How can electric two-wheeler concepts shape a sustainable mobility sector in Sub-Saharan Africa

Assessing the economic, social and environmental sustainability potential of a battery-swap motorbike business model in Kenya

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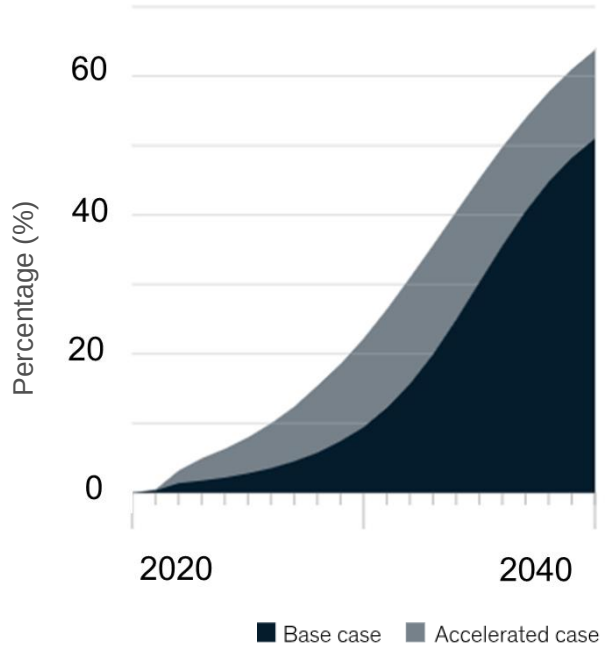
Agenda

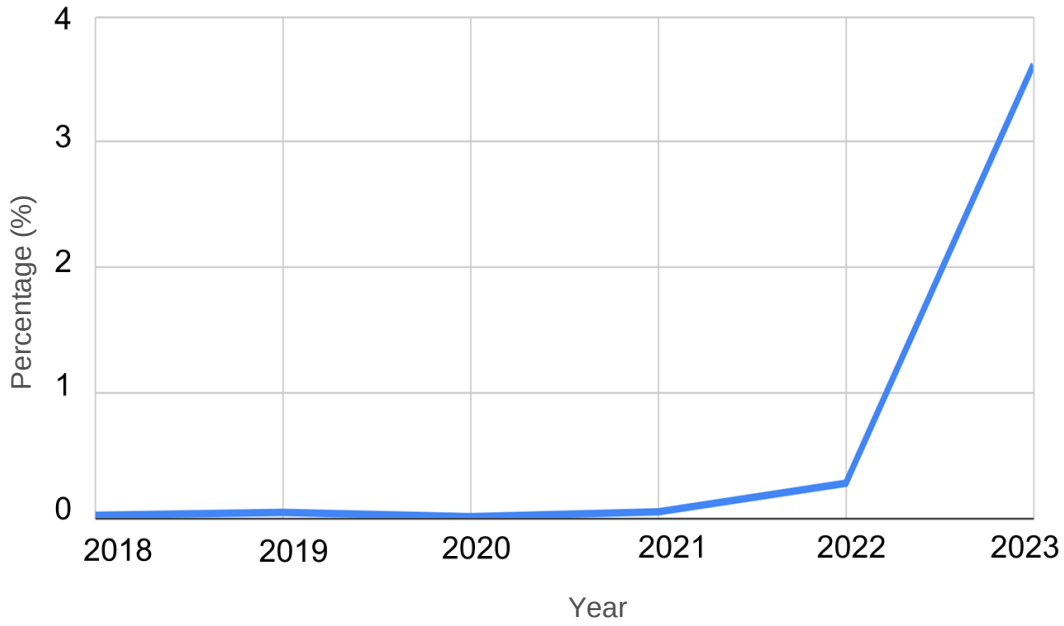
1. Motivation
2. Research Questions
3. Methodology
4. Results
5. Conclusion

Motivation



Source: McKinsey Centre for Future Mobility analysis, 2021

Fig. Two-wheel electric vehicles Expected market share of in Sub-Saharan Africa by 2040



Source: NTSA, KNBS, Aug 2024

Fig. Electric Motorcycle Share (%) of Motorcycle Sales in Kenya

In 2023
70,691
motorcycles sold in Kenya

2,557 electric

3.6% of motorcycles sold in 2023 in Kenya were electric

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Research Questions

Ampersand's battery-swapping approach support ~ sustainable electrification of Kenya's mobility sector?

Critical success factors ~ similar battery-swapping business models in emerging markets?

Identified success factors ~ applied to Ampersand's operations in Kenya?

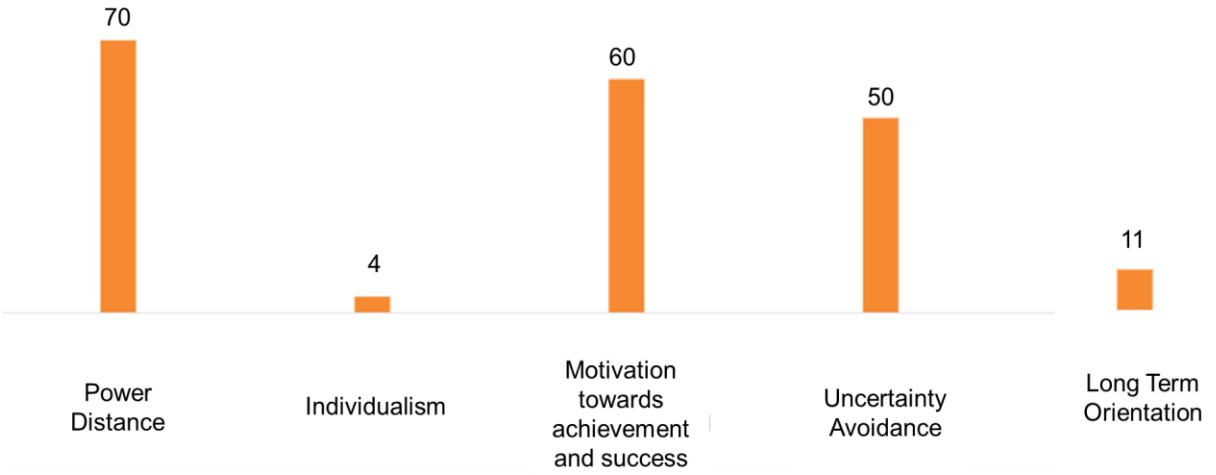
Analytical Frameworks Utilized

- Hofstede's cultural dimensions Theory
- Technological Innovation Systems Approach
- The Triple Layered Business Model Canvas
- Stakeholder Analysis

Provide insights into the **cultural, social, economic, and technological** factors influencing the success of e2w battery-swapping business models in the Kenyan context

Methodology

Hofstede's Cultural Dimensions Theory



Source: https://www.theculturefactor.com/country-comparison-tool

Fig. Cultural Insights of Kenya according to Hofstede (Index out of 100)

Power Distance
Hierarchy, authority, centralized decisions
→ *Government & fleet owners influence adoption*

Individualism
Community-driven, collectivist, group decisions
→ *Boda-boda groups drive adoption*

Achievement & Success
Competitive, financial success matters
→ *Riders adopt if they earn more*

Uncertainty Avoidance
Moderate risk-taking, need proof
→ *Trust & reliability needed for adoption*

Long-Term Orientation
Focus on short-term gains
→ *Immediate cost savings*

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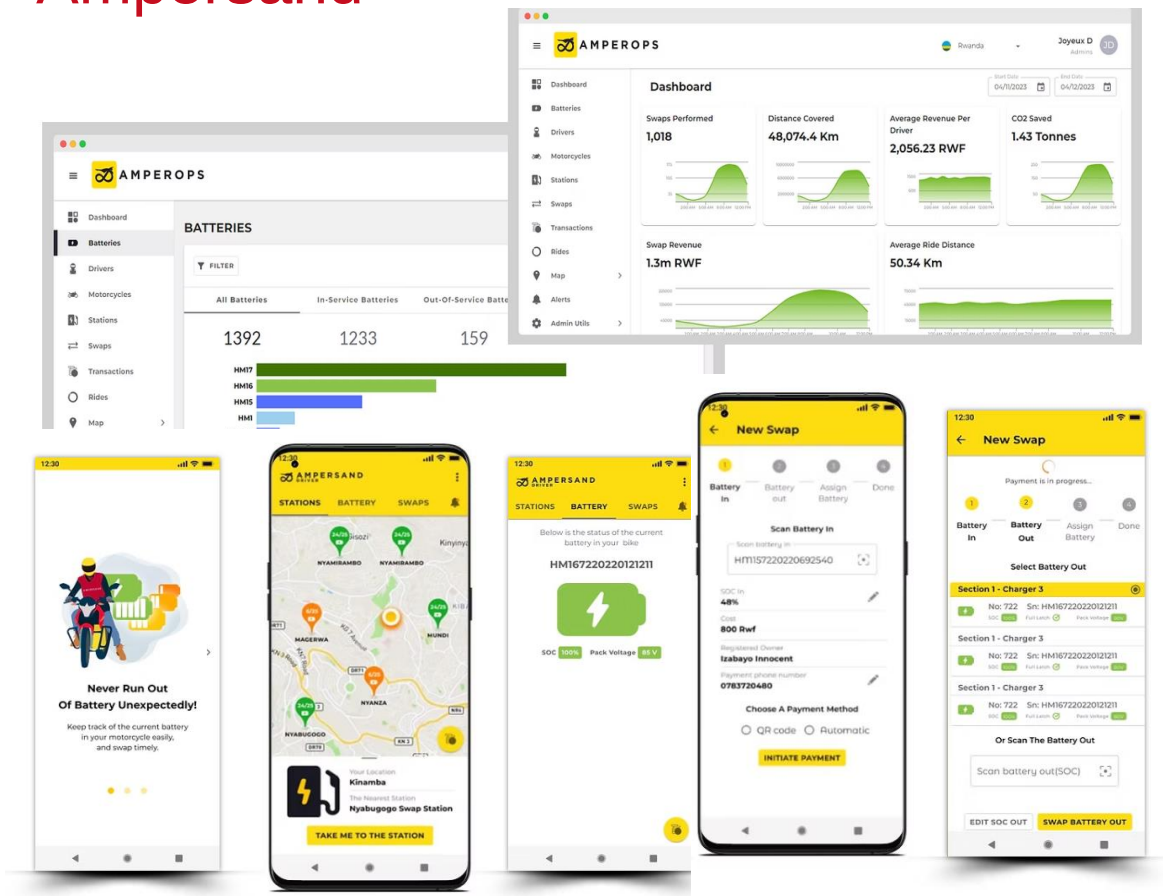
Ampersand

1. Drivers purchase or leases a pay-as-you-drive Ampersand e-moto
2. Through Ampersand's Driver App, they check when the battery is low and visit a battery swap station
3. In less than 2 minutes, Ampersand swaps out the depleted battery for a new one and the driver pays for the energy used
4. The driver continues their day, swapping when required

Source: ampersand.solar/technology

Ampersand



Source: ampersand.solar/technology

Methodology

Technological Innovation Analysis

Assess how technological advancements are reshaping the transportation sector, structure and functions, focusing on key drivers, barriers, and opportunities for growth.

Drivers of Adoption
- Environmental Concerns
- Cost-Effective
- Improvements in technology

Technological Innovations
- Battery-Swapping Stations
- Charging Infrastructure
- Energy Storage

Market Impact
- Economic Empowerment
- Rural and Urban Connectivity
- Knowledge diffusion

Electric Two-Wheelers (E2W)

F1: Entrepreneurship, F2: Knowledge Development, F3: Knowledge Diffusion,
F4: Guidance of Search, F5: Market Formation, F6: Resource Mobilization, F7: Legitimacy

Methodology

Business Model Analysis - Economic

Source: Ampersand Impact

Cost Structure
- Motorbike & battery production
- R&D, technology development
- Workforce & maintenance costs

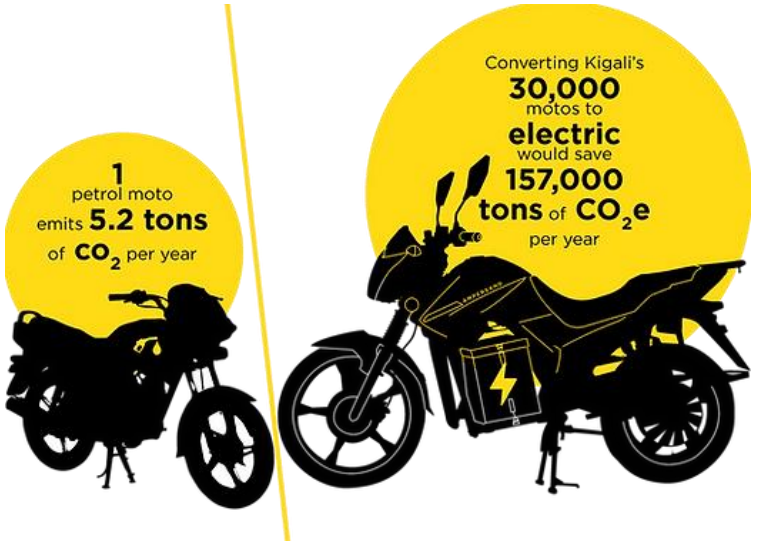
Revenue Streams
- Direct sales & leases of electric motorbikes
- Pay-per-swap battery model and subscriptions

Value Proposition
- Lower operating costs for riders
- Fast & convenient battery swaps
- Reduced fuel dependency & price fluctuations

Key Business Components
Partners: FI's, Battery manufacturers, Government regulators
Activities: Expanding battery swap stations, e-motorbike production
Resources: Digital fleet management, charging infrastructure

Methodology

Business Model Analysis - Environmental



Source: Ampersand Impact

Energy Efficiency & Usage
- Lower energy consumption compared to petrol bikes
- Energy usage - electricity mix (renewable vs. grid power)

Sustainable Production & Materials
- Lithium-ion batteries, steel, and composites: Resource recovery
- Sustainable manufacturing

Eco-Friendly Supply Chain & Distribution
- Locally assembled bikes to reduce import emissions
- Global supply chains for raw materials with sustainability focus

Key Environmental Benefits
- 75% lower greenhouse gas emissions vs. petrol motorbikes
- Reduces 2-3 tonnes of CO_2 emissions per e-motorbike annually
- Improves air quality in urban areas

Methodology

Business Model Analysis - Social

Source: Ampersand Impact

End Users
- Boda Boda Riders
- Logistics and delivery services
- Individual commuters

Empowering Local Communities
- Job creation & fair opportunities (career, wages)
- Promoting social equity

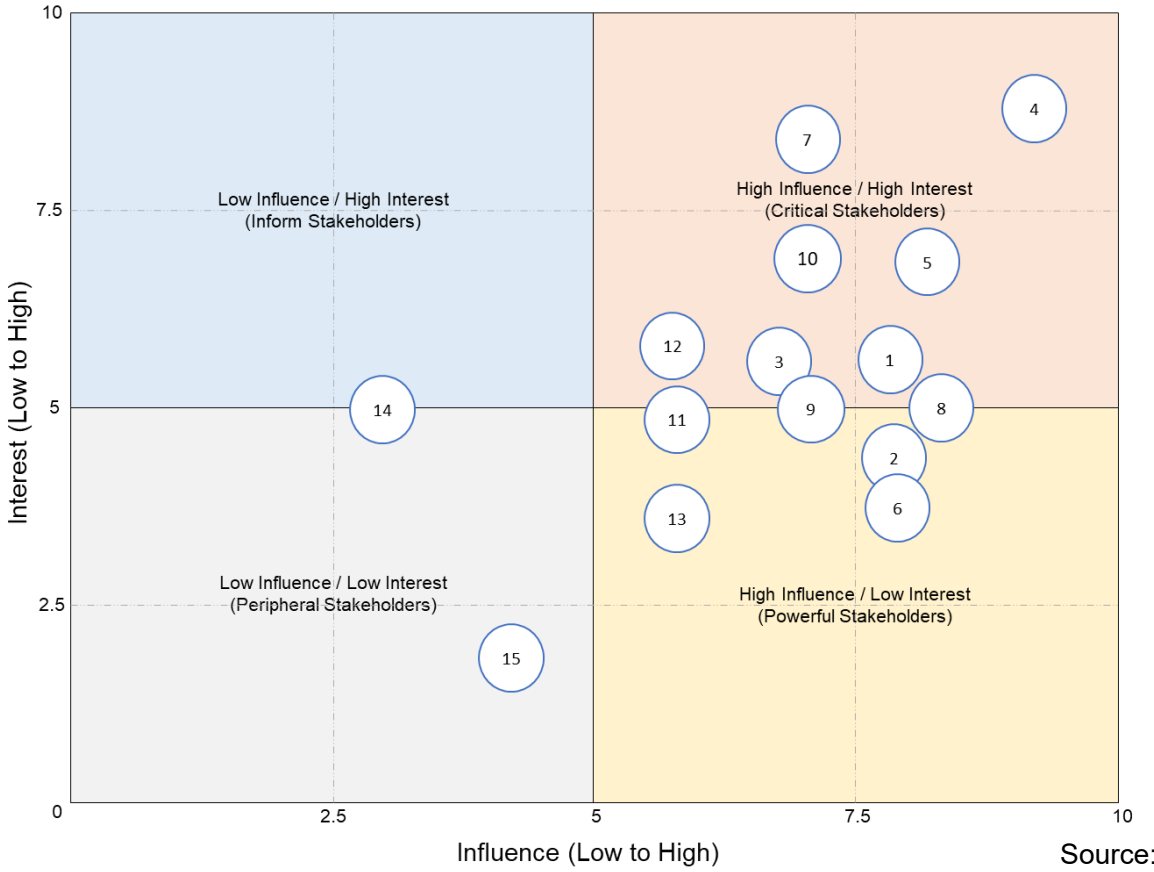
Social Value & Impact
- Affordable & accessible transport
- Safety & reliability for riders
- Public health benefits (less pollution)

Community Outreach
- Over **3,350 riders** in Kenya & Rwanda (expanding to 5M by 2033)
- Strengthening commercial fleets
- Bridging technology adoption & infrastructure gaps

Methodology

Stakeholder Analysis

- Collected different stakeholders from the theoretical part (all relevant actors in Kenyan E2W ecosystem)
- Analysed stakeholders with influence-impact matrix



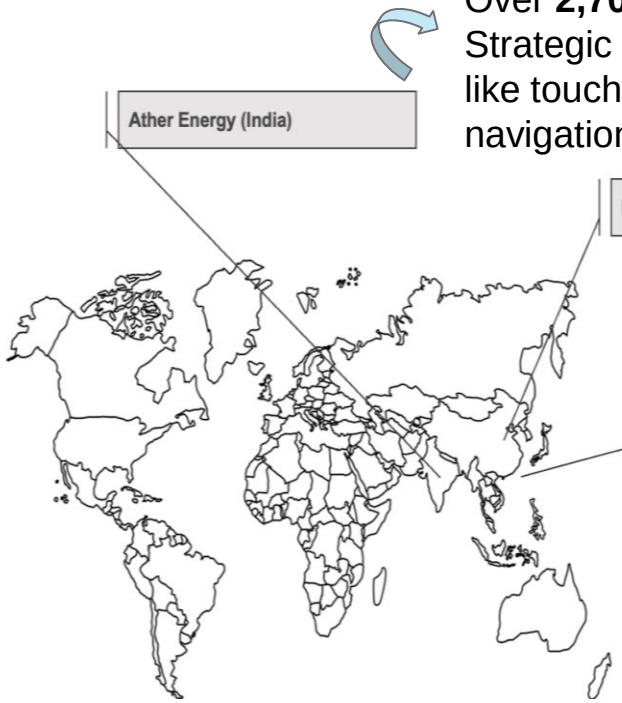
1. Main Customer
2. Further Customer
3. Employees
4. Private Funding
5. Public Funding
6. Government
7. Energy Provider
8. Swapping stations
9. Main Customer Association
10. E2W-Provider Kenya
11. E2W-Networking Organisation
12. EV Association
13. Development Organisation
14. Society
15. International E2W-Operator

Source: Author's own illustration

Fig. Influence-Interest Matrix

Methodology

Comparative Case Studies



Over **2,700 fast-charging stations** across 230 cities in India.
Strategic partnerships and government collaboration, Features like touchscreen dashboards, smart diagnostics, and GPS navigations

Established over **700 battery-swapping** stations
Integrates innovative technology such as GPS, cloud-based services to enhance user experience

Nearly **13,000 smart battery-swapping** stations at 3,000 locations across nine countries
An **open ecosystem** for battery swapping (third-party e-vehicles can use their swapping stations)

Relevance to Kenyan Context

- **Open Battery-Swapping Ecosystem**
  Common swapping infrastructure
- **Strategic Infrastructure Deployment**
  High-traffic urban areas
- **Affordable Payment Models**
  Pay-as-you-go and subscription models
- **Partnerships**
  Collaborations with different stakeholders

Findings and Analysis

Market Potential & Business Models

Growing Demand: Boda boda sector adoption

Swapping cost per battery – 240 KES (1.68 Euros)
Number of Swapping Station – 16 (Source: Benoit, 2023)

KPs:

- **Ownership Model** - High upfront cost, limited financing options.
- **Lease-to-Own** - More accessible but needs stronger microfinance
- **Battery Swapping** - Cost-effective, reduces range anxiety
- **Fleet/Ride-Hailing** - High scalability but affordability & convenience

"Battery Swapping gaining traction due to affordability & convenience technology innovation"

1 Kenyan Shilling = 0.0070 Euros (Exchange rate 03.04.2025)

Key Lessons from Ampersand

- **Battery Swapping** = Higher Adoption
- **Microfinance Partnerships** = Increased Accessibility
- **Technological Innovation** = Enhances User Experience
- **Government Incentives** = Faster Market Growth
- **Test Rides & Training** = Overcoming Skepticism

Challenges

- Infrastructure & Energy Supply
- Battery Technology & Supply Chain
- Economic & Market Barriers
- Policy & Regulatory Challenges

Opportunities

- Technology & Innovation
- Environmental Impact & Sustainability
- Cost Savings & Economic Benefits
- Government & Investor Support

Key Takeaways and Outlook

Key Takeaways

- Economic Sustainability: A Cost-Effective Mobility Solution
  - ~45% cost savings for riders compared to petrol alternatives
  - Job Creation & Industrial Growth
- Social Impact: Accessibility & Improved Livelihoods
  - ~50% higher earnings for boda-boda (motorcycle taxi) riders
  - Energy Inclusion & Mobility Access
  - Health Benefits
- Environmental Sustainability: Reducing Carbon Footprint
  - Prevents 2-3 tonnes of CO_2 emissions annually
  - Renewable Energy Integration

Outlook

- Growth Potential & Market Expansion
- Policy & Regulatory Support is Key
- Infrastructure & Battery Technology Advancements
- Public-Private Partnerships Drive Scalability

Future Directions

- Financial Models for Affordability & Scalability
- Smart Battery Swapping Networks (AI Driven Optimization) & IoT Integration
- Perception & Behavioral Studies on EV Adoption
- Government Incentives & Policy Recommendations
- Evaluating the impact of import duty exemptions, tax incentives, and subsidies on EV adoption.

Additional Sources

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Thank you for your attention !

Appendix

Business Model Analysis - Economic

Partners
- Battery suppliers & manufacturers
- Government & regulatory bodies (for incentives, policies)
- Financial institutions
- Renewable energy providers

Activities
- Establishing battery swap stations & Expanding
- Manufacturing

Resources
- Digital fleet management platform
- Infrastructure & stations

Value Proposition
- Lower operational costs
- Faster, convenient battery swaps
- Reduced fuel dependency & price fluctuations

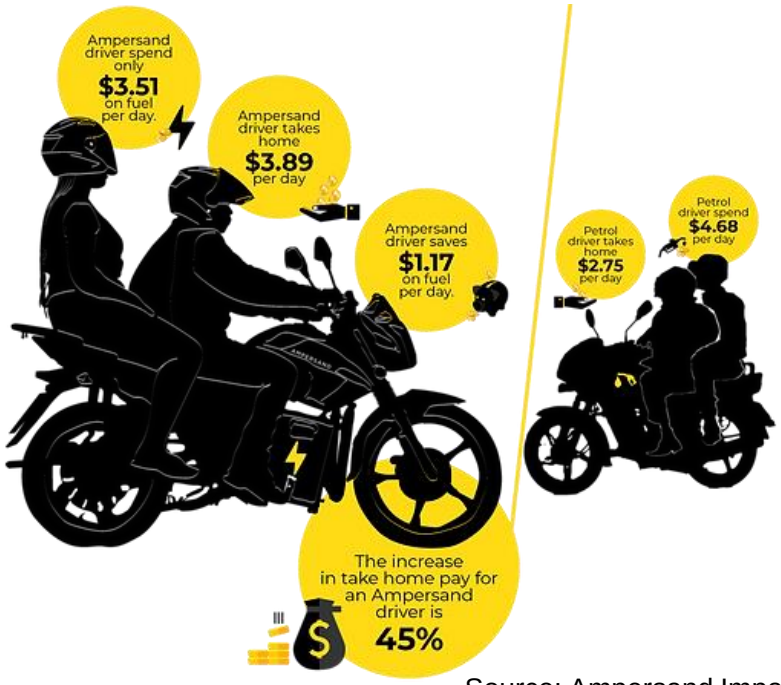
Customer Relationship
- Subscription & pay-per-swap models
- Maintenance

Channels
- 1,150 in Kenya and 2,200 in Rwanda (e2w)
- 5 million by 2033

Customer Segments
- Boda Boda Riders
- Logistics and delivery services
- Individual commuters

Costs
- Battery & motorbike production costs
- R&D & Technology development
- Workforce & Maintenance costs

Revenues
- Direct sales and leases of motorbikes
- Pay-per-Swap option, Monthly subscription
- Carbon Credit Sales



Source: Ampersand Impact

Fig. Business model analysis of Ampersand from an **economic perspective**

Source: Author's own illustration, based on (Joyce and Paquin 2016)

APPENDIX

Business Model Analysis - Environmental

Supplies and Out-sourcing
- Energy, Batteries and components
- Global supply chains for battery raw materials
- Local assembly to reduce import reliance

Production
- 21,000-square-meter facility 60 e2w/day
- Sustainable manufacturing

Materials
- Lithium-ion batteries
- Steel, aluminium
- Plastics and composites

Functional Value
- Community Engagement
- Accessibility
- Affordability
- Education and Awareness
- Safety & Reliability
- Sustainability

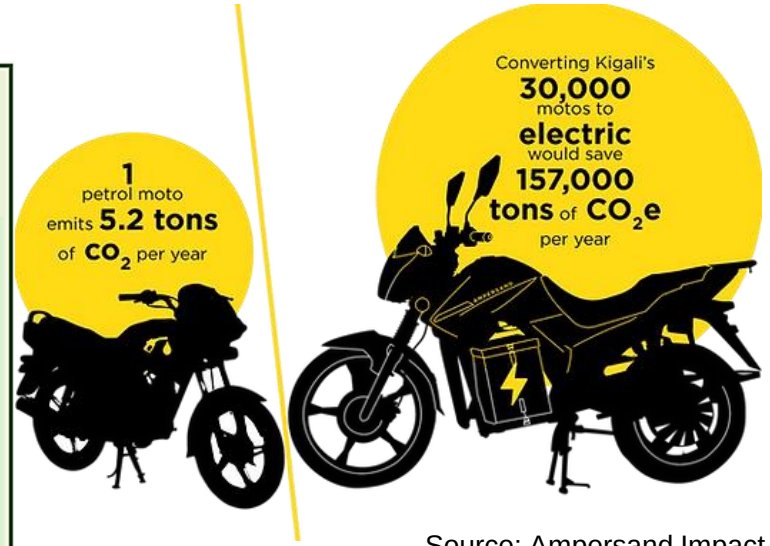
End-of-Life
- Battery Recycling
- Proper disposal methods

Distribution
- Network of battery swap stations
- Collaborations in integration

Use Phase
- Emission Reductions: 2 to 3 tonnes annually/e2
- Operational Efficiency
- Energy usage for software, influenced by electricity mix

Environmental Impacts
- 75% less lifecycle greenhouse emissions than petrol motorbikes using grid power
- Air Quality Improvement

Environmental Benefits
- Climate Change Mitigation
- Toxicity Reduction
- Sustainable Development



Source: Ampersand Impact

Fig. Business model analysis of Ampersand from an **environmental perspective**

Source: Author's own illustration, based on (Joyce and Paquin 2016)

APPENDIX

Business Model Analysis - Social

Local Communities
- Engagement with Boda Boda Riders
- Job Opportunity
- Equity

Governance
- Policy Alignment with National E-Mobility Goals
- Transparent

Employees
- Fair Wages and Benefits
- Inclusion
- Job, Skills Development

Social Value
- Community Engagement
- Accessibility
- Affordability
- Education and Awareness
- Safety & Reliability
- Sustainability

Societal Culture
- Technology Adoption
- Infrastructure Gaps

Scale of Outreach
- 1,150 in Kenya and 2,200 in Rwanda (e2w)
- 5 million by 2033

End-User
- Boda Boda Riders
- Logistics and delivery services
- Individual commuters

Social Impacts
- Improve Accessibility to Transportation
- Public Health
- Long-Term Social Sustainability

Social Benefits
- Community Development
- Job Creation and Economic Empowerment

Source: Ampersand Impact

Fig. Business model analysis of Ampersand from social **perspective**

Source: Author's own illustration, based on (Joyce and Paquin 2016)