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Design and Development of a Delivery Carrier

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***Abstract*: The rapid rise of e-commerce, food delivery, and last-mile logistics has changed urban mobility, placing delivery personnel at the front of supply chains. Despite their critical role, the gear they rely on, especially carriers, remain under optimized for years. This leads to inefficiencies and physical strain. This project addresses the urgent need for redesigning a carrier for delivery personnel that improves efficiency and functionality. The proposed design focuses on human - centric design that includes both qualitative and quantitative research followed by ideation, concept generation, design thinking, and prototyping. The design includes lightweight composite materials and modular structures that adapt to various package sizes and weights. Adjustable harnesses and load distribution systems are incorporated to minimize musculoskeletal stress and fatigue during long shifts. The carrier contains multiple pouches that can adapt to different packages by collapsing and expanding. Reflective safety strips, Weatherproof materials, and insulated compartments ensure resilience in diverse climates and urban conditions. The carrier contains detachable pouches and quick-access compartments that reduce delivery time. The design not only enhances the efficiency of delivery personnel but also reduces health risks and increases customer satisfaction through faster and safer deliveries. By bridging technical innovation with social impact, this carrier becomes more than a tool by empowering delivery workers, supporting urban logistics, and advancing sustainable mobility.**

***Keywords*: Delivery Bag, Food Delivery, Grocery Delivery, Rider Well-being, Delivery carrier, Last mile.**

1. Introduction

The food and grocery delivery sector in India has witnessed explosive growth from USD 3.05 billion in FY 2024 to USD 9–13 billion at the end of the decade [1] due to the rise of instant delivery platforms where “instant access” is seen as a normalized practice [2]. Delivery personnel use large-sized boxes made of PVC or polyester and have volumes from 20 to 150 liters; their main purpose is not convenience but marketing. Such boxes have a design that allows stacking several orders into one; however, they prioritize capacity and marketing over ergonomic design with their rigidity, reflective stripes, and vehicle fixation straps. [3]

Unfortunately, existing products create many problems. Firstly, there are complaints of musculoskeletal strain caused by poor ergonomics [4] and heavy loads. Non-breathable waterproof materials worsen this problem because they prevent sweat from evaporating in a hot and humid climate like the Indian one. Also, the absence of compartments creates risks of spills, damaged packaging, and inconvenience in handling different orders [5]; it affects customers negatively. The redesign should address these aspects.

2. Background Theory

A. Delivery Bags

Food and grocery delivery are on-demand courier services that provide meals and everyday essentials to customers. They are usually ordered through mobile apps. [7] Food delivery focuses on dishes from restaurants or cloud kitchens, while grocery delivery provides essentials like packaged foods, fresh produce like vegetables and fruits, and frozen items. [8] Delivery systems have expanded to provide clothes, cosmetics, and electronics within a short duration of time (10- 15 min) at the doorstep. Both rely on digital ordering, payment, and last-mile logistics and have grown immensely as customers see the importance of convenience and spending less time in physical stores [9]. Delivery bags are carriers that allow food and groceries to be carried safely while maintaining temperature, hygiene, and product integrity. They come in backpack, saddle/box, or handheld formats with insulation and easy-to-clean surfaces.

B. Literature Survey

The literature review identifies numerous innovations related to delivery and transportation technologies to improve efficiency, safety, and passenger convenience. Modern multifunctional luggage bags are equipped with GPS trackers, biometric locks, and power banks, while the intelligent locker systems offer cloud-based scalable solutions for package delivery in multi-family accommodation [11], [12].

Innovative delivery boxes employ the technology of exhaust heat transfer from vehicles for temperature regulation, whereas modified frames for motorcycle boxes are designed using aluminum after passing stress tests [13], [14]. Foldable electric cargo vehicles with e-scooter chassis frames are environmentally friendly, flexible, and reliable [15], [16].

Food delivery is centered around innovation that ensures the delivery maintains the qualities of being safe, healthy, and beneficial to riders. Multi-chambered and sealed delivery bag innovations come with reflective materials and are ergonomically designed to prevent spills and injuries and keep the food at optimal temperatures [17]. There have been heated delivery bags with electric hot plates and innovative motorcycle delivery solutions that use ceramic heaters, fans, and lithium-

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ion batteries for food protection during transportation [18], [19]. In conclusion, the studies above emphasize the importance of innovations that are ergonomically designed and sustainable.

3. Research Problem

The difficulties experienced by delivery persons with present delivery bags include discomfort during long usage hours, low capacity, a lack of versatility in handling different types of deliveries, and poor aesthetics. All these problems result in inefficiency, danger, and inconvenience. Consequently, product quality suffers. The development of delivery bags has been stalled due to the numerous problems that have remained unresolved. These include excessive last-mile delivery costs in densely populated urban locations, operational challenges associated with regulatory and profit-based considerations, and food safety and quality issues. It becomes crucial to design aesthetically appealing, ergonomic, versatile, and safe delivery bags.

4. Data Collection and Analysis

A. Product Study

The product study was done by comparing the delivery bags provided by 4 competitors (Swiggy, Zomato, Zepto, Ekart)

Table 1 displays the physical specifications of different bags, highlighting the varied suitability of each bag in different circumstances.

Table 2 shows the choice of material and the insulation capacity of each bag. These factors ultimately determine the freshness of food and groceries as well as the durability of the bag.

Table 3 displays the safety and ergonomic features of the bags. The padded/cushioned straps provide ergonomic comfort to the users. Safety features like reflective strips allow safety during night deliveries; good zippers and buckles allow safety for products.

Table 4 displays the functional focus, price availability, and other features that make the bags stand out or more desirable compared to the competitors in terms of function.

B. Perceptual Map

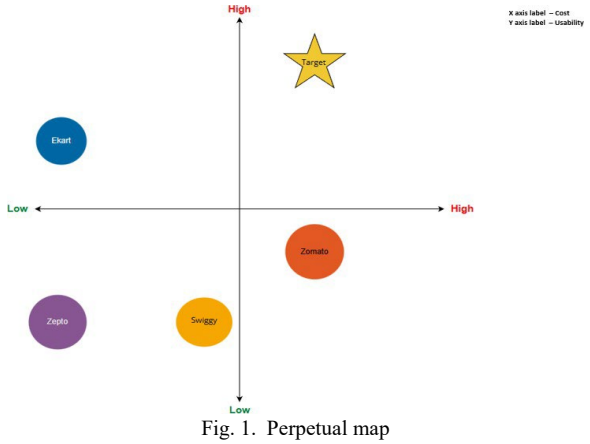

Fig. 1. Perpetual map

The x-axis represents the cost of delivery bags, ranging from low to high. The y-axis indicates the usability of delivery bags, also from low to high. The usability of the Zepto bag is relatively poor. Since Zepto does not charge delivery drivers for the bag and T-shirt, the cost can be considered low. Thus, the Zepto bag is in the third quadrant. The usability and comfort of Swiggy bags are also lacking. Swiggy charges approximately Rs 1000 for the bags and T-shirts, placing the Swiggy bag in the third quadrant as well. The Ekart bags offer considerably better usability. Drivers do not incur any charges for the bag. Due to this improved usability, the Ekart bag sits in the second quadrant. The Zomato bags provide slightly better usability compared to Swiggy bags. Zomato charges around Rs 1600 for the bag and T-shirt, which puts the Zomato bag in the fourth quadrant. Notably, there is a market gap since no products exist

Table 1
Physical specifications

Feature	Swiggy	Zomato	Zepto	Ekart
Dimensions (in)	14 x 14 x 14	18 x 16 x 12	14 x 14 x 14	22 x 15 x 24
Capacity (litres)	45	60	45	130
Capacity & Compartments	Less Capacity	Roomy compartments	Moderate capacity	Large capacity, 3

Table 2
Material and insulation

Feature	Swiggy	Zomato	Zepto	Ekart
Material	Durable, waterproof, dustproof	Durable waterproof, easy to clean	Functional waterproof moderate durability	waterproof, durable
Insulation	Effective insulation	Effective insulation	Basic insulation	No insulation

Table 3
Ergonomics and safety

Feature	Swiggy	Zomato	Zepto	Ekart
Ergonomics	No Cushion Straps	Padded Straps	Padded straps	Extra padded straps
Safety	Reflective strips	Velcro tapes, Zipper and buckles	Reflective strips Velcro tapes and buckles	Heavy-duty zippers, sliders, push clips

Table 4
Functional focus

Feature	Swiggy	Zomato	Zepto	Ekart
Functions	Food Delivery	Food delivery	Grocery delivery	Multipurpose
Price and Availability	Mid-to-premium	Premium	Affordable	Moderate
Others	Robust build, frequent use	Resistant to wear	Simple design	Foldable, heavy-duty, multiple access points (top/back), rain cover

Table 5
Ergonomic considerations

Design Feature/Metric	Traditional delivery backpack	Optimized padding (Mountaineering Benchmark)	Suspended Load System
Maximum measured back pressure	10 kPa (research data)	Significantly Reduced	Reduced (Implied by physiological benefit)
Max load carried by back	184N (approx. 18 Kg)	Reduced	Reduced (By shifting load movement)
Musculoskeletal disorder risk	High (Linked to pain complaints)	Moderate (Reduced by better fit and dispersion)	Lower (Energetic advantages noted)

in the first quadrant. Therefore, our goal is to create a bag that occupies the first quadrant.

C. Strengths, Weaknesses, Opportunities and Threats

The Indian market for delivery vehicle accessories offers great growth potential due to the boom in online sales and quick commerce, the versatility of two-wheelers, and the development of environment-friendly electric cars. Safe, reliable cargo boxes make the process faster, easier, and safer; moreover, innovations in digitalization and cloud kitchens drive revenues to increase to USD 55 billion in 2025. Nevertheless, there are obstacles to the adoption of such cargo boxes – diversity of vehicle types hinders a uniform design solution; expensive initial investment prevents poor people from buying the accessory; and rough roads require durable and maintenance-free cargo boxes. On the other hand, the threats include the availability of cheaper cargo boxes, unstable income of gig economy workers, differences in safety standards across India, fast pace of changes in technology, as well as possible legal and reputation risks in case of unsafe attachment of cargo boxes.

D. Material and Ergonomic Performance

The categorization approach focuses on materials used (PET, textile, non-woven materials, polyethylene, polyurethane, gel packs), forms of packaging (boxes and containers, bags and pouches, wraps), and the type of structure (rigid, flexible, semi-rigid). This allows us to take a comprehensive approach when studying delivery systems. Besides that, the ergonomic comparison of various backpacks as seen in Table 5 shows that traditional delivery backpacks create a high back pressure (10 kPa with a weight of 15 kg) and a high force transfer to the spine (184 N), which creates a high risk of musculoskeletal disorders. However, the optimization of a padding system (which is based on the technology of mountaineering backpacks) reduces the back pressure and the risk of musculoskeletal disorders due to better fit and even load distribution. The suspended load system allows reduced physiological loads by changing the dynamics of load and creating energetic benefits

5. Ethnography Survey

Insights into rider behavior and delivery bag usage demonstrate critical design shortcomings of the standardized company-provided delivery bag design. Many of the riders customize their bags on their own, showing the presence of design gaps and willingness to consider better solutions. The current design solutions are difficult to apply to large grocery deliveries, liquids, and different types of loads, thus causing extra stress during peak hours. Design problems include unreliable temperature control, lack of protection against the weather, and instability of the bag when it is only partially loaded, making the process of carrying the items uncomfortable and risky, while a completely loaded bag causes ergonomic and weight distribution problems. The durability of the bags is also an issue; for example, zippers and seams become unusable too quickly because of intense use, forcing riders to use the bag for longer than its replacement cycle. Compatibility issues, especially with different transportation methods and different body sizes, can lead to safety and ergonomic problems as well.

A. User Persona

In order to get a better understanding of ergonomics and vehicle compatibility issues related to delivery bags, we have come up with user personas of typical delivery rider situations. For instance, Rajesh (delivery via scooter, mid-career) personifies problems such as improper positioning of footrests, leg comfort impairment, and instability when positioning the bag on the pillion seat, especially if the order contains liquids. Thus, Rajesh's persona shows the importance of developing a more effective buckling system and the presence of storage pockets. Sandeep (delivery via bike, early career) personifies delivery riders who are facing rapid deterioration of bags, torn panels, and lack of appropriate compartments for liquids. Problems with securing the bags on the bike seat show the need for modularity and detachability of the interior of delivery bags. These personas, although they are fictional characters, summarize common insights gained from fieldwork and rider feedback.

B. Empathy Study

Empathy sheds light on the many problems that they have to deal with, which range from physical exhaustion and safety issues to environmental and psychosocial issues. Ergonomics-related challenges like backaches, stiff shoulders, and joint pain stem from the prolonged period of riding and carrying heavy bags along with unstable straps, shifting cargo, and awkward lifting of objects. The safety challenge involves the potential for accidents caused by abrupt braking, lack of visibility, unstable riding of the vehicle, and weather conditions like slippery roads and fogged visors. The environmental challenge is manifested through rain, heat, and cold, which affect the quality of the food carried and increase the likelihood of bag deterioration, hygiene challenges, and frequent spillage, broken zippers, and poor temperature maintenance of the bag. Moreover, emotional challenges involve difficult relationships with customers and restaurants due to being blamed for delays and damages, waiting, and the absence of places to rest, which put extra pressure on the delivery person.

6. User Flow

A. Complete Journey of a Delivery Task

It can be noticed from Figure 2 that the delivery process is an ongoing, multi-step process that requires close integration of riders' activities, carrier systems, and the safety of the package. From the beginning of the process that includes merchant pickup, riders should be able to ensure that there are no errors during order verification and loading of the packages. Transit involves vibration, balancing, and exposure to the environment, which requires secure carrier systems depending on the sensitivity of the packages. The drop-off process demonstrates how access systems, hygienic procedures, and internal organization affect efficiency and professionalism. In addition, it can be noticed from the cyclical process of task performance that the design should consider reducing reset time and avoiding physical and mental fatigue.

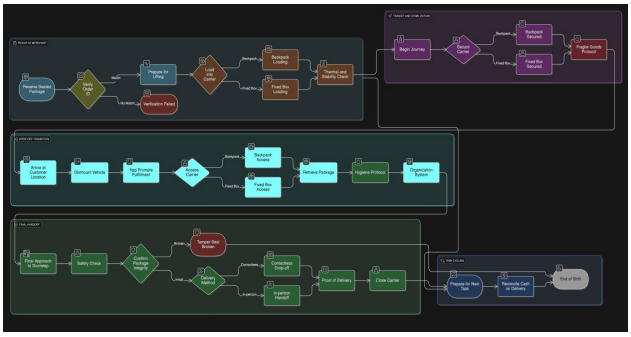

Fig. 2. User journey

B. Complete Journey of a Delivery Order

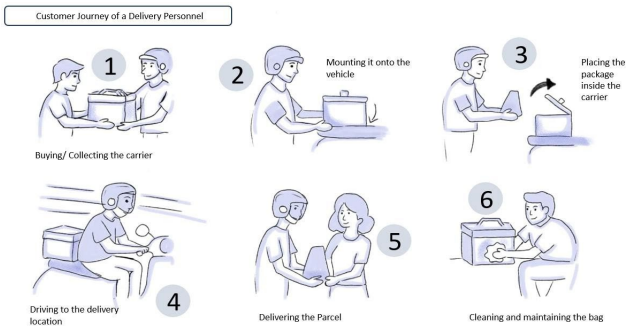

Fig. 3. Complete journey of a delivery task

The delivery order user flow in Figure 3 demonstrates an extremely tight system that is shaped by the app's logic, the interactions of the merchant and the rider, the actions of the rider, and payment transactions. From the request and pickup stage, the rider makes decisions that are affected by incentives and order information, with merchant counters playing a key role as major coordination nodes vulnerable to being misverified. Simultaneously, the process of verification and activation defines operational preparedness, with riders becoming verified players under the platform's control. The transit and fulfillment stages combine logistical considerations with privacy management, treating last-mile deliveries as a protocol for accountability and conflict resolution. Payment closure entails asynchronous branching into prepaid and cash-on-delivery modes, often inducing stress from poor communication, while the task close-out is marked by cyclical reputation building with ratings and future work decisions. Figure 4 illustrates the user journey from order collection to delivery to the customer.

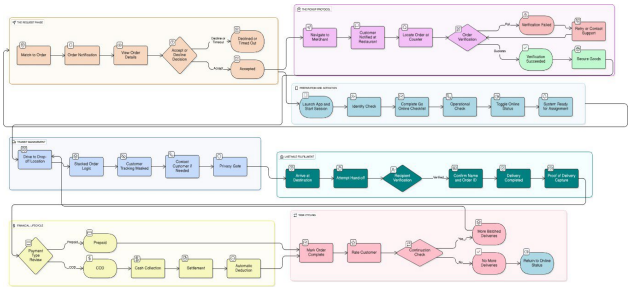

Fig. 4. Complete journey of a delivery task

7. Quality Function Deployment

Customer needs were then analyzed to convert them into technical specifications. This helped us conduct Quality Function Deployment (QFD). QFD pointed out that ergonomics, comfort, and safety should be the priority while designing the bags for the riders. Thickening the padding and optimizing the buckles came out as good practices for improving usability and reducing strain on the rider.

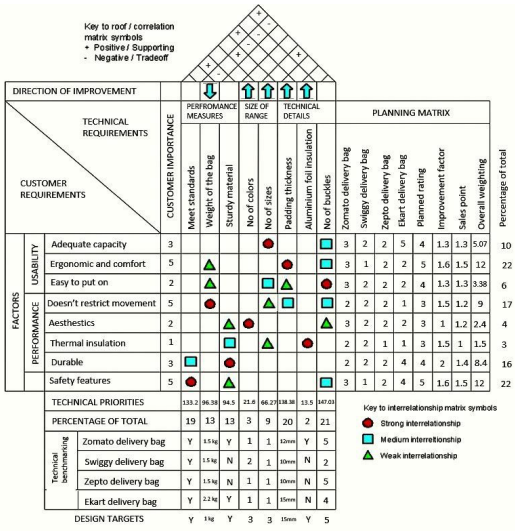

Fig. 5. Quality function deployment

8. Location Study

Analysis of the position of delivery bags on scooters and bicycles shows different levels of ergonomics and stability depending on the means of transportation. As far as scooters are concerned, the rear carrier is neither convenient nor safe because of the problems with balance, vision, and maneuverability, while the footrest or the floorboard proves to be the best place, providing a low center of gravity, convenience of placement, a rider's vision, and saving one from physical effort. As far as bicycles are concerned, attaching the bags to side or rear carriers leads to imbalance and trouble with maneuvering, while the bag becomes dirty, whereas wearing it as a backpack proves to be the most convenient variant.

Table 6
Vehicle mapping

Vehicle Type	Swiggy	Zomato
Scooter	Footrest/floorboard (front green dot)	Low center of gravity, easy access, minimal fatigue
Bike	On back (as backpack)	Balanced load, hands-free, stable during turns

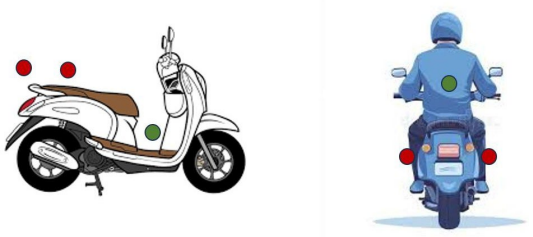

Fig. 6. Location mapping

9. Concepts

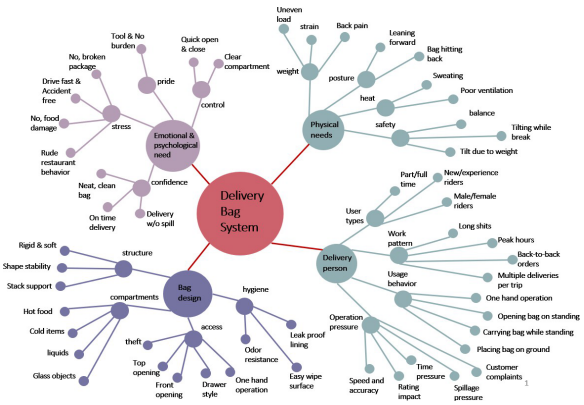

Fig. 7. Brainstorming 1

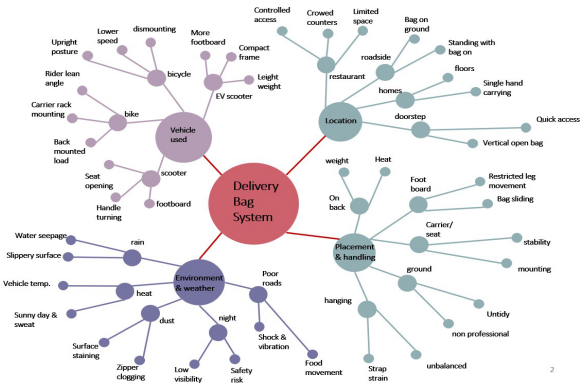

Fig. 8. Brainstorming 2

A. Concept 1

Fig. 9. 3D model

This idea allows delivery personnel to secure the products inside and return with ease. From the exterior, it appears to be a typical backpack; inside, there are two sections, one on the base, and a side opening that allows access to the middle and bottom sections. Food distribution is the main focus of this design. The aperture is easily accessible and precisely fits the seat size of delivery personnel's bikes and scooters. Additional side pads were created or affixed to the box to eliminate sliding and tilting.

B. Concept 2

This modular harness has four attachments, namely: front pouch, side pouch, belt pouch, and backpack. The front pouch, which can be expanded using buckles, can also attach to the belt and to bikes. The side pouch opens up to provide additional space, while the belt pouch attaches to the belt via a zip. The backpack, inspired by the shape of a turtle's shell, is designed for carrying heavier loads.

Fig. 10. 3D model back view

Fig. 11. 3D model front view

C. Concept 3

A half vest that has two belts going to the back. The bag is attached to one of the straps and can be moved along the axis of the strap. The bag can be expanded using extra material on the sides when there are more activities.

Fig. 12. 3D model

D. Concept 4

There is a cylindrical bag that is supported by a harness, which is in turn connected to the front support, which has hooks and belts mounted on it to provide additional storage. The bag can be compressed and pulled to the side, which then acts as a small side bag. Minor lightweight bags can be hooked to the front support.

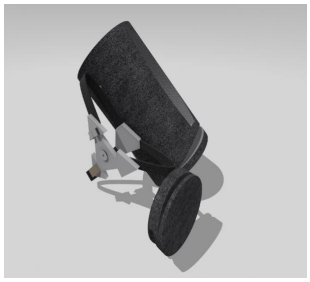

Fig. 13. 3D model

10. Concept Detailing

A. Concept Validation

Concept 2, which was collapsible with bags, was the most liked design by riders through the survey conducted among dark stores and doorsteps, garnering 15 votes. The most frequent clients also liked this design. The delivery people felt more confident and optimistic, hoping for a better delivery experience with this product. They wanted the bag to be a bit bigger and liked the collapsible option.

B. Pugh Matrix Analysis

We created a Pugh Matrix to do a final analysis of the analyzed features.

This helped to compare the concepts and rank them. Concept 2, with harness, got the highest score. This helped us to finalize the concept and take it forward with further refinement and development.

		Pugh Concept Selection Matrix	Weight	Design Concepts: concept with harness	concept with combination of sling and sliding	concept with vest	concept with sling
Selection Crieteria	Ergonomic & Comfort	Like a Backpack	S	+	0	-	-
		Equal load distribution	S	+	-	-	-
		Shoulder + waist Strap Harness	S	+	-	-	0
	Usability and Access	Quick Access	S	S	S	0	0
		Easy to carry off vehicle	S	S	0	0	S
		Multiple ways to wear	S	+	0	0	0
	Form and Perception	avoid awkward appearance	S	+	+	+	+
		Not Bulky	S	+	+	S	+
		Avoiding Customer Judgment	S	+	+	+	0
	Mounting and Mobility	Easy mounting on bike/Scooter	S	S	S	0	0
		Stable during riding	S	S	S	0	0
		Easy to remove and wear	S	S	+	S	+
	Storage and Adaptabilit y	Collapsable structure	S	+	-	-	-
		Extra strap for load control	S	+	-	-	-
		Flexible capacity usage	S	+	-	-	-
		Total +		10	4	2	3
		Total -		0	-5	-6	-5
		Total Score		10	-1	-4	-2
		Weighted Score					

Fig. 14. Pugh matrix table

C. Final Concept

The proposed design is a modular harness system for grocery and food delivery, adaptable for platforms such as Zepto, Instamart, Blinkit, Zomato, and Swiggy. Two detachable bags can function as a backpack or be mounted on a vehicle, depending on delivery needs. The harness incorporates cushioned shoulder straps, a broad waist belt, and Velcro strips for modular attachments, ensuring even weight distribution across the body.

The front pouch offers dual compartments and flexible orientation, secured with Velcro and clasps. Side pouches are collapsible, expandable, and fastened to the waist belt. The backpack features a single compartment with an expandable zipper and integrated thermal lining to maintain food temperature. The assembly can be secured to a bike using the waist belt buckle and an auxiliary safety strap.

Quick-access front and side pouches are optimized for rapid grocery deliveries, while the insulated backpack supports longer food orders, enhancing efficiency and delivery experience.

Fig. 15. 3D model

Fig. 16. 3D model

Fig. 17. Exploded view

Fig. 18. Developed product

Fig. 19. Product rendering

11. Conclusion

Through this project, it is established that an anthropologically oriented, modular harness and bag combination may be able to solve the ergonomic, usability, and efficiency issues faced by food and grocery deliveries in India. The design goes one step further from branding-oriented backpacks and adopts collapsible volumes, multiple entry points, and insulation, among other features, while also managing to distribute load on the shoulders, waist, and chest to minimize fatigue. The design has been carried out using ethnographic research, journey mapping, and ergonomic evaluation to ensure that it allows various modes of usage (backpack, scooter floor, bike mount, quick access grocery bags) and incorporates various functionalities (weather resistance, reflectivity, capacity adjustments). Initial business research shows a high level of feasibility of the design through platform integration, customizability, and warranties.

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