

Swappable Battery Delivery Motorcycle With Active Thermal Food Compartment

Abdulrahman Abusharifah, Osama Alghamdi, Abdullah Alhathlul, Osama Althunayyan
Coach: Dr.Uthman Baroudi



Introduction + Integrated Specifications

• Problem Statement “Rising demand for last-mile delivery in Saudi cities has increased reliance on gasoline motorcycles that drive up costs and emissions, worsening urban air quality, while technical barriers such as battery sizing in extreme heat and limited charging infrastructure hinder electric adoption, making the development of efficient, affordable e-motorcycles a key enabler of Vision 2030 goals for sustainability, economic diversification, and improved quality of life.”

Integrated Specifications

Operational Spec – Battery lifecycle (0% to 80% charge time in <45 min)

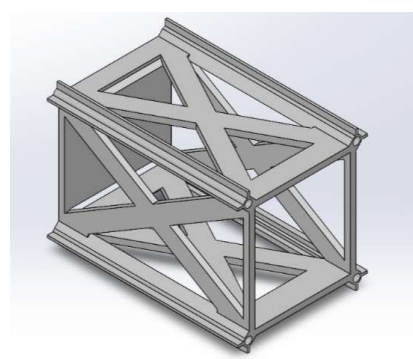
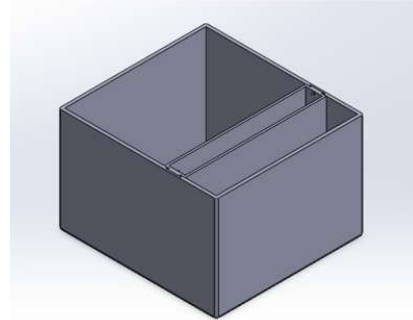
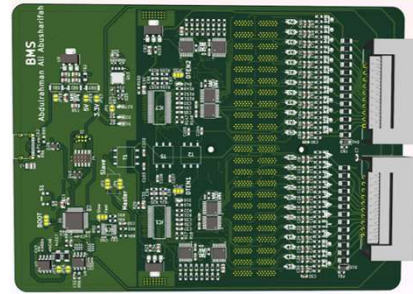
Thermal management system (± 2 °C precision; -30% spoilage)

Quick-release swap system (<3 min swap time)

Constraints & Specifications

Constraints	Specification
C1 – Box mass & size (30–40 kg; ≥ 45 kg load; ≤ 2.2 m length)	S1 – Food compartment temps (Hot >50 °C, Cold <5 °C)
C2 – Operating cost reduction ($\geq 40\%$ vs gasoline)	S2 – Station proximity optimization (≤ 5 km to charging station)
C3 – Temperature tolerance (operate reliably up to 40 °C)	S3 – Internal volume (120 L total; Hot 90 L, Cold 30 L)
C4 – Battery & motor requirements (≥ 120 km range; 130 V; 1.8 kW; ≥ 3 kWh)	S4 – Motor performance ($\eta >90\%$, speed up to 70 km/h)
C5 – Charging network requirement (≤ 5 km to nearest station)	S5 – Thermal uniformity (± 2 °C; Hot >50 °C, Cold <5 °C)
-----	S6 – BMS accuracy (SOC/V/I $\pm 2\%$; Temp ± 2 °C)

Prototype Design



Testing Validation & Conclusion

- Mechanical Verification
 - Load test confirmed box supports **>45 kg** using 2.5 kg weights.
 - Hot zone maintained **>50 ° C** at 35–40 ° C ambient.
 - Box mass verified within **30–40 kg** requirement.
- Electrical Verification
 - BMS voltage, current, and temperature readings accurate to **$\pm 2\%$** .
 - Dashboard and IoT communication validated.
- Operational Verification
 - Quick-release system achieved **~30-second** battery swaps.
 - Workflow analysis confirmed improved efficiency and reduced operating cost.

The prototype demonstrated the feasibility of a swappable-battery electric delivery motorcycle with reliable thermal control, strong structural performance, accurate battery monitoring, and rapid battery replacement. Testing confirmed that key objectives—food quality preservation, reduced downtime, and improved operational efficiency—were achieved. The results establish a solid foundation for transitioning to full aluminum construction, complete electronic integration, and large-scale deployment.