is that the quality is bad, the waterproofing is not up to standard, the heat shrink is not contributing for repairability and the hot glue attached to the connector sticks to the heat shrink if it is applied which makes it hard to remove afterwards.

Solution
In other parts of the e-Kick, different cable connectors are used. These are according to the standards of IP56 (See figure above). These cable connectors need to be applied to all connection points in the e-Kick.

The difference in size of the old and new connector can be seen in figure below.



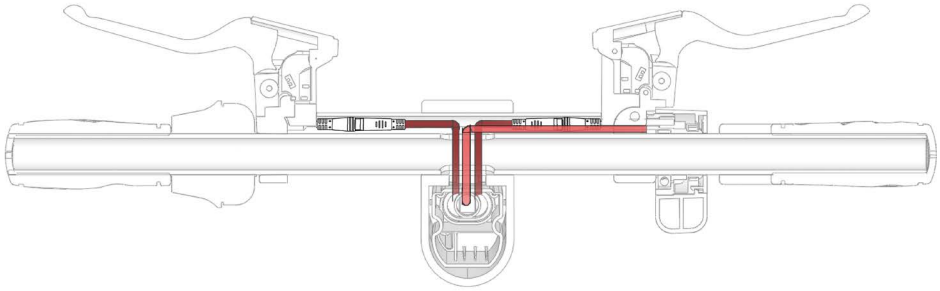
Implementing this type of connector for the rear light is easy for the manufacturer, it is simply replacing the connector to the IP56 connector. There is enough space for this inside the battery housing.

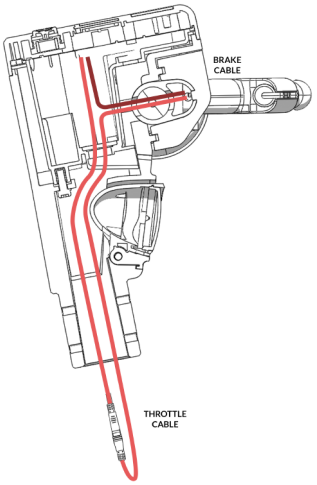
Replacing the cable connectors inside the steer is not that easy because the space is limited. Especially the right side of the steer where two cables go parallel to the throttle and the brake.

Iteration 1:
First of the cable connectors were replaced with the new type. Inside the steer the connectors do not fit next to each other so they are placed outside the steer shown in the figure below.

The issue with this solution is that there is no space for the connectors to fit in when the steer is attached to the steering column. It needs a new solution where the cable connectors have space.

Iteration 2:
The new design for the cables is shown in figure below. The cable connectors are now in locations that they fit in. The installation method is now slightly different from the original one.
The cables running to the hand brakes will be inserted from the display side. The cable running from the throttle to the display will go the other way around.
With this solution the cable connectors are separated from each other and have enough space to be attached and detached.



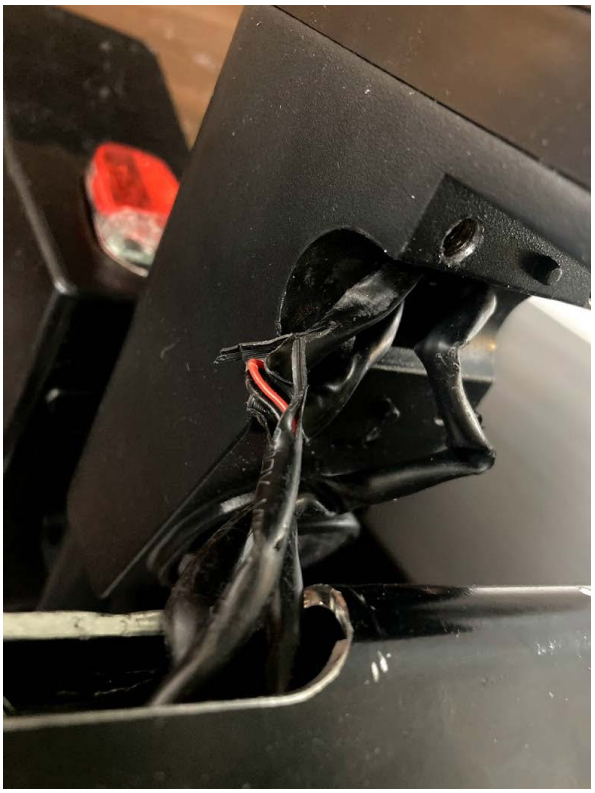


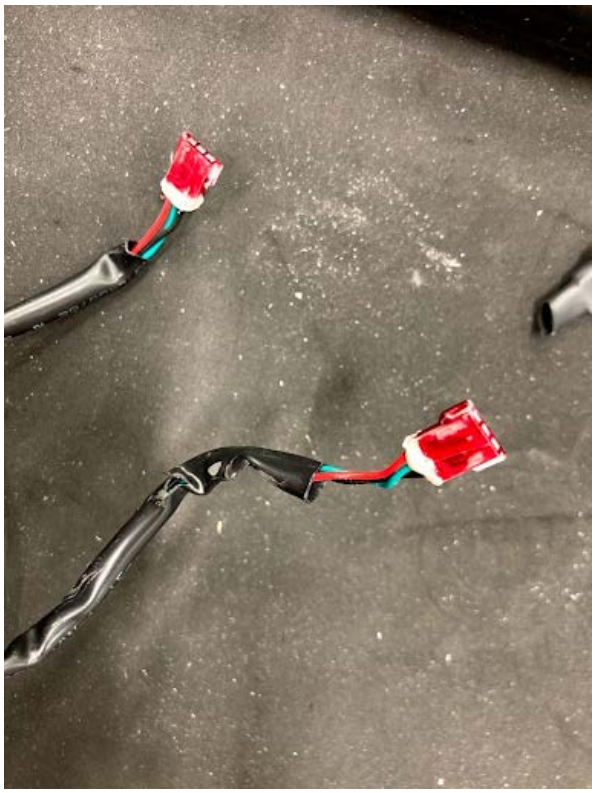
Validation
The complete cable route is prototyped inside a standard e-Kick 1.0 shown in the image below.
This prototype needs to be tested with the Swapfiets mechanics. Due to time constraints this was not possible to do at the warehouse. This needs further attention and testing to validate if this new solution is truly possible to operate by the mechanics.

Conclusion
After multiple iterations the final new cable route is determined shown in the image above.
This new cable route creates space for the new, bigger cable connectors inside the steer and still improves the repairability by avoiding difficult handlings in tight spaces.

Cable quality

Looking at the cables running from the display to the handbrakes and the throttle, the cable consists of three small cables covered in a rubber tube with no tight fit, it is just shoved over as you can see in figure below on the right. This rubber tube is not resistant to frequent movement or bending. Shown in the other figure below you can see the result due to bending.
As you can see in figure, there is a permanent bend in the cable. This is making it hard for the mechanic to put it in the steer.





Solution
Use everywhere high quality, pre manufactured cables. In this way the standard will be the same throughout the whole e-Kick and the cables will be more resistant to wear and bending.

Appendix 14: Sprint 4 Lock

The current lock on the e-Kick 1.0 is the AXA fold or the Trelock TF100 (see images below). This lock is attached to the steering pole with a holder bolted into the frame.
By locking the e-Kick, the lock is taken out, looped through the folding mechanism or the front fork and attached to a bicycle rack or something alike.

The problem is that the location to loop the lock through is not very clear. It does not look that the cavities on the e-Kick are designed for a lock.
Next to that, the location to loop the lock through iw low at the ground. The user needs to bend over all the way down to attach the lock.
Another occurring problem is the lock holder falling off. This is because the bolts are not resistant to the vibration and eventually come off. This problem is solved in the e-Kick 1.2 version by using thread locking adhesive by assembly.

The current lock type attached to the e-Kick has a safety mark of ART 2 which is comparable with a high quality bike lock. The new design needs to aim for the same safety mark.

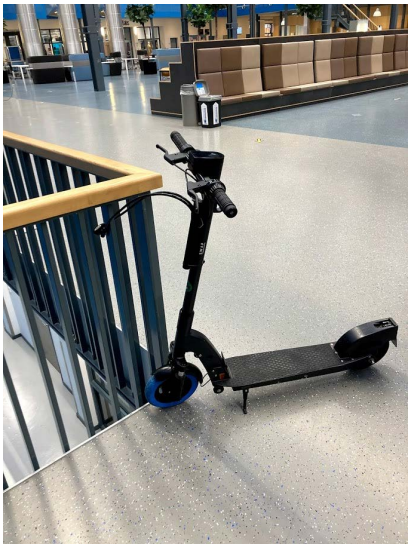
Solution
In cooperation with the pioneer in security company Allegion, multiple ideas are discussed and designed for implementation in the new e-Kick. In the next part, 3 different designs are discussed. These are also discussed with the engineer of Allegion.

Option 1
The first option is the Interlock principle. Interlock is a kickstarter company who designed a lock that slides inside the bike frame. In this way the lock can be stored when not used and easily taken out for locking. For this idea the same principle is used.
It is a cable lock integrated into the steering pole which can be slided out and used as a cable lock.

+ Very user friendly / easy to use
+ Well integrated into the frame

- Needs to fit inside the steering pole
- The lock can block the folding mechanism
- Installation/repair is not easy

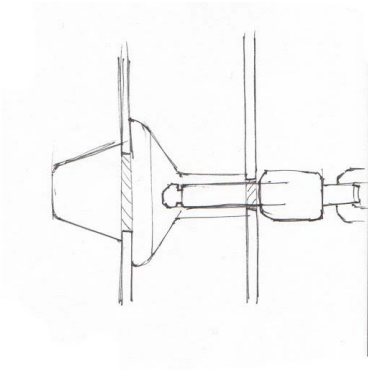
By linking the Interlock to the e-Kick, it could be tested. This resulted in very enthusiastic users, it was very easy to use.



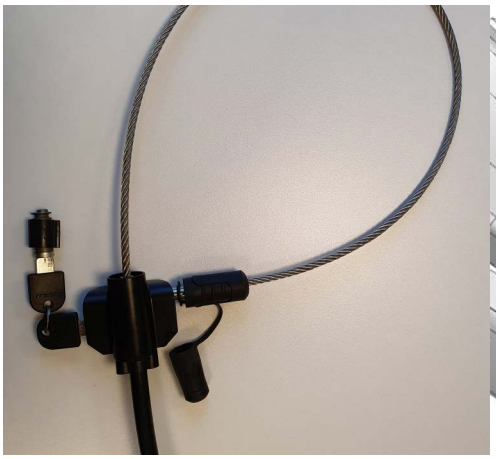
Allegion did look into this company for buying the idea. However they did not proceed because they did not like the level of security. The thin cable can be cut with a simple handwork tool. Next to that they did not believe the market for this lock to be very profitable.
Inserting this into the steering pole is not possible according to Allegion. There is not enough space. Especially when there are also cables running through.

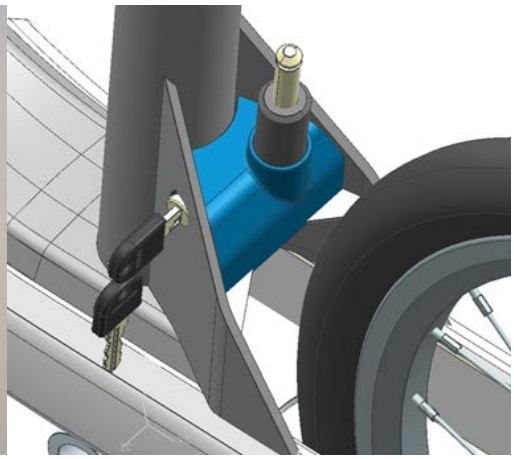
Option 2

The second option is to add an integrated plug-in cable lock. This resembles the same working principle of the locks on the Swapfiets bikes. On the top of the steering pole, a lock is installed in which a plug-in lock can be put in. Originally the plug-in lock is combined with a regular bike lock. But this time the key is only unlocking the plug-in part.



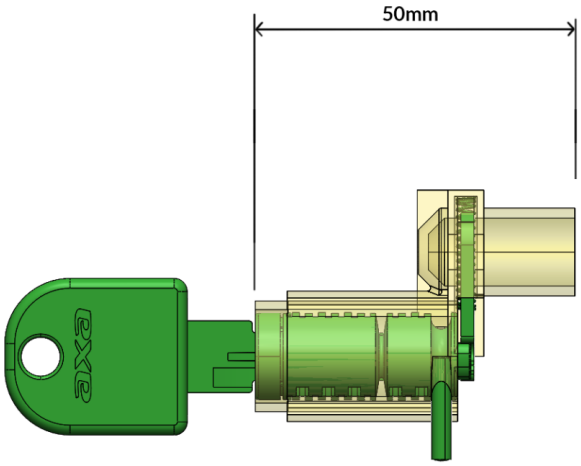
Allegion has already some work done on this topic. They have a plug-in design for rental bikes shown in image below. This design needs more space and cannot be installed in the steering pole.





The basic plug-in lock design can be seen in the figure below where the minimal dimension is shown. This still does not fit in the steering pole. Another option is to implement this somewhere else in the frame, with more space.

A potential location is the frame part shown in figure below. This new solution comes with multiple pros and cons



+ The same lock as on the Swapfiets bikes can be used
+ The lock is integrated in the frame
+ It can be made by AXA

- The user still has to bend down locking it
- The plug-in cable needs to be carried along in a holder
- It is not determined ART safe

Options 3
The third option is not changing the lock but creating locations on the frame to loop the lock through. So the lock type is still the AXA fold or the Trelock TF100 so the level of security is up to standard. There are two different locations which are a possible solution:

The steering pole
Place a ring or handgrip on the steering pole to attach the lock to. The handgrip will be made of aluminium (same material as frame) and be welded to the frame. In this way the carrying solution and the lock improvement can be solved in one go. If the handlebar is used for carrying, the location must be low on the steering pole because the handlebar needs to line up with the centre of mass of the e-Kick.

+ Combined solution for lock and carrying
+ Ergonomically friendly location for lock

- The handlebar needs a permanent fixation to the frame (welding)
- The lock is not integrated inside the frame

The spoiler
Attach a bracket to the rear mudguard of the e-Kick pointing backwards. This gives the opportunity to attach the lock to and protect the rear light. This part is also welded to the mudguard. This mudguard however, is attached to the frame with simple screws.

+ Protect rear light
+ Can be used as a handle when rolling the folded e-Kick

- The user still has to bend down
- The rear mudguard can be detached with simple tools

Allegion preferred this idea of adding an attachment to the frame because it was simple and easy to realize. The design for the attachment on the mudguard was not a good idea because the lock that is frequently looped through it, can damage the fragile parts like the light.

In the TU Delft workshop this option is prototyped and tested. As you can see in the figure below.

Conclusion
The best option for the e-Kick 2.0 is to make an attachment to the steering pole. This not only improves the ease of use for locking the e-Kick, but also makes it possible to carry the e-Kick in a more ergonomic way.

The level of safety is achieved with the current AXA and Trelock locks. The only disadvantage is that this lock is quite expensive for Swapfiets to buy.
The lock holder currently attached to the e-Kick 1.0 did come off multiple times (See Appendix 2). By adding thread locking adhesive like Loctite this problem will not occur this often.

Next level
With the Chinese manufacturer some initial orientation was discussed about using a smart system for tracking and locking the e-Kick. This system could be built inside the e-Kick but would make the price definitely higher. This development is often used for the sharing market where multiple customers must be able to unlock the same vehicle.

Out of the user research, multiple people wanted to have an electronic lock on the e-Kick which they could unlock with their phone. Locking the e-Kick only with an electronic lock does not prevent it from being stolen by just picking it up and carrying it away. This is the main reason why this smart lock is not implemented in the new version of the e-Kick.

However for a e-Kick version beyond the 2.0 it could be possible to implement.
There are two main things that need to be checked out. The integration with the current Swapfiets app and back-end system and the development of the smart plug-in cable lock.

Smart plug-in lock development
Looking at option 2 of this design sprint, the plug-in locking mechanism is operated with a key. This key needs to be replaced with a bluetooth controlled lock. This Bluetooth part can be added into the steering column right under the display according to the Chinese manufacturer.
This must be linked to the locking mechanism where the cable lock can be plugged into.

Appendix 15:
Sprint 5 Kickstand

On the e-Kick 1.0 the kickstand is an aluminum piece, rotating under the e-Kick. The issue of this component is the hinge. This part is not resistant to high frequent usage which results eventually in a Swap.
In left picture below you see the original kickstand. In the image next to it, you see the issue of the hinge not being strong enough and flipping the other way around.



The Chinese manufacturer already has a new model ready for the new e-Kick 1.2 which is shown in the last figure above. The improvement is visible in the plateau under the kickstand. This improves stability of the e-Kick while parked. Next to that the bigger surface has a lower impact on the surface the e-Kick is parked on (by for example scratching the floor).
This is not solving the initial problem of the broken hinge.

Advice to Chinese manufacturer:
The improvement is acceptable but the hinge inside the kickstand needs to have a higher quality. Otherwise the new type kickstand will have the same defects.

Manufacturers response:
They came up with a new design. They adjusted the material of the lower part of the kickstand and still did not change or improve the hinge (See figure below). Bad communication?

The manufacturer needs to check new suppliers for a different type of kickstand with better quality. This is not easy because the holes for the bolts connecting the kickstand to the frame need to be at the same location. China is proceeding to look for a new model.

Conclusion

The Chinese supplier does not understand which part to replace. Hopefully, after two wrong attempts they finally come up with a decent replacement. In the meantime the old kickstand version is ordered for the new e-Kick 1.2 model including extra spare parts. In this way potential breakdown can be replaced quickly.

Appendix 16:
Sprint 6 Cable protection

Problem:
The cable running from the rear light to the power source is going via the rear fender. This is attached with hot glue to the fender which is a simple one time fixation and bad for repairability. Next to that is the motor cable badly unattached to the frame and badly protected from dirt and impact.

Possible solution:
Add a cable guard on the inside of the rear fender. Next to that protect the motor cable better and attach it to the frame.

Manufacturer response:
After checking with their own engineer they came up with a solution. A clip will be added to the inside of the frame which supports the motor cable. For the cable of the rear light inside the mudguard they do not want to change their approach. The hot glue works fine for them. There is no existing alternative solution that can be added to the current design.
If we really want to keep them from not using hot glue, a complete new cable guide method needs to be designed, tested and validated by Swapfiets.

Conclusion:
The motor cable is guided in the new design. The rear light cable will be attached with hot glue and will currently not be further developed by Swapfiets. First intensive operating with the e-Kick will be analysed for a longer time. If this will occur as a frequent problem, further measurements will be taken.

Appendix 17:
Sprint 7 Charger plug

Problem:
Charger plug breaks down easily because of the small size of the plug. Comparing it to the charger plug of the Segway Ninebot ES2 the diameter is smaller, adding more stress to the plug. Under my own experience I had a plug break down without any weird impact happening to it.
Next to that, the charger port cover falls off easily. The simple fixation of the rubber ring around the charger port, it comes off easily with a small force.

Possible solution:
Investigate is if there is a different charger plug that can be added to the charger, preferably one with a bigger diameter. By making an angle in the cable at the charger plug, the plug is better protected against impact while plugged in. (See image below)
For the charger port a better version is demanded, not falling off easily with a more solid fixation to the plug port.

Manufacturer response:
We will provide the testing report for the plug next week. Charger cover: We are sourcing for new cover with better quality.
The testing report done by their supplier shows that it is strong enough and does not break down under normal circumstances. The broken chargers are sent to China for further evaluation.

Conclusion:
The Chinese manufacturer is still sourcing for a new plug cover and for a plug with a bigger diameter with their suppliers.

Result:
A new alternative is found shown in the images above. The plug of the charger is changed to a version with a bigger diameter. The plug cover is now also bigger which attaches it better to the port.

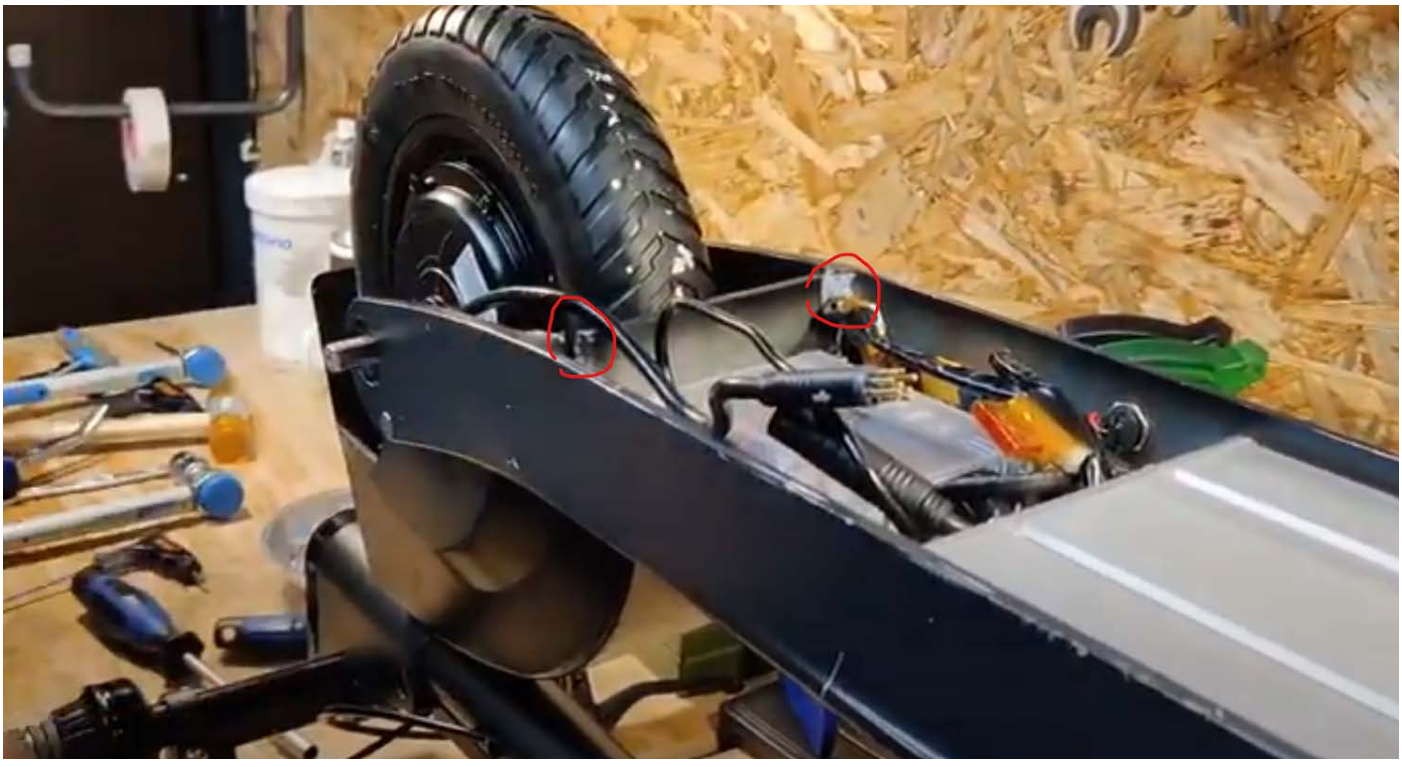
Appendix 18:
Sprint 8 Wiring to battery

Problem:
At the entering of wires coming from the display or from the motor and rear light leading into the battery compartment, the seal is made with hot glue. This is a permanent solution and not contributing to the repairability of the e-Kick. Next to that they easily come off.

Possible solution:
Using rubber washers to seal the opening. In this way they can be reused by a repair and don't come off easily.

Manufacturers response:
Suggest to use hot glue as currently for better waterproof. Pls use the hot glue and the tool for maintenance purposes.
The manufacturer is not familiar working with other solutions apart from hot glue. This means that a different solution with rubber washers must be fully developed and investigated by Swapfiets. Or a validated solution in a similar product can be implemented.

Conclusion:
The wires going inside the battery compartment will be sealed off with hot glue in the e-Kick 1.2 version. For the next version an existing part used in another kick-scooter type must be used after testing done by Swapfiets.



Appendix 19:
Sprint 9 Loctite

Problem:
Multiple bolts, screws and nuts on the e-Kick come loose due to vibrations during use. This cannot be solved by tightening the bolts because it will break the parts.
The main issue is the lock holder. Multiple cases have been orruces under the customers.

Possible solution:
Add a thread locking adhesive to the screws, bolts or nuts before assembly. This adds extra friction on the thread without permanently locking the part or damaging it.
A good example of thread locking adhesive is Loctite, shown in the image below.

Manufacturer response:
We will use the same Loctite on stem bolts for new orders. The Loctite price is EUR6/bottle. We will check the cost for each scooter using Loctite in the new order.

Conclusion:
The manufacturer is going to use Loctite on each bolt. This will prevent bolts and screws from falling out of the e-Kick due to vibrations. Shown below is an overview of the bolts and nuts which need Loctite application.

Appendix 20:
Sprint 10 Charging feedback

Problem:
While charging the e-Kick, there is no visual feedback of the status of charging apart from an indicator light on the charger block which turns green if the charging is finished. The display of the e-Kick does not work and there is no indication of charging progress.

Possible solution:
Add a loading bar on the display for charging indication. Or something else which gives an indication about the charging progress.

Manufacturer response:
The manufacturer discussed with the controller and battery supplier for a solution. They will update the software of the e-Kick. This will result in a charging status shown on the e-Kick display while charging.

Appendix 21:
Sprint 11 Cruise control

The other electric kick-scooter type Swapfiets operates with is the Segway Ninebot G30 MAX. This version has a cruise control built into its software. By holding down the throttle at the same position driving a constant speed for 5 seconds, the cruise control automatically turns on. If the brakes or the throttle are used again it automatically stops the cruise control.
This is also desired in the e-Kick 2.0 design.
Checking with the manufacturer they suggested two options.

Option 1:
Adding a software feature that resembles the same working principle of the Segway Ninebot. This has no influence on the design of the e-Kick apart from a possible increase of the computer controller inside the frame.

Option 2:
Adding a button somewhere on the steer which activates the cruise control. When the brakes or throttle is activated or the button is pressed again, the cruise control goes off again.
This is almost the same as option one except from two things. The first one is the added button on the steer which requires a design adaptation on the steer. The second one is the users intention of using cruise control. The button needs to be pressed so the user is conscious about using it. Looking at option 1, sometimes the user can be surprised by the activation of the cruise control.

Manufacturers response
According to the manufacturer the least invasive method for adding cruise control is option 1.
Looking at the German eKFV §7.7e (BdJufV, 2019) it is required for self balancing vehicles that the motor stops if the driver is not on the vehicle anymore. This can be interpreted in multiple ways, if the user falls off the e-Kick the motor can keep on spinning but the e-Kick will stop because it falls on the ground. The rear wheel will not touch the ground anymore.
The e-Kick is not a self balancing vehicle so must not apply to this requirement. However it adds extra safety.
This issue is checked by the motor controller supplier. The current status is that there is no safety feature in case of an accident. The cruise control will only switch off when touching the throttle or brakes. The supplier is analysing if they can update the function to achieve the German standards.

Operations
When the e-Kick 2.0 will be launched, previous versions will be in operation. It is important that these different versions can be operated simultaneously. The new e-Kick version must not eliminate the older version from the market. Therefore it is checked at the manufacturer if the cruise control can be added to existing products. Because it is a software extension it is possible to update all e-Kicks with a cruise control.
This is being checked by the supplier and we are waiting for their response.

Conclusion
The cruise control will be added to the e-Kick 2.0. Making longer rides for the user more comfortable.
The cruise control will be added to the e-Kick 2.0 and if possible also to all previous e-Kick versions by updating them done by Swapfiets mechanics.

Appendix 22: Strenght and fatigue test e-Kick steer

This report is added as a PDF to these appendices.

Appendix 23: Strength test e-Kick steer holder under angle

This report is added as a PDF to these appendices.