FLEX

Urban shared micro-mobility solution

Master Thesis
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FLEX- Urban shared micro-mobility solution

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Abstract

The development of energy has an impact on the evolution of travel modes. With the iterative update of electrification on private and public transportation, micro-mobility has always been one of the essential options to support cities and commuters. With the explosive growth of shared transportation in the past decade, many companies have invested in the sharing economy market. In order to create a more sustainable way of travel, the current sharing model will be changed in the near future. This project aims to redefine the boundaries of sharing micro-mobility and explore the possibility of its character in modern cities in the future from the perspective of energy sharing.

PHOENIX

This project was created in collaboration with the Phoenix Design and was a project work at Lund University in the 2 year of the industrial design master programme. The documentation will show the design process from design research and product development to the final design. The project was supervised by Sven Feustel, principal designer of Phoenix Design.

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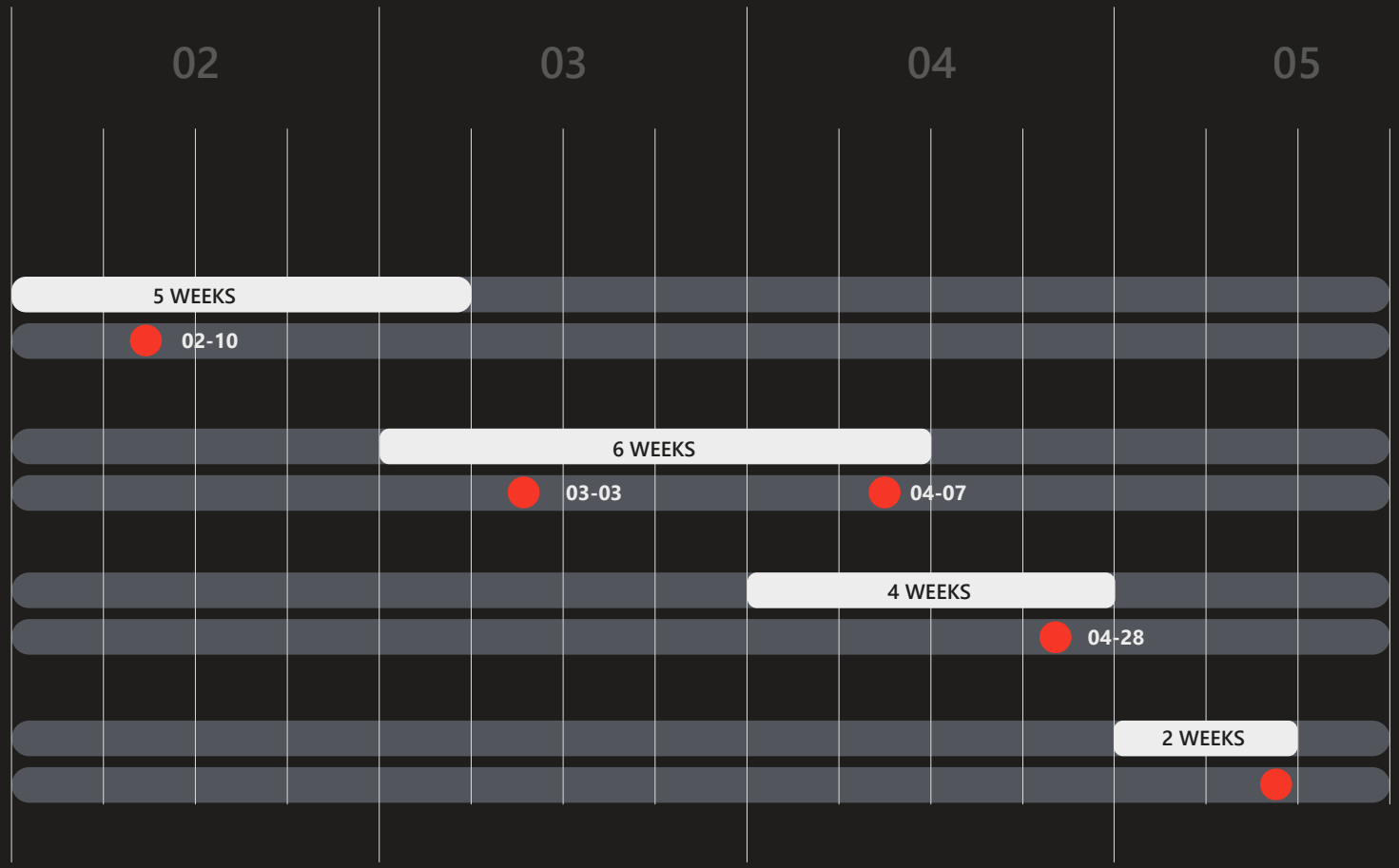
Project Management Timeline



Introduction

The sharing economy encompasses all aspects of services and products, of which transportation is also an area of note. Micro-mobility has become an important means of transportation in modern cities, and although shared transportation products in other countries such as China bring convenience to users, the negative impact on the environment is indeed huge and irreversible. With the gradual development of shared travel in the European market, many new brands have begun to put vehicles into cities, which not only destroys the appearance of the city, but also brings safety concerns to pedestrians.

The project's objective is to explore the future potential of micro-mobility and modify the current service model to affect the interaction between users and products so that users and products can achieve their goals in a more environmentally friendly and sustainable way.

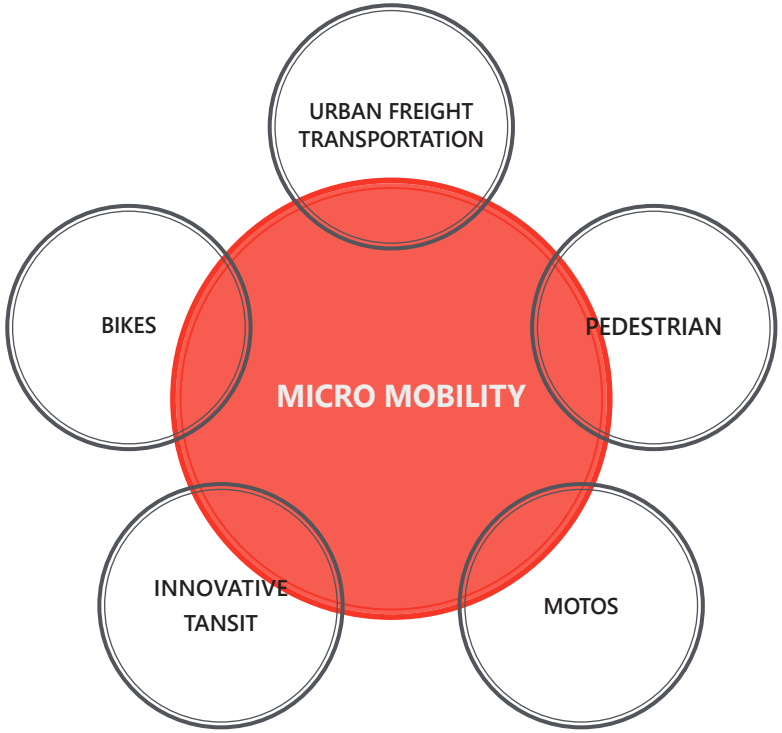

43
dott
dott
by Uber
by Uber
Electric

Project Background
Micro-mobility

A micro-mobility stands for transportation over short distances provided by lightweight, usually single-person vehicles such as bicycles and scooters. This mode of transportation brings convenience to daily transportation and short-distance travel and negatively impacts the environment. With the emergence of different business models and the sharing economy, the focus of micro-mobility has also shifted from products to part of services.

While the Covid-19 pandemic continues to disrupt business and society, a micro-mobility revolution is quietly growing rapidly. The design and range of lightweight human-powered and electric vehicles have evolved, and adoption has spread quickly, with scooters, mopeds, skateboards, and bicycles in every shape, size, and colour crowding the streets.

Some wrecked and discarded e-scooters appear on the streets one after the other, destroying the appearance of the city and endangering the safety of pedestrians. Although most micro-mobility rental companies claim that their services are environmentally friendly, the truth is that shared micro-mobility is only eco-friendly when it is used. When companies maintain and dispatch vehicles, the negative environmental impact far outweighs the actual benefits of such services. To decrease waste and harm to the environment, I considered whether the new sharing model could replace the existing floating and station-based two major sharing models.



Background Research
Mega trend

The development of a city is influenced in part by its public transit infrastructure and accessibility. Before beginning research on micro-mobility, it is necessary first to evaluate present traffic patterns and potential future traffic patterns and why people require such short-haul rental services. According to the present general trend, urbanization and population growth will impact modern city traffic throughput. The present world population is 7.6 billion, projected to be 9.8 billion by 2050. In this framework, the number of megacities will be expanded from 43 to 50.

Automotive manufacturers have traditionally dominated the transportation industry, with business strategies built on inventing, mass-producing, and marketing automobiles. Every second European now has a car, yet 95 per cent of the vehicles are idle and take up valuable city space (ACEA, 2017; Morris, 2016). The usage of automobiles is wasteful since many people commute alone. Consequently, traffic gets crowded and chaotic, making everyone nervous and irritated.

With the global population increase, urbanization is anticipated to add another 2.5 billion people to cities by 2050, resulting in 68 per cent of all humans living in crowded places. 2018 (United Nations). As a result, by 2050, worldwide demand for inner-city mobility is predicted to quadruple (Van Audenhove et al., 2018), bringing tremendous difficulties to cities. Existing transportation infrastructure is reaching capacity, and urbanites' mobility needs have grown increasingly complex.

Background Research
World population and city growth

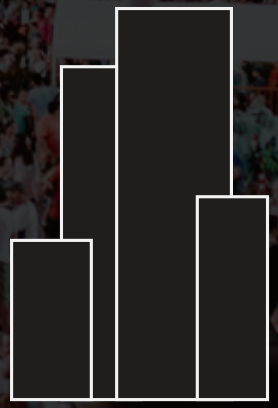
7.6 billion

8.6 billion

9.8 billion

2020 > 2030 > 2050

43 Mega cities



2030

50 Mega cities

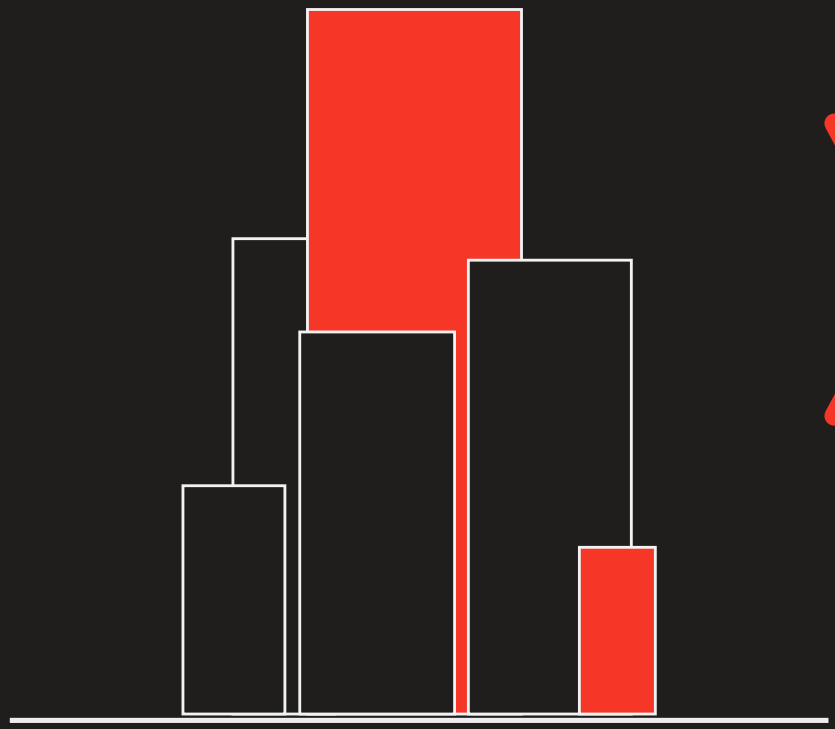
2050

The next urban migration shows the importance of developing high-quality, well-planned infrastructure to provide urban citizens with the necessary resources and everyday services.

Reference: https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html

Background Research
World population and city growth

Influencing trends of urbanization and urban expansion in European cities



URBAN CONGESTION

Urban areas congestion continues to rise; time losses from traffic congestion are **estimated to cost the equivalent of 2% GDP in Europe,** and 2–5% in Asia.

NEW SERVICES & MOBILITY

Mobility and service provision in cities are two of the sectors that are expected to change the most in the future as a result of **technological innovation and behaviour changes.**

DIVERSIFIED TRANSPORTATION

The ownership of private vehicles will likely decrease as **mobility as a service (MaaS),** combining multiple modes of transport, becomes more prominent in cities. Already more than 40% of trips are made on foot or by bike in Copenhagen, Helsinki, Amsterdam and Vienna.

Background Research
Current Transportation Modes

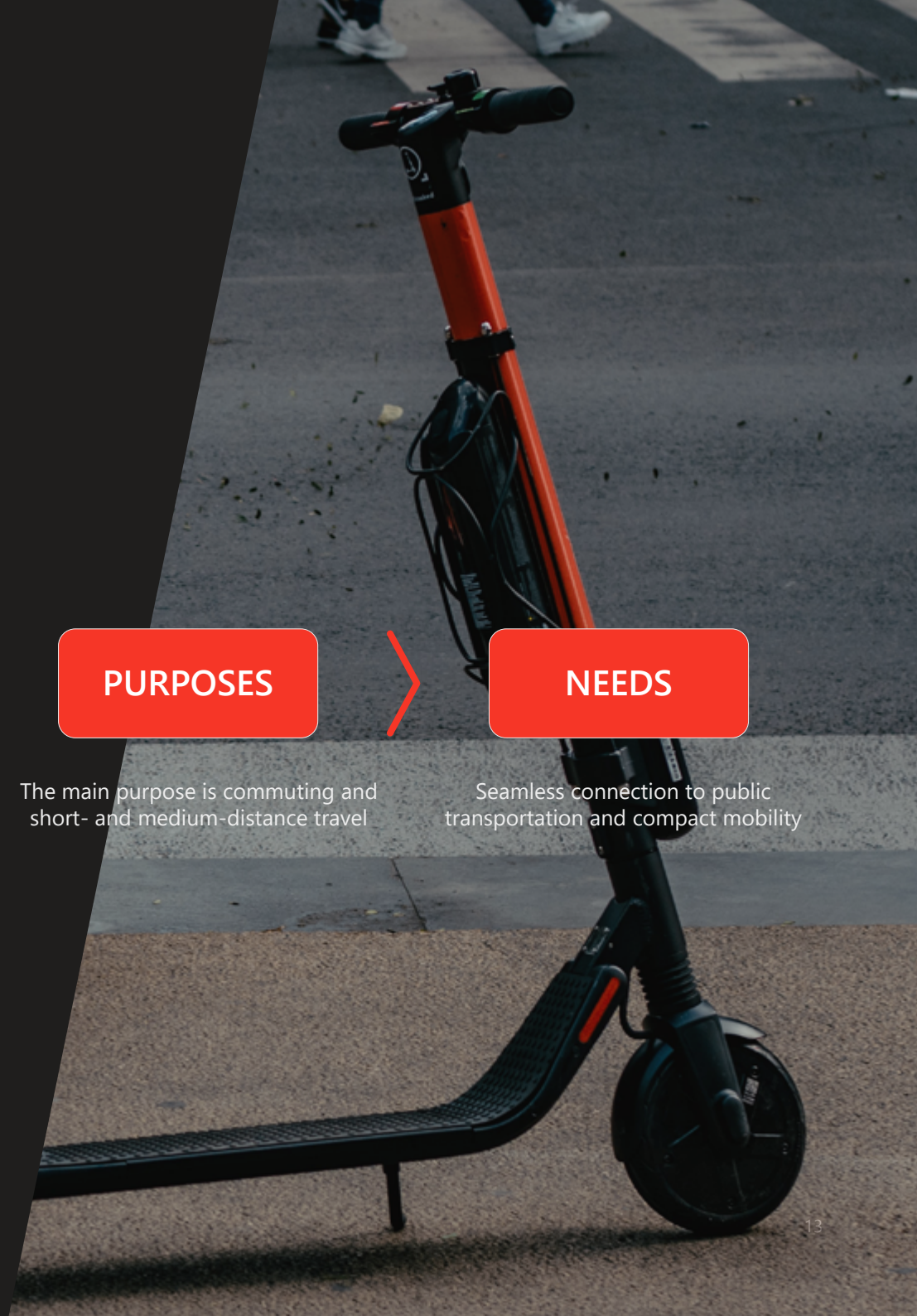
SCENARIO 〉 **MODE** 〉 **PURPOSES** 〉 **NEEDS**

The infrastructure of modern cities gives users more travel options

Public transport networks allow micro-mobility to gradually replace cars

The main purpose is commuting and short- and medium-distance travel

Seamless connection to public transportation and compact mobility



Background Research
Future Trends

REDUCED TRAVEL TIME BETWEEN CITIES

With the emergence of new types of **public transportation**, people's travel mode and traffic have also changed, and **the demand for the first mile and the last mile has increased.**

SEAMLESS OF INTEGRATING MULTI TRANSPORTATION

The convenience of public transportation will always be limited by the location of the station. In order to better match the formation of users, micro-mobility has the potential to compensate for this deficit by better matching user formation, therefore **portability and flexible transportation modes have considerable promise.**


NEXT HL >Barcelon
Frankfurt
ZELEROS HYPERLOOP
NEXT HL >Barcel

Project Objectives
Design strategy

MOTIVATIONS

Explore the future of micro mobility

GOALS

"Provide a **sustainable and safe** alternative for the last and first mile of future urban cities"

STRATEGY

Improve the sharing micro mobility ecosystem by **designing a new sharing service system** based on the characteristic of customer behaviors and cities.

TACTICS

PRODUCT Redefine the products based on the actual user's needs in a sustainable and safe way

USERS Provide a sustainable sharing system for daily commute

SERVICE Change the user's usage behavior through a new service design, make the situation of random discarding disappear, and provide a safer riding system

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OPERATIONS

Redefine the vehicle and explore the new archetype and design

Understand the user characteristics, needs, user scenarios

Redefine the existing sharing service ecosystem

In order to complete this design systematically, the design strategy will be based on the previous project context and motivation and refined to the product, user and system.

Due to the environmental impact of existing sharing models and their products, this project will use a new sharing system as a starting point to change existing rental habits.

PHASE 2 RESEARCH & ANALYSIS


LATFORM
5

Initial Research

What do public transport commuters want?

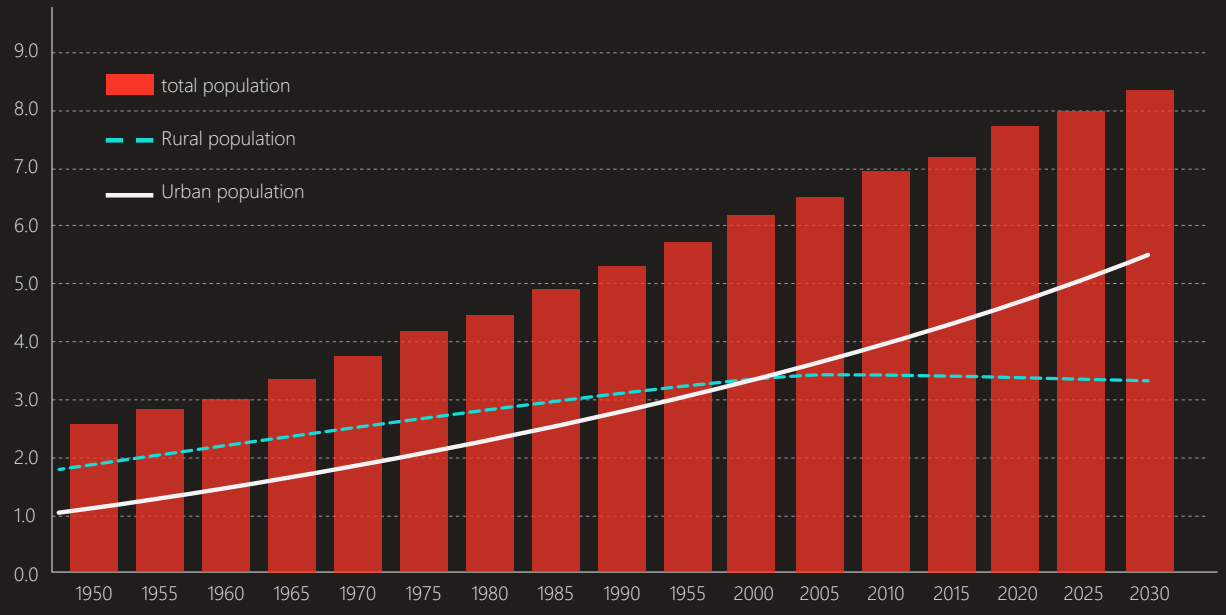
The effect of commuting time should not be underestimated. Research by the UK's Office for National Statistics suggests that a longer commute impacts people's well-being, including their happiness, anxiety levels, life satisfaction, and the extent to which they feel the things they do in life are worthwhile.

The research commissioned by Visa found that **44 per cent of urban residents use public transport as a way to get to work,** school or university, **rising to 54 percent for personal travel.** Travelling on public transport seems to result in longer journeys, with a mean weekly travel time of 3 hours 35 minutes, compared to 3 hours 17 minutes for private modes of transport.

The research found that people make an average of about six journeys to work/school/university every week. The extra minutes of travelling and the corresponding aggravation cost individuals, employers, and society.

Secondary Research
Population growth and transportation

Urban driving is increasing: vehicle miles traveled 1960–2000.



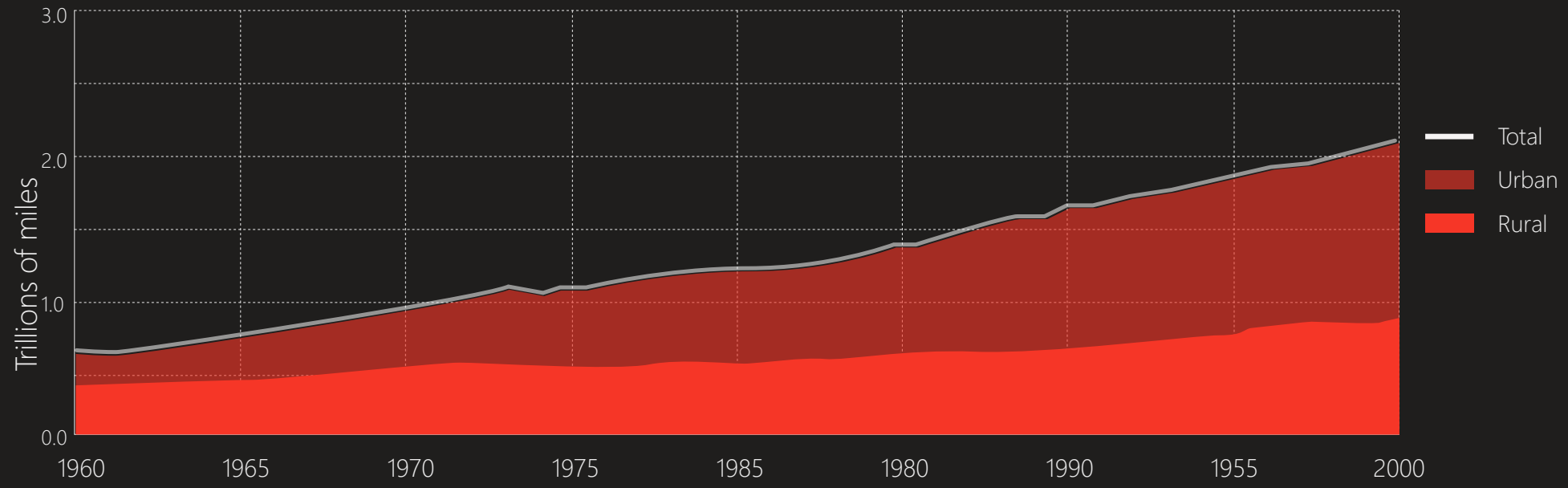
As the total population increases, so does the number of urban and rural populations. However, by 2030, rural population growth is slowing down. The urban population is still growing.

This trend can be understood as two phenomena, and one possible scenario is an increase in the size of the city or an increase in the population moving into the city.

The above two assumptions will increase the demand for personal and public transportation.

Secondary Research
Trend Analysis

Urban driving is increasing: vehicle miles traveled 1960–2000.

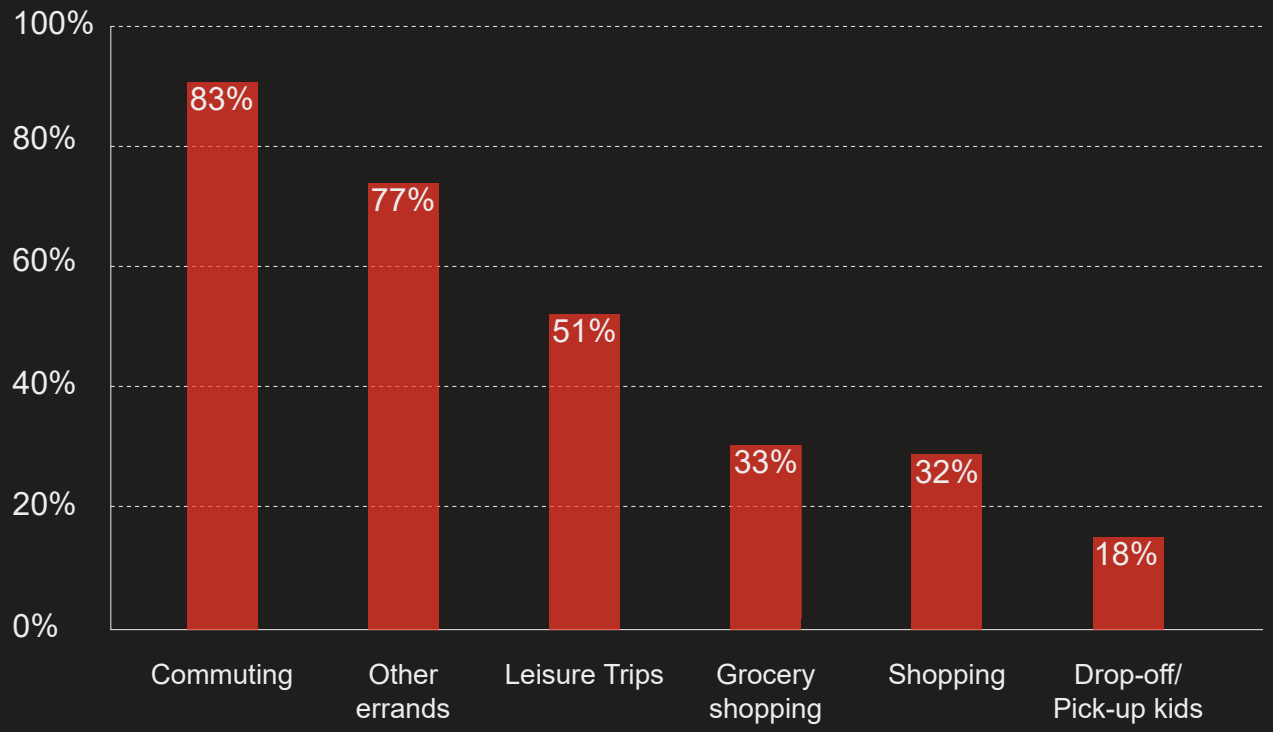


The given diagram shows the vehicle travelled from 1960 to 2000. From the vehicle mileage data, the impact of urban expansion will lead to an accelerating trend in total mileage. This trend highlights the importance of people's need for urban transportation. Rural area traffic growth is relatively flat relative to urban growth.

According to these statistics, the overall mobility volume in urban regions is substantially more than that in rural areas. This phenomenon might be attributed to the more extensive urban population base or to the fact that the purpose of urban travel is more diversified and complicated than in rural areas.

Secondary Research
Cost of the sharing mobility

Travel purposes that can be replaced by E-bikes and Escooters (2021)

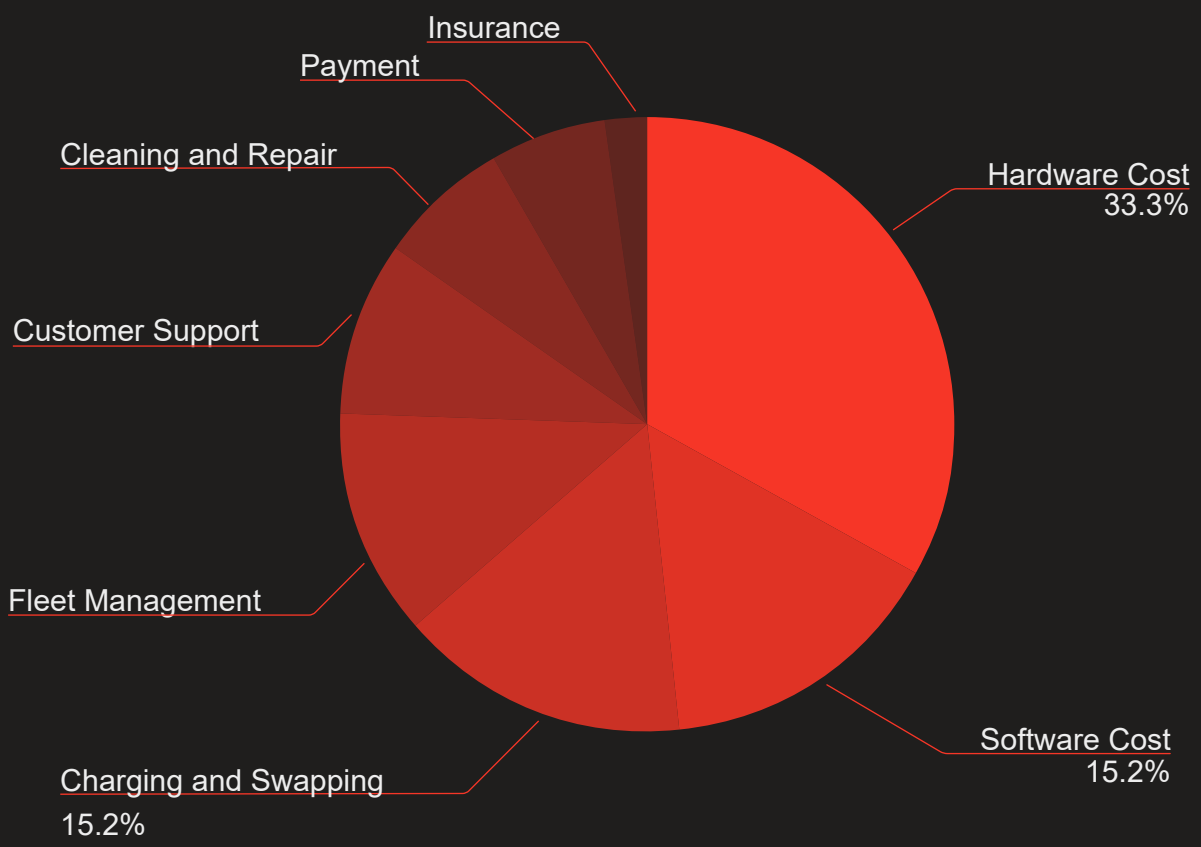


The chart shows an overview of the travel purpose when adapting shared E-bikes or E-scooter. Commuting is one the most significant purposes where the Leisure trips also take a big part of it.

The travelling purpose would lead to different target groups, influencing the design definition in the conception phases.

Reference :*Transportation Research Part D* by **Alfred S¨oderberg**

Cost of the sharing mobility



To better understand the composition of shared transportation, analyzing the cost of sharing micro-mobility would be beneficial in the future design process.

According to the given pie chart, the top three items are hardware cost, software cost and charging.

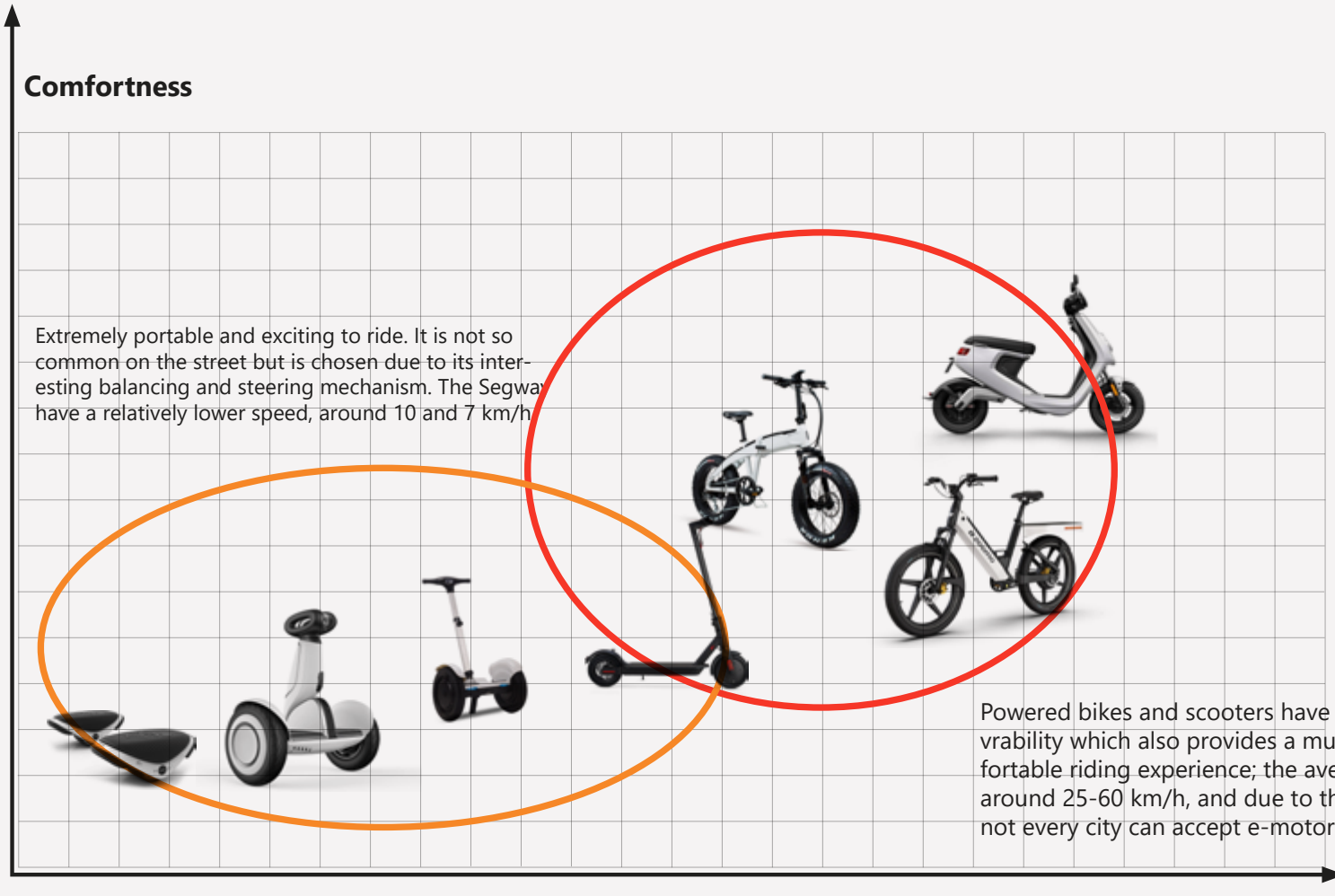
The cost composition of shared transportation contains various aspects. According to the given chart, one highlight is that the hardware cost took a significant portion of the overall cost. Another key finding is that charging and swapping costs have the same portion of software cost.

Reference :The cost of running scooter sharing operations by Felix Jonathan Jakobsen

Secondary Research
Current travel mode

The horizontal axis of the given graph shows the appropriate travel distance in order to compare the various modes of transportation properly. When it comes to urban transportation, micro-mobility is still the best option, with shared electric vehicles being the preferred method of urban transportation when external factors like bus stops, roads, and parking lots are considered.

Market Research
Micro-Mobility



Maneuverability

One of the most advantage of micro mobility is its maneuverability which allow users to travel in the crowed area of the city.

Comfortableness

The comfortableness of micro mobility would affect users' motivation of choosing a type of vehicle.

Market Research
Micro-Mobility

Micro-mobility could be presented in many types of vehicles, among which electric scooters and electric bicycles are common products on the market with relatively complete regulations.

The comparison of electric scooters and electric bicycles will be made as the electrification of transportation becomes more popular. The criteria include the product price, portability, riding speed, riding distance and safety.

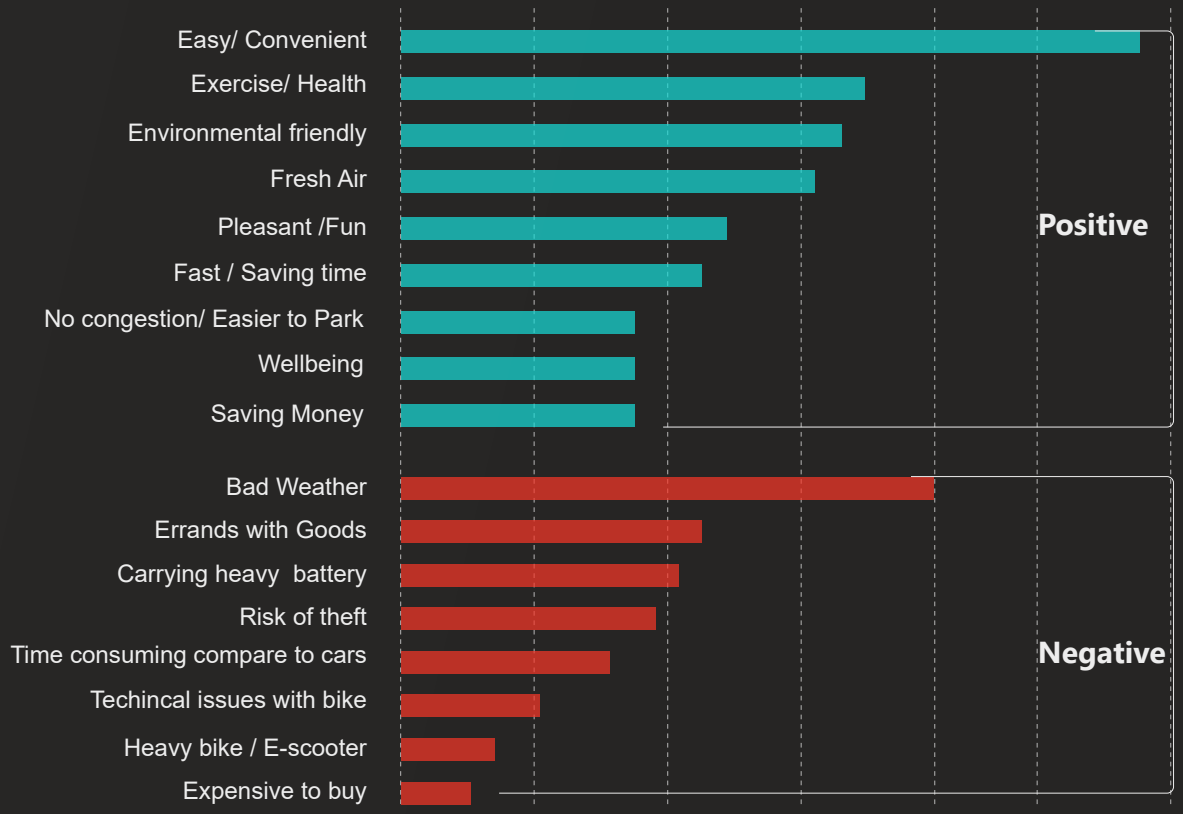
Market Research
Micro-Mobility

E-scooter

E-bike

Electric scooters are, as a whole, more affordable than electric bikes. **The average price range is around 500-700$**	**PRICE**	Battery sizes and speeds tend to be more standardized, so paying more tends to translate into higher quality components and lighter weights the **price starts from 1000$.**
The average electric scooter is smaller and lighter than the average electric bike. A typical electric scooter weight is **10-12.5 kg**	**PORTABILITY**	E-bikes tend to come with heavier frames and tires to accommodate higher forces. Which would lead to **a heavier weight around 25-30kg**
According to the Swedish regulation **the maximum speed for personal e-scooter is 20 km/h**. The engine power must not exceed 250 Watt.	**SPEED**	In Europe, most e-bikes are limited to **25 kph or 15.5 mph.** Some places allow 45 kph e-bikes, but they are usually classified as mopeds, requiring insurance and a license plate.
Riding an e-scooter is kind of **passive**. The rider stands still and the scooter does all the work. It's cool, but kind of unnatural and, **over long distances, a little boring.**	**EXERCISE**	In fact, one European study last year **showed e-bike riders tend to get more exercise than those on regular bikes,** simply because they tended to ride **further and more often**.
Most electric scooters will carry you for a **maximum of 25km between charges,**This is around half what you can expect from an electric bike.	**RANGE**	Most e-bikes provide much better range than e-scooters. More importantly, e-bikes are still **fully functional when the power runs out.**
E-scooter riders generally stick to pavements, cycleways and other motor traffic-free routes, which might lead to some safety issues.	**SAFETY**	The big wheels and heavier frames mean better stability, and the larger size of a bicycle should also **make you more visible on the road.**

Secondary Research
User feedback on Micro-mobility



The given chart is a qualitative research result about E-bike users; as E-bike shows are among the most common micro-mobility modes, it would be beneficial if some pros and cons could be covered in the early research stage.

Overall, the advantages outweigh the disadvantages, although it is evident that weather is an issue in e-cycling. The other main disadvantages are practical issues like performing errands that include transporting goods/passengers and the risk of theft. Some claim that riding an e-bike takes longer than driving, has technical weaknesses such as poor speed and poor geometry, and is heavy and expensive to buy. According to the participants, the most excellent aspect of the e-bike is how simple and convenient it is to operate (more than half of the sample thought so).

Reference :*Transportation Research Part D* by **Alfred S¨oderberg page8/ fig3.**

Secondary Research
Key Findings

With the increase in the total mileage of urban traffic and the rising trend of urbanization, the future urban traffic will be dominated by pedestrians and micro-mobility. After comparing technical constraints such as existing travel modes and vehicle size, the following design research will focus on lightweight and environmentally friendly mobility.
According to the user feedback on E-bike

PHASE 2 RESEARCH & ANALYSIS

PRIMARY RESEARCH

In this session, some primary research is applied to gather data from a target group, which contains qualitative and quantitative information. Basic research methods are firstly applied to gather segments, and it would create a trend of specific scenarios. Questionaries will be sent out for quantitative research to create an overview of participants' feedback. Interviews with random samples will be conducted for qualitative research to understand better micro-mobility users' current scenario and the underlying factors behind such pain points.

Primary Research
Field trip

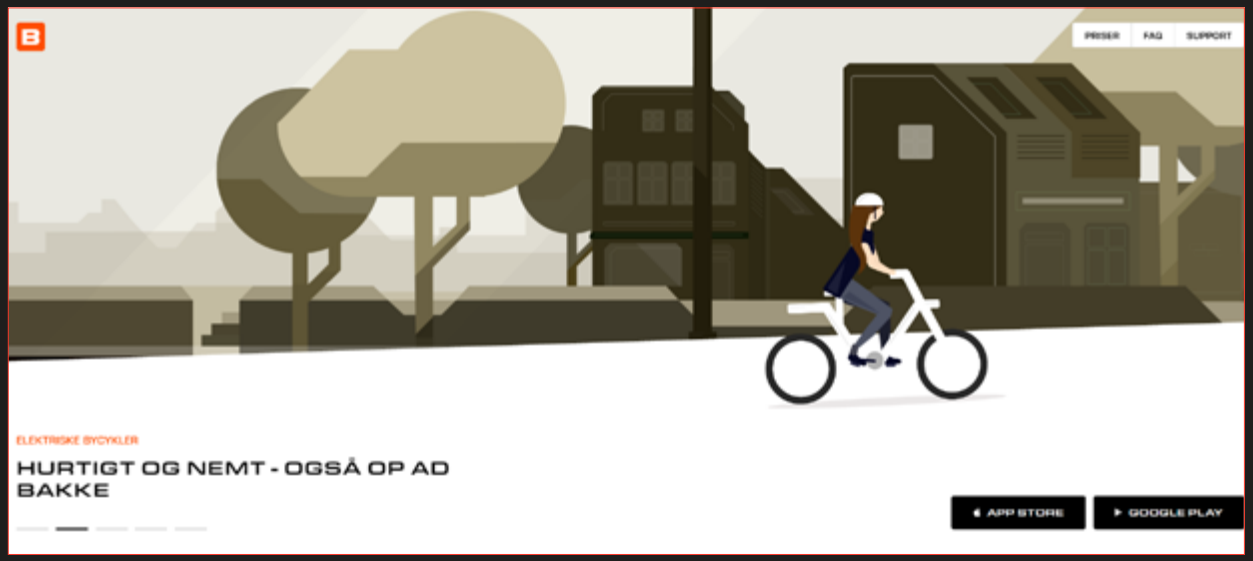
In order to simulate the commuting scenario, I arranged a route that is similar to the average cycling time and distance of Copenhagen citizens. The average commute distance and time in Copenhagen are 34 minutes and 11 kilometers respectively

- Copenhagen Central Station
- Five Circles Pedestrian Bridge
- Copenhagen Opera House
- Rosenborg Castle Gardens
- Superkilen Park

Total travel time	36 min
Travel distance	10.2km

The primary purpose of this field trip is to simulate and experience being a bicycle commuter in Copenhagen.

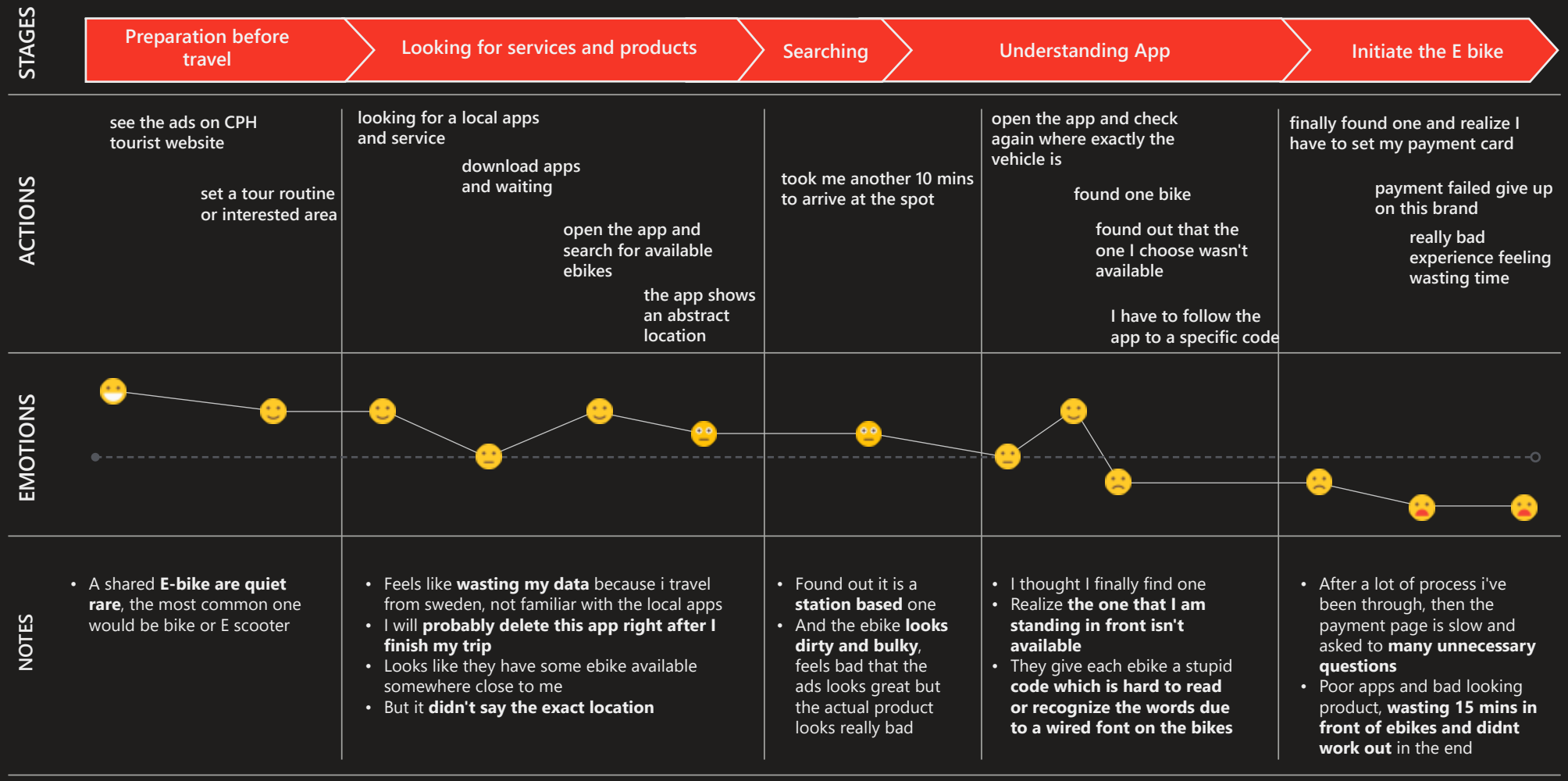
Primary Research
Field trip- Bycyklen



The initially selected brand of shared bicycles is called **Bycyklen,** a local shared bicycle in Denmark. It is worth noting that they use the rental model of **a fixed station,** and the product uses **electric bicycles.**

But the actual product is not as beautiful as the official website looks, **the actual product looks very old and dirty**.

Primary Research
User journey map-Bycyklen



Primary Research
Field trip- Bycyklen

Most of the shared service product has a unique code on each product, making the initial operation complicated and wasting time.

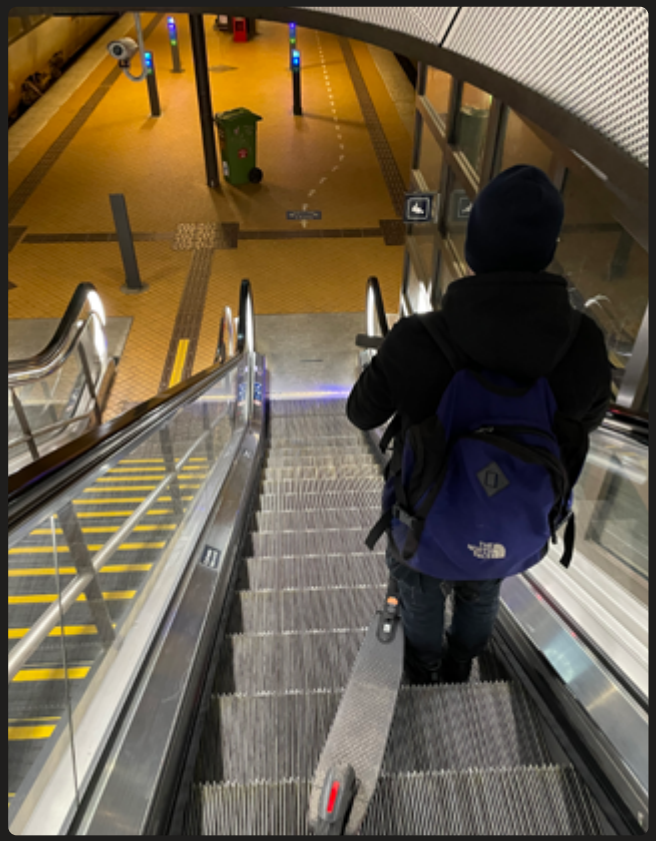
White color is a poor example which looks damaged and dirty; product appearance might affect users' motivation to rent.

Primary Research
Observation

Copenhagen has a well-developed bicycle lane running through the city and the MRT to form a transportation hub. Most of the blocks in such a modern city are dominated by pedestrians and bicycles. Among them, many passengers also use electric scooters as means of transportation. During the trip, I noticed that the existing electric scooters have a folding function. However, the user does not fold it up in most practical situations, especially when getting on and off the subway.

A specially designed railing for cyclists the cycling habits and balance needs.

The train carriage has a space reserved for bicycles, which can be parked with the chairs stowed and has a special seat belt.

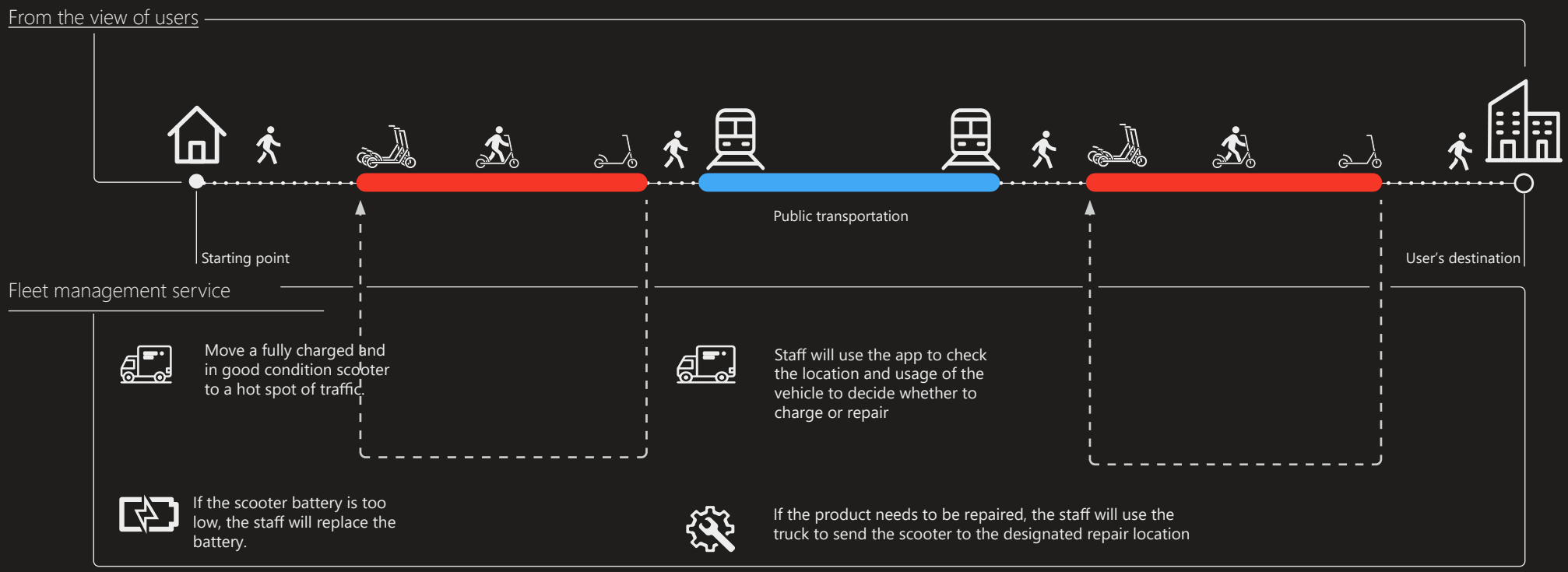


However, due to the station's design, some users who use the scooter will use the hand-held power to reach the platform. During this period, the scooter is not folded.

Many different cargo bikes are found on the road but did not find the case with cargo bikes in the carriage, even if the space is sufficient.

Project Research
System Map

Current floating sharing scooter journey



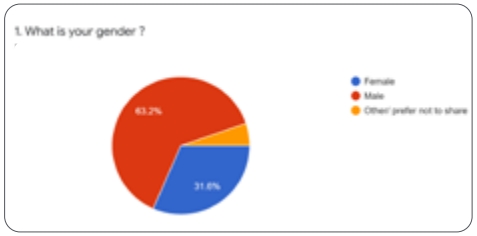
During the early stages of design research, I discovered that fleet management is critical to the entire sharing business. TIER, for example, will deploy trucks throughout the city to collect vehicles for charging and routine maintenance.

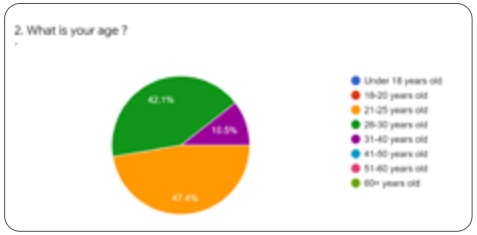
While this is unavoidable, the energy and greenhouse gas emissions produced by moving trucks also contribute to the pollution. Such a system contradicts their promotion of environmentally friendly travel.

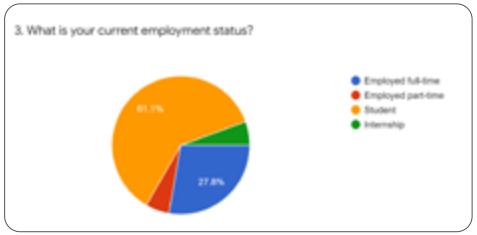

TIER
This van is
100% ELECTRIC
TIER
INZILE

Primary Research
Survey

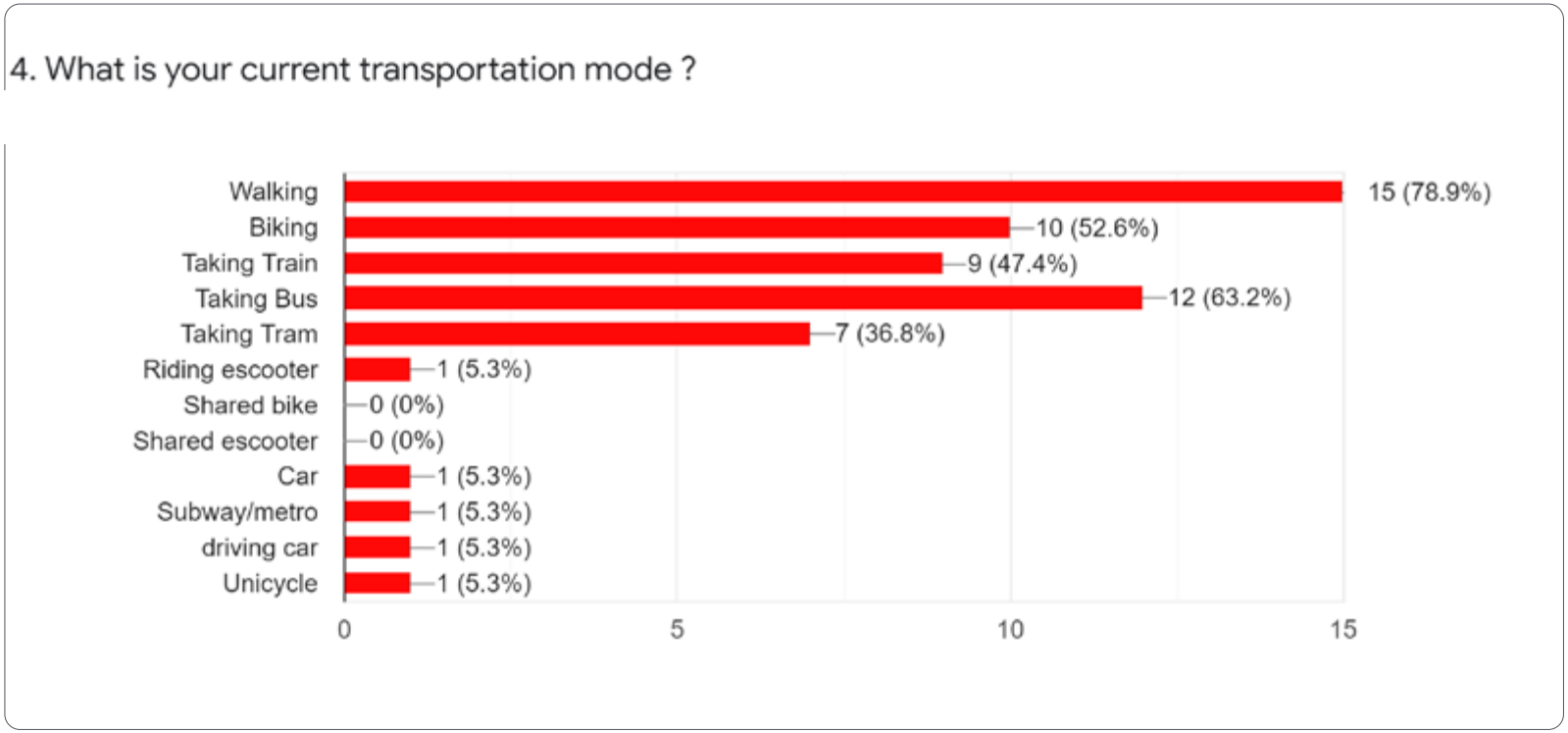
Demographic







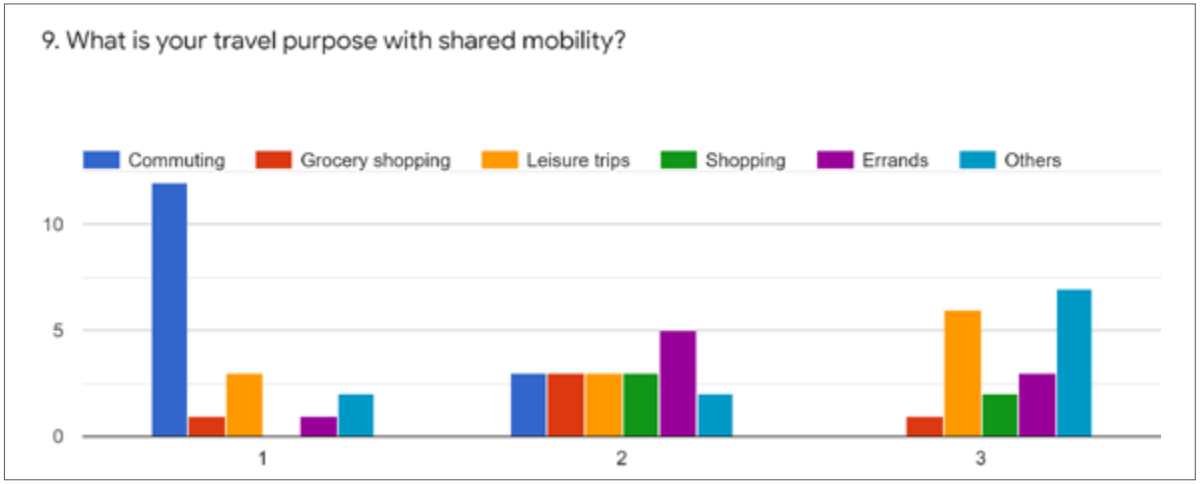
Transportation Mode



The online questionnaire will provide quantitative and qualitative feedback to be as close to the actual needs of users as possible and to discover some new design directions.

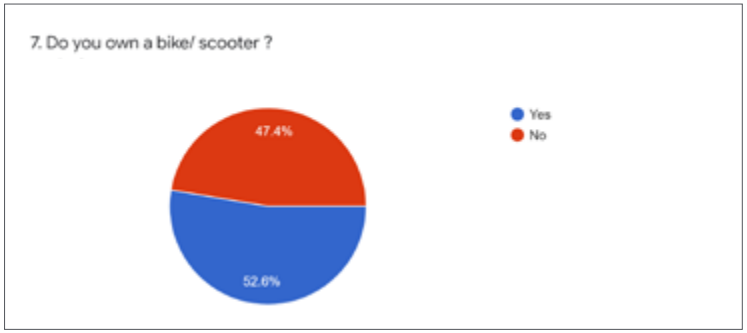
The questionnaire will start with essential demographic characteristics such as age, gender, job, etc. and then ask about their travel habits and opinions on shared transportation. At the end of the questionnaire, there will be an open-ended question.

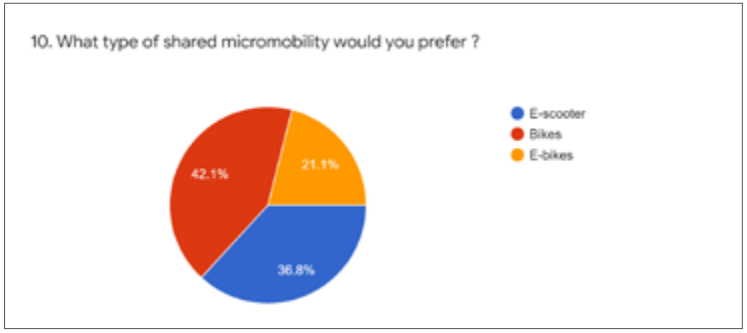
Travel purposes comparison, with or withour shared vehicle

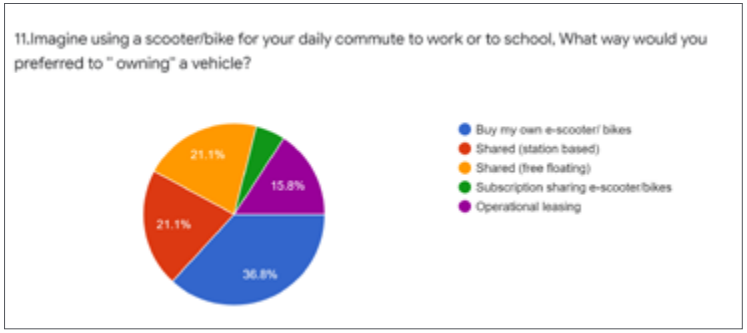


The travel purposes of shared micro mobility are various compared to the existing users habit.

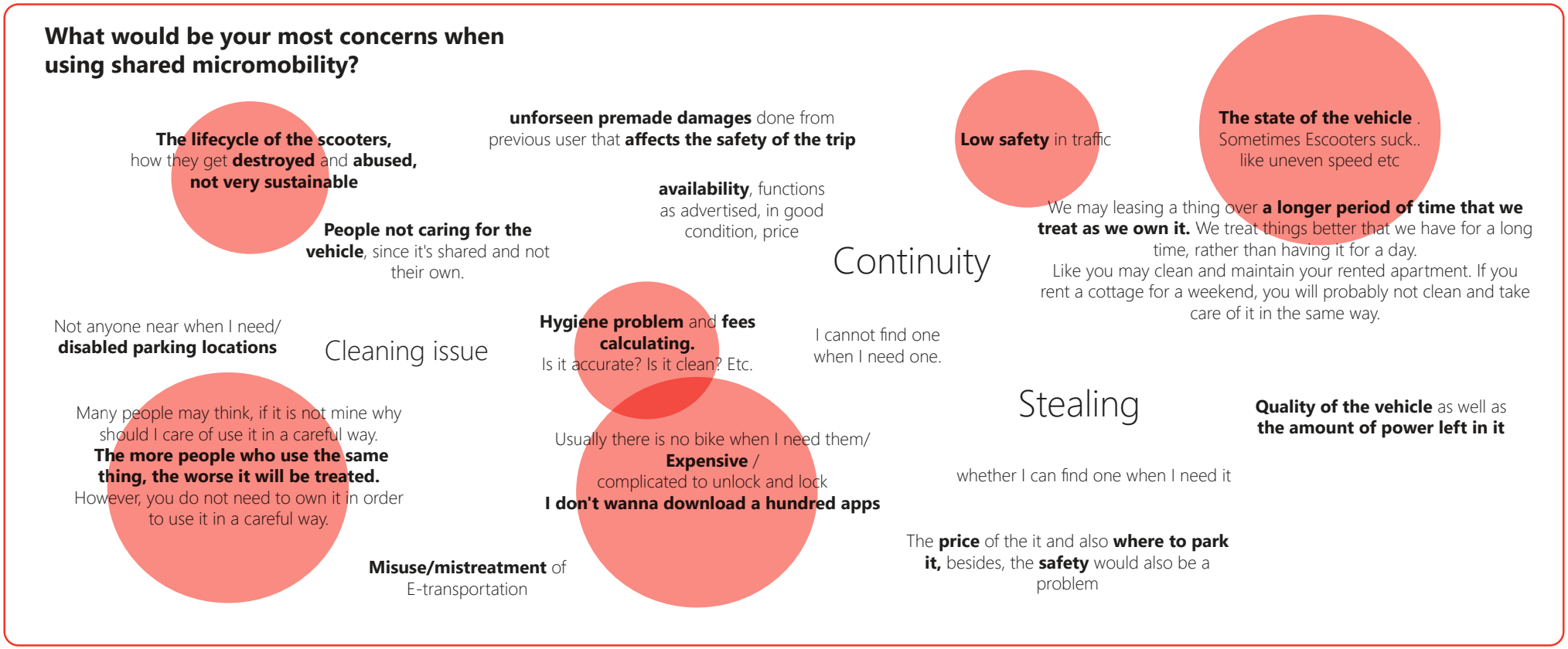
Ownership







Primary Research
Survey



Online Survey
Key Findings

According to user feedback, their top concerns aside from safety concerns are fees and product ownership

Product Ownership

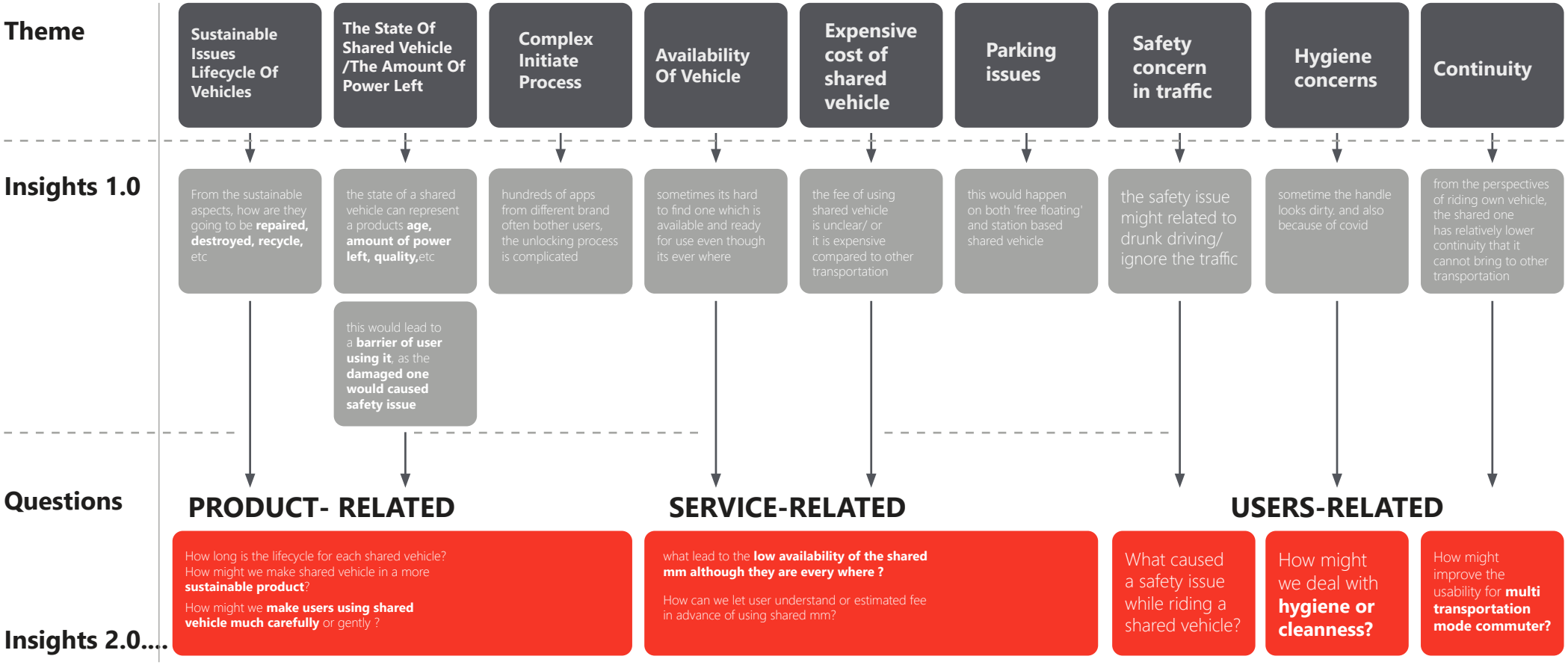
According to the received answers, people are willing to take shared services as a commute option more than owning a bike or escooter. Such a phenomenon can be interpreted as the flexibility and convenience of shared vehicles.

Charging Method

At present, the shared mobility charging method on the market is often based on the usage time. This model is the same whether it is floating or station based.Such a mode will lead users to speed up and shorten their journeys in order to save money, which will raise safety concerns for bystanders.

Primary Research
Insight Statements

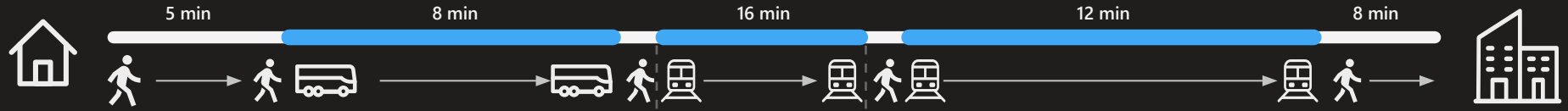
Identifying the insights that will drive the research question from a massive volume of information is critical for the Ideation process. The methodology will begin with some keywords related to the research question; this process aims to generate insights from a specific theme. These new insights can be reorganized based on their hierarchy. The risk of personal information leakage and discomfort is the most significant concern; this method allows the researcher to filter key factors and generate new insights. Cameras, in these circumstances, will overly magnify human behavior, causing discomfort and privacy concerns.


Theme
Sustainable Issues Lifecycle Of Vehicles
The State Of Shared Vehicle /The Amount Of Power Left
Complex Initiate Process
Availability Of Vehicle
Expensive cost of shared vehicle
Parking issues
Safety concern in traffic
Hygiene concerns
Continuity
Insights 1.0
From the sustainable aspects, how are they going to be **repaired, destroyed, recycle,** etc
the state of a shared vehicle can represent a products **age, amount of power left, quality,**etc
hundreds of apps from different brand often bother users, the unlocking process is complicated
sometimes its hard to find one which is available and ready for use even though its ever where
the fee of using shared vehicle is unclear/ or it is expensive compared to other transportation
this would happen on both 'free floating' and station based shared vehicle
the safety issue might related to drunk driving/ ignore the traffic
sometime the handle looks dirty. and also because of covid
from the perspectives of riding own vehicle, the shared one has relatively lower continuity that it cannot bring to other transportation
this would lead to a **barrier of user using it**, as the **damaged one would caused safety issue**
Questions
PRODUCT- RELATED
SERVICE-RELATED
USERS-RELATED
Insights 2.0....
How long is the lifecycle for each shared vehicle?
How might we make shared vehicle in a more **sustainable product**?
How might we **make users using shared vehicle much carefully** or gently ?
what lead to the **low availability of the shared mm although they are every where ?**
How can we let user understand or estimated fee in advance of using shared mm?
What caused a safety issue while riding a shared vehicle?
How might we deal with **hygiene or cleanness?**
How might improve the usability for **multi transportation mode commuter?**

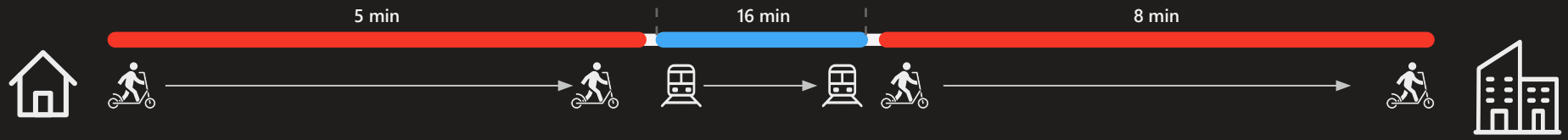
Primary Research
End User Interview

Before the interview, the interviewee used her escooter to meet me because she missed the bus, she shared the route and time of the trip.

Scenario 1 Total duration **49 min**



Scenario 1 Total duration **29 min**



Each type of public transportation has its timetable, and there are longer wait times when changing between different public transportation.

The benefits of using escooter are reduced crowd contact and higher convenience. In this case, it also saved some time for the user.

On foot
Public transportation
Personal transportation

End User Feedback

Advantages:

1. Convenience, after folding, the bell and the folding buckle are shared, which is more convenient. The weight is about 10kg, and you can carry it with one hand

2. Beautiful, matte black paint appearance + yellow tire embellishment is very fashionable. Although the battery life is not as good as the shared scooters on the street, it also becomes an advantage in terms of size, and the body looks very light

3. Easy to assemble, and the package provides a wrench

4. The speed is relatively slow (this varies from person to person, and safety is more important to me). The speed limit of my car is 20km/h, and the shared scooter can reach 25km/h is too fast. Ride fast because you have to save money

5. The price is affordable. It has been around 3,500 sek for a year, and it can be sold for 1,000 second-hand, which is less than 3 yuan per day. When I travel to other countries, I have ridden the shared scooter several times instead of the bus, and it is 20. It is more than one ride, so it is more cost-effective to buy your scooter for those who ride often.

Disadvantages:

1. The battery life is short, and the battery is basically out of power after going out for 3km. Every day you go out, you need to charge every day

2. I have to take it with me when I go shopping by bicycle. I often get scorned in the store because I am afraid of being stolen when I park outside, and I don't have a proper lock.

3. The tires are easy to leak, the shared scooter should be a solid tire; there is no tire blowout problem

4. The brake pads will ring on a rainy day

5. Small bearing capacity, not suitable for fat people to ride

6. The quality is not good enough at present. Several Xiaomi scooters around me.

PHASE 3 CONEPTION AND DESIGN

Design Development
Design Objectives

WHY

With the rapid development of public transportation in the near future, the **demand for micro-mobility is increasing**. However the shared transportation modes on the market today are **causing a negative impact** on the environment and the users in the street.

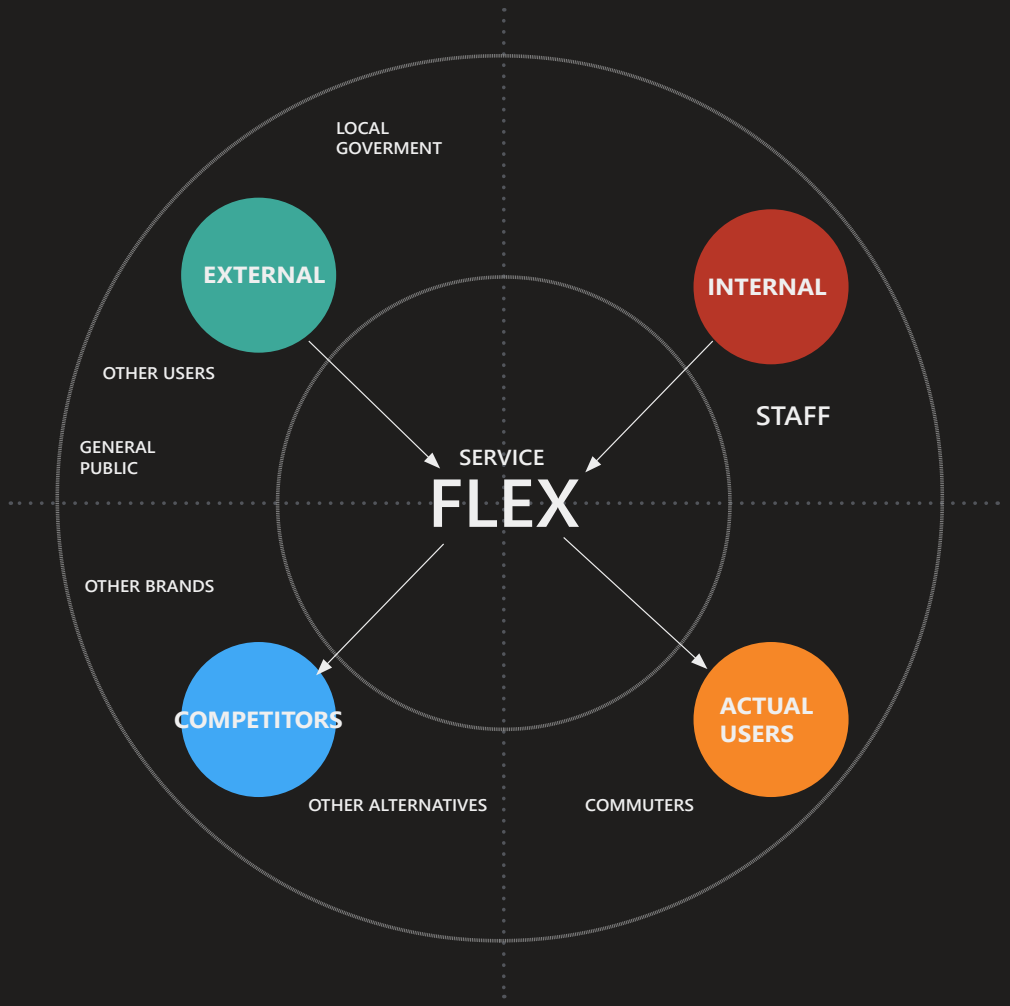
WHAT

The aim of this project is to **redefine the ownership of sharing micro mobility** from perspective of **energy sharing network**, provide user a **sustainble** micro mobility solutions while having a compact riding experience.

HOW

By introducing **swappable batteries** on e-scooters and setting a energy network thourgh sever**l swapping stations**. Combining a **lightweighted and longlasting ecosystem** for micro-mobility.

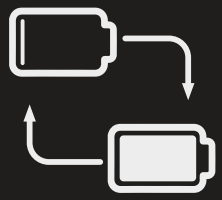
Design Development
Stakeholders Map



FLEX's stakeholders include internal, external, end-users and competitors. The staff and related fleet management are included in the internal aspects. External groups include the public, local governments, etc., as their opinions will affect the image of FLEX in society. In addition to other shared scooters on the market, the existing competitors are other vehicles of the same size. Still, due to the different characteristics of the FLEX system, the influence of competitors is relatively minor since users own the scooter rather than share it. The actual users are usually commuters, and previous research pointed out that most of the users' travel purpose is commuting.

The different functions of government and firm controls also help explain the importance of cooperation between transportation authority and firms. The battery-sharing firms should focus on how to affect consumers' awareness of uncivilized behaviors when they design their control mechanisms. Battery-sharing companies, for example, may indicate the negative consequences of uncivilized behavior, which will help consumers become more conscious. Meanwhile, government or transportation authority should consider how to strengthen the relationship between awareness and behavior intention. The collaboration will maximize the impact of control mechanisms and encourage users to use battery-sharing in proper approaches.

Design Development
Eco-Design



Swappable battery

Product Ownership

Energy network

In this system, users have ownership of the vehicles rather than sharing them with others. The system allows users to cherish the product and prolong the product's life cycle. The battery separation design speeds up charging time and enables more efficient battery recycling.

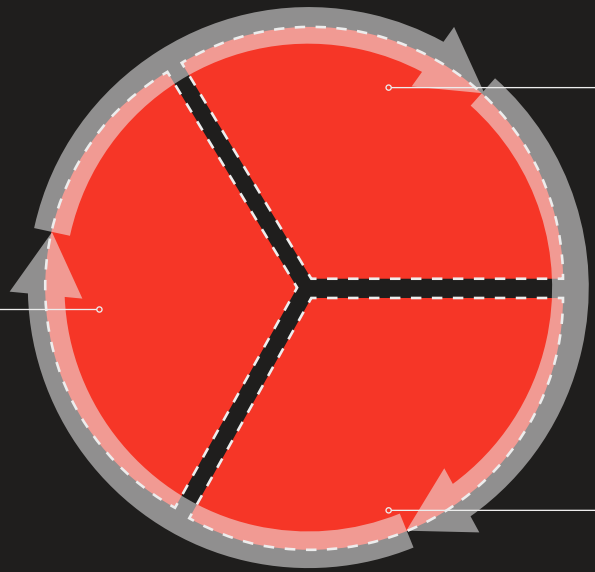
In this way, the grid system can guarantee the battery's state, and the user can also use his battery charger at home or in the office. Moreover, the product itself is no longer subject to the weight of the battery, making the product more light-weight and convenient to carry.

USER

Commuting

Micro transport

According to the previous research, the user range of micro-mobility is extensive, and commuting is the primary purpose. In order to maximize the number of users, at this stage, we will focus on users from the different themes and use them as material for portraits to inspire the main features of the product.



PRODUCT

Portability

Smaller footprint

Swappable battery

The primary use case for micro-mobility will be urban scenario,that easy storage, indoor parking, and portability can be major design factors. In this ecosystem design, products serve as touch-points for providing services, and design features such as function, material, shape, colour ergonomics, etc will respond accordingly to users and services.

SERVICE

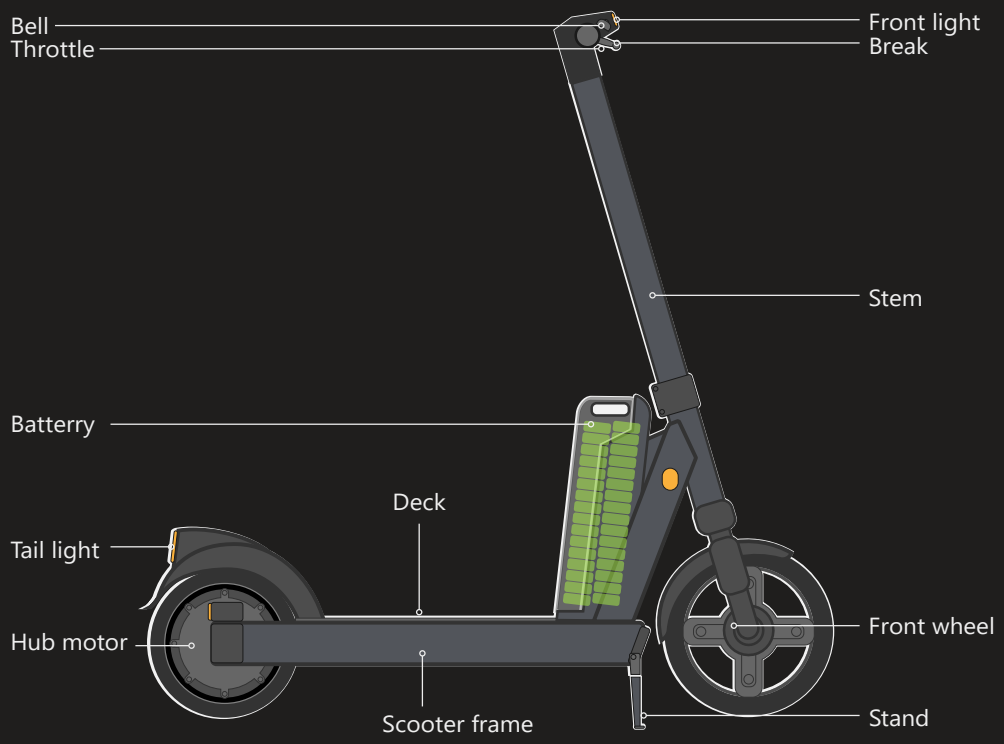
Energy network

Circular design

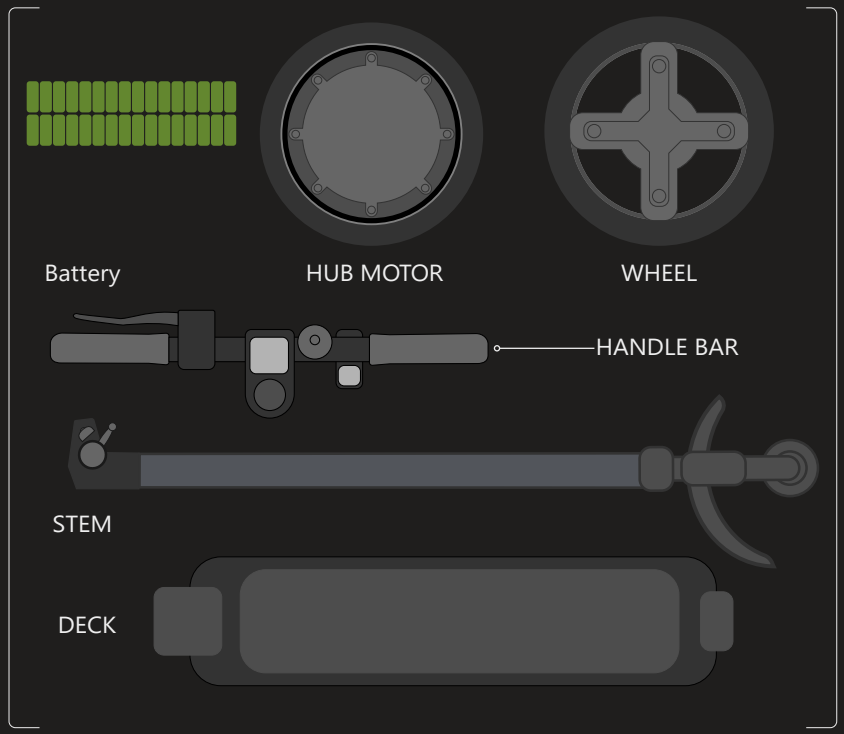
Long lasting

The power exchange system is one of the features of this project, but considering the actual usage and the number of users, other swapping scenarios are currently being considered. In addition, medium and long-term rental services will also lead to a long-lasting product life cycle.

Eco-Design
Function Analysis



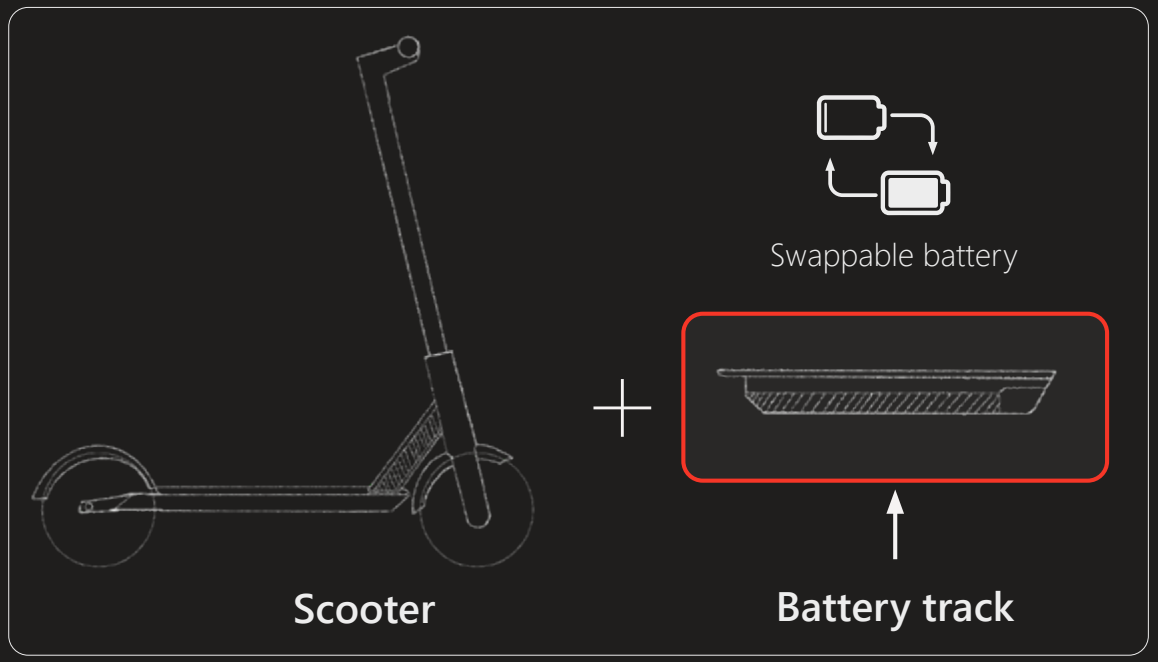
CRITICAL COMPONENTS



Eco-Design
Product Design

Shared product (scooters)

Sharing batteries



Users own the scooter **sharing batteries**

The shared E-scooter was designed to have a longer battery capacity, leading to a heavy and bulky vehicle.

The swappable design makes the product's weight lighter by splitting the battery from a scooter.

Eco-Design
System Map

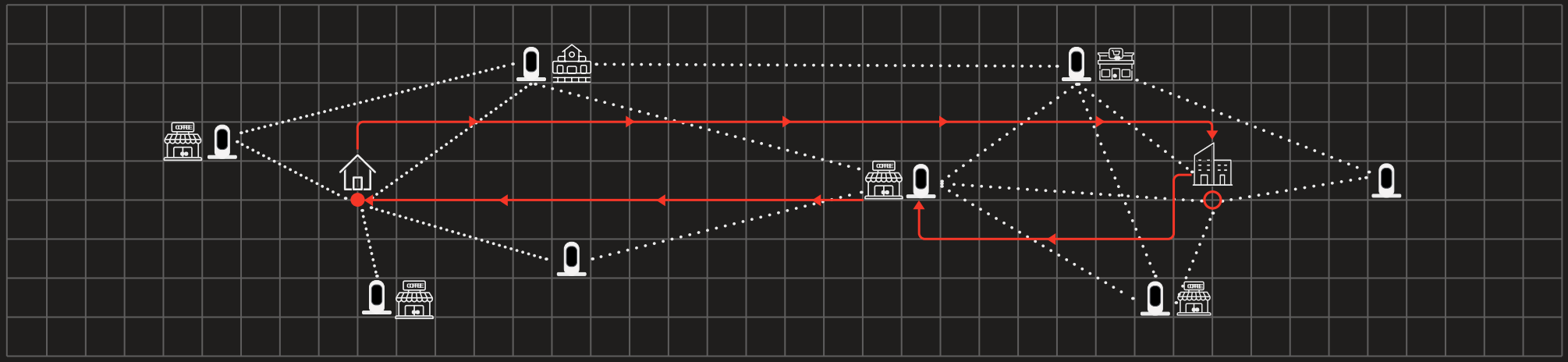
Train Station

Restaurant

Supermarket

After a series of design studies and in-depth research of some weaknesses of the existing shared mobility model, the new system will build a set of services for battery replacement based on the energy network. Users can subscribe to pay for electricity in this system and use swap stations to get fully charged batteries. The advantage of this is to allow the battery to circulate and ensure that it is in good condition when the user returns the battery, making the riding experience smoother.

Energy Network



Swapping Station

Long lasting product and service

The establishment of the battery swap network not only allows users to charge more flexibly, but also allows the vehicle to reach a fully charged state faster. Stores can also increase customer traffic by installing swapping stations.

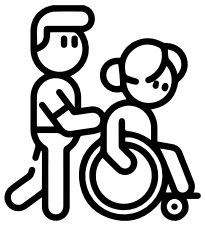
STARTING POINT

DESTINATION

ROUTE

Universal design

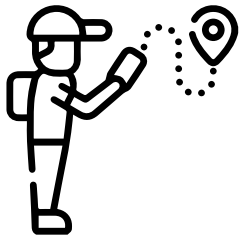
Situational



Eldercare

This type of eldercare user requires intensive and short-distance mobility. Typically, the eldercare nurse will be responsible for the patients in the designated area. Although the distance of each action is not far, but the number of times is very frequent.

Temporary



Toursit

Tourist-type users' demand for mobility is mainly reflected in the free riding experience. Such users focus on the experience when moving, while the distance and number of rides are relatively low and scattered.

Permanent

Daily Commuter

The user group of commuters has a stable demand for mobility, and the mobile route is also very fixed. These users focus on portability and product endurance.

User Research
Case Study

Erika

OCCUPATION: Nurse Aide
AGE: 22

ABOUT

Erika, a second-year nursing student at Lund University, has a positive and compassionate personality. In her spare time, she often participates in charity activities and also uses the summer vacation to participate in the practice of elderly care.

GOALS

- Ensure patients' well being
- Provide a daily assistance
- Deliver medicine to patients

FRUSTRATION

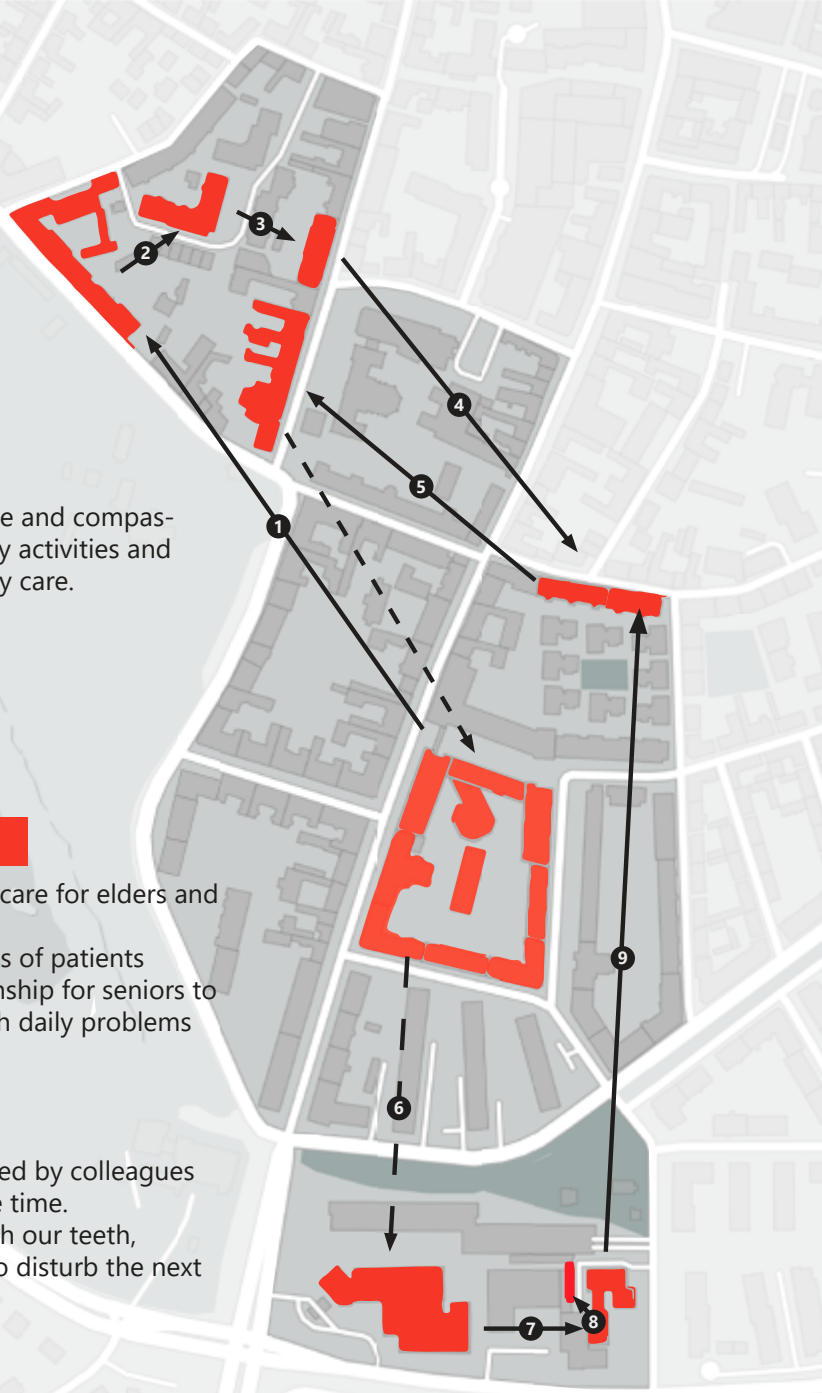
- Too much information to retain
- Missing patient information
- Tight and uncertain schedule
- Long walk to reach the patient's home
- A bulky nursing bag must be carried

MOTIVATION

- Providing the best care for elders and patients
- Helping the families of patients
- Provide companionship for seniors to help them deal with daily problems

CHALLENGES

Although the hospital also provides bicycles, they are always borrowed by colleagues on the morning shift. I walk or run to the patient's house most of the time.
Many patients wait for us to start the day, such as getting up to brush our teeth, shower, or take medicine for a walk. I have to be there on time not to disturb the next patient.



User Research
Case Study

Max

OCCUPATION: Software Engineer
AGE: 27

ABOUT

Max is an entrepreneur who lives in Copenhagen, where he found a small startup. He commutes between Copenhagen and Malmo by train with his bike. His job requires travelling and meeting with new clients at different locations. He enjoys going to the gym in his spare time.

GOALS

- Flexible and convenient travel mode
- Vehicles with easy storage and portability features

FRUSTRATION

- Parking at extra cost
- Long commuting time
- Location proximity
- Transportation needs in business trips.

MOTIVATION

- A cheaper cost while travelling to other cities
- Need a proper daily routine for the exercise
- A smarter way for him to carry a gym bag.

CHALLENGES

A bicycle is a good option, but it is not something I want to exercise every day. I wish my transport would be lighter to take them with me on public transport. I always carry a gym backpack, and I wish I had enough storage space.

User Research
Case Study

Alex

OCCUPATION: Photographer
AGE: 25

ABOUT

Alex lives in an apartment in Copenhagen. He travels for work reasons around Copenhagen and the cities nearby. He often takes photo walks during the weekend and constantly searches for new cool spots.

GOALS

- Meet up with clients in the city
- Going to co-working office for work.

FRUSTRATION

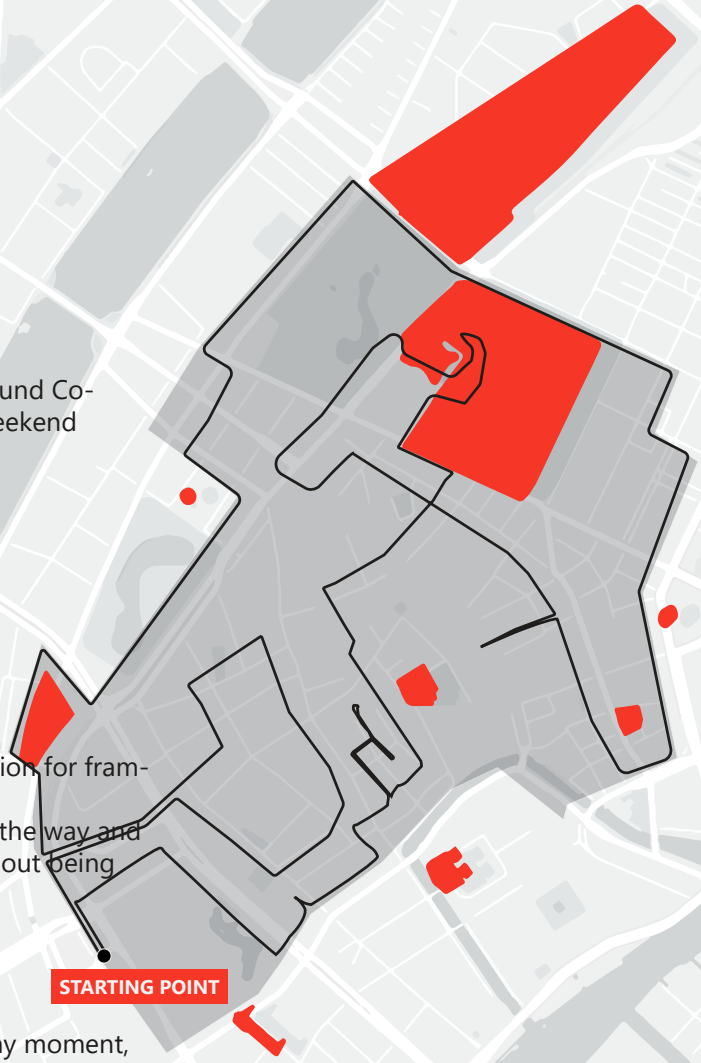
- The research for the photo-shoot is time-consuming.
- Reaching an ideal spot would take some time
- Location, Sun position, weather, walking distance

MOTIVATION

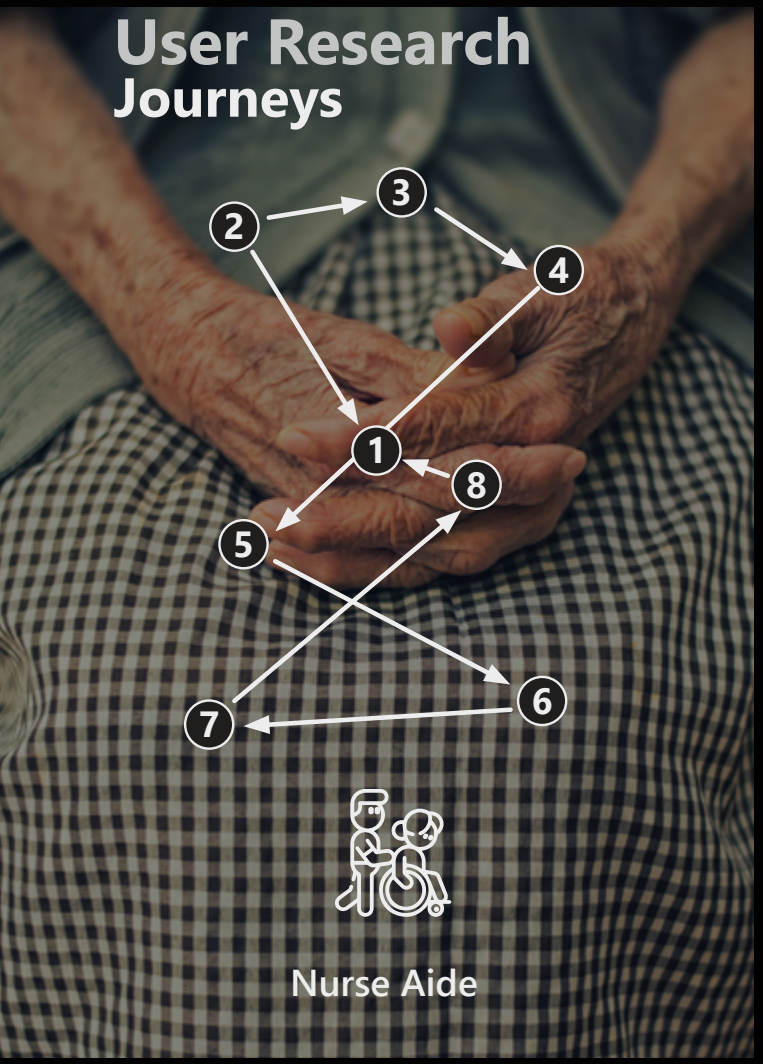
- Finding the perfect location for framing photography
- Enjoy the scenery along the way and freely find materials without being restricted by the route

CHALLENGES

While using a shared bike is an excellent way to complete my service at any moment, getting another bike can be challenging at times. I occasionally need to use public transportation, which requires me to repeatedly active the vehicle that would charge me again.



User Research
Journeys



Different travel reasons are targeted at different target groups depending on their motivations. According to the persona page, there are three types of users. The commuter group was chosen as the user group. Because commuters' travel distances and habits are predictable, the following design directions will be based on their demands.

Design Development
Hypothesis

HYPOTHESIS

1. Convenient parking and high-capacity vehicles can make the experience of high-frequency short-distance traffic better; vehicle stability and comfort are the main goals.
   - Comfortableness
     - Good riding posture
   - Better control on vehicle
     - Less shaking on handlebar

2. The main goals are clear navigation and a safe driving experience, and accessibility and product-related maintenance will make the vehicle more likely to reach more users.
   - Increasing Safety
     - Increased Vehicle grip
     - Striking while riding
     - Lighten Weight design
   - Sustainable design
     - Long-lasting product

3. Portability and lightweight product design will allow users to better adapt to urban environments, and indoor parking and small footprint can improve product application capabilities.
   - Urban user scenario
     - Space management
     - Easy to move

A design hypothesis is an assumption based on the collected data from previous design research. In order to create design reasonings for the e-scooter, several user needs are highlighted as opportunities.

Taking account of varied travel purposes, usage, and routines, the following hypotheses are proposed will be focused on its use scenarios and their related needs.


Ergonomic concerns
User's postures
Static posture
Height of the seat
Position of seat
Dynamic posture
More wheels?
Arrangement of wheels
Morphological design exploration
Bigger wheel diameter ?
Especially for european pavements
New types of wheel type
Treads design
Transformed wheel
Indicators
To remind pedestrians
To reminds users
Obvious riding profile
Design for disassembly
Cradle to cradele
Modular design
Indoor parking
Storage
Smaller footprint
Foldable mechanism
Could be hang to the wall
Charger as hanger
Stairs
Escalater
The footprint could be smaller than a step of escalator
Lifts
Slopes
Portability in urban commuting scenarios

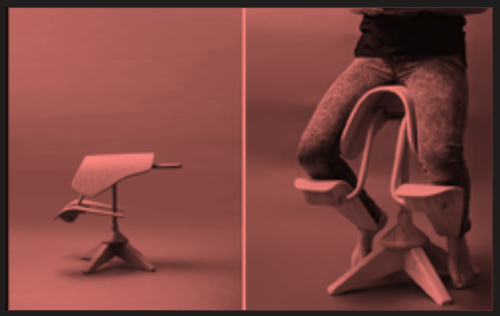
Design Development
Design Reasonings

STRIKING WHILE RIDING

DESIGN FOR STORAGE

CARGO VEHICLE

DYNAMIC



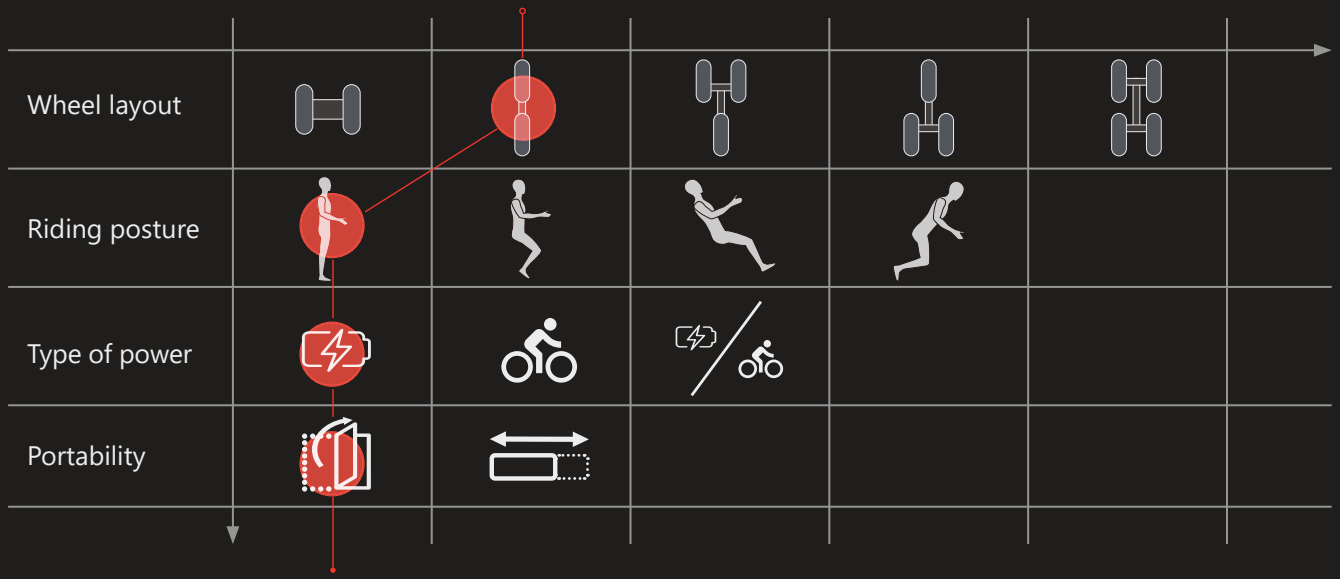
ERGONOMIC DESIGN

BIGGER WHEEL

SMALLER FOOT PRINT

CLEAN BOTTOM

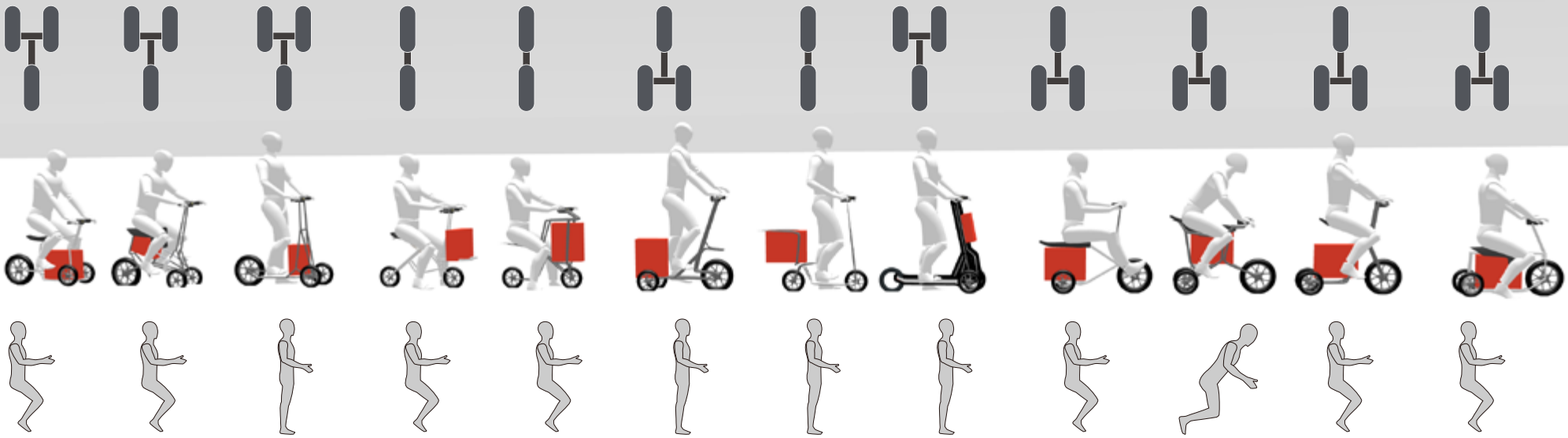
Design Development
Morphological Chart



A morphological chart is a tool that represents a large qualitative design exploration. These charts list the functions identified for the design variables and the means (solutions) to perform each function. Combining one means for each function will produce a potential integrated conceptual design solution.

Design Development
Ideation

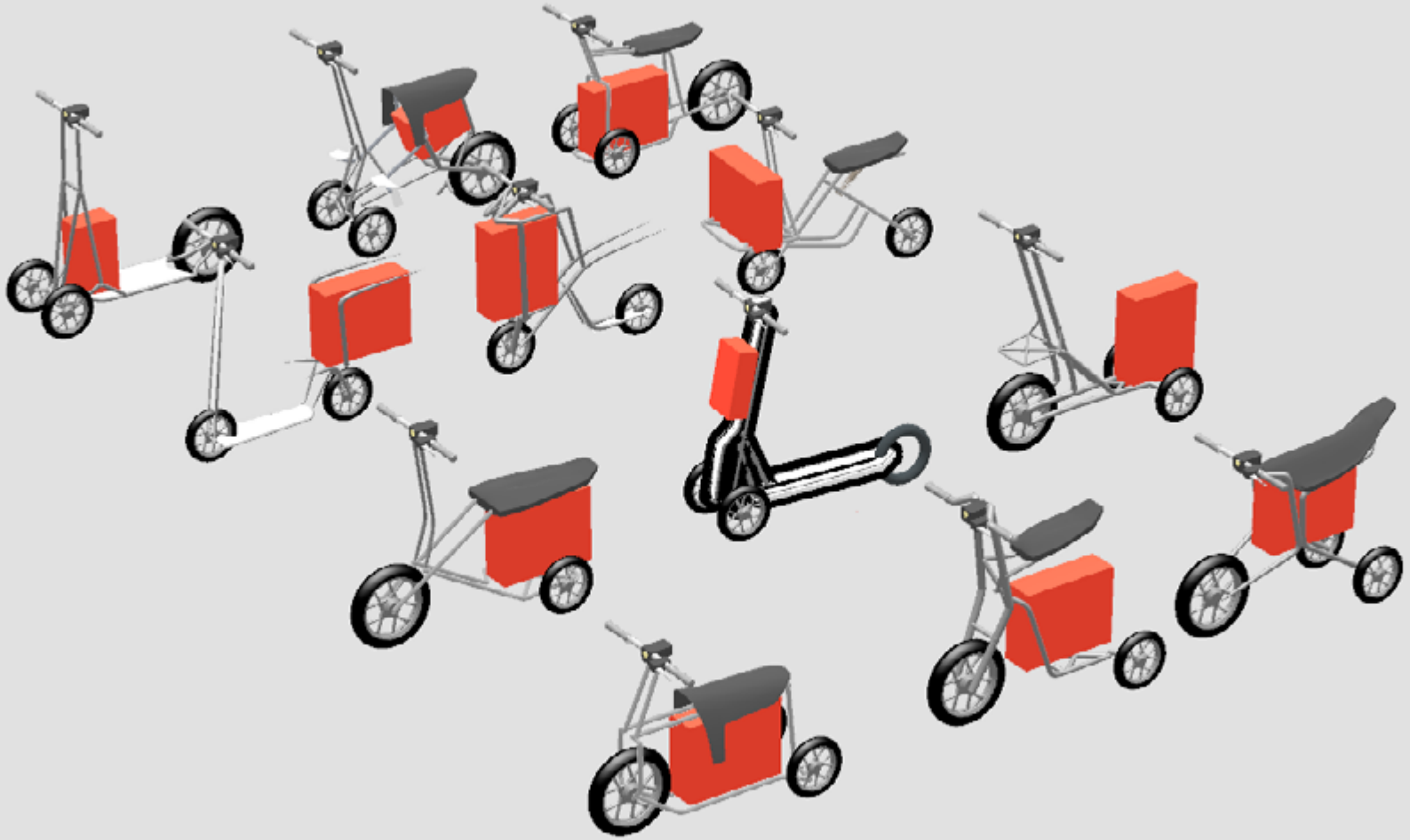
Quick mockup in **Gravity sketch**



Various archetypes can be obtained by testing with various riding postures.

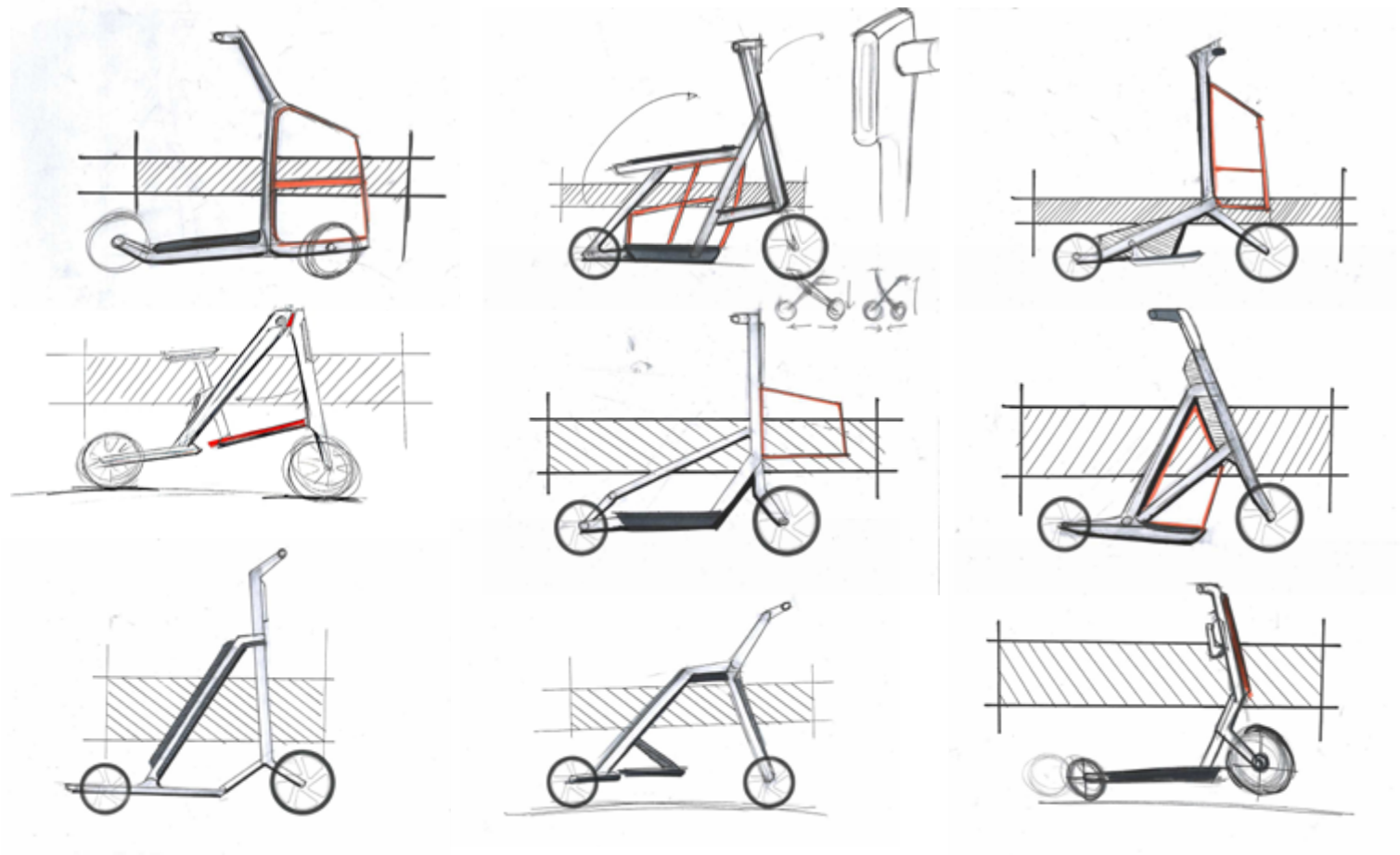
Design Development

Ideation



The red volume represents the storage area where users can store their belongings. At this stage, the exploration is aimed to create a variation that diverted from the original archetype.

Design Developent
Sketches



Scooter sketches

Based on the research outcomes, the initial archetype of scooters was explored. The sketches focus on the cargo feature of the vehicle and how it folds.

Design Developent
Moodboard

Design Developent
Moodboard

Shape

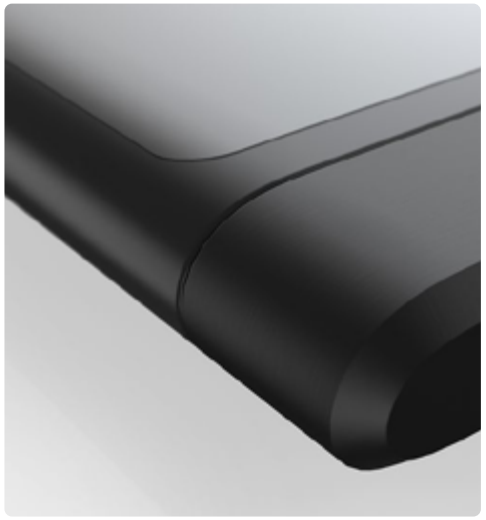
Light

Key words: Function Driven / Constant Thickness/Reduced/ Inviting/ Modest

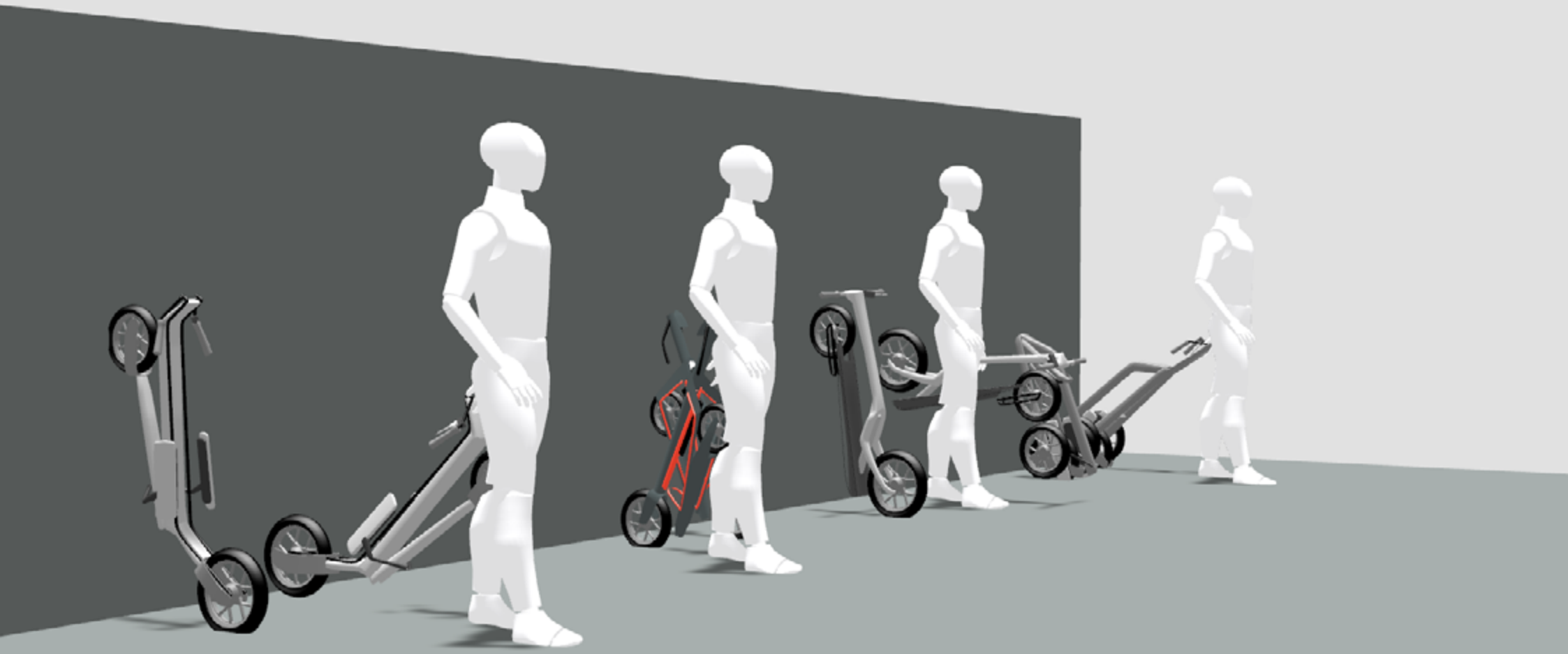
Detail




Material adn Surface

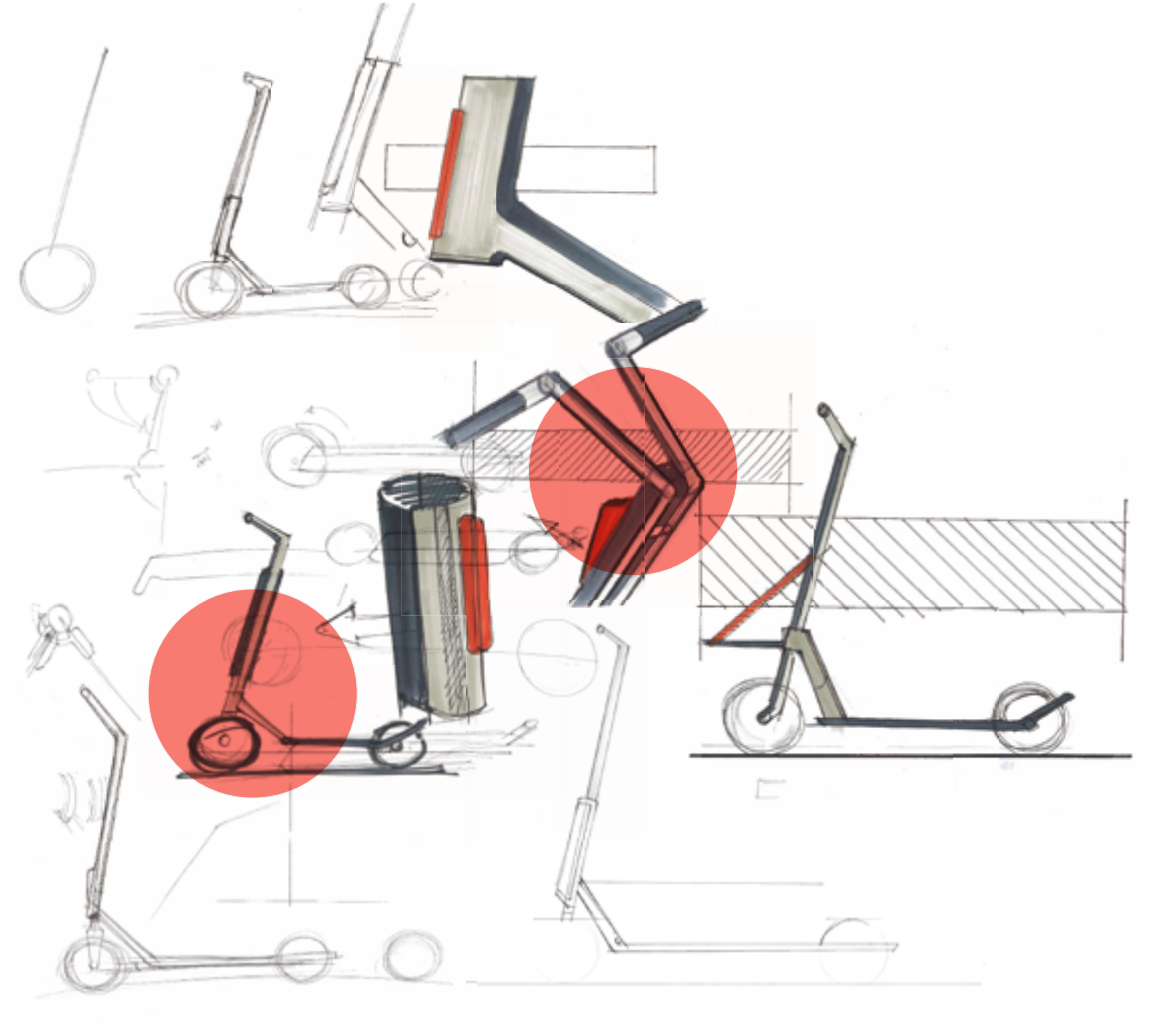



Design Developent
Ideation



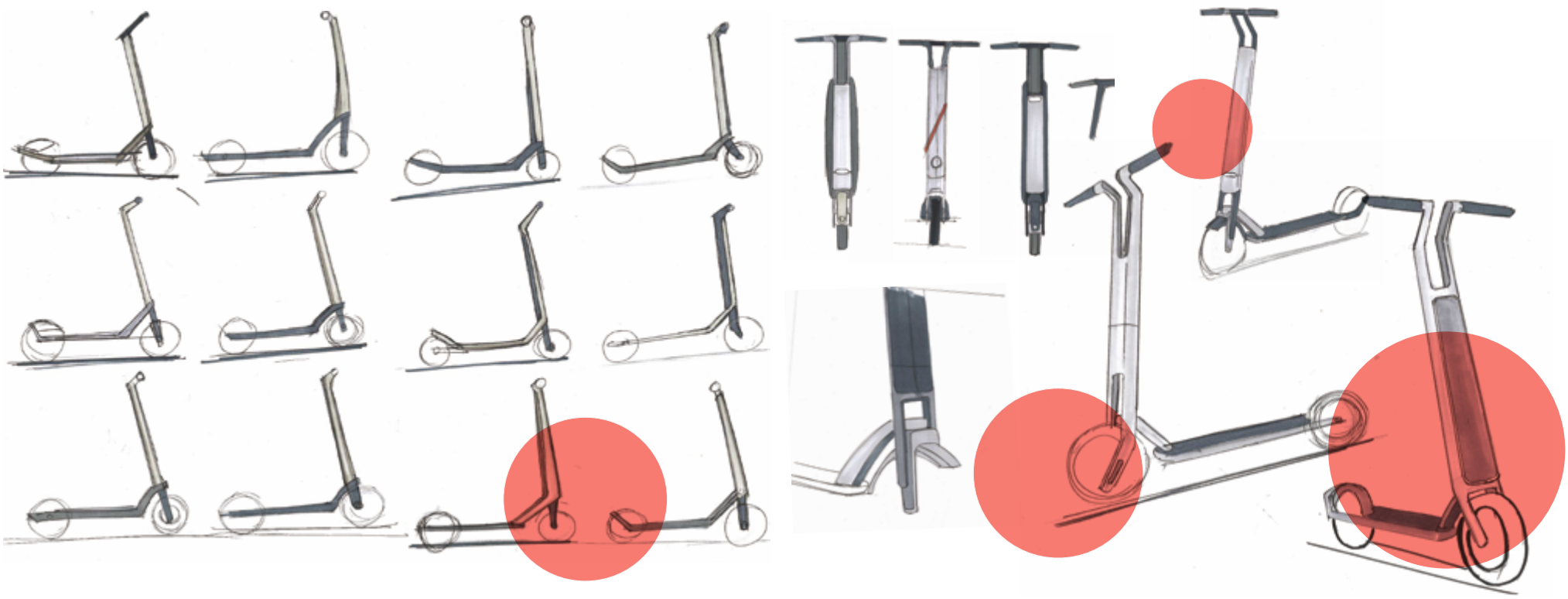
Some chosen concept are evaluated in Gravity sketch by comparing the scale with the mannequin.
This step can quickly express how the product interacts with the user and the size of the design.

Design Refinement
Initial Design



Initial archetype
Although most wheel arrangements, such as tricycles, can improve vehicle stability, they also increase the vehicle's size and weight, reducing its portability. In order to emphasize the flexibility and portability of the vehicle, the finalized prototype will feature a folding function.

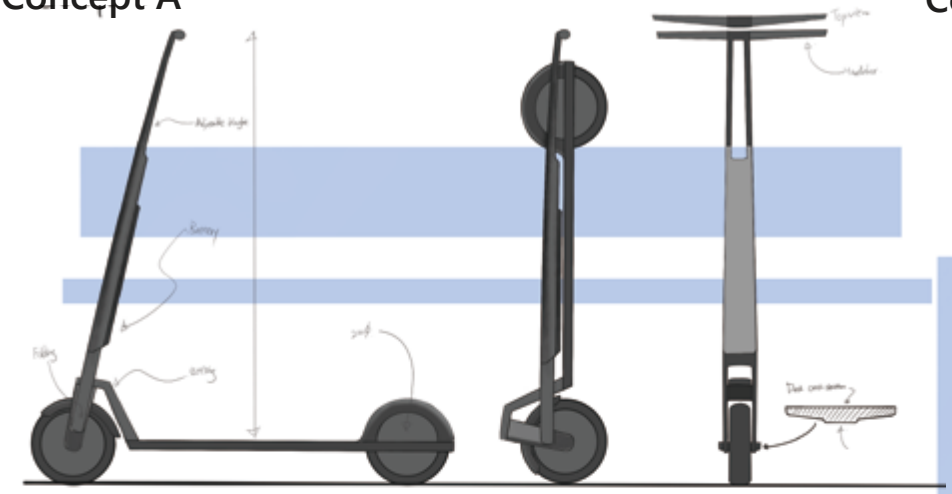
Design Refinement Sketches



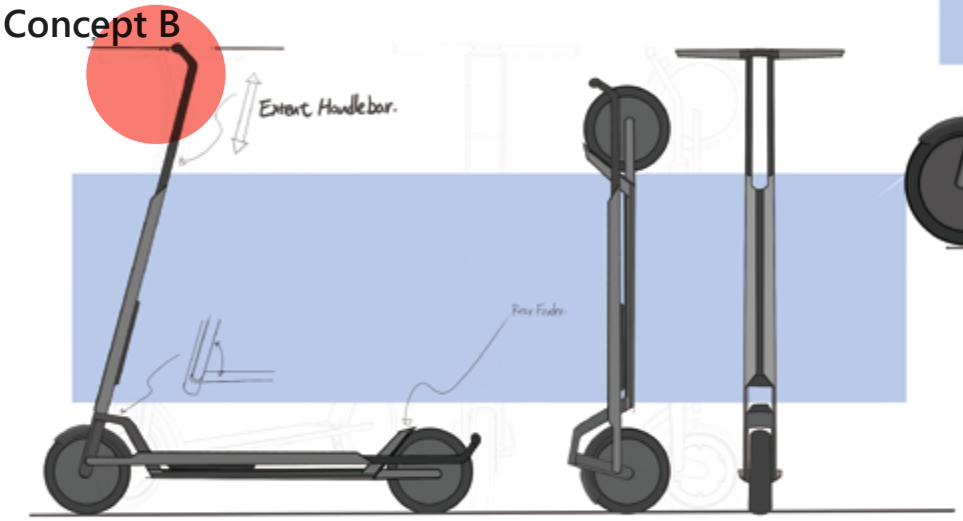
In the second round of ideation loop, the internal structure are defined. The aim of these sketches is to narrow down the concept and focus on the product details.

Design Refinement Sketches

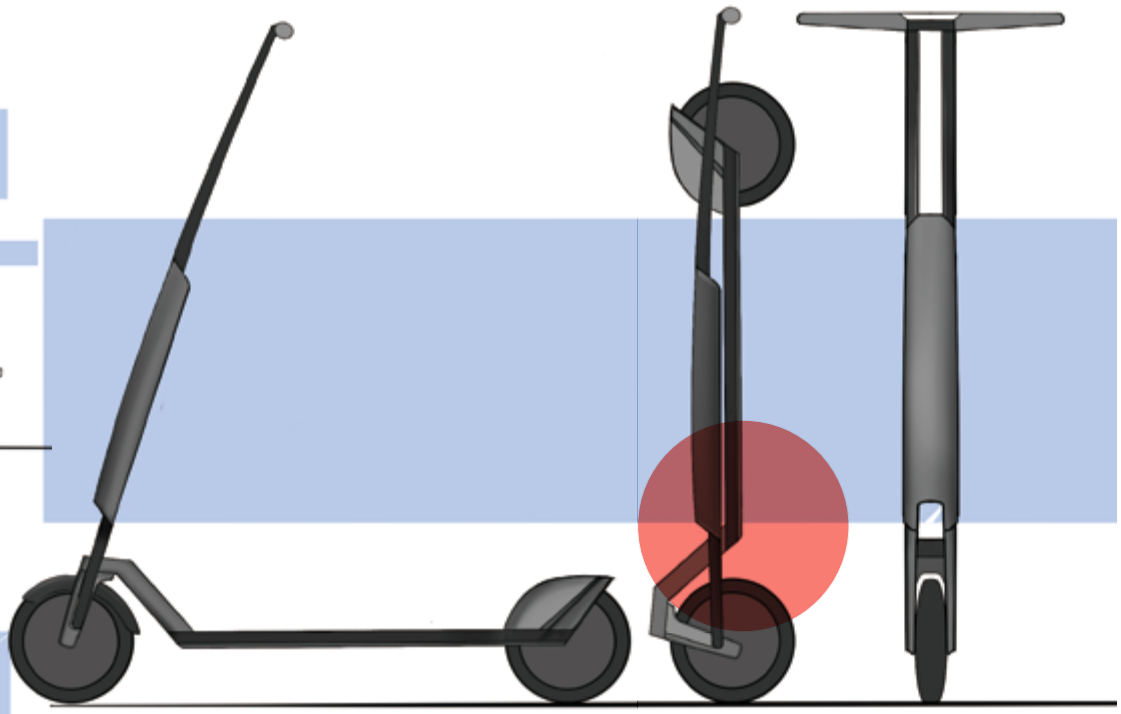
Concept A



Concept B



Concept C



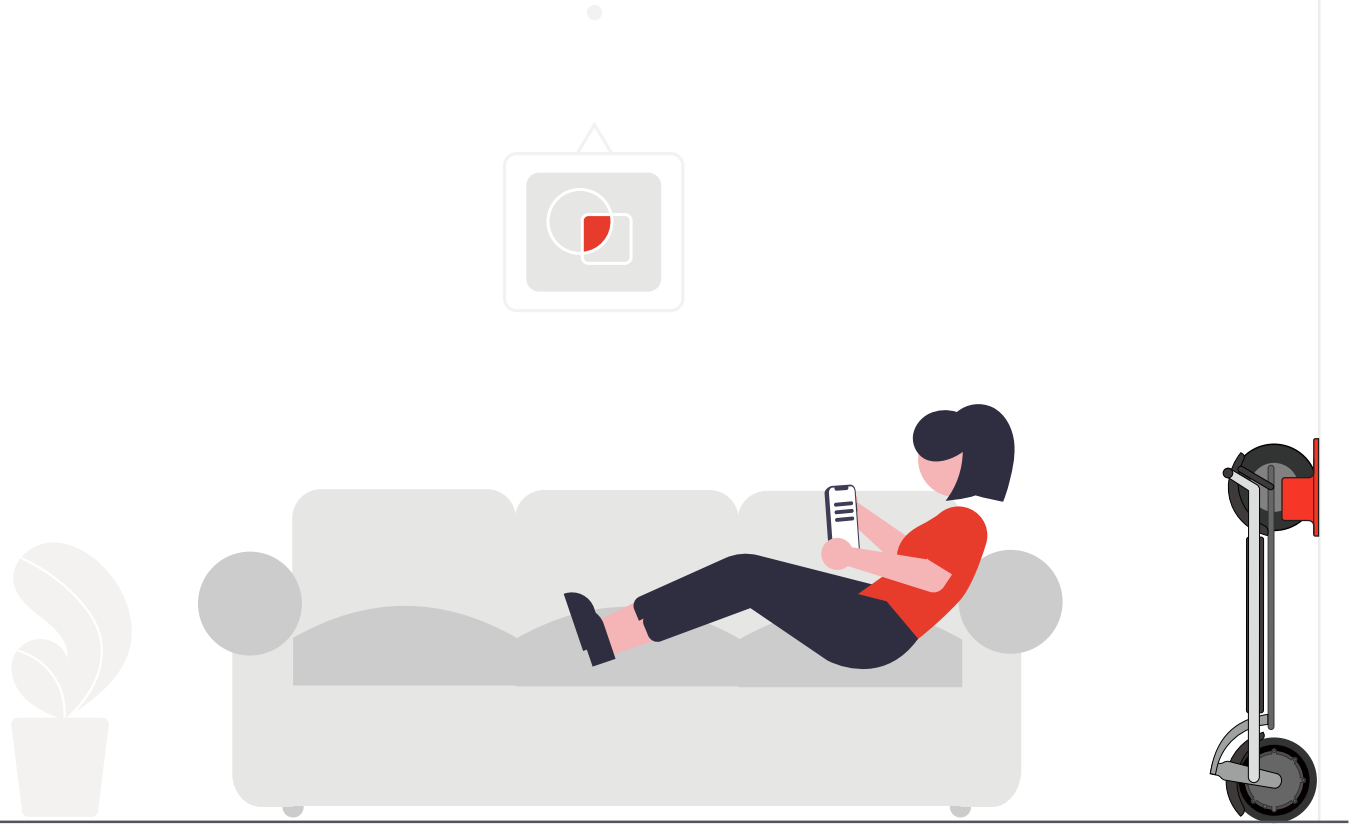
The refined sketches aim to focus on the form when folded, and there are three possibilities provided.

Design Considerations
Portability

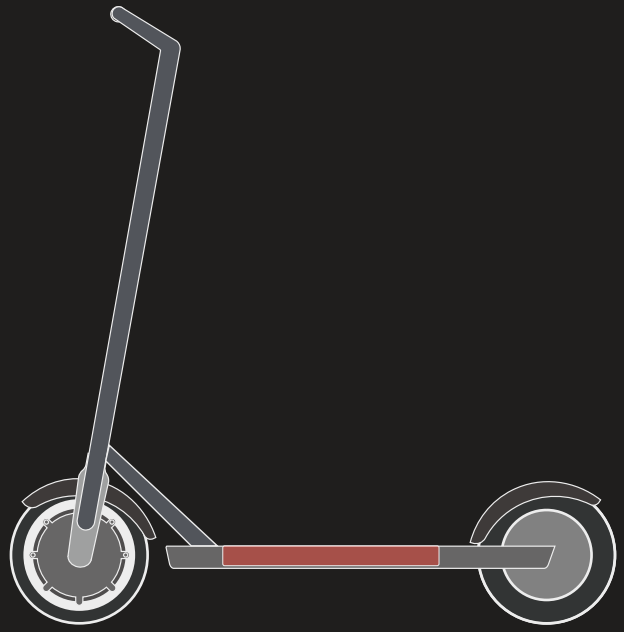
In the second round of ideation loop, the internal structure are defined. The aim of these sketches is to narrow down the concept and focus on the product details.

Design Considerations
Indoor Parking

STORAGE
Since the volume of the escooter is much smaller than that of other vehicles, the most common storage method is indoor parking. In order to make the product better integrate into the home, the dock of the escooter is consciously designed as a household appliance.



Design Development
Prototyping

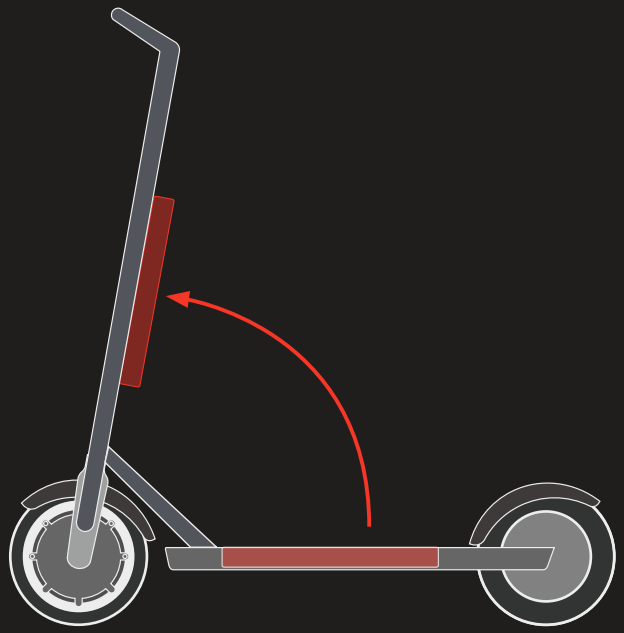


Product study

In order to quickly understand the actual size of the product and the proportion in the real situation, several important components of the electric scooter will be extracted separately and applied to the model making.

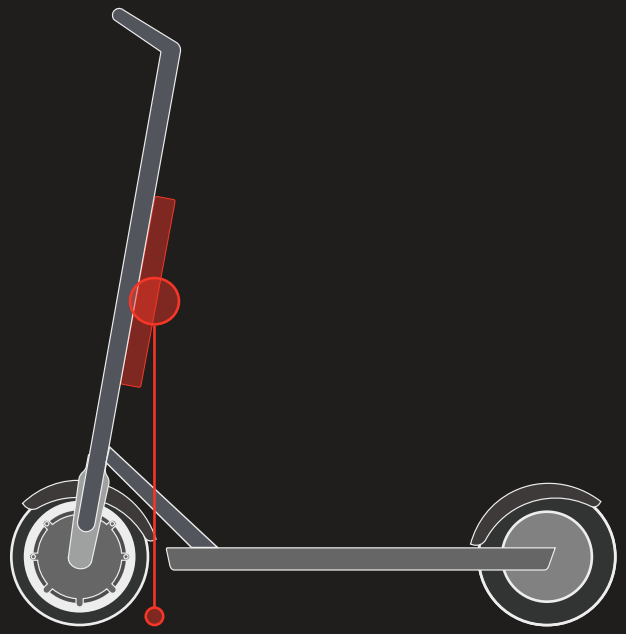
Design Development
Prototyping

Relocating battery



The battery removed from the scooter was smaller than expected, so I decided to try replacing the battery from the deck to the stem; the advantage of this is that all the essential parts are in one place for easy service and maintenance and also for the user's comfort angle to replace the battery.


Skum
Kolsyra



Cetner of gravity

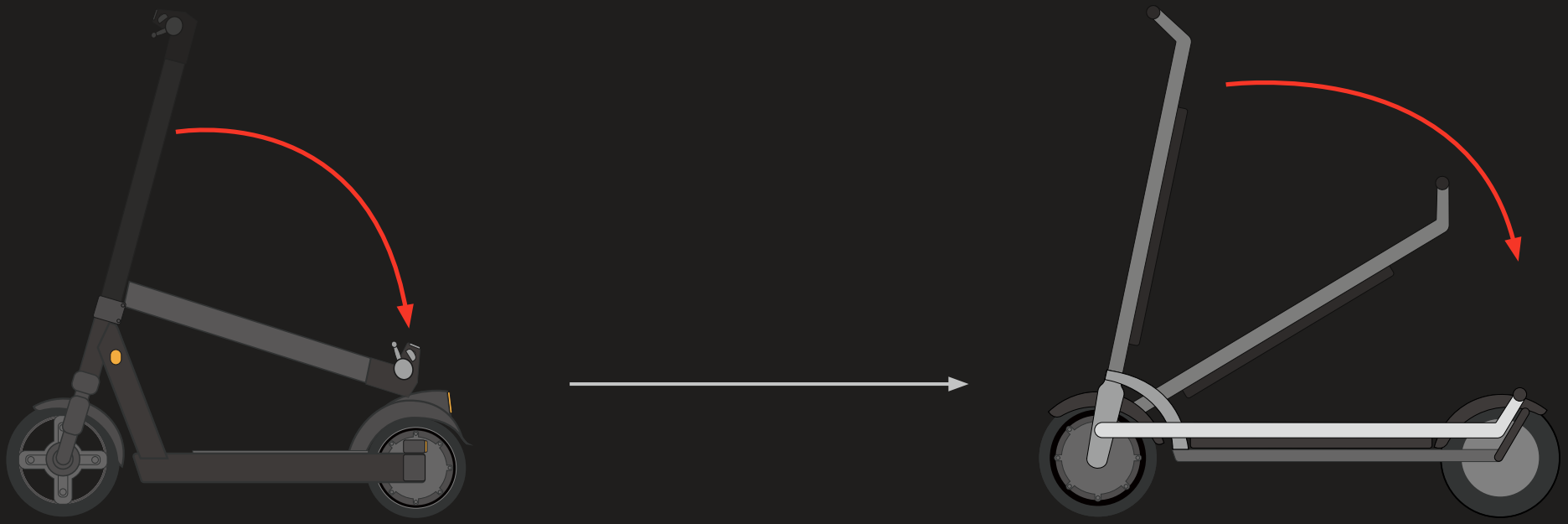
The mockup at this stage will help me understand the position of the center of gravity of the product, in order to prevent the possibility of tipping forward, I tilt the design of the stem back a little, so that the weight of the stem can be kept above the user's feet.

Folding and steering mechanism design

Folding and steering are essential features of this design; therefore, I chose a dual-stem design to avoid interfering with the hinge and stem. This saves battery space while also providing a more stable structure.


TOILET
PERSONS


Design Development
Foldable mechanism



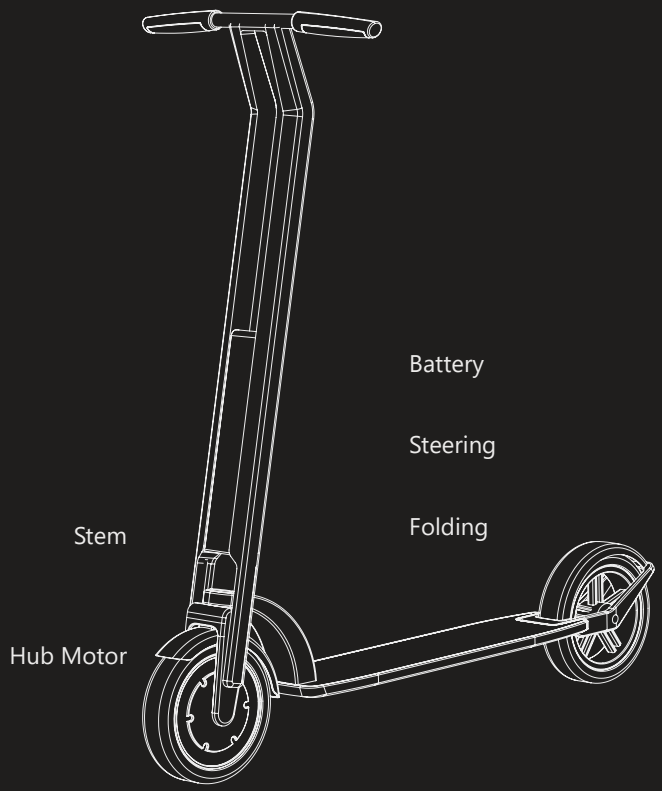
Original Folding Mechanism

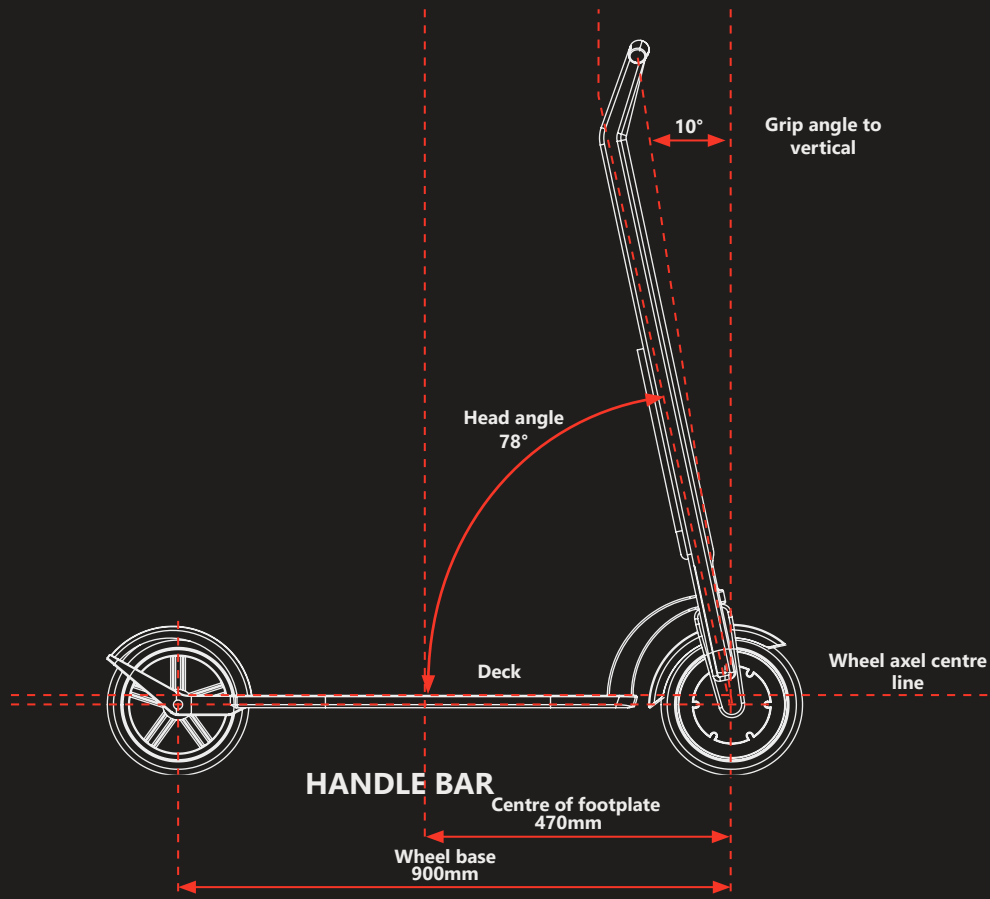
The existing folding method requires the user to divide the shaft into two sections, which will cause future wear and tear and make the shaft unstable and wobbly.

Improved Folding Mechanism

The new mechanism allows the folded shaft to be parallel to the pedal, which can minimize the folded volume of the product and make the appearance more harmonious.

Design Development
First Mockup

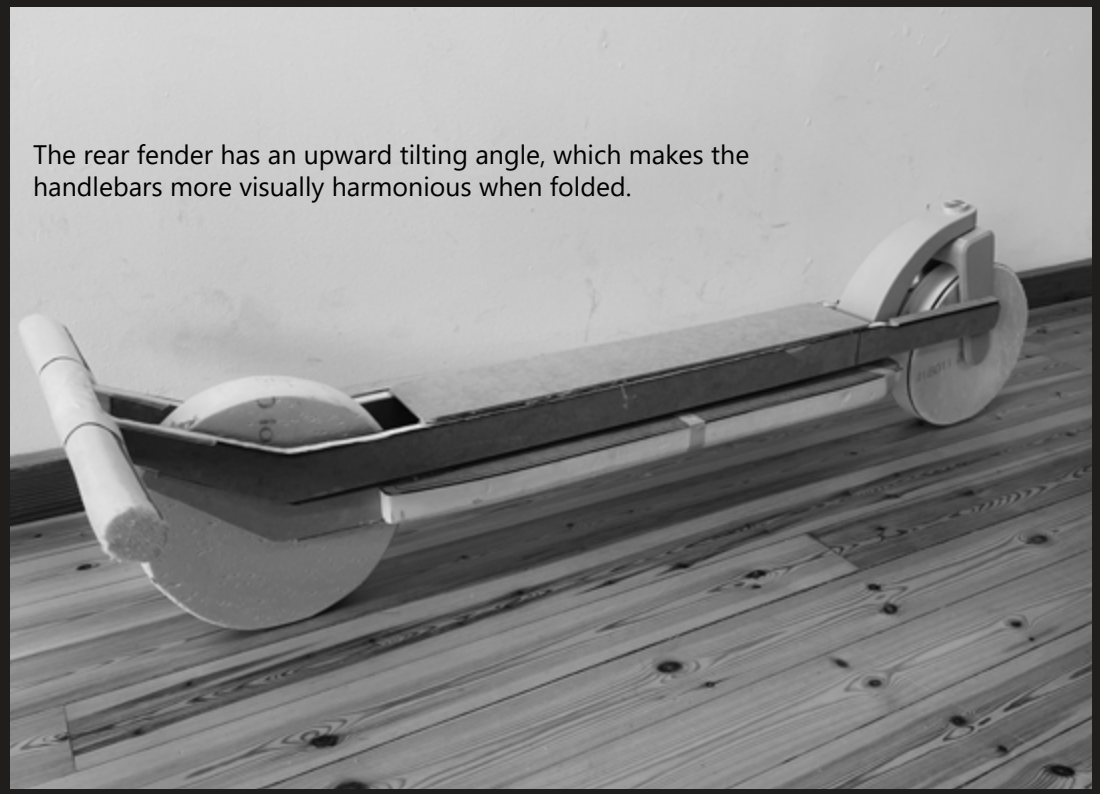


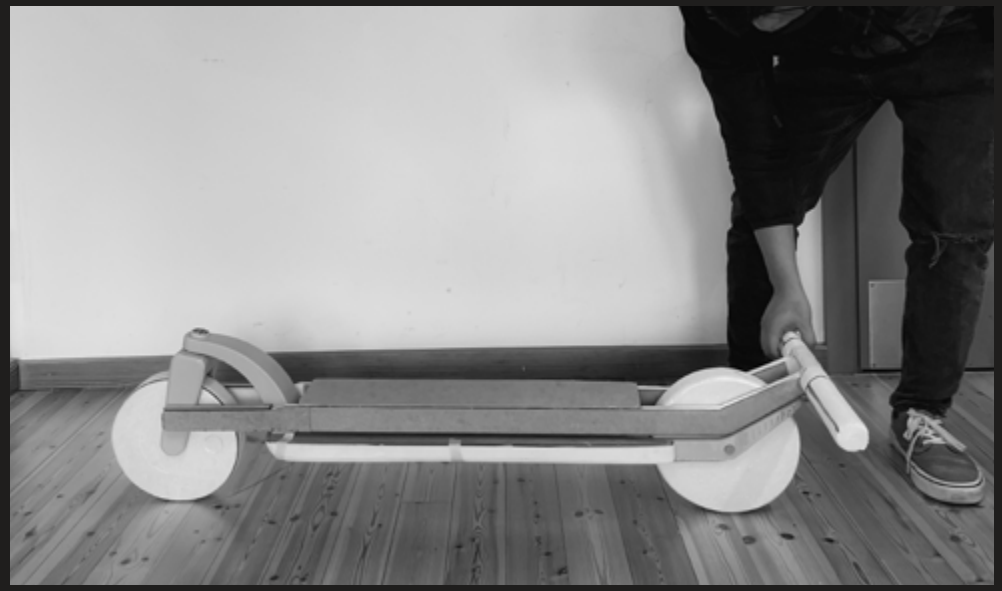


The first version of the mockup was built according to its product functions. A slot in the stem provides space for the back fender and tire when the vehicle is folded.

The first prototype is made of foam and MDF boards, and the diagram shows a general dimension of the escooter design. This prototype aims to examine the steering mechanism, the swapping battery feature and have a full-scale feeling of the design.

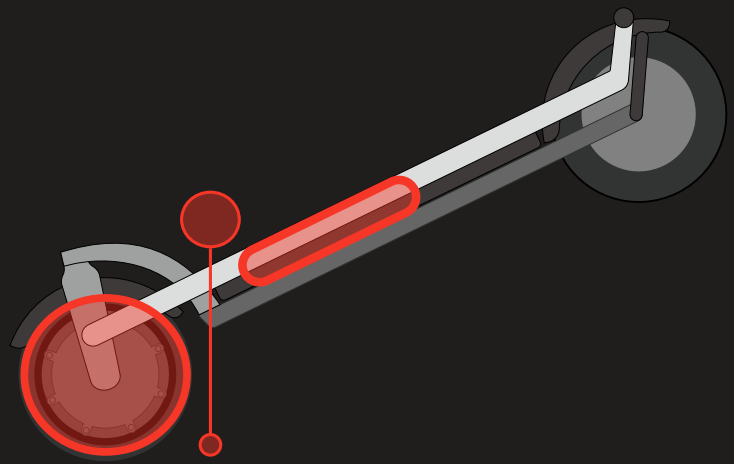
The rear fender has an upward tilting angle, which makes the handlebars more visually harmonious when folded.





Design Development
Indoor Parking

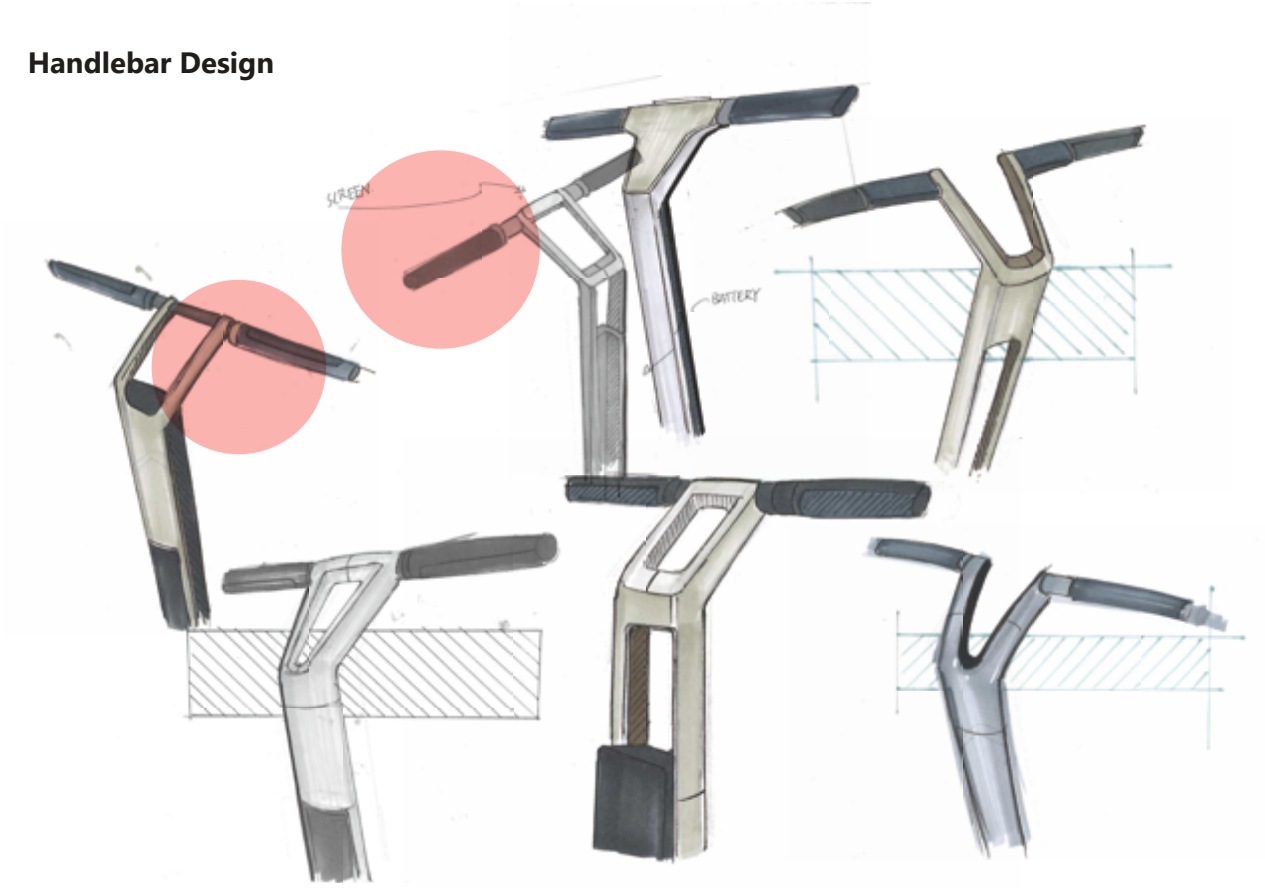
Since the battery and hub motor will be the components that take up the most weight in this design, so when the user folds the vehicle and drags it around, the centre of weight will be closer to the ground, making it easier for the user to move around.

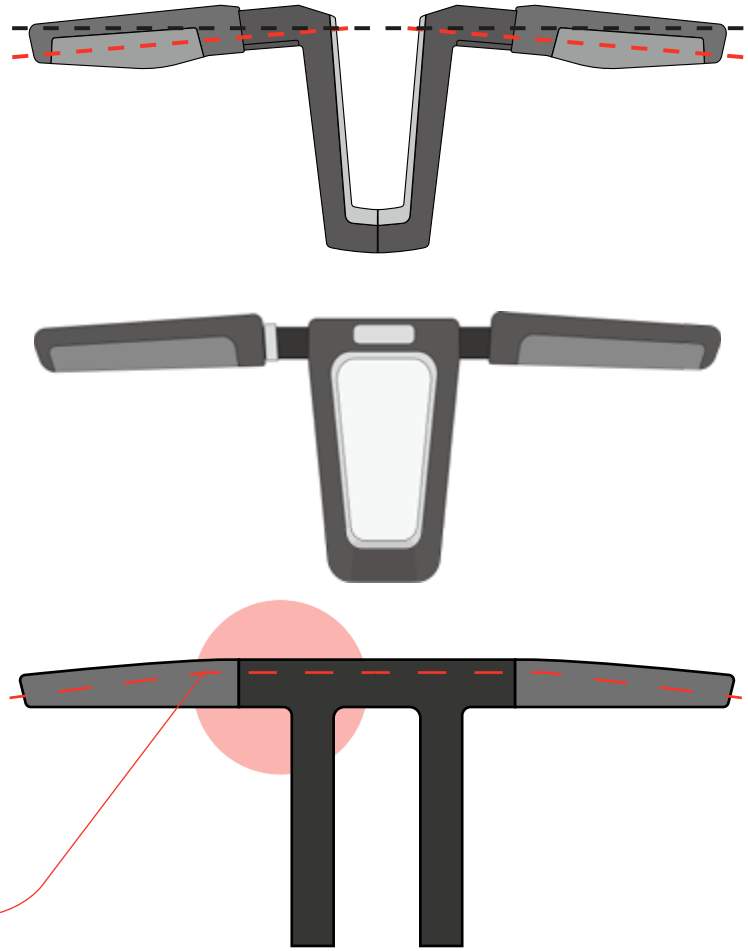


The key design feature of the scooter is focused on the folding mechanism. The design should look unified while the stem is folded.

Design Development
Interface

Handlebar Design





During the handlebar design phase, some ergonomic features were introduced to the handle. The folded form inspired other sketches. The final design aimed to keep the handle's integrity as much as possible while still including some angles at the grip.

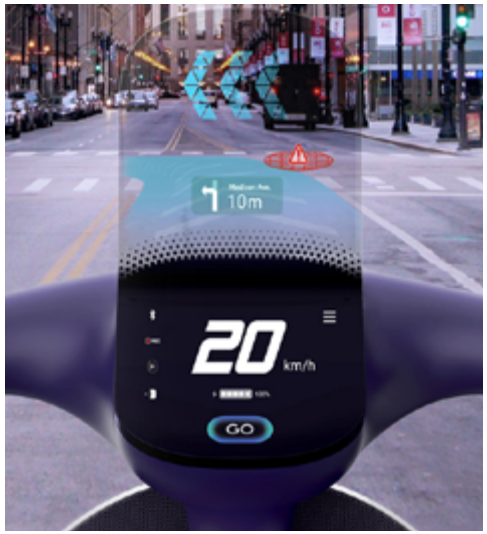
Design Development
Interface

Talkative ——————————————————————————————————→ **Discrete**

E-motor

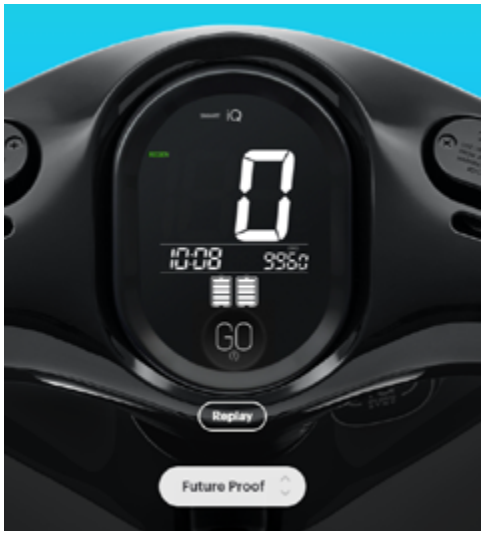
Odometer · High Beam · Clock · Limp mode · Diagnose · Side stand · blue-tooth · Range Left · Battery · Lights on/off · Turn indicators · Speed · Navigation

E-motor (concept)



Clock · Speed · Lights on/off · blue-tooth · Navigation · HUD · Battery · Record · High Beam

Gogoro



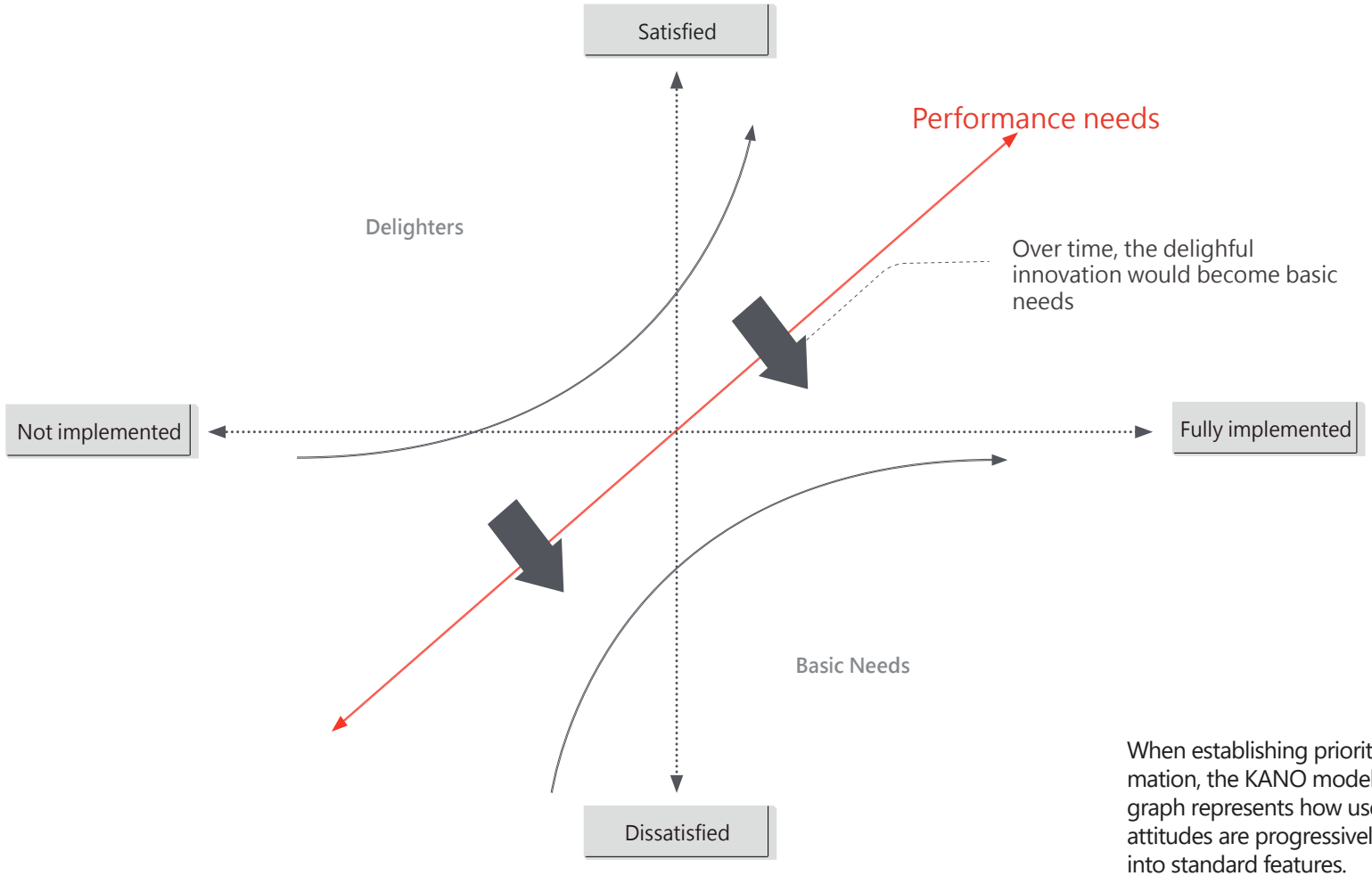
Clock · Speed · Lights on/off · Blue-tooth · Navigation · Odometer · Battery · High Beam

Bolt

Battery · Speed · Lights on/off

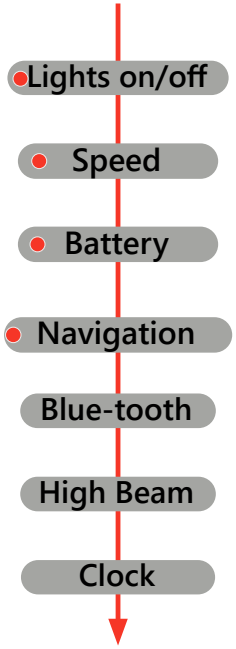
The interface design combines many electric scooter interface styles, including models from various companies such as Gogoro and Bolt. The information to be shown on the interface varies depending on the requirements. The features shown by red icons provide the essential information that electric scooter riders require.

Interface Development
KANO Model



When establishing priorities and needed data for interface information, the KANO model can assist in formulating user needs. The graph represents how users embrace new features and how their attitudes are progressively transforming some of these elements into standard features.

Interface Development
Info layout



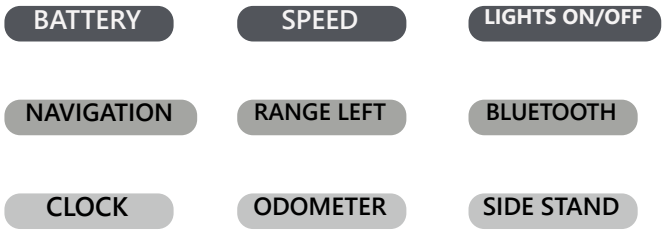
	I like it	I expect it	I am neutral	I can tolerate it	I dislike it
Functional					
How would you feel if the product had navigation?		●			
How would you feel if there was more of integrated display?	●				
Dysfunctional					
How would you feel if the product did not have odometer?			●		
How would you feel if there was a smaller screen?			●		

Functional		Dysfunctional		Categories
I like it	+	I dislike it	→	MUST BE!
I expect it	+	I can tolerate it	→	ONE DIMENTIONAL
I am neutral	+	I am neutral	→	ATTRACTIVES
I can tolerate it	+	I expect it	→	INDIFFERENT
I dislike it	+	I like it	→	REVERSE

This method compares the most expected and least expected functions through a series of information functions after finding certain essential information functions. This method may be used to add new features or eliminate less essential information such as the odometer or high beam mode.

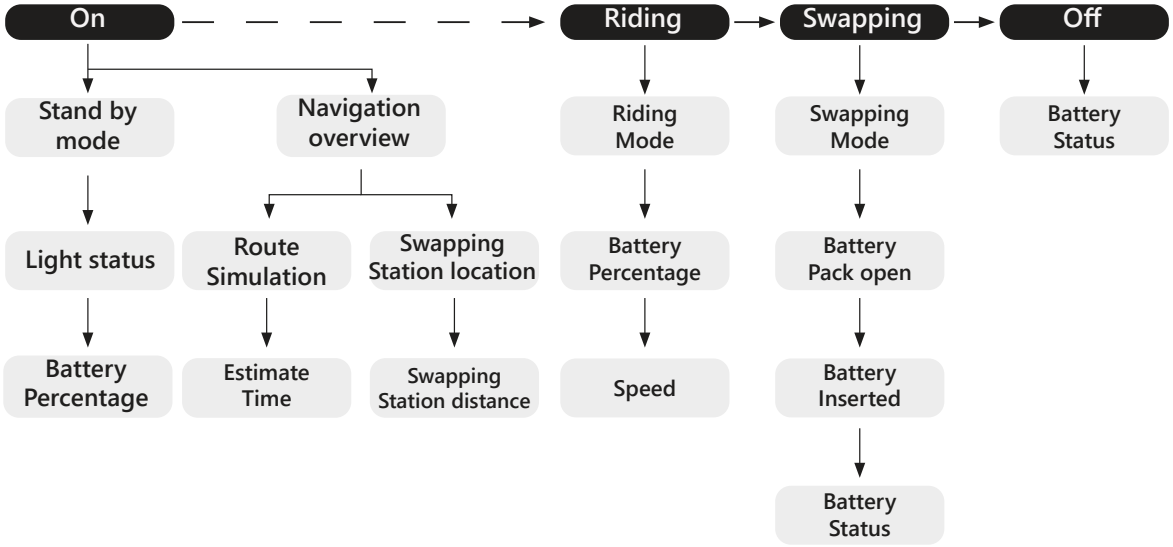
Design Development
Interface

Information analysis



After comparing and classifying the functions of four common micro mobility interfaces. A total of **9 functions** are screened out, and these functions are **graded according to the user's frequency of use and basic needs.** The first column is the most basic functions such as battery, riding distance and speed, and lighting

Screen modes



Design Development
Interface

Screen Design

According to the previous research and analysis, we can know that when users actually use micro mobility, the information received from the screen is limited. Therefore, the data should be focused on basic information, and the screen should be kept as low-key as possible. In order to continue the pattern on the handle, the screen can be presented in the form of LED light spots

Design Development
Interface

Design Development
Interface

Cmf Exploration
Urban Smartness

Different CMF can reflect the user's life style and personality, and different combination are proposed in CMF exploration.

Performance,Speedy,Expressive,
Friendly

Credible,Confident,Trendy

Youthful,Stylish,Elegant,Individual

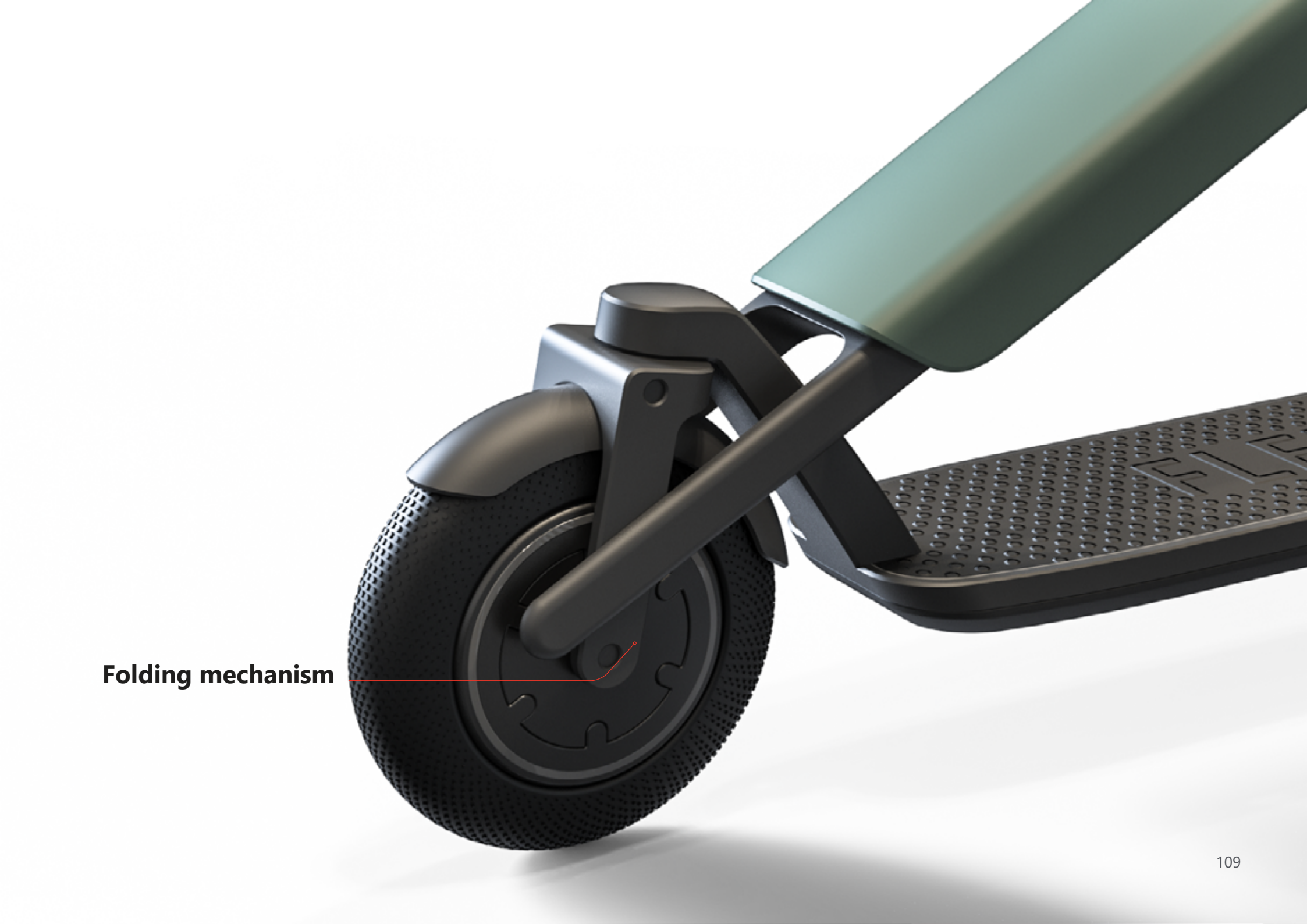
Credible,Confident,Elegant
Classic

PHASE 4 FINAL DESIGN

FINAL DESIGN

DESIGN FEATURES

PRODUCT DETAILS

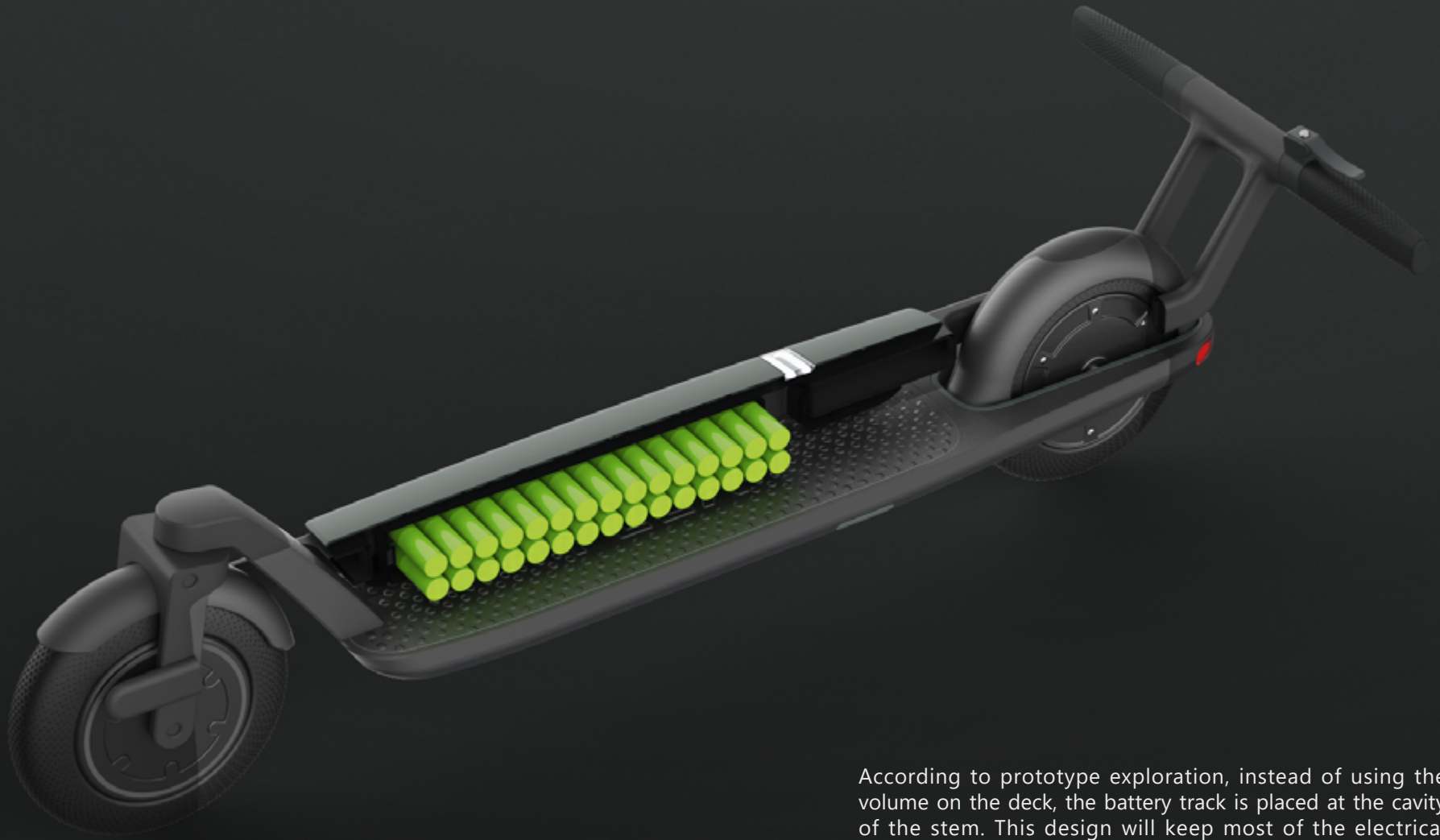

Folding mechanism

HANGER DESIGN

DECK DESIGN

REAR LIGHT

STEM DESIGN



According to prototype exploration, instead of using the volume on the deck, the battery track is placed at the cavity of the stem. This design will keep most of the electrical components in the same location for future maintenance.

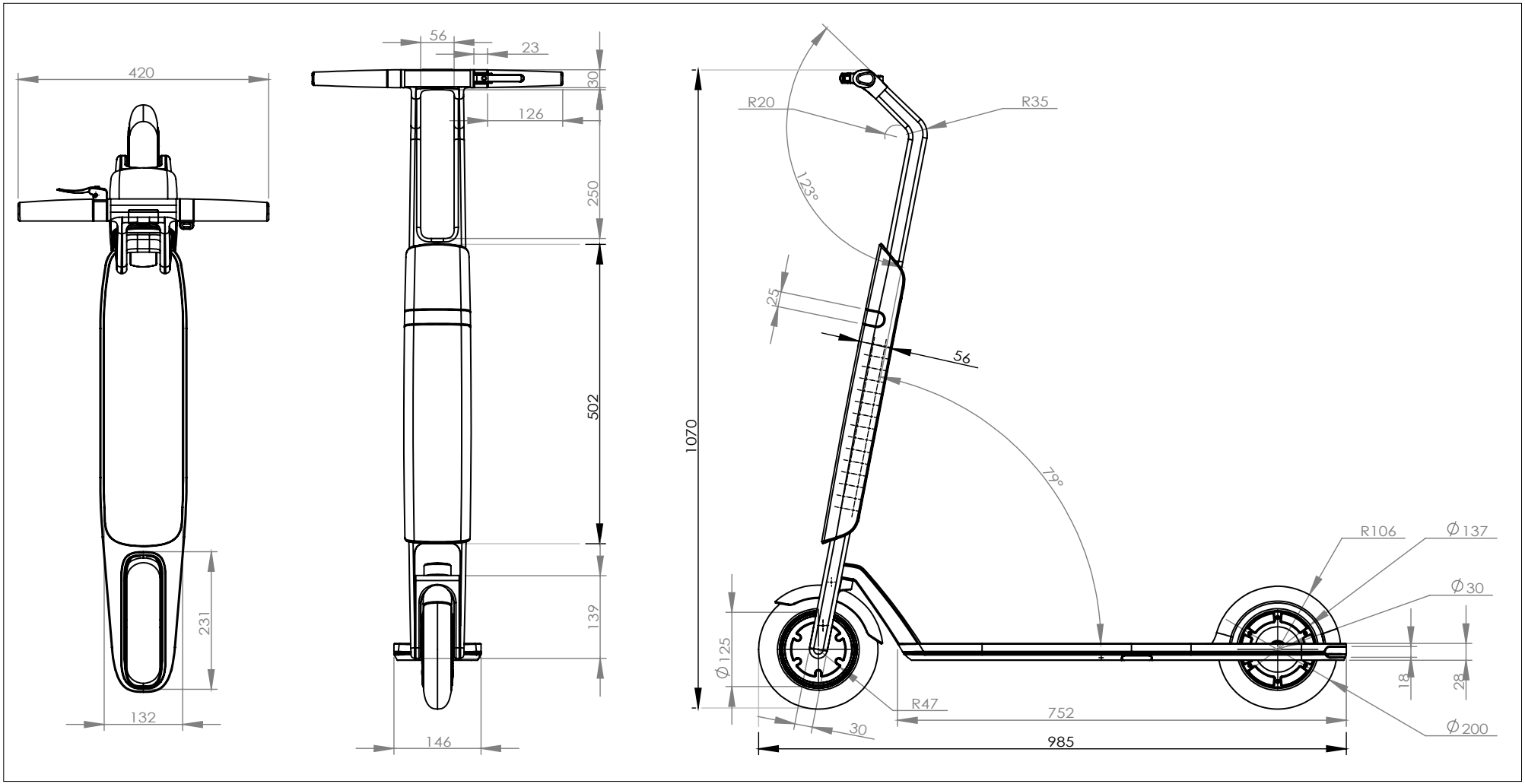
Exploded View
Design Details

Bill of Materials

Part No.	Name	Material	Color	Finish
1	Front Light Cover	Acrylic	White/Transparent	
2	Front Cover	ABS+PC	Pine	Matt
3	Flex Unibody Front Part	ABS+PC	Dark Grey	
4	Handle Bar	Rubber	Dark Grey	Rubbery
5	Accelerator	Aluminum	Silver	Anodized
6	Finger Lever	Aluminum	Silver	Anodized
7	Stem Frame	Stainless Steel	Dark Grey	
8	Flex Unibody Rear Part	ABS+PC	Dark Grey	
9	Battery Track	ABS	Black	Matt
10	18650 Lithium Battery	---	---	
11	Rear Fender Cover	ABS+PC	Pine	
12	Rear Fender	ABS+PC	Dark Grey	
13	FLEX Deck Top Cover	ABS+PC	Dark Grey	
14	Rear Light Cover	Acrylic	Red/Transparent	
15	Hub Brake	---	---	
16	Hub Brake Clutch	Stainless Steel	Silver	
17	Inner Tube Tire	Styrene-Butadiene	Black	Rubbery
18	FLEX Stand	Aluminum	Pine	Anodized
19	FLEX Deck Bottom Cover	ABS+PC	Grey	
20	Hub Motor	---	---	
21	Front Fender	ABS+PC	Dark Grey	
22	Fork/ Folding Part	Stainless Steel	Dark Grey	
23	Steering Part	Stainless Steel	Dark Grey	

Technical Drawings

E-Scooter



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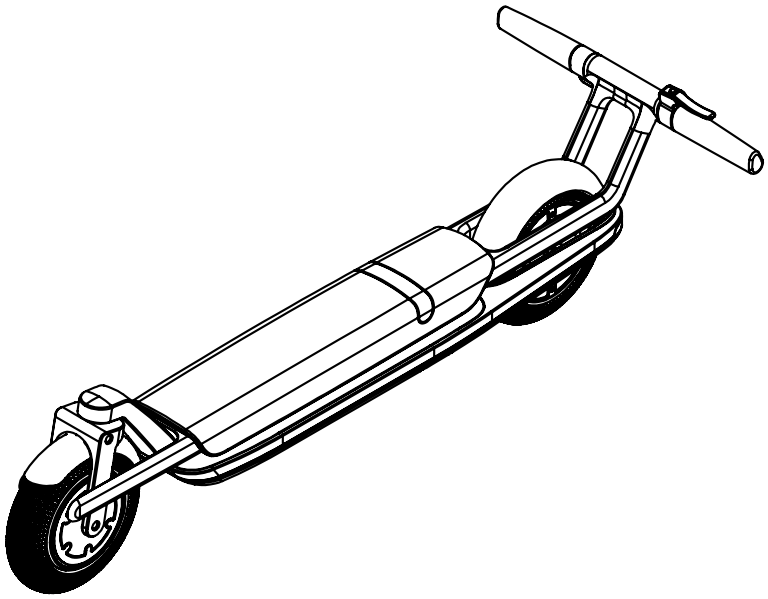
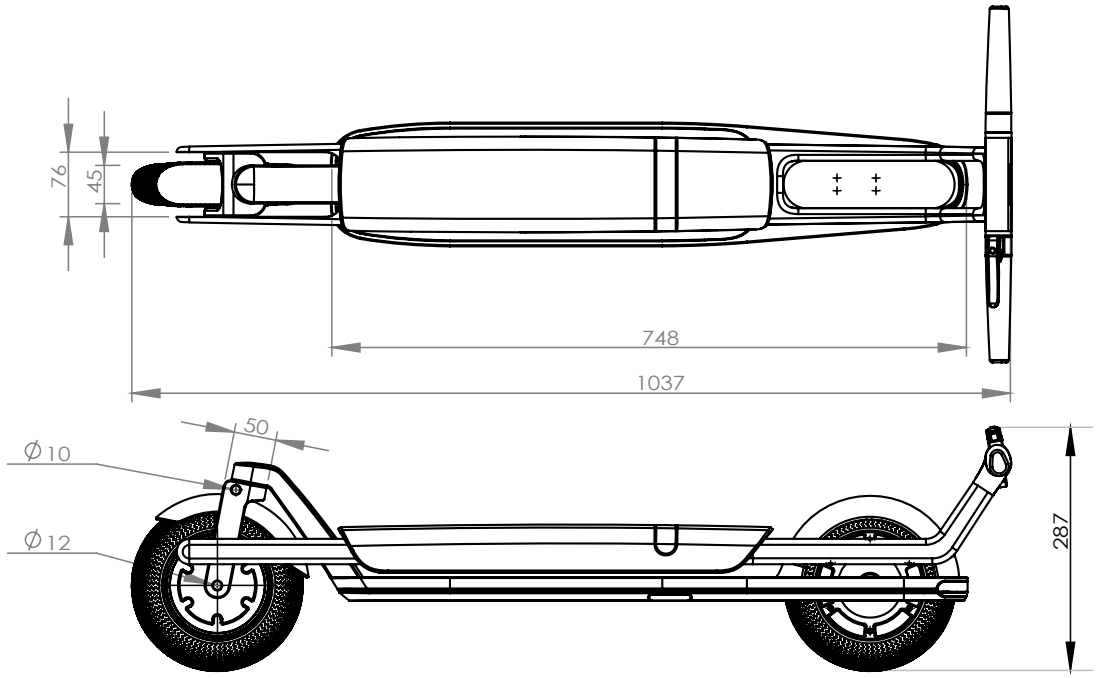
Technical Drawings

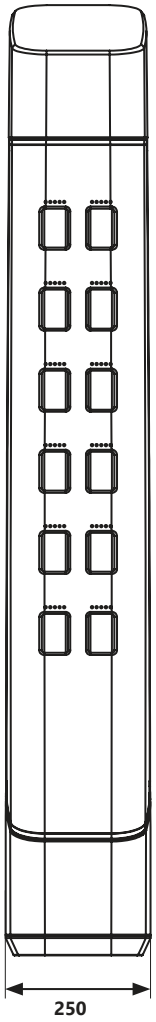
E-Scooter (Folded)

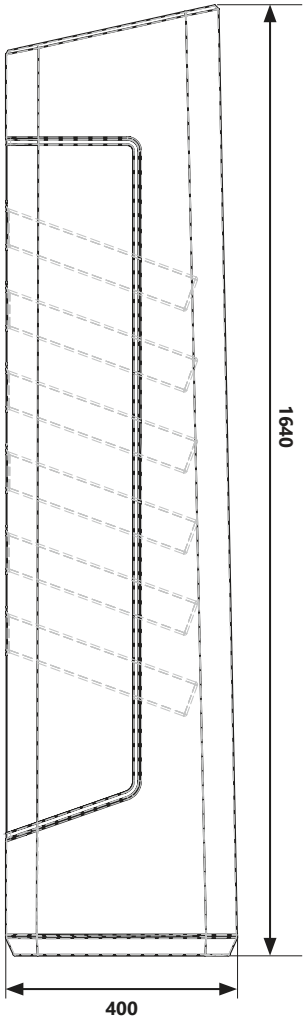


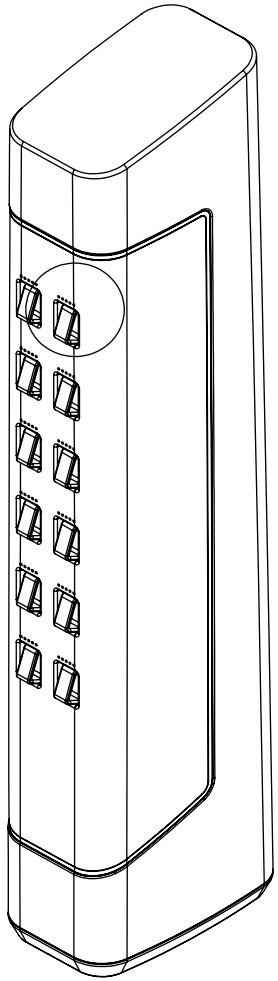


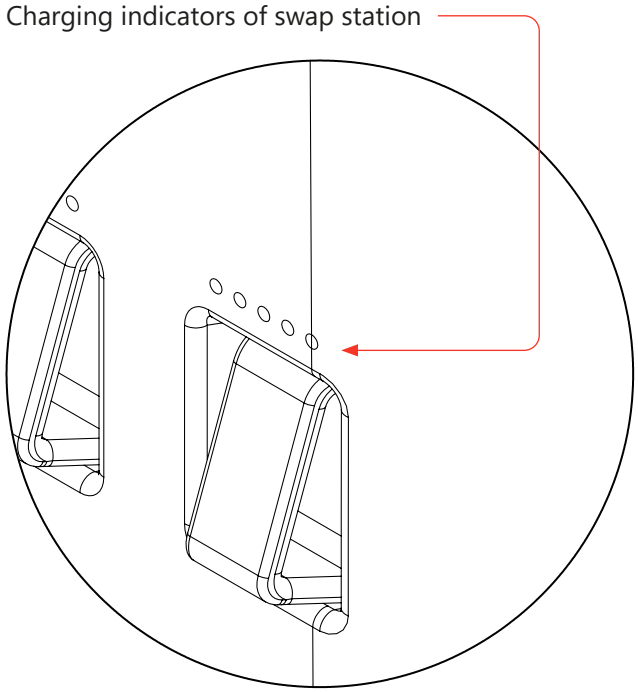
Technical Drawings

Swap Station





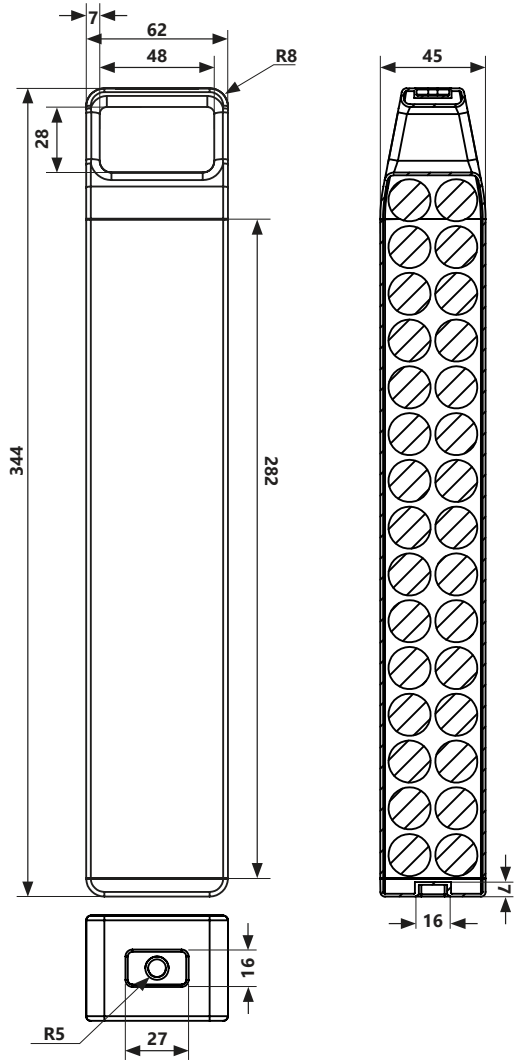


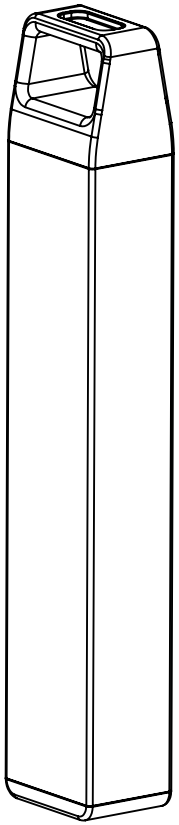


The swap station has 12 slots that can charge 12 batteries simultaneously. The angle used in the slot allows the user to take out the battery more ergonomically, and this design also allows the overall volume to be smaller and more compact.

Technical Drawings

Battery Pack





Each battery pack contains 30 lithium batterys. There is a slot at the handle of the battery which allows users to snap into the scooter.

PHASE 5 REFLECTION

To be concluded, the whole project takes the post sharing economy as the research goal, and as the project progresses, many new insights are gradually becoming clear. Design strategies and some design methodologies were applied in this project, which made the idea more credible and made the overall project more user-friendly. FLEX can be seen as a new option for modern people's commuting, and such a result was not expected at the beginning of the project. During the design process, I gradually realized the close relationship between the modern sharing economy and the environment. In order to prevent foreseeable environmental pollution and other issues, FLEX proposed a new alternative in a much more sustainable approach. Thanks to the support of the swap station, users can make the journey smoother based on this platform. At the end of the thesis, I would like to thank my supervisor Claus and Sven from Phoenix Design for their support and guidance.

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