



DEP702

DESIGN PROJECT 2 - REPORT

'Door to door milk delivery vehicle for rural/suburban regions'

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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited of whom proper permission has not been taken when needed.

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Approval Sheet

This Mobility and Vehicle project titled "Door to door milk delivery vehicle for sub-urban/rural regions", by Manan Sharma is approved in partial fulfillment of the requirements for Masters in Design in Mobility and Vehicle Design.

Approved by -

Guide -



Chairperson -

Internal Examiner -



External Examiner -



Acknowledgement

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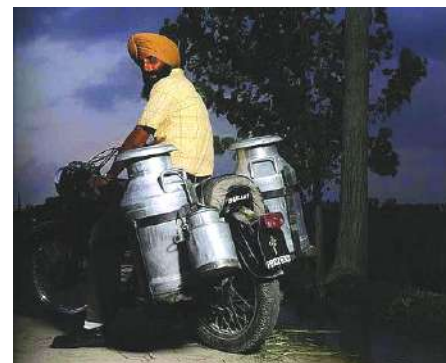
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1. Introduction

India as a country, is the highest milk producer in the entire world, with a staggering 22% of the global supply coming from India. As a result, the dairy industry contributes 5% to the national economy and sector provides employment to millions throughout India. Being the highest consumer of milk, most of the milk production is used internally, with a small amount being exported to other nations.

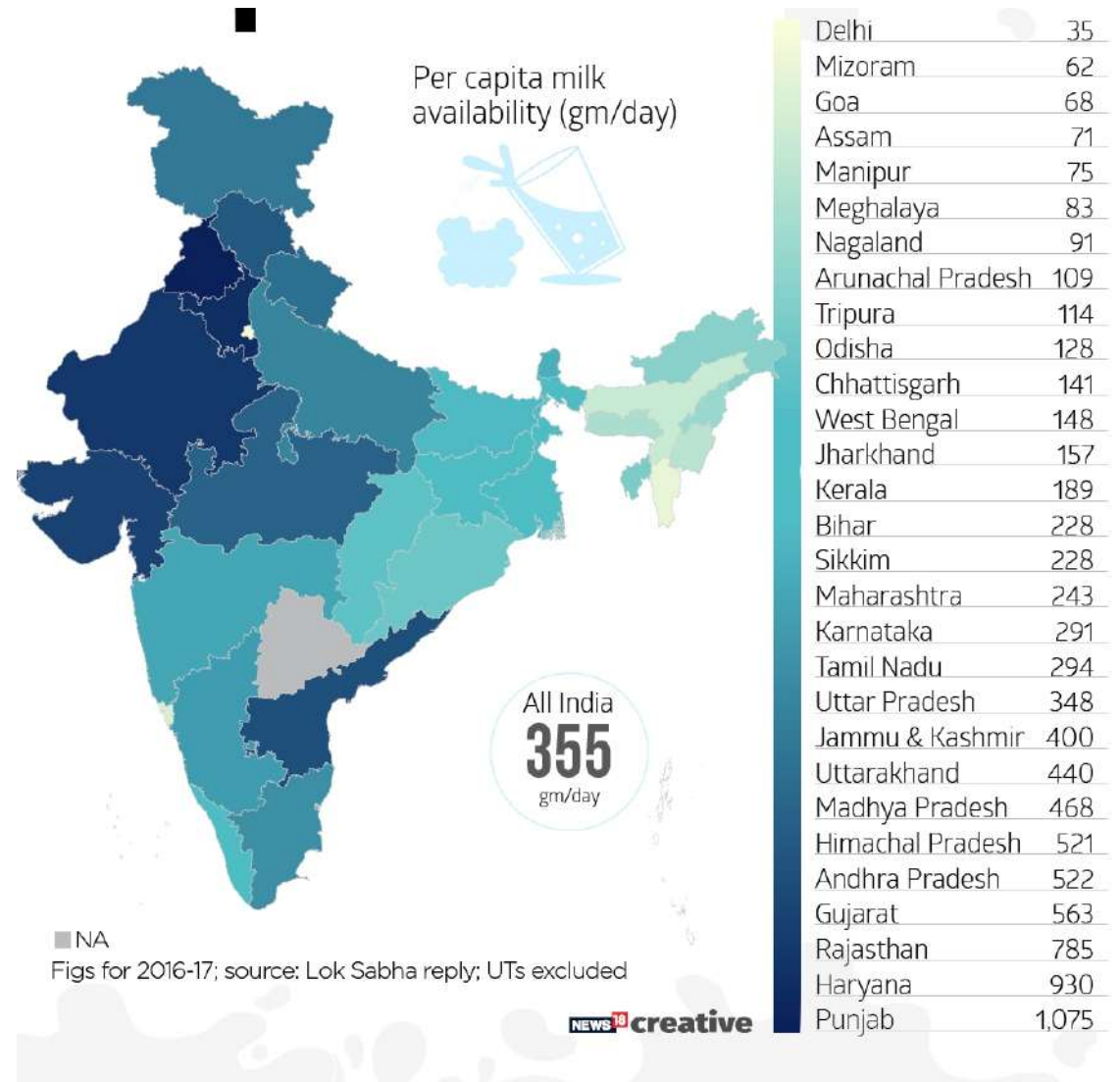
But how is this milk delivered to the consumer ?

While bakeries, industries and factories receive their milk through freight, a large portion of rural and sub-urban households in north and north-western India receive fresh milk daily, delivered on 2 wheelers early morning, right from the source, the dairy farm itself. Fresh milk delivery on 2 wheelers has been a popular profession among small dairy farmers. Being an unregulated business, the vehicles used by the dairy farmers are unsuitable for the purpose, often creating a safety hazard for the farmer as well as other road users as well. Through this project, I aim to understand these problems, the user, their needs and aspirations and create a purpose-made vehicle for door-to-door fresh milk delivery for North western, with Uttarakhand chosen as the domain for context research.



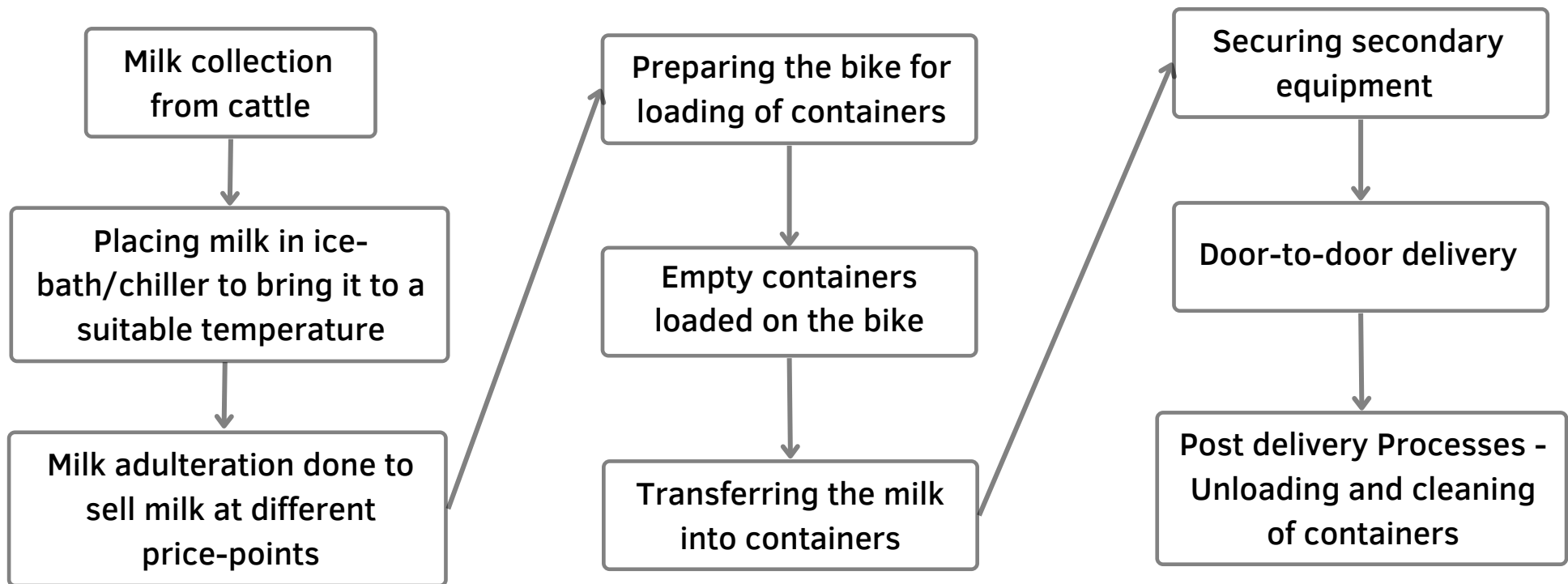
1.1 Why Uttarakhand?

There are over 51,000 milk cooperative members, mostly farmers in Uttarakhand, who kept supplying milk during the lockdown period. Most of Uttarakhand's regions and remote locations are only accessible through 2-wheelers, hence 2-wheeler milk delivery vehicles are immensely popular for this profession. The fresh milk delivery business in regions like Uttarakhand booms because of lack of online grocery retail services, hence delivery services using 4 wheelers are few. All these factors combined, make 2 wheelers the preferred mode of delivery of fresh milk. The chart on the right showcases the per capita milk production of each state., Uttarakhand at a commendable 8th position with 440 gm/day per person.



1.2 Delivery Process

Before designing a vehicle for this profession, it is imperative to understand the process and procedure followed in this particular business. This helps us understand any pre or post delivery complications/difficulties that we might be able to solve through design. The process begins from the collection of milk from cattle/cow sheds and ends with some post-delivery processes. The detailed steps of the process, including the pre and post delivery processes, are shown in the flow chart below -



Images for the delivery process -



Milk collection
from cattle



Chilled milk transported
via tanker/truck to dairy



Milk adulteration done to sell milk
at different price-points



Preparing the bike for loading
of containers



Empty containers
loaded on the bike



Transferring the milk
into containers



Securing secondary equipment -
Raincoat, Wet jute cloth etc.

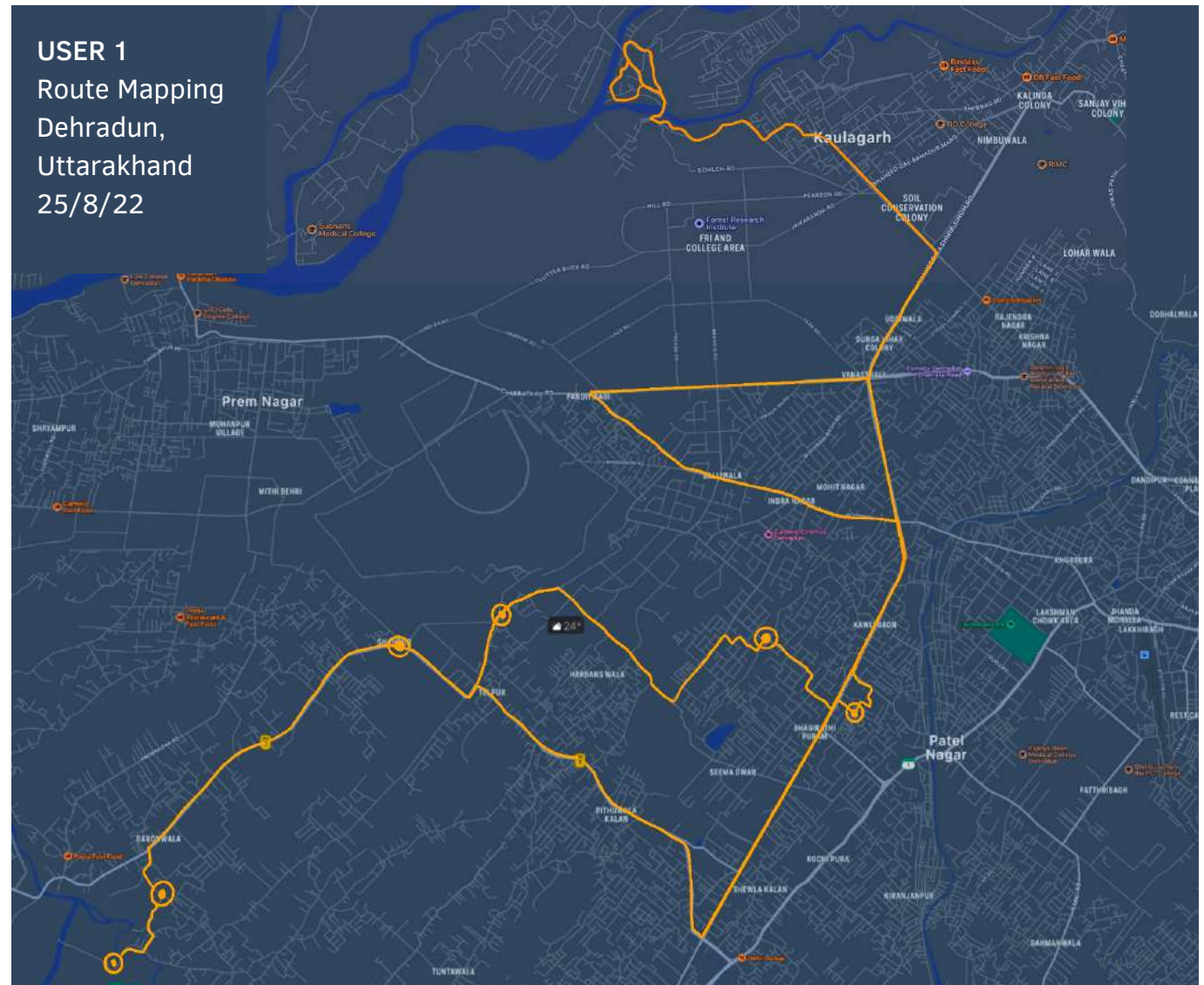


Door-to-door delivery

1.3 Terrain

The user research and documentation helped to understand the terrain and related problems faced by the riders on a daily basis. Their daily commute in and around Dehradun includes a variety of terrain - Broken roads, hilly roads, trails, highway segments, narrow and crowded roads etc.

User 1 was closely followed during the delivery process and his daily route was documented. The route has been charted and shown in the adjacent map. Images depicting the various kinds of terrain and road conditions are depicted in the next slide.



Terrain



Narrow, suburban roads



Highway segments



Hilly segments



Steep inclines/declines



Broken roads/Trails



Populated residential areas



1.3 Market Research

Several products and vehicles used for milk/dairy delivery in domestic as well as overseas market were studied. Their weight, carrying capacity and dimensions study was used to formulate the dimensions and packaging of the new vehicle. The applications, pros and cons of each vehicle help us understand the scope, benefits and drawbacks of these vehicles, as well as their suitability and relevance in certain terrains, situations and scenarios.

VEHICLE IMAGES	CATEGORY	VEHICLE WEIGHT	CAPACITY	DIMENSIONS
	2-wheeler with top-box	Weight of bike + 8 kg	Upto 75-80l	Length - upto 2 m Width - upto 0.8 m Height - 1.2-1.3 m
	Coco karts (Motorized Fridge)	Approximately 250 kg	220l fridge capacity	Length - < 2 m Width - < 1 m Height - 1-1.2 m
	E-rickshaw Milk ATM	130-150 kg (unladen) + upto 200 kg	Upto 500l	Length - 2.7 m Width - < 1 m Height - 1.8 m
	LCV Milk ATM/Tanker	885 - 1000 kg (Unladen) + upto 200 kg	Upto 1000l	Length - 4 m Width - 1.5 m Height - 1.8-2 m

VEHICLE IMAGES



APPLICATIONS

- Delivery of milk packets, tetra packs from online or kirana store.
- Delivery of paneer, mawa from online dairy stores.

- Used to deliver dairy products from locality to locality.
- Nowadays used to deliver coffee and ready to cook kits

- Used for milk and dairy products delivery in a locality to locality basis.
- Used to haul bulk amounts to nearby bakeries/local factories

- Used for milk delivery in a locality to locality basis in remote regions.
- Used to haul bulk amounts to regional small bakeries and factories.

PROS

- Physical footprint is very small
- Highly efficient vehicle

- Physical footprint is very small
- Weight is well balanced throughout the vehicle

- Physical footprint is small
- 3 wheels makes weight balancing much easier.

- Weight distribution is better.
- 4 wheels provide higher stability and weight balancing, safety

CONS

- Most of the weight is concentrated at the back
- Causes ergonomic issues for the rider
- Low capacity

- Very one-dimensional use case.
- Can only be used for short distances

- Weight distribution of the vehicle is rear-biased.
- Can only be used for smaller distances

- High loading lip.
- Physical footprint is too big for small/crowded areas.
- Low on efficiency.

VEHICLE IMAGES



CATEGORY

Single seater
EV 4 wheeler

VEHICLE WEIGHT

300 kg kerb weight

CAPACITY

upto 800l
capacity
of storage box

DIMENSIONS

Length - 2.4 m
Width - 1.14 m
Height - 1.57 m



'Milk Float' Truck

2.2 Tonnes (Unladen)

1.1-1.5 tonnes
(1000-1500 l)

Length - 4.1 m
Width - 2.1 m
Height - 2.3 m



Light truck
Milk Tanker

4-9 Tonnes
Depending on model

Upto 5000l

Length - 5-6 m
Width - 3 m
Height - 2-2.5 m



Full-size truck
Milk Tanker

9-16 Tonnes
Depending on model

5000-10,000 l

Length - 6-10 m
Width - 3 m
Height - 2.5-3 m

VEHICLE IMAGES



APPLICATIONS

Not sure of exact application.

- Used for milk and dairy products delivery in a locality to locality basis in cities of UK.
- Used for delivery of dairy products from industry to local stores.
- Used for milk delivery in a locality to locality basis in remote regions.
- Used to haul bulk amounts to large industries and factories.
- Used for milk delivery in a locality to locality basis in remote regions.
- Used to haul bulk amounts to large industries and factories.

PROS

- Physical footprint is small
- 4 wheels provide higher stability and weight balancing
- Weight is well balanced throughout the vehicle.
- Stable vehicle, suitable for a variety of terrain.
- Stable vehicle, can be used for a variety of terrain.
- Well balanced, good for hauling bulk amounts.
- Stable vehicle, can be used for a variety of terrain.
- Well balanced, good for hauling bulk amounts.

CONS

- High loading lip.
- Cargo compartment doesn't seem suitable for fresh milk delivery.
- Loading/unloading of containers/boxes seems like a hassle.
- Substantial physical footprint.
- Massive physical footprint.
- Can only be used for bulk deliveries, unsuitable for door-to-door fresh milk delivery.
- Massive physical footprint.
- Can only be used for bulk deliveries, unsuitable for door-to-door fresh milk delivery.

2. User Research

To better understand the problem at hand, we need to have a detailed knowledge regarding the business, the people running it, their problems and their mindsets. To accomplish this, a detailed user research was carried out where 21 people were interviewed. Out of the sample size of 21, the daily activities and procedure of 3 users was closely understood and documented.

2.1 User Questionnaire

Along with the detailed interviews and documentation of the first 3 users, 18 more users were interviewed briefly, for a total sample size of 21 users. The aim of this questionnaire was to have a brief understanding of their lifestyle, business model, scope of change/preferences and problems faced in their day to day business. The users in question use a variety of delivery vehicles, such as - 2 wheelers, 3 wheeler E-rickshaws and 4 wheeler LCVs. The questions are as follows -

- What is your mode of delivery ?
- Where do you deliver milk ?
- Is the delivery vehicle used as your personal vehicle too ?
- How much milk do you deliver in one trip ?
- How long is your commute in one trip ?
- Major problems you face while delivering milk ?
- If given the opportunity to deliver 400-500l milk using a different/new vehicle, would you do it ?

The answers to the questionnaire have been tabulated and presented in the following slides.

QUESTIONS	ANSWERS Sample size - 21	OBSERVATIONS	REASON
What is your mode of delivery ?	4-wheeler - 2 3-wheeler - 3 2-wheeler - 16	2 wheelers are the more popular vehicles for household/locality delivery. 4 wheelers are used solely for factory/bakery delivery. 4 and 3 wheelers have certain graphics to identify them as milk delivery vehicles, 2 wheelers don't.	2 wheelers have a significantly smaller foot-print, more suitable for crowded streets, localities. (Door to door delivery) 2 wheelers offer good efficiency, beneficial for small businesses 3 and 4 wheelers provide the required stability, safety and carrying capacity for bulk deliveries to industry.
Where do you deliver milk ?	Door-to-door delivery - 9 Locality delivery - 2 Factory/Bakery - 10	- Milk delivery and transport is generally done in bulk amounts. - Delivery of smaller amounts is usually done through milk packets/tetra packs.	These vehicles are subjected to a lot of damage, physical stress and cyclic loading. Personal vehicles can't be sacrificed
Is the delivery vehicle used as your personal vehicle too ?	Yes - 2 No - 19	Most 2-wheeler riders are content with the amount of milk they transport. A bigger vehicle won't be suitable for them.	The type of vehicle and amount of milk carried depends on their daily production.
If given the opportunity to deliver 400-500l milk using a different/new kind of a vehicle, will you be willing to upgrade?	Yes - 4 No - 13 Not sure - 4		

QUESTIONS	ANSWERS Sample size - 21	OBSERVATIONS	REASON
How much milk do you deliver in one trip?	Less than 50l - 2 50-80l - 6 80-100l - 13	- Milk delivery/transport is usually done in bulk amounts. - Delivery of smaller amounts is usually done through milk packets/tetra packs.	Milk goes bad within a few hours. So the daily amount of milk produced has to be transported within a short period of time.
How long is your commute in one trip ?	less than 50km - 10 50-100km - 11	2 and 4 wheelers have a higher commute. 3 wheelers are used for shorter distances only	2 wheelers provide good efficiency hence profitable for longer commutes. 3 wheelers have low range and speed - used within a short radius.
Major problems you face while delivering milk?	Vehicle Balancing - 16 No weather protection - 19 Vehicle Instability - 14 Suspension - 16 Ingress/Egress - 13	2 wheelers suffer from problems of vehicle balancing, instability, suspension and weather. 3 wheelers suffer from suspension and weather issues	- Difficulty balancing bulk amount of milk on 2 wheels. - Majority of the weight is placed at the back, which causes vehicle instability and straining of components.
If given the opportunity to deliver 400-500l milk using a different/new kind of a vehicle, will you be willing to upgrade?	Yes - 4 No - 13 Not sure - 4	Most 2-wheeler riders are content with the amount of milk they transport. A bigger vehicle won't be suitable for them.	4 wheelers are already being used for industry-delivery, they aren't suitable for door-to-door delivery.

2.2 Key takeaways from User Questionnaire

Based on the user questionnaire, there are certain key takeaways that help us get a preliminary sense of the scale of the business as well as the user's concerns and priorities.

- The user owns exclusive vehicles for this business, and they are rarely used for personal transportation. The vehicles are **owned for a long term**, as much as 10-15 years.
- The users prefer commuter segment bikes for the delivery process owing to their cost, efficiency, ease of repair and maintenance.
- The vehicle go through immense physical stress, damage and cyclic loading, hence they **don't sacrifice their personal vehicle for this task**.
- The amount of milk production determines the delivery quantity, as well as the delivery vehicle.
- Users are **apprehensive of upgrading to a bigger vehicle** as the **extra cost and complexity is not justified**. They are **satisfied with the size of their business**. A bigger business comes with further complexities and input costs like more cattle, requirement of extra land, extra help and maintenance etc.
- **2 wheelers offer great efficiency**, hence they're profitable for smaller businesses delivery lesser milk quantity.
- **2 wheelers are the preferred vehicle for crowded streets/localities** owing to their small footprint.
- **3 wheeler e-rickshaws are used for delivery within a small radius** due to their limited range and performance capabilities.
- The major problems reported by the users are - **Vehicle balancing, vehicle stability, ingress/egress and lack of any weather protection whatsoever**.
- Problems of vehicle balancing and stability stem from the fact that **all the weight is concentrated towards the rear of the vehicle**.

2.3 User 1

Satpal, 38

Lives in Baronwala, Dehradun

- He has been using a 2007 Honda Shine for 15 years. (Commuter bike, long term usage)
- His father owned the cowshed, which was then passed down to him. (Generational business)
- He lives in his ancestral home in Baronwala with his family and aged parents. He has a wife with 2 kids, aged 11 and 13. (Traditional, close to his roots)
- He aspires to have his generational home renovated and secure a good education for his children. (Simplicity in their goals and aspirations)



Business details

Based on the data collected from the user, the business details are as follows -

VEHICLE

- 2007 Honda Shine.
- Honda is very reliable and smooth, can be serviced anywhere.

MILK SUPPLY

- Owns his own cow shed with a total of 9 cows + buffaloes.

CUSTOMERS AND COMMUTE

- Delivers milk to 50 households daily, with 2l per house (average)
- Daily commute is app. 50-60 kms.

COMBINATION OF CONTAINERS

- Carries 100l milk in containers of sizes - 30l, 20l, 15l, 10l and 5l.
- Combination of the boxes change daily

TOTAL LOAD CARRIED

- Total weight of boxes - 35 kgs,
- The milk weighs - 100 kgs approx.
- Total weight - 135 kgs.

TOTAL SALE

- Cost of milk - Rs. 60/l average.
- Total sale - Rs. 6000/day
- Total sale p/m - Rs. 1,80,000

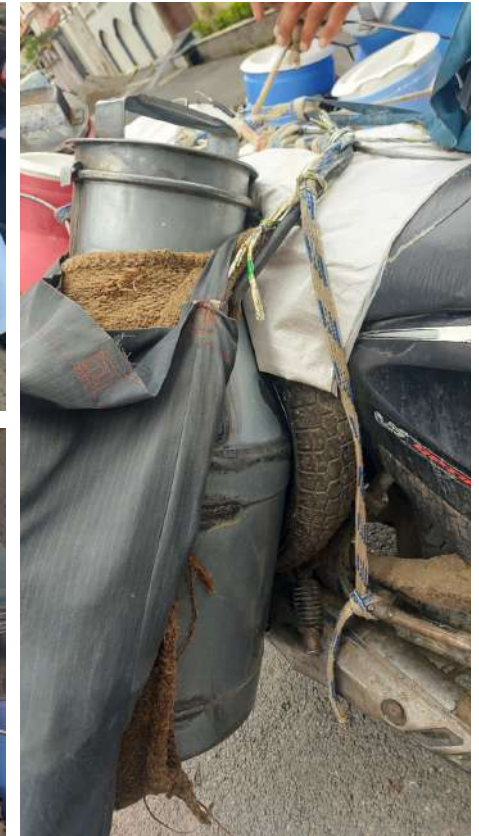
COSTS INCURRED

- Maintenance of cattle per day - Rs. Rs. 2500
- Bike maintenance - Rs.10,000 p/m

NET MONTHLY INCOME

- Net monthly income - Rs. 95,000 per month

The images below depict the setup used by the user for delivering milk. The layout of the containers, the way they're mounted, the subsequent damage to the vehicle and the steps taken to prevent it. The images also give an idea of the size and the enlarged footprint of the vehicle due to the added containers.



The images below show the setup used by the user for delivering milk. The first image gives an idea of the size and the enlarged footprint of the vehicle due to the added containers, which makes the containers prone to damage in crowded areas and traffic, as shown in the last image. The second and third picture depict the resourcefulness of the user, how they're aware of the issues regarding weight and how they use cheaper methods to alleviate their problems to an extent.



The width due to the added containers as much as a hatchback



Combination of steel and plastic containers as a method of weight saving



Wet jute cloth wrapped around to keep the milk cool for longer



Sustained damage to the containers over a long period.

User problems

Based on the interview conducted with the user, these are the most common problems faced on a daily basis -

BALANCE

- Maintaining balance was difficult at first, but he got used to it after a while.

SLOW PROGRESS DUE TO WEIGHT

- Progress overall is slow due to the excessive weight.

PHYSICAL STRESS

- Physically tiring job, as he always has to stay alert.
- Lots of smaller inconveniences related to ergonomics but he has gotten used to it.

AFTERMARKET FRAMES

- Aftermarket frames, help secure the containers but limit the amount of milk that can be carried. They are shabbily made.
- Frames should be supplied by OEMs

HIGHER MAINTENANCE AND RUNNING COSTS

- The rear suspension takes a beating and needs to be repaired/replaced regularly.
- The engine also gets stressed, requiring frequent servicing.
- Mileage of the bike also decreases significantly.

POST DELIVERY PROCESSES

- Cleaning and sanitization of the containers is a tedious job as they are always tied together.

LACK OF WEATHER PROTECTION

- No protection from weather - have to carry their own raincoats in case of rain.

VEHICLE DAMAGE

- The containers cause significant damage to the bike over time

2.4 User 2

Vinod, 52

Lives in Shimla Bypass, Dehradun

- He has been using his Honda CD100 since the 1990s. (Long term usage of commuter bike)
- He is married, has a wife and 3 kids. All his children are settled/married and working in other professions. (Traditional and close to his roots)
- He used to own a cow shed and handle the entire collection and delivery process alone. As he grew older, he sold his cow shed to an established dairy and handles just the delivery aspect now. (Experienced, been in the business for long term)
- Does this business on the side to have a steady income and secure a good retirement for himself. Aspires to have his home renovated and upgrade from his ageing Maruti Alto to a bigger hatchback. (Simplicity of goals and aspirations)



Business details

Based on the data collected from the user, the business details are as follows -

VEHICLE

- Hero Honda CD100.
- Very fuel efficient, can be serviced everywhere.

MILK SUPPLY

- He sold his cow shed to an established dairy and collects milk from the dairy daily for delivery.

CUSTOMERS AND COMMUTE

- Delivers milk to a regional factory daily, 70-80l in one trip. He makes 3 trips a day.
- Daily commute on the bike is approximately 80 kms.

COMBINATION OF CONTAINERS

- Carries 70-80l milk at once in 2 - 40l containers.
- Combination of boxes is constant.

TOTAL LOAD CARRIED

- Total weight of boxes - 20 kgs, the milk weighs 80 kgs approx.
- Total weight - 100 kgs in one trip.

TOTAL SALE

- Cost of milk - Rs. 55/l
- Total sale - Rs. 4400/day
- Total sale p/m - Rs. 1,32,000

COSTS INCURRED

- Monthly fuel and Bike maintenance - Rs.8,000 p/m

NET MONTHLY INCOME

- Net monthly income - Rs. 25,000 - Rs. 30,000 per month



IDC School of Design - Door to door milk delivery Vehicle for rural/suburban regions

User Problems

Based on the interview conducted with the user, these are the most common problems faced on a daily basis -

WEIGHT DISTRIBUTION

- First and foremost problem is the weight that they carry on the bike - entirely on the rear of the bike.
- The weight causes problems while going uphill, or on speed-breakers.

VEHICLE DYNAMICS

- The weight causes difficulty while regular riding and cornering.

HIGHER REPAIR/MAINTENANCE COSTS

- Shockers get ruined within the year and have to be serviced regularly.

EXTRA PRECAUTIONS WHILE IN TRAFFIC

- They constantly have to watch out for traffic on either side to avoid hitting other road users.

ERGONOMIC PROBLEMS

- Ingress/egress is tedious due to the width of the containers, but they get used to these inconveniences, which causes even more problem in the long run, like back pain, sore joints etc.

NO WEATHER PROTECTION

- Have to compromise in the case of bad weather and deliver milk anyway.

NO EXTERNAL MEASURES

- They don't invest in any external measures to increase comfort/efficiency of the delivery process. No good equipment is available on the market for this purpose.

PRE AND POST DELIVERY PROCESSES

- Cleaning and sanitization of the containers is a tedious job as they are always tied together.
- Loading and un-loading of containers from the bike is also a strenuous process

2.5 User 3

Gupta and sons, 78

Based in Patel Nagar, Dehradun

- The business is owned by Mr. Gupta (78). His 2 sons help him maintain the dairy, while his 3 grandsons manage the delivery of milk. **(Generational business)**
- They have a reputed business that has been going on for 4 generations, and their societal image is very precious to them. Their youngest grandson is 26. The oldest member, Mr. Gupta himself, is 78 years old. **(Image conscious)**
- It is an old and ancestral family business, and this business is of great pride and importance to them. **(Professional, give importance to this business)**
- They use a TVS Star City, Bajaj Boxer and an old Yamaha RX100 for their business. **(Long term usage of efficient commuter bikes)**



Business details

Based on the data collected from the user, the business details are as follows -

VEHICLE

- Vehicles - TVS Star City, Bajaj Boxer and Yamaha RX100
- Why these bikes - TVS is a very fuel-efficient bike - Bajaj is a workhorse and Yamaha RX has been in their family for 3 decades and still runs well.

MILK SUPPLY

- They own 3 cow-sheds which are run and maintained by workers.
- Every morning, chilled milk reaches the dairy via a truck.
- The milk is then segregated for delivery and to be sold at the dairy.

CUSTOMERS AND COMMUTE

- Deliver milk to a local bakeries, rusk factories and restaurants.
- 2 containers of either 40 or 50 kgs are loaded on each bike, 80-90l milk delivered in each trip.
- 2 trips are made daily on each bike - 50km daily commute for each bike

BUSINESS OWNERS/RUNNERS

- Mr. Gupta (78), his 2 sons and 3 grandsons run this business together.

TOTAL LOAD CARRIED

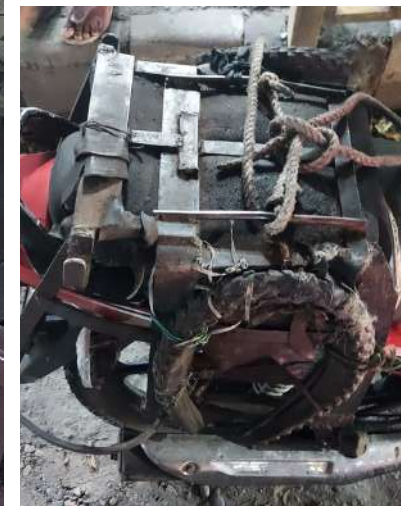
- Total weight of boxes - 20 kgs, the milk weighs 80 - 90 kgs approx.
- Total weight - 100 - 110 kgs in one trip.

WELL ESTABLISHED/REPUTED

- They have a reputed business that has been going on for 4 generations, and their societal image is very precious to them.

TOTAL DAILY SALE

- Total sale per day - Rs. 50/l * 500l - Rs. 25,000



User problems

Based on the interview conducted with the user, these are the most common problems faced on a daily basis -

TEDIOUS LOADING PROCESS

- Loading the shipments on three different vehicles is a tedious and time consuming task as the milk needs to be divided among numerous containers.

LACK OF OEM OR WELL-MADE FRAMES IN THE MARKET

- The OEMs should supply a custom made or factory made frame. The aftermarket frames are very shabbily made.

PROBLEMS CAUSED DUE TO EXTRA WEIGHT

- Can't place the bike on side stand for too long. Centre stand has to be used to load the milk and containers.
- Very difficult to balance the bike with the added weight, especially in traffic or narrow streets.

VEHICLE DYNAMICS

- The weight causes difficulty while cornering.

DIFFICULTY IN SECURING CONTAINERS

- Even after using the frame, securing the containers is a tough job.

HIGHER REPAIR/MAINTENANCE COSTS

- Maintenance and running costs of 3 bikes at the same time is a costly affair.

NO WEATHER PROTECTION

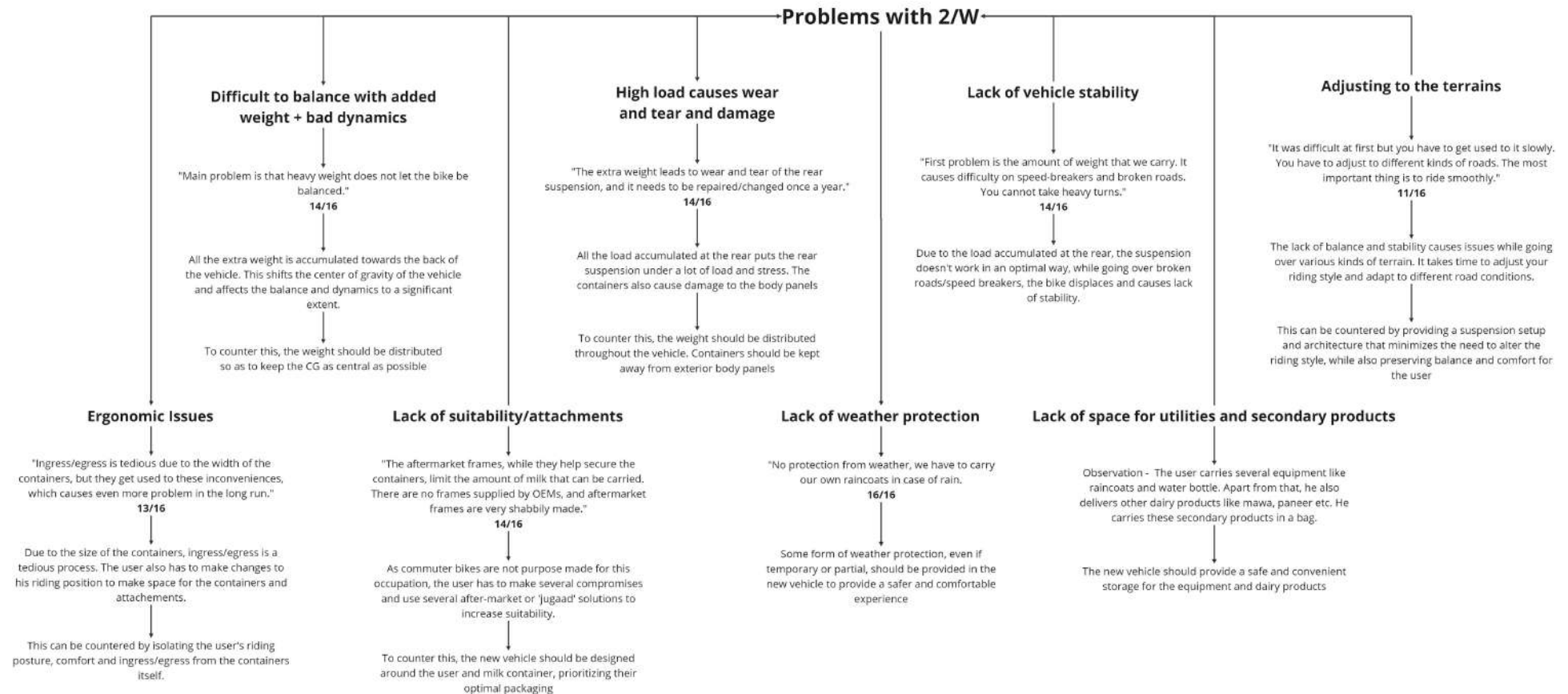
- No protection from bad weather, either to the delivery person or the milk itself.

STRENUOUS DELIVERY PROCESS

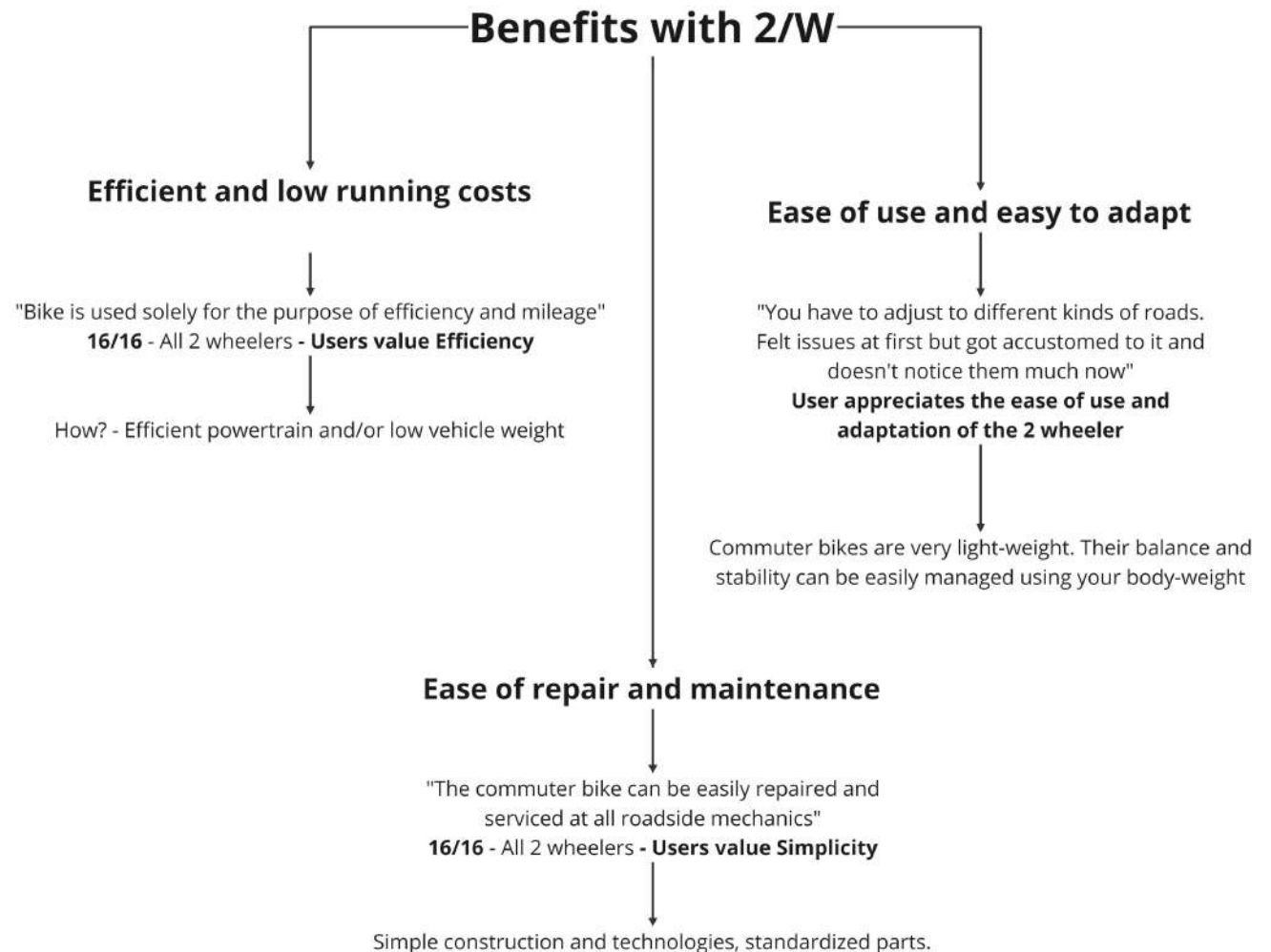
- Riding the vehicle is a strenuous affair due to the ergonomics, balance and added weight.
- Multiple trips on the vehicle leads to physical ailments like back pain, sore joints etc.

2.6 Mind Mapping

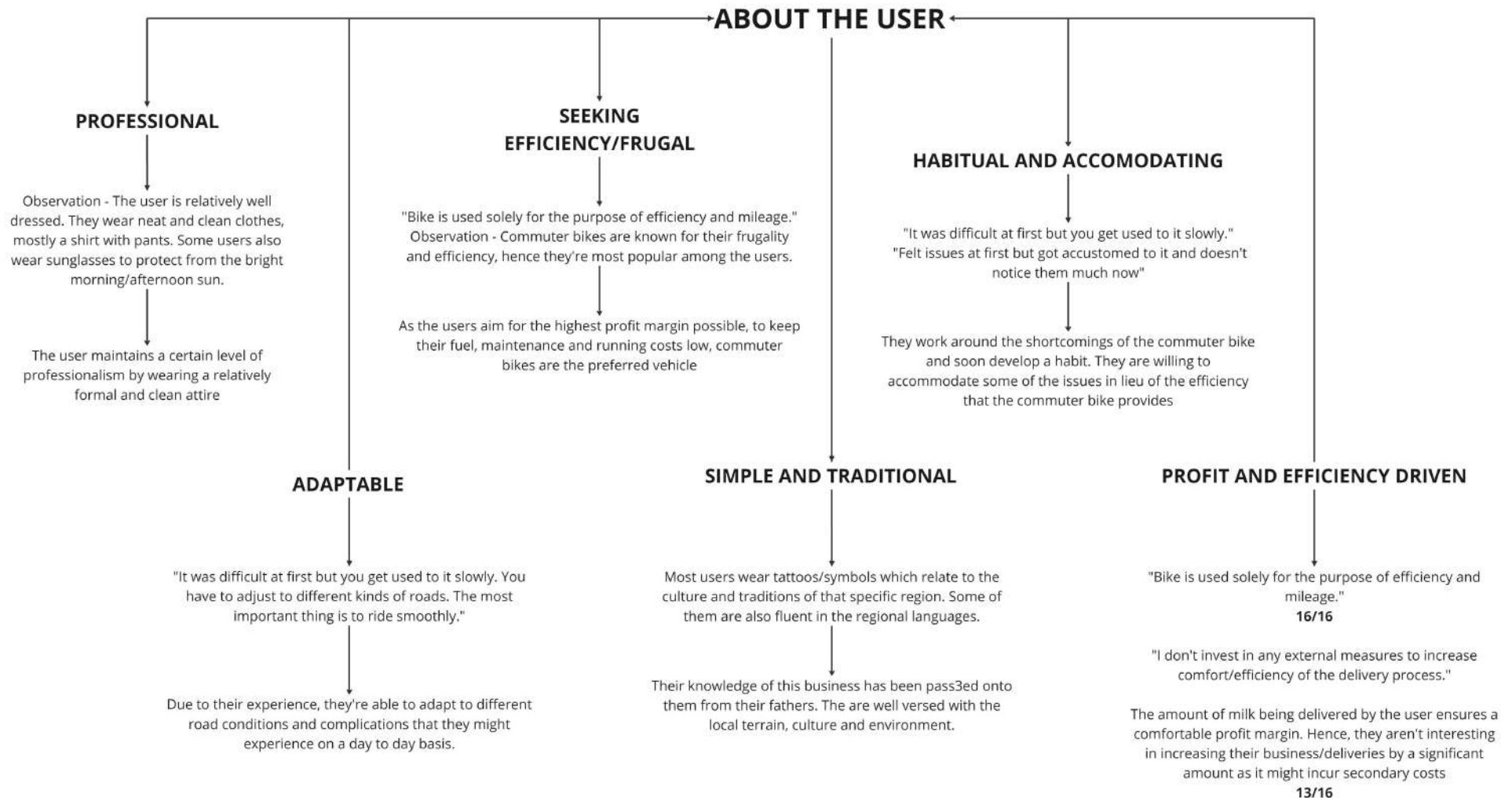
Following the research and key takeaways, a mind map was created to tabulate each and every insight gathered from the research. The flow-chart below lists the problem experienced by the users while using 2 wheelers and the relevant insights via - User verbatim (WHAT), the reasoning behind the verbatim (WHY), and how we may solve it (HOW).



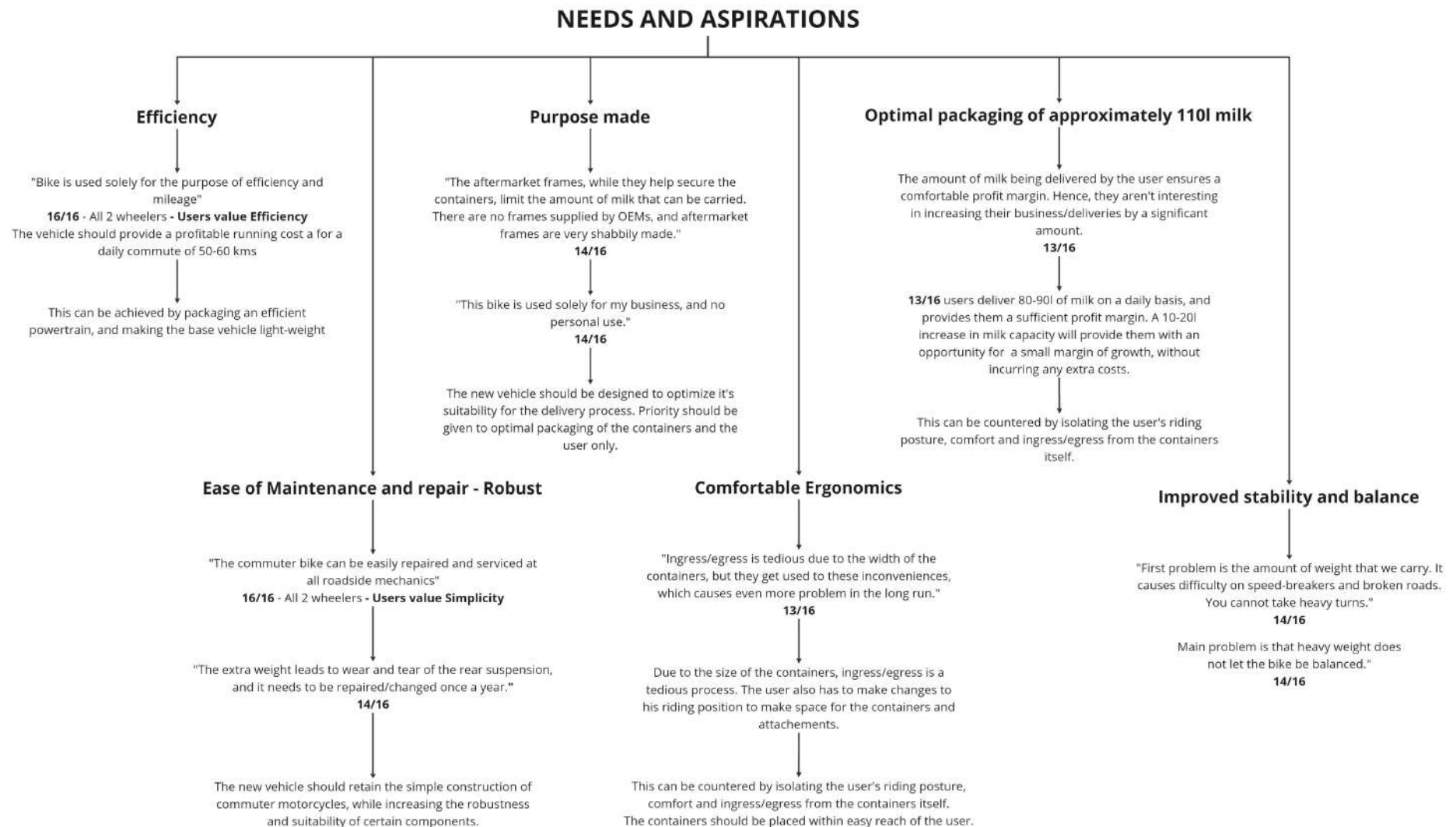
In spite of the problems faced by the users, they continue to operate their business via a 2-wheeler. Hence, it is imperative to understand what qualities/benefits of the 2 wheeler make them so viable for the user, and those same characteristics should be carried forward to the new vehicle. From the user research, it was gathered that the main benefits provided by the 2 wheeler are - Efficiency and low running costs, Ease of use and easy to adapt, Ease of maintenance and repair. For a frugal and profit driven user, these benefits weigh out the negative aspects. The benefits are explained as - User Verbatim (WHAT), the reason behind the verbatim (WHY) and the factors/design features that contribute to these benefits (HOW).



The user research helped to gather insights regarding the psyche and thought process of the user. This helps us to understand the user's mindset, his preferences and priorities. The keywords and insights have been derived from the user verbatim and observations made during the research (WHAT), as well as the reasoning behind the verbatim (WHY).



Lastly, the needs and aspirations of the user were figured out, which can form the basis of the design decisions taken for the new vehicle. The keywords and insights have been derived from the user verbatim and observations made during the research (WHAT), as well as the reasoning behind the verbatim (WHY).



3. Design Brief and Platform

From the mind-map, we can determine the points of action where we can provide a design solution. The needs and aspirations of the user help us determine the priorities when designing the new vehicle, namely - A purpose made vehicle with a greater focus on efficiency, ease of use, ease of maintenance and repair and improved stability/balance. Further consideration of the user, problems and benefits of 2 wheelers, and we can define the design brief as follows -

3.1 Design Brief

Design a purpose-made vehicle for door-to-door fresh milk delivery that ensures a safe, comfortable and efficient delivery experience for a dairy farmer, across various different types of terrains.

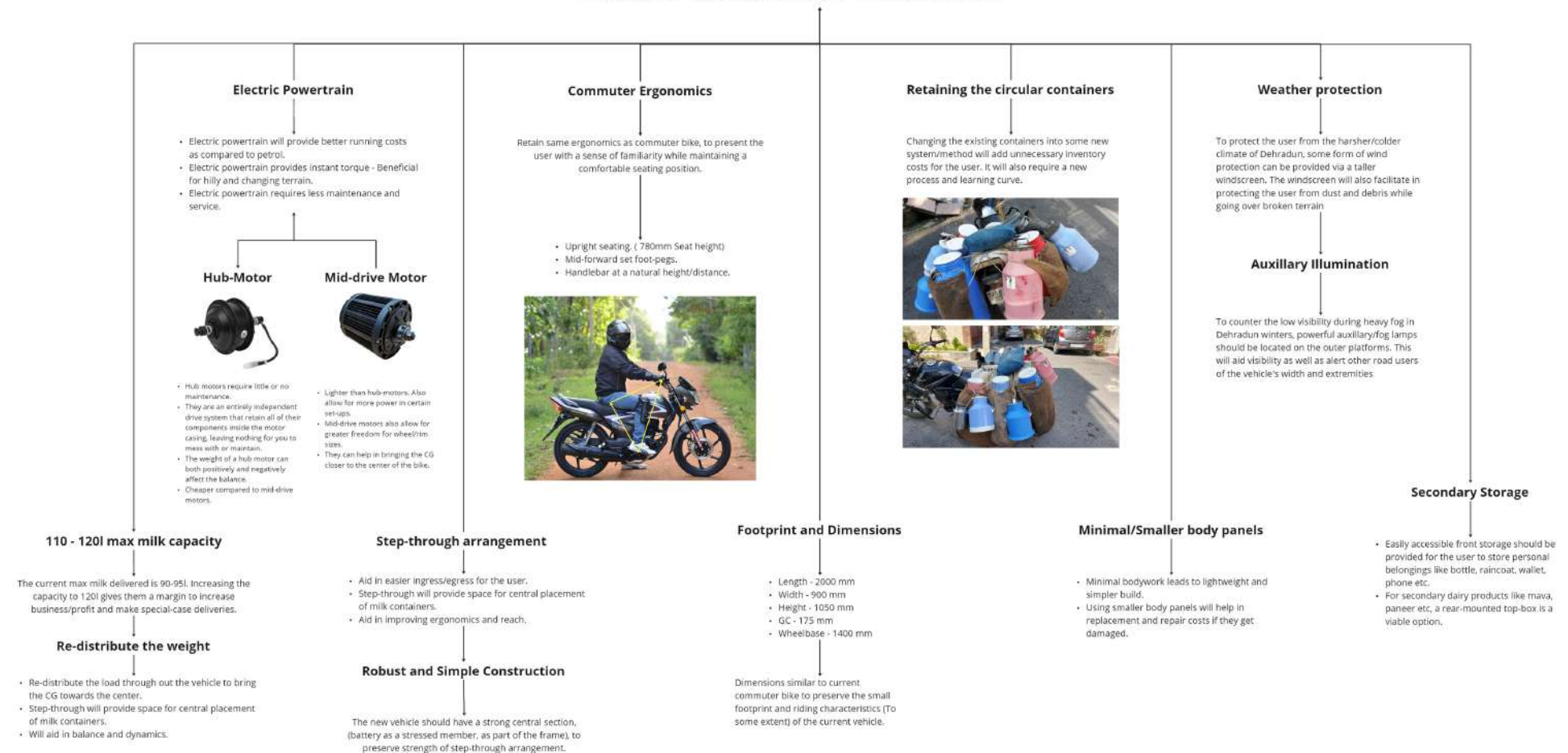
The vehicle should have the capability to deliver 100-110l of milk in a comfortable and safe manner. It should build upon the positive aspects of the existing two wheeler and provide a familiar and well rounded riding experience with reduced running costs. The vehicle should align with the user's idea of tradition, simplicity, ease of use and cost-effectiveness. Moreover, it should have a rugged built and execution to deal with the physical stresses and loads of the delivery process.

- Inclusion of standardized parts to boost ease of service, maintenance and repair.
- Provide lower running costs by virtue of powertrain and/or weight reduction.
- Suitable weight distribution to provide stability and balance when in operation.
- Design features considering the often harsh climate of the region of operation.
- Simple mechanisms and structures instead of complex mechanisms to avoid future expenses in repair and maintenance.
- A distinct and strong visual identity and presence.

3.2 Design decisions

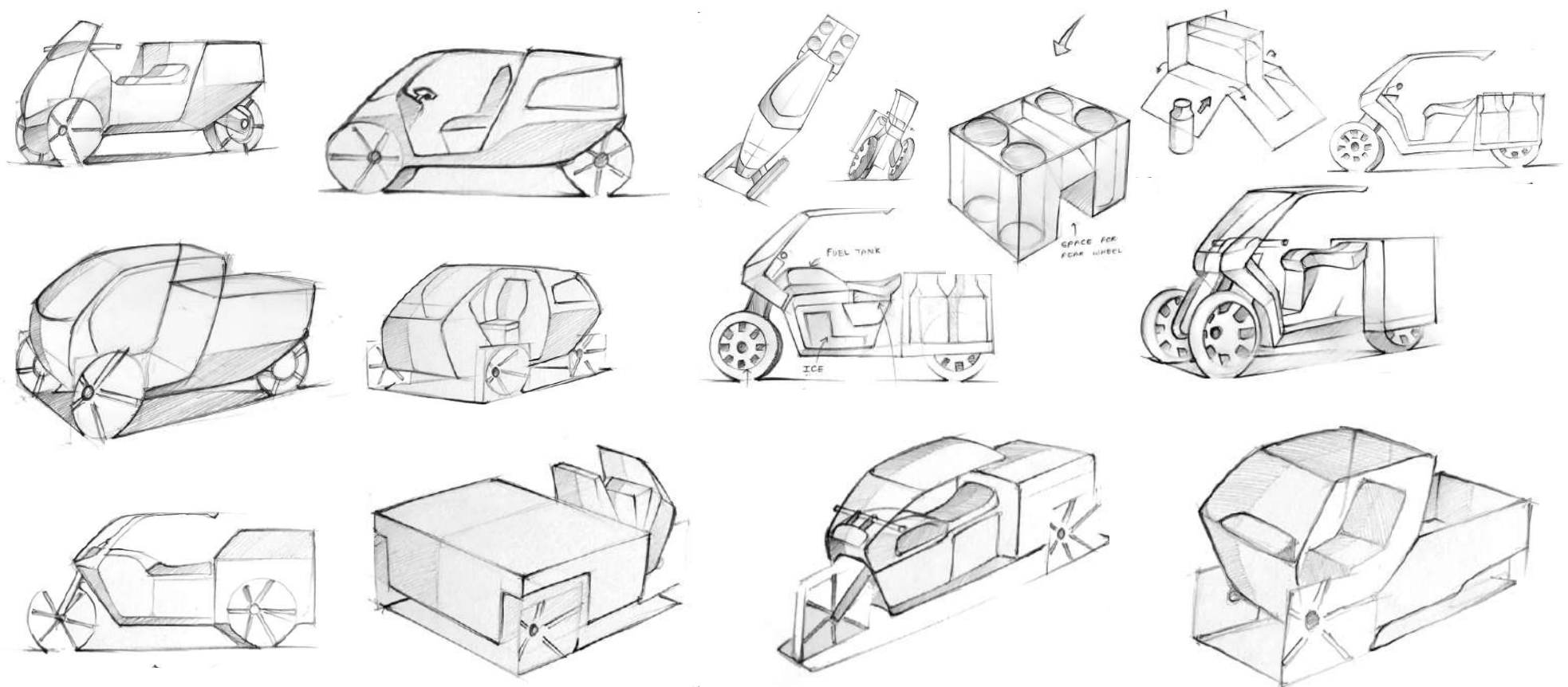
Building upon the design brief, certain design decisions were made to ensure the feasibility of the product and its adherence to user's needs and priorities. The design directions will also help us develop the overall package as well as some niche features of the vehicle.

DESIGN DECISIONS / DIRECTION



3.3 Platform Ideations

Following the development of a design brief, some platforms were ideated and explored to understand their feasibility, suitability and relevance with respect to the problem at hand. The platforms explored include 2 wheelers, reverse trikes, delta trikes and tilt - steer trikes. Looking at the constraints of weight, cost and practicality, a 2 wheeler platform was finalized.

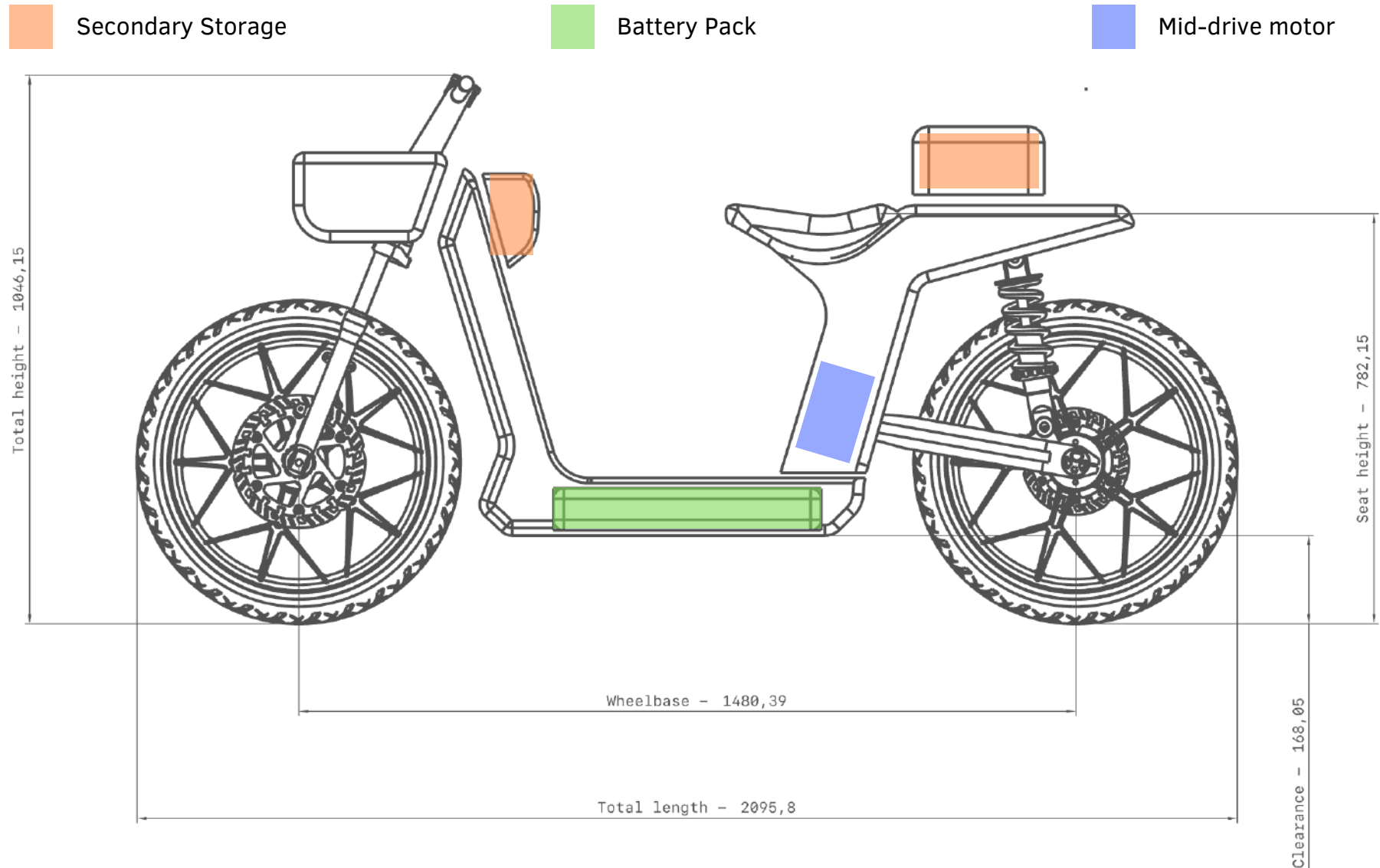


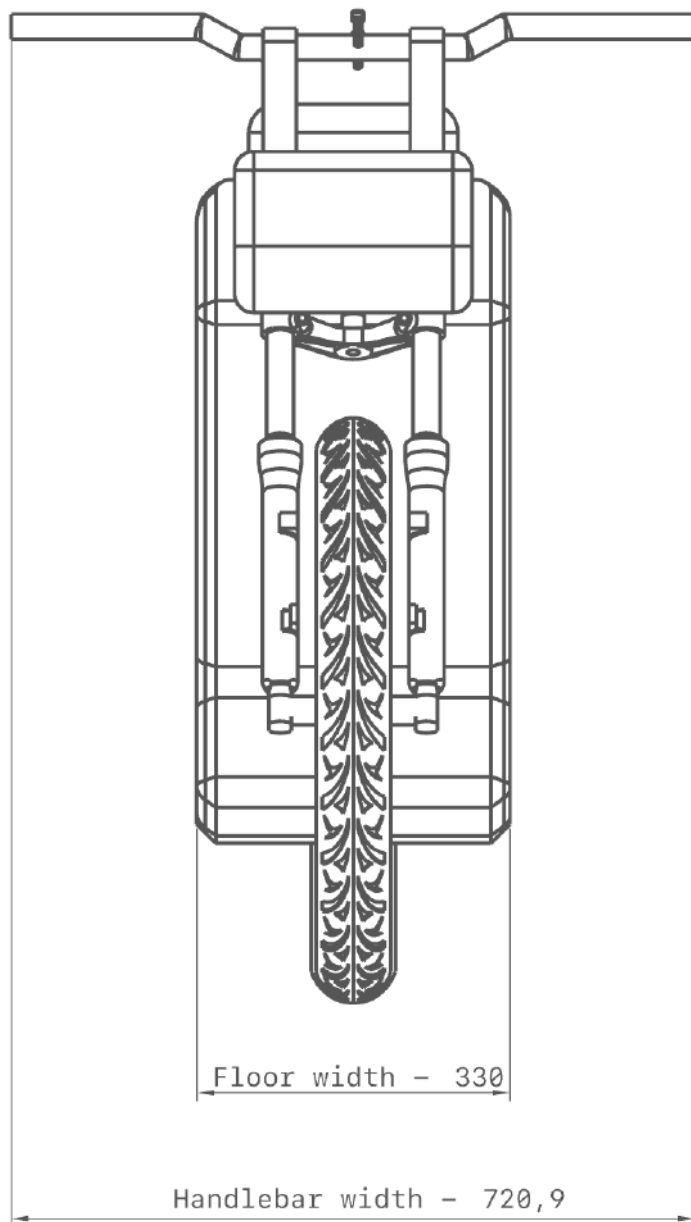
3.4 Proposed Platform and details

After corresponding the ideations with the design brief, the proposed platform is that of a Step-through, single seater, 2 wheeler with an electric platform. The various features of the platform and their purpose have been listed below -

- **Why 2-wheeler ?** - As found from the user research, cost, efficiency, simplicity, ease of maintenance are the user's main priorities. A 2-wheeler fulfills all requirements, along with retaining some sense of familiarity to the current motorcycle.
- **Single seater** - As these vehicles are used for professional work only, a pillion seat is not required.
- **Electric Powertrain** - The daily commute of the user is no more than 60-70 kms. The low range requirement, combined with lower running costs and higher torque output vs IC engines makes it a suitable choice.
- **Floor mounted battery** - The battery is the heaviest element of the powertrain. Packaging the battery in the floor brings the CoG down by a considerable amount, stabilizing the vehicle and easier to balance. It also allows us to incorporate a step-through layout.
- **Step-through platform** - A Step-through improves the ingress/egress by a significant margin vs a conventional motorcycle. Step-through also allows us to include a flat floorboard for storing extra milk containers.
- **Wheelbase** - A 200mm longer wheelbase compared to a commuter motorcycle enhances the stability. It also liberated more space between the wheels which can be utilized for enhanced comfort or storage.
- **Ground clearance** - 170mm clearance helps tackle broken terrain better and reduces scraping/contact of the floor.
- **Mid drive motor** - A mid drive motor improves the weight distribution. It also helps in proper utilization of the under-seat space. Mid drive motors allow for customizable final drive ratio to enhance the torque output.
- **80/100 R18 wheels** - Same size wheels as regular motorcycle ensure ease of replacement and maintenance.
- **Dual secondary storage** - The front storage allows the user to keep valuables like wallet, phone and utilities within easy reach. Rear storage accommodates secondary dairy items like paneer and mawa.

The layout and dimensions of the package is as follows. All dimensions in mm -

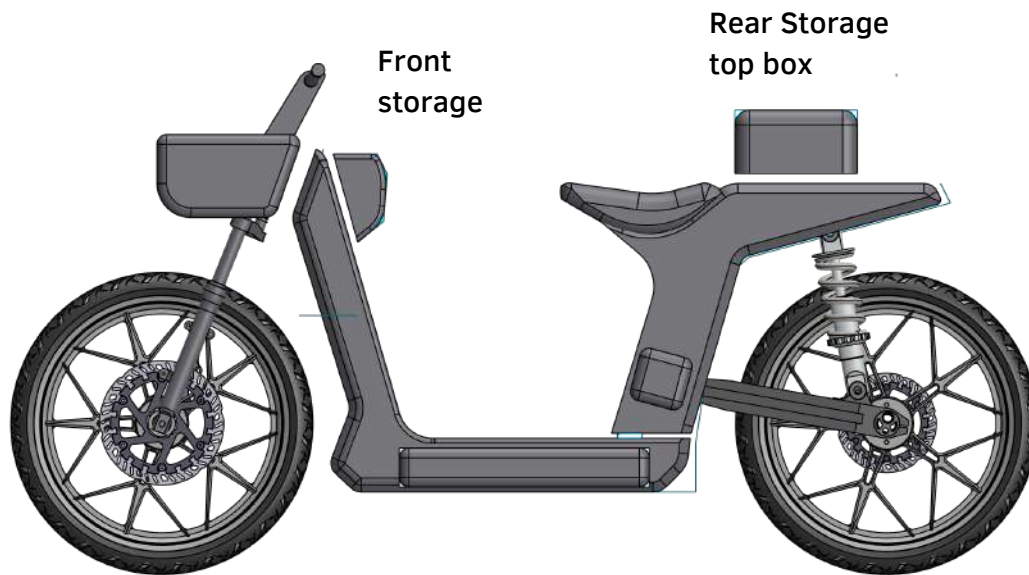
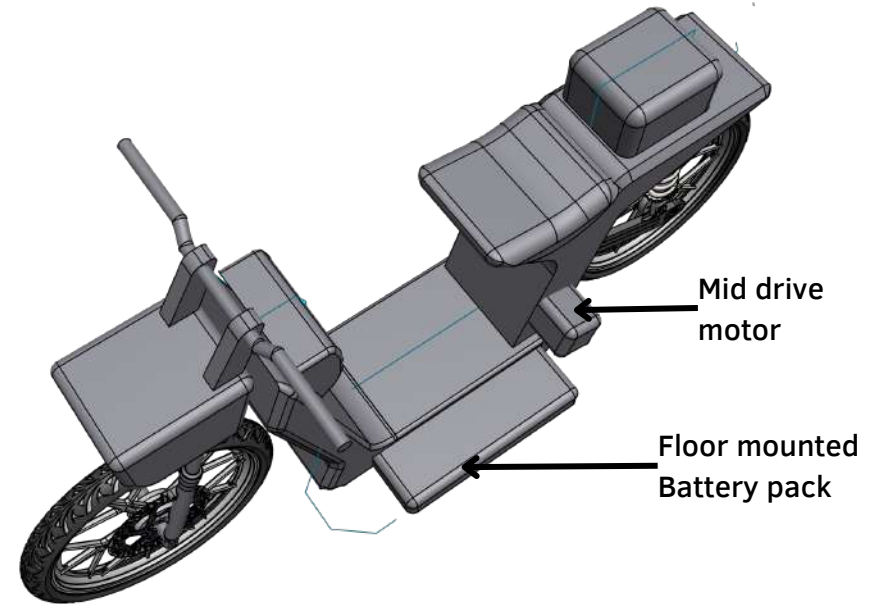
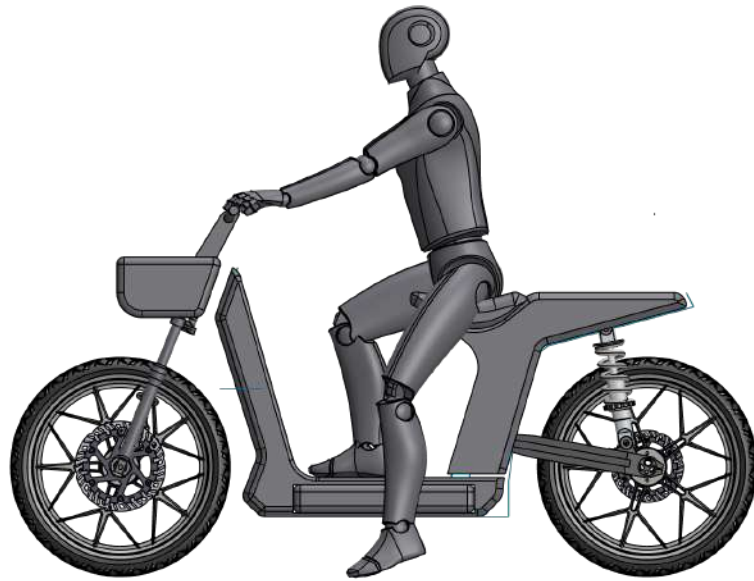


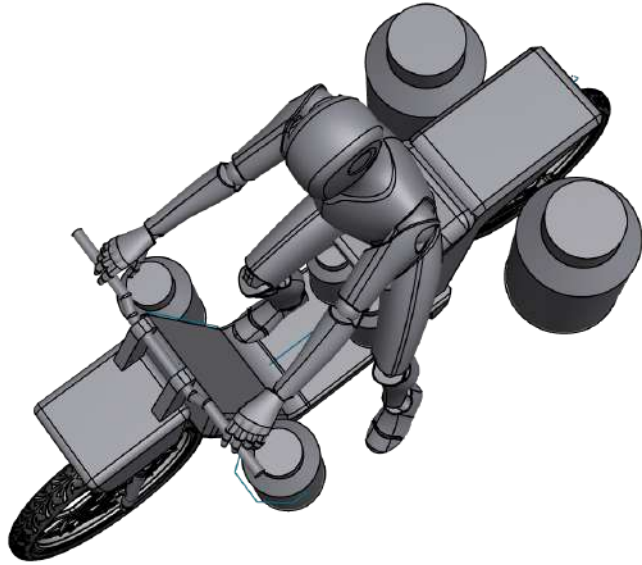


After finalizing the platform, an initial CAD model was developed to understand the volumes, proportions and the placement of components. The proposed specifications are as follows -

- Wheelbase - 1480 mm
- Length - 2095 mm
- Ground clearance - 172 mm
- Seat height - 780 mm
- Wheel dimensions - 80/100 - R18
- Handlebar width - 720 mm
- Floorboard width - 300 mm
- Milk capacity required - 100 - 110l
- Front storage - 3 l approx.
- Rear storage box - 6.6 l approx.

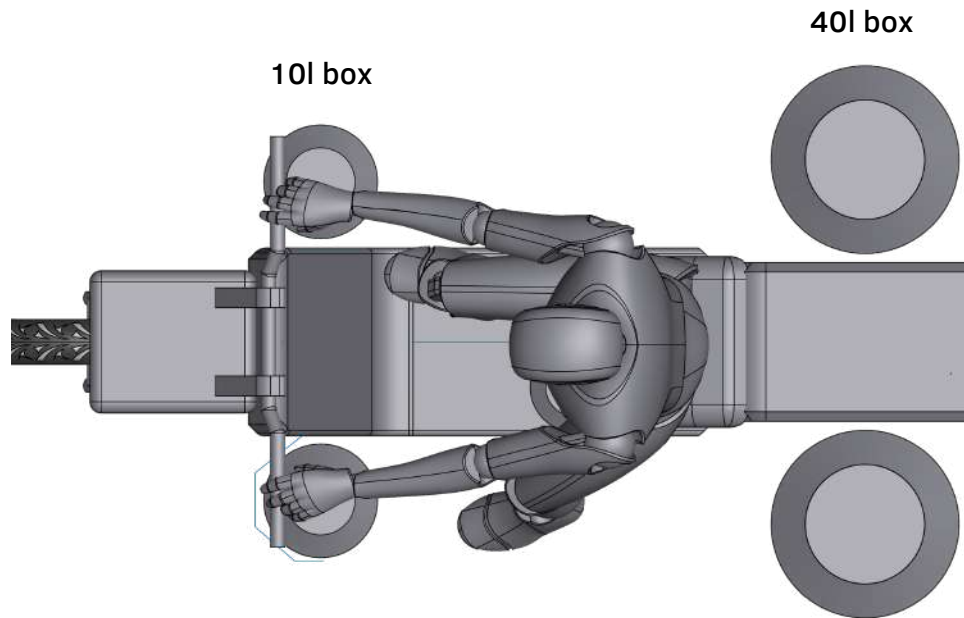
After development of the initial model, packaging ideations were performed to determine the placement of components like suspension, swingarm, battery, motor as well as optimizing the location and distribution of milk containers to. The main goal is to bring the CoG as central and low as possible. This can be achieved by shifting a percentage of the milk forward, as well as using a floor-mounted battery pack.

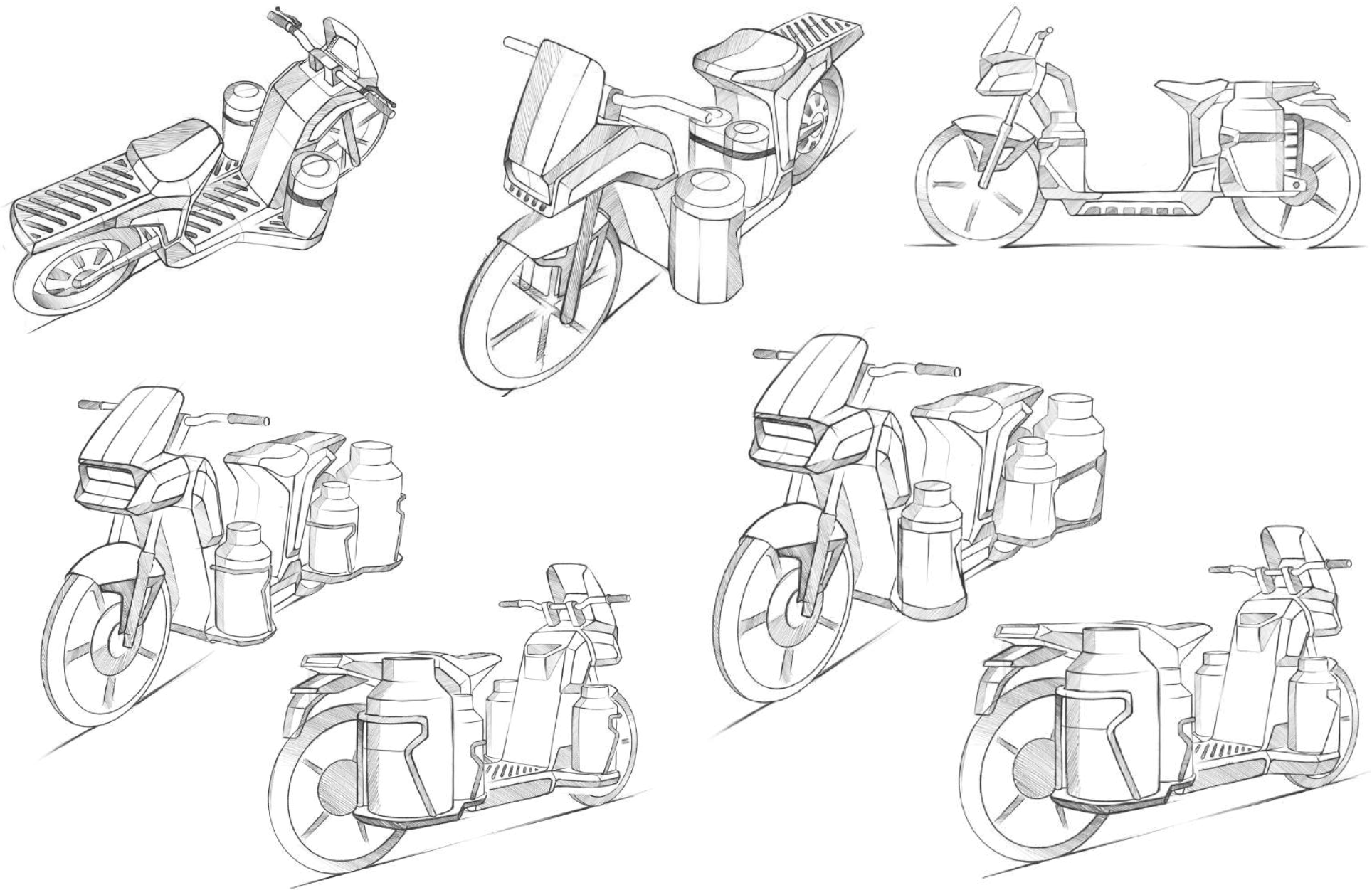




PROPOSED DISTRIBUTION OF MILK - The 110l capacity will be divided into a 30/80 ratio. 30l of milk will be placed in front of the passenger seat using 2 - 5l containers under the seat as well as 2 - 10l containers on either side of front apron. The sizes of the containers are as follows -

- 5l - 15 * 15 * 29 cm
- 10l - 20 * 20 * 35 cm
- 30l - 30 * 30 * 44 cm
- 40l - 33 * 33 * 49 cm





4. Design Development

4.1 Image Board

An image board was created to create a design direction for the vehicle. The visual cues will be inspired from the images shown and directly translated on to the vehicle. The final form should be rugged and purposeful with a sense of simplicity.



RUGGED

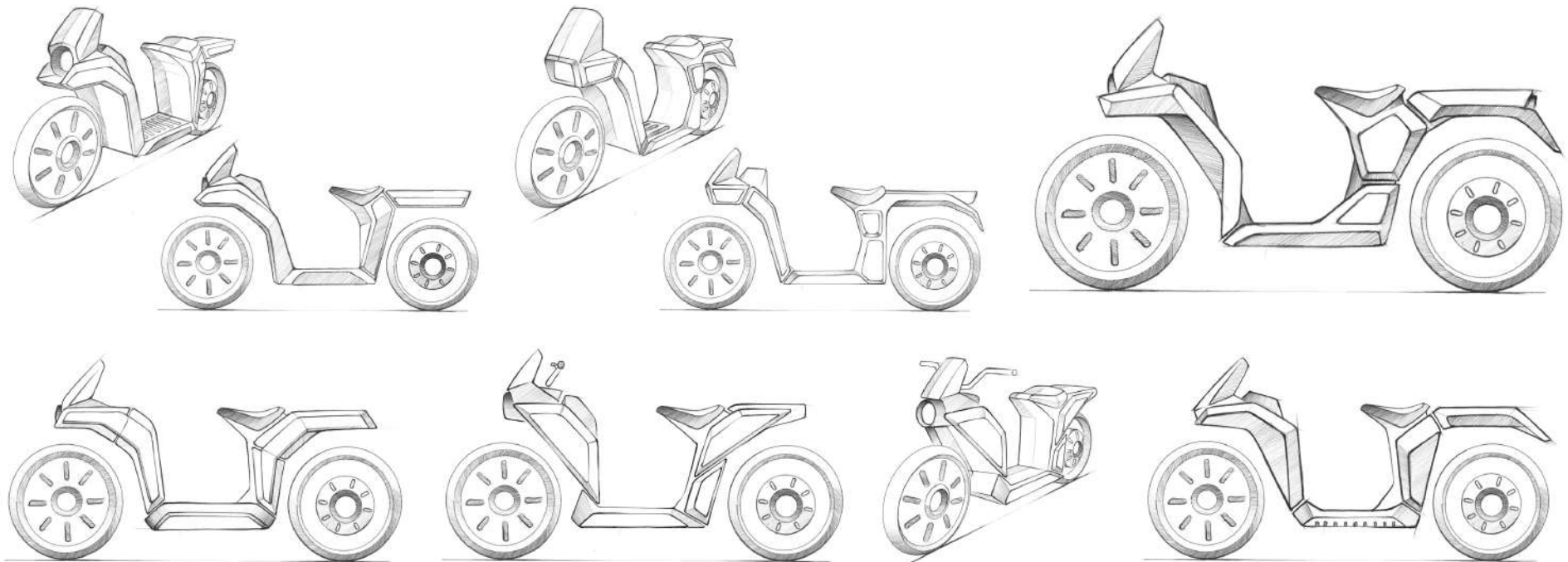
SIMPLICITY

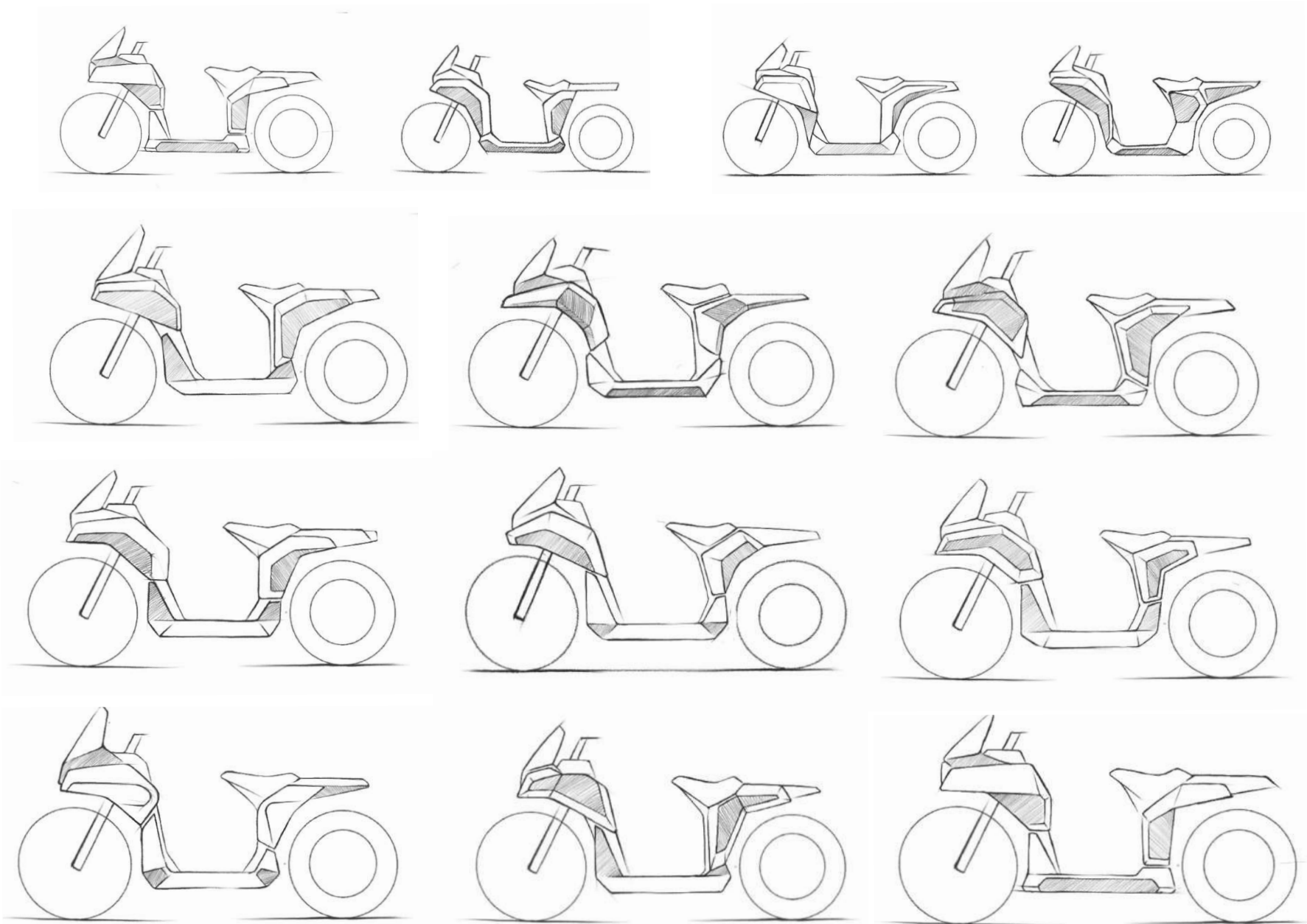


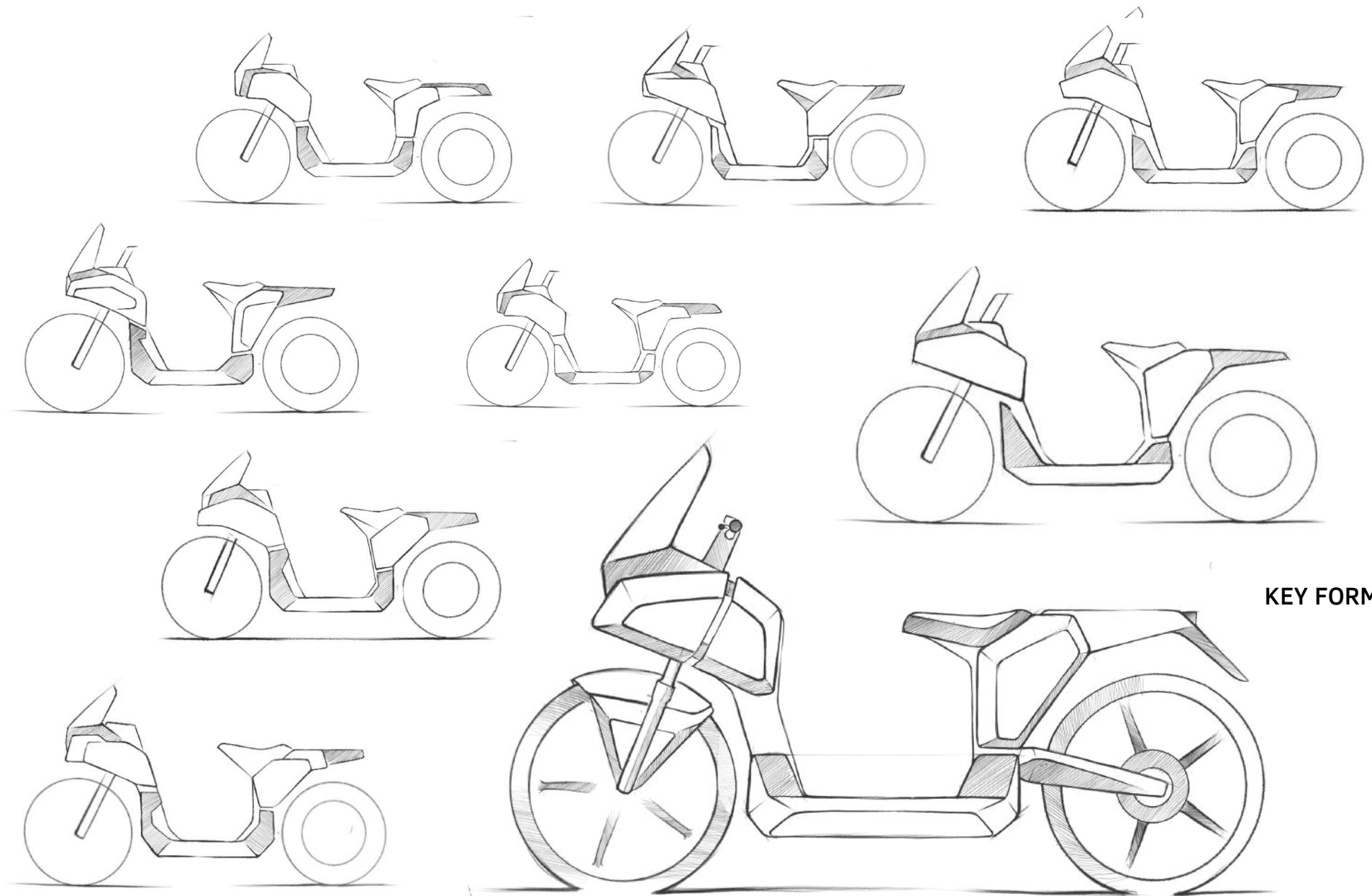
PURPOSEFUL

4.2 Form Ideations

Using the image board, form explorations and development is performed. The ideations follow the image board's visual form, and should contain certain design elements that are common throughout the image board. The forms were developed further and further to come up with a key sketch. The forms should include visual elements like well-defined edges, parallel surfaces and strong volumes. Some of the form ideations have been depicted in the following slides -

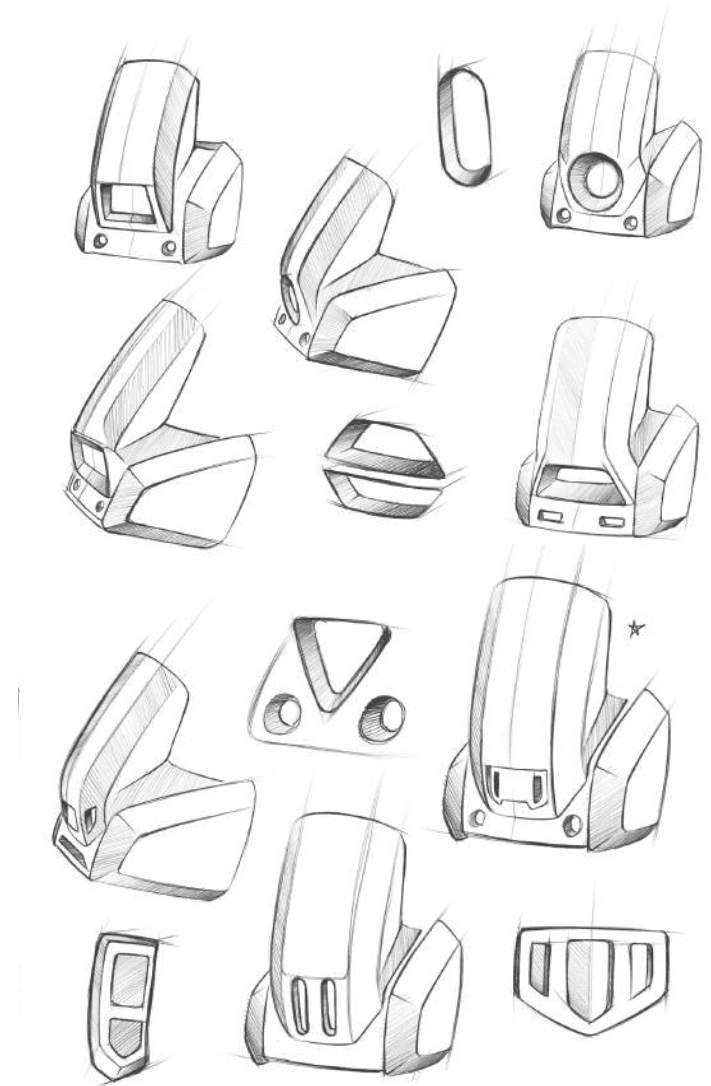
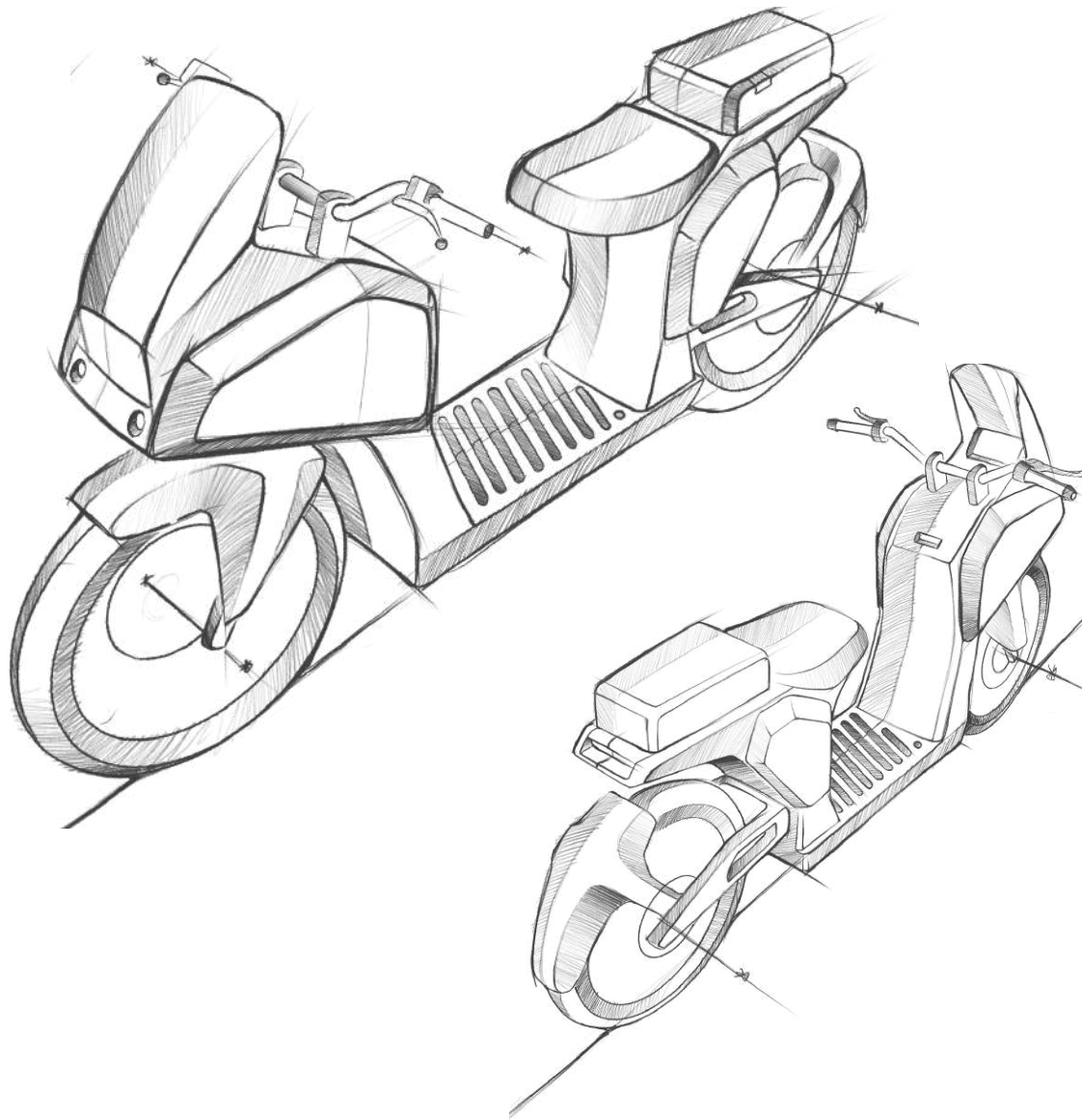






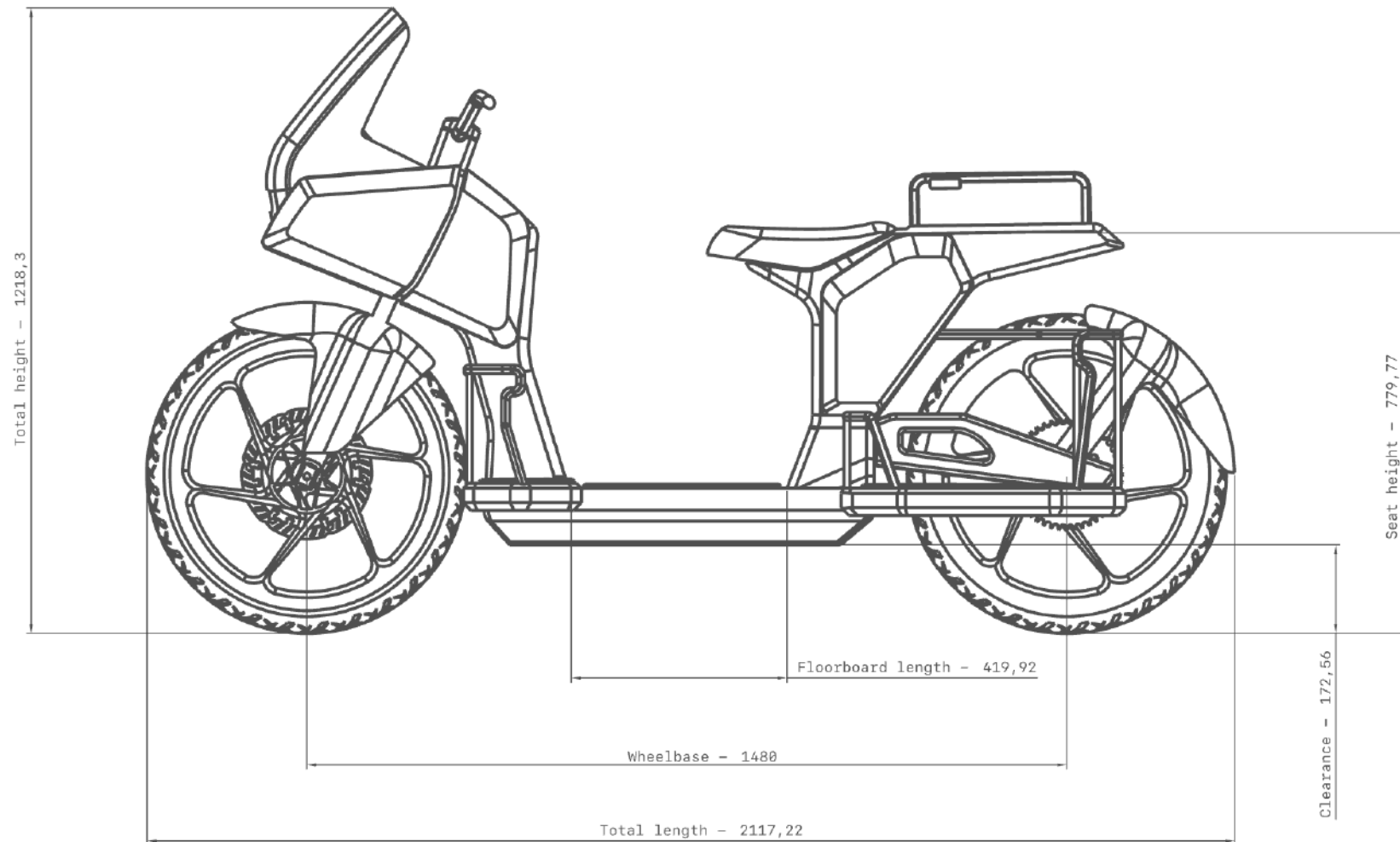
KEY FORM

KEY SKETCH



4.3 Developed Package and CAD Model

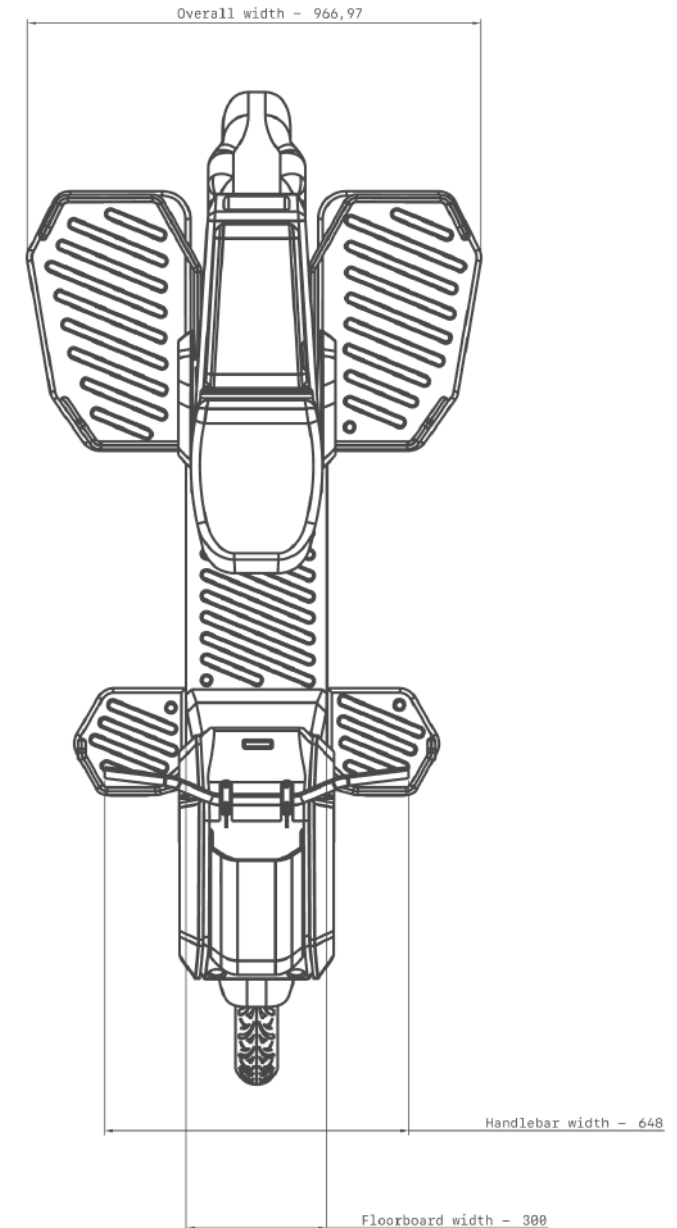
All dimensions in mm



Using the key form and the proposed platform, an initial CAD model of the vehicle was developed. Through ideation and development, the dimensions and design was optimized. The dimensions of the developed and optimized model are as follows -

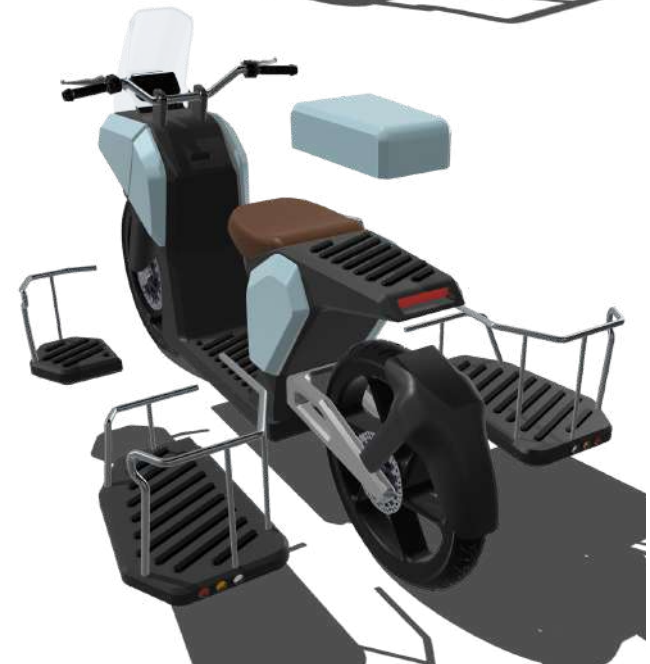
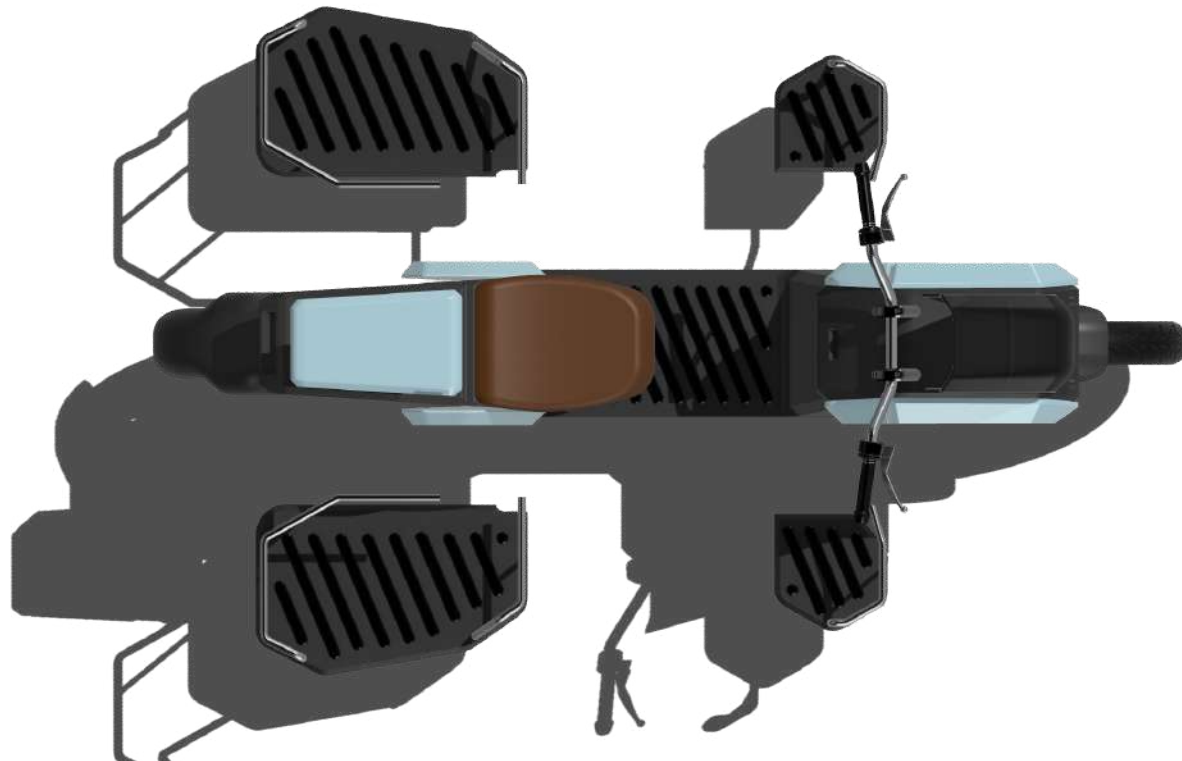
- Wheelbase - 1480 mm
- Length - 2117 mm
- Width - 967 mm
- Ground clearance - 172 mm
- Seat height - 780 mm
- Wheel dimensions - 80/100 - R18
- Handlebar width - 650 mm
- Floorboard width - 300 mm
- Milk capacity - 110l
- Front storage - 3 l approx.
- Rear storage box - 6.6 l approx.

The 3D model was developed via CAD using Shapr 3D and Blender, and is shown in the next few slides -

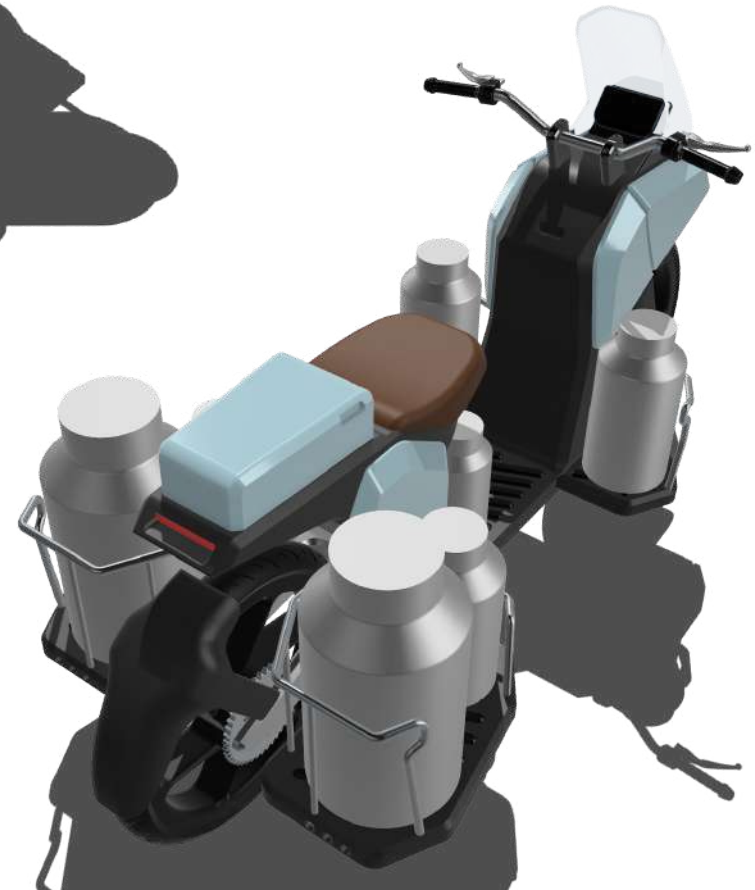
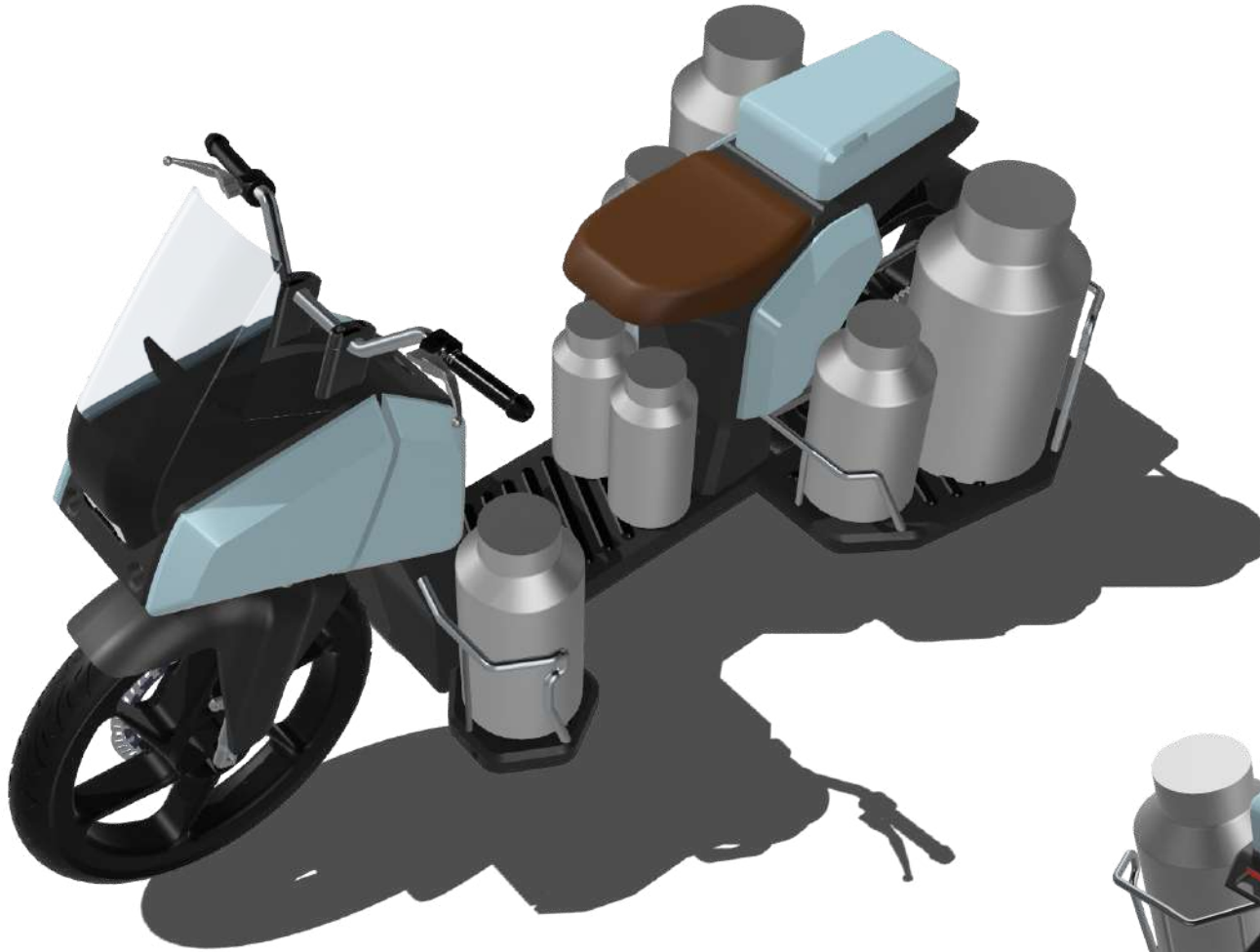


4.4 3D Visualization

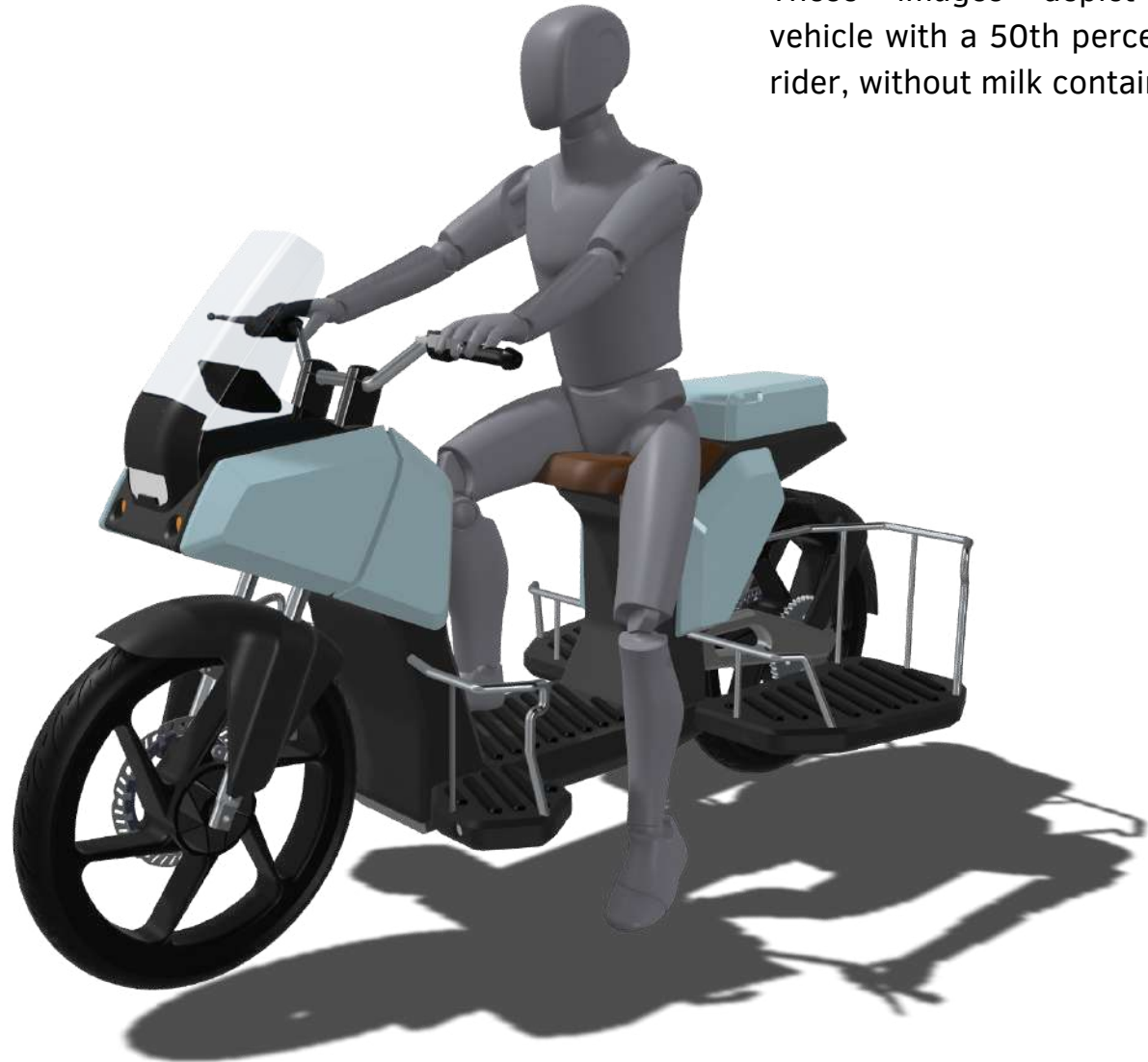
These images depict the base vehicle, with an exploded view of the top box and container platforms



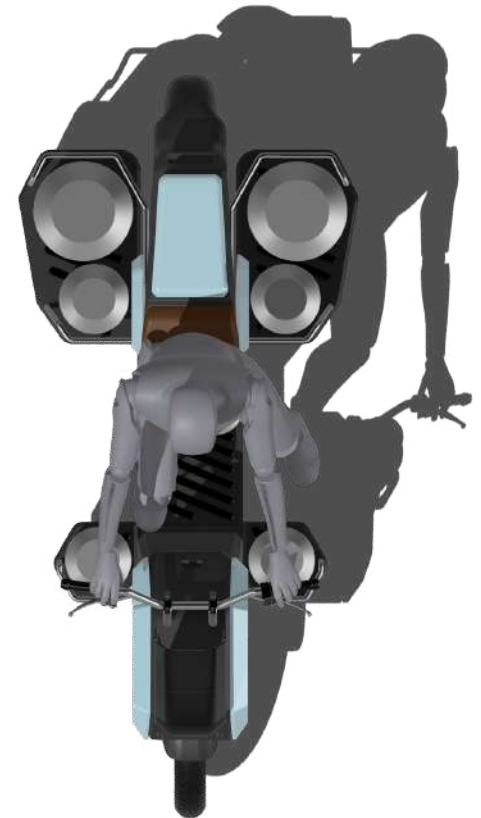
These images depict the vehicle at full carrying capacity of 110l.



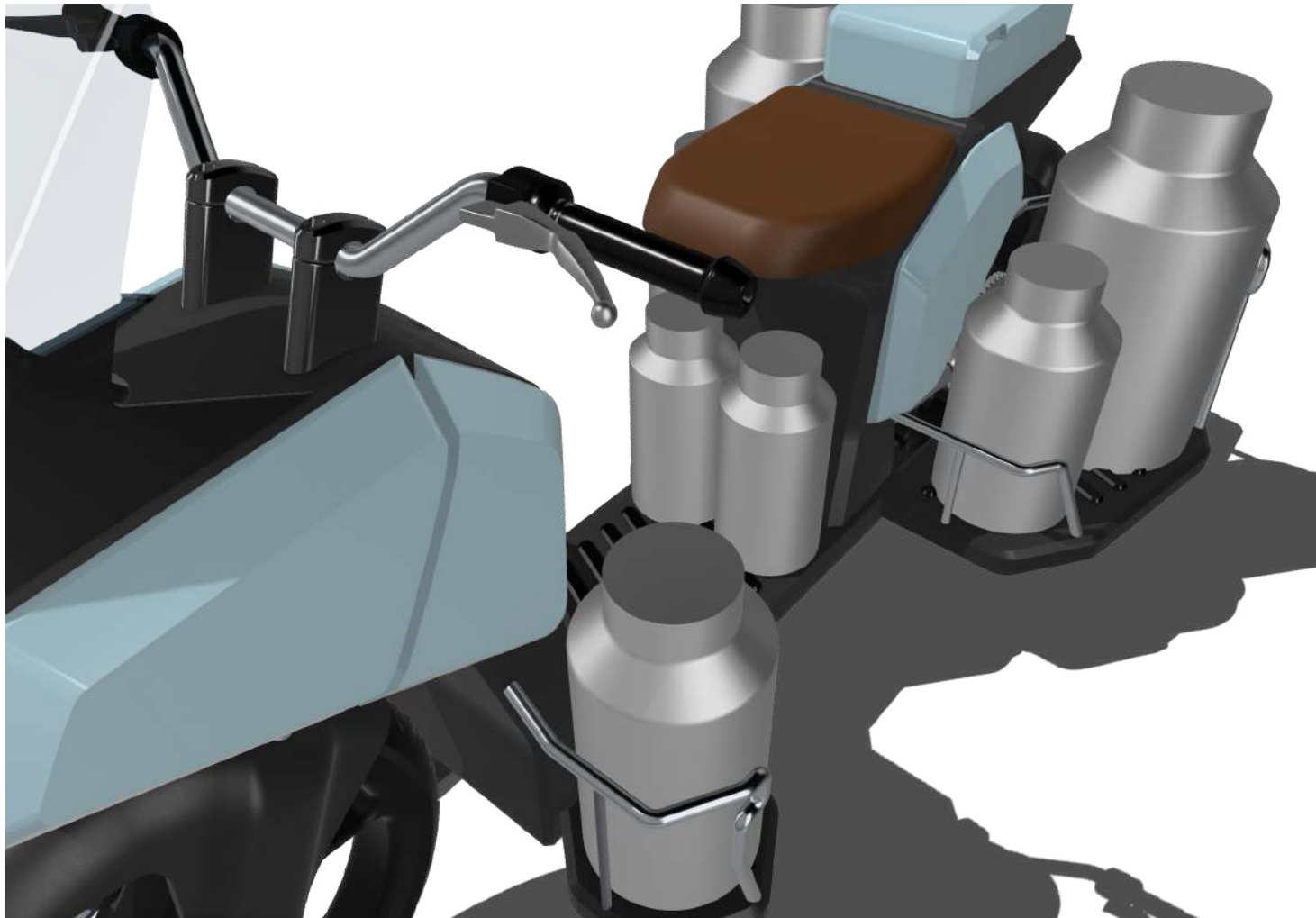
These images depict the vehicle with a 50th percentile rider, without milk containers.



These images depict the vehicle with a passenger and a full load of milk - 110l divided in 8 containers



Flat body panels devoid of extrusions ensure the width of the vehicle is minimized. The flatter panels ensure there is sufficient gap between the panels and containers, to prevent any damage that might be caused upon contact. Flat panels on the apron and seat post help us maximize the floorboard space.

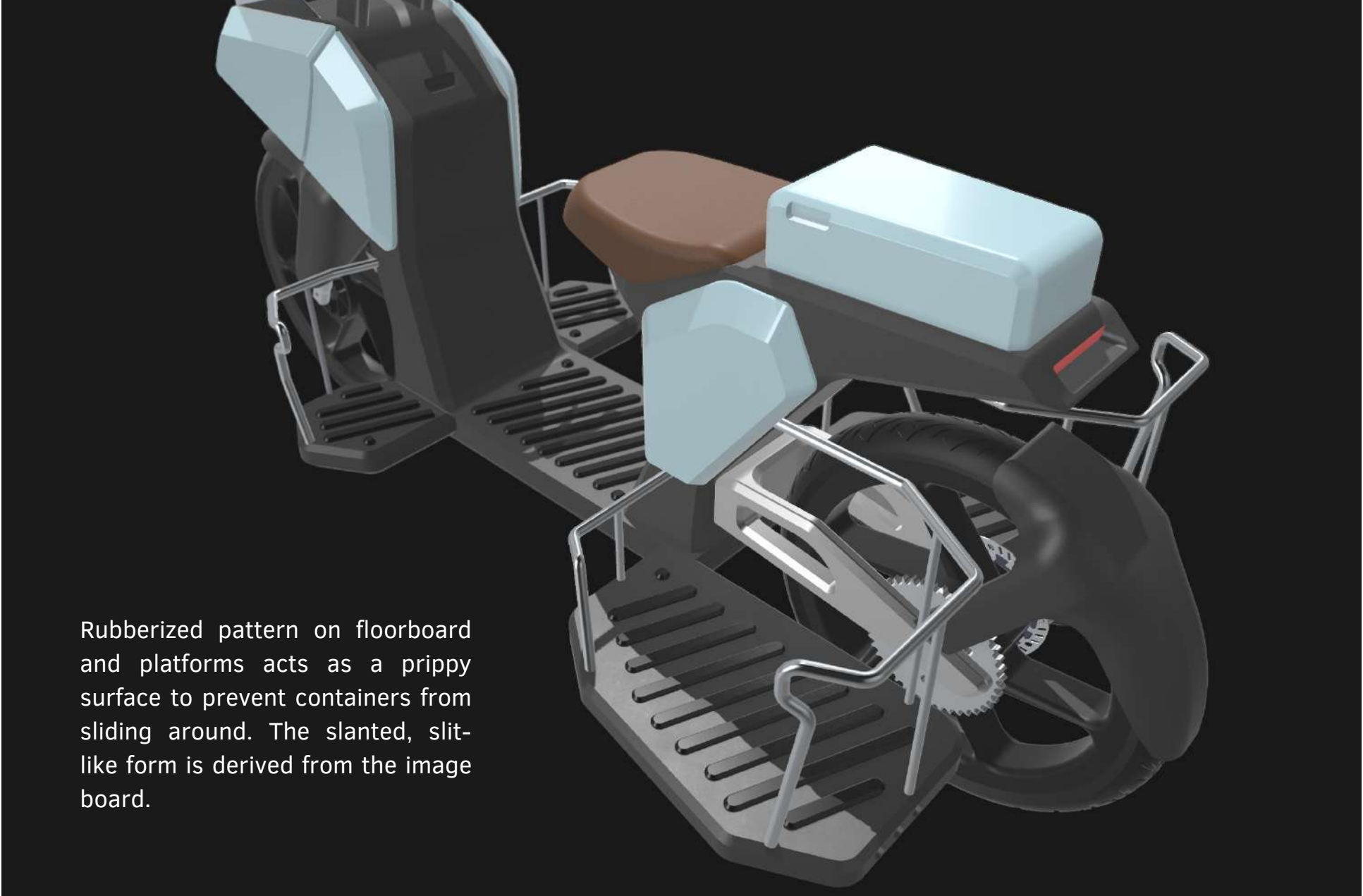




The concept aims to improve ergonomics of the user by bringing the containers within easy reach, hence allowing for easier and quicker milk transfer.



LOADING / UNLOADING OF CONTAINERS -
A convenient loading height of 25-28 cm allows for easier loading and unloading of heavy containers.



Rubberized pattern on floorboard and platforms acts as a grippy surface to prevent containers from sliding around. The slanted, slit-like form is derived from the image board.

Tall front windscreen provides protection from harsh/cold winds, dust and debris.



Front foglamps integrated in platform to aid visibility and safety in a foggy environment

Hazard and fog lights integrated in the rear platform as well to aid visibility and safety during fog and low-visibility situations.



5. Renders

Studio renders of front and rear 3/4, without milk containers.



Studio renders of front and rear 3/4, with milk containers.



Renders in the targeted environment.



6. Physical Mockup - WIP

Physical mockup - work in progress. Each element of the model will be 3D printed, sanded, applied with primer and finally finished with paint.



7. References

1. The Milk Float, *Youtube*, <https://www.youtube.com/watch?v=8m4VWrfPNxM>
2. Milk Float, *Wikipedia*, https://en.wikipedia.org/wiki/Milk_float
3. Electric hub motors vs mid-drive motors, *Electrek*, <https://electrek.co/2018/06/07/electric-bicycle-hub-motors-vs-mid-drive/>
4. Yakult Lady System committed to bring good health and cheer to your doorstep, *Business Standard*, https://www.business-standard.com/article/news-ani/yakult-lady-system-committed-to-bring-good-health-and-cheer-to-your-doorstep-117011900586_1.html
5. On National Milk Day, a look at India's per capita milk availability, *CNBC TV18*, <https://www.cnbctv18.com/market/data/on-national-milk-day-a-look-at-indias-per-capita-milk-availability-1499131.htm>
6. UCDF, *Uttarakhand Cooperative Dairy Federation*, <https://www.ucdfaanchal.org/>
7. Honda Shine user review, *Zigwheels*, <https://www.zigwheels.com/user-reviews/Honda/CB-Shine>
8. Milk collection bike service, *Youtube*, <https://www.youtube.com/watch?v=baETwF8EsfQ&t=159s>