



A Feasibility Study of Electric Bicycles

Case of Manikkal Gram Panchayat, Kerala
Report | February 2024







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Publication team:

Tanu Chaudhary, Facet Design

Organisation:

The Council on Energy, Environment and Water (CEEW) is one of Asia's leading not-for-profit policy research institutions and among the world's top climate think tanks. The Council uses data, integrated analysis, and strategic outreach to explain – and change – the use, reuse, and misuse of resources. The Council addresses pressing global challenges through an integrated and internationally focused approach. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with the wider public. CEEW has a footprint in over 20 Indian states and has repeatedly featured among the world's best managed and independent think tanks. Follow us on X (formerly Twitter) @CEEWIndia for the latest updates.

Efficiency Services Limited (EESL) is a Super Energy Service Company (ESCO), which enables consumers, industries and governments to effectively manage their energy needs through energy efficient technologies. EESL is implementing the world's largest energy efficiency portfolio across sectors like lighting, buildings, industry electric mobility, smart metering, agriculture, etc. at an enormous scale. EESL's energy efficiency solutions have saved India over 47 billion kWh energy annually while reducing 36.5 million tonnes of carbon emission. Founded in 2009, EESL is promoted by the Ministry of Power, Government of India as a Joint Venture of four reputed public-sector undertakings NTPC Limited, Power Finance Corporation Limited, REC Limited and POWERGRID Corporation of India Limited. EESL focuses on solution-driven innovation without taking support of any subsidy from the Government

Convergence Energy Services Limited is a green energy focused venture of the EESL Group owned by central public sector undertakings under the Ministry of Power, New and Renewable Energy. It offers interventions that solve multiple gap areas in the energy ecosystem by amalgamating seemingly independent sectors such as electricity, transport, home appliances and introducing models for adaptation at scale through government partnerships and innovative financing such as carbon markets.

Energy Management Centre (EMC), under Department of Power, Government of Kerala, is the first State-level organisation exclusively for promoting energy conservation, came into existence on 7th February 1996. EMC is designated as the State Designated Agency (SDA) of the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India to coordinate, enforce and implement Energy Conservation Act in the state of Kerala. With a view to making the energy sector achieve such a lead and catalytic role, EMC has evolved a novel and comprehensive energy management approach and institutional philosophy encompassing management of energy technology systems – both conventional and non-conventional, energy conservation in all sectors of the economy, energy resource management, rural and urban energy systems, energy education and training, energy generation and conservation-based employment and poverty alleviation programme.

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Key Contributors

Nilanshu Ghosh, Council on Energy, Environment and Water
Anannya Jha, Council on Energy, Environment and Water
Himani Jain, Council on Energy, Environment and Water

Amit Sood, Convergence Energy Services Limited
Ritu Singh, Energy Efficiency Services Limited
Chetna Gogna, Energy Efficiency Services Limited
Suraj Kant, Energy Efficiency Services Limited
Akshita Arora, Energy Efficiency Services Limited

Narayankumar Sreekumar, Shakti Sustainable Energy Foundation
Priyadarshini Alok, Shakti Sustainable Energy Foundation

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Image credit: The photos included in the report were specifically taken by the members of the CEEW team with the consent of the women who rode the e-cycles that were displayed during the demonstration phase in Manikkal Gram Panchayat.





अभय बाकरे, आईआरएसईई
महानिदेशक

ABHAY BAKRE, IRSEE
Director General



सत्यमेव जयते
75
Azadi Ka
Amrit Mahotsav



ऊर्जा दक्षता ब्यूरो
(विद्युत मंत्रालय, भारत सरकार)

BUREAU OF ENERGY EFFICIENCY
(Ministry of Power, Government of India)



Foreword

In an era marked by technological advancements and an ever-evolving landscape, **the Bureau of Energy Efficiency (BEE)** is committed to **improve energy intensity of Indian economy, thereby contributing towards sustainable development of the country**. One of the transformative innovations that has captured our attention is the **integration of electric cycles** as a last mile e-mobility solution. The emergence of e-cycles offers a unique opportunity to revolutionise livelihoods and quality of life. **Electric mobility** presents a viable alternative in addressing the energy challenges by balancing energy demand, energy storage and environmental sustainability. When coupled with the **decarbonisation of power sector**, electric mobility can considerably **assist India in meeting its climate goals**.

This report highlights the views of Anganwadi, Accredited Social Health Activists (ASHA), and Self-Help Group members, emphasizing the **significant potential of e-cycles nationwide**. **The findings underscore e-cycles as a promising solution for short distance travel, offering operational sustainability and environmental friendliness**.

Women's participation is vital for inclusive economic growth, particularly in rural areas where they represent half of the population. Juggling diverse responsibilities, from household chores to agricultural work, entrepreneurship or professional engagement, women can benefit greatly from an economical and eco-friendly mobility solution that aligns with their aspirations. Such a solution not only contributes to environmental protection but also enhances convenience and time savings for women in their daily commutes.

I am hopeful that this report will lead towards a future of rural empowerment and community development through electric cycle adoption.

अभय बाकरे 11.1.24.
(Abhay Bakre)

Date 11.01.2024

स्वहित एव राष्ट्रहित में ऊर्जा बचाएँ Save Energy for Benefit of self and Nation



चौथा तल, सेवा भवन, आर.के. पुरम, नई दिल्ली-110066 / 4th Floor, Sewa Bhawan, R.K. Puram, New Delhi-110 066

दूरभाष / Tel. : 91 (11) 26766701, 20867389, फ़ैक्स / Fax : 91 (11) 20867396

ई-मेल / E-mail : dg-bee@nic.in, वेबसाइट / Website : www.beeindia.gov.in





Energy Management Centre

State Designated Agency to Enforce Energy Conservation Act 2001)
Department of Power, Government of Kerala

Foreword



06.12.2023

In our pursuit of energy-efficient solutions, the Energy Management Centre (EMC) collaborated with Convergence Energy Services Limited (CESL) and the Council on Energy, Environment and Water (CEEW) to conduct a comprehensive feasibility study focusing on the demonstration of electric bicycles in a rural context, with Manikkal Gram Panchayat serving as a case study. Our exploration zeroed in on micro-mobility, particularly electric bicycles, as a transformative alternative.

From the in-depth survey and demonstration of electric cycles in Manikkal Gram Panchayat, it became apparent that micro-mobility solutions are not merely a means of eco-friendly transportation but also possess the potential to economically empower women, alleviate fatigue, and enhance work efficiency. Micro-mobility solutions, especially e-bicycles, can support women with convenient commutes for work, fostering self-dependence.

I extend my appreciation to CESL and CEEW for their unwavering commitment to facilitate affordable and energy-efficient transportation modes. The insights gained from this initiative have yielded practical recommendations, identifying specific e-cycle features to suit the unique needs of different worker groups. This study represents a step toward a more sustainable and inclusive future, where micro-mobility solutions play a pivotal role in addressing transportation challenges and empowering individuals, particularly women, in their daily lives.

Dr R. Harikumar
Director

**Sreekrishna Nagar, Sreekariyam PO
Thiruvananthapuram 695017**

Tel: 0471-2594922,2594924 Fax: 0471-2594923

E-mail: emck@keralaenergy.gov.in | Website: www.keralaenergy.gov.in



एनजी एफिशिएंसी सर्विसेज़ लिमिटेड
विद्युत मंत्रालय के सार्वजनिक क्षेत्र के उपक्रमों की संयुक्त उद्यम कंपनी
ENERGY EFFICIENCY SERVICES LIMITED
A JV of PSUs under the Ministry of Power



Foreword

In the pursuit of sustainable solutions and energy-efficient technologies, the realm of clean mobility has emerged as a beacon of progress, paving the way towards a greener future. E-cycles represent a ground-breaking leap towards energy-efficient mobility solutions. These electric bicycles stand as a testament to technological innovation, offering a clean, cost-effective, and environment-friendly means of transportation.

At Energy Efficiency Services Limited (EESL), we have spearheaded several initiatives to promote energy efficiency across diverse sectors. From the successful implementation of LED lighting programs to the adoption of energy-efficient appliances, our endeavours have contributed significantly to reducing energy consumption and carbon footprints.

The collaborative efforts between Convergence Energy Services Limited (CESL) (EESL's subsidiary), the Energy Management Centre (EMC) and the Council on Energy Environment and Water (CEEW) on this report have been instrumental in driving forward the agenda of clean mobility. The report highlights e-cycles as an energy-efficient technology which will be instrumental in transforming livelihoods by addressing their mobility needs.

The integration of e-cycles not only addresses transportation challenges but also embodies our collective commitment to reducing carbon emissions and fostering a cleaner environment. Through strategic collaborations and innovative solutions, we are reshaping the landscape of transportation, emphasising sustainability and efficiency. Together, our initiatives not only pave the way for a more sustainable future but also empower communities by providing them with eco-friendly and accessible transportation options.

(Mr Vishal Kapoor)
CEO, EESL

पंजीकृत कार्यालय: एन. एफ. एल. बिल्डिंग, पाँचवा और छठा तल,
कोर - 3, स्कोप कॉम्प्लेक्स, लोधी रोड, नई दिल्ली - 110003
दूरभाष: +91 (011) 45801260, फ़ैक्स: +91 (011) 45801265
वेबसाइट: www.eeslindia.org

REGISTERED OFFICE: NFL Building, 5th & 6th Floor,
Core - III, SCOPE Complex, Lodhi Road, New Delhi - 110003
Tel.: +91 (011) 45801260, Fax: +91 (011) 45801265
Website: www.eeslindia.org





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Acronyms

ASHA	Accredited Social Health Activists
AWC	Anganwadi Centres
CDS	Community Development Society
DAY NRLM	Deendayal Antyodaya Yojana – National Rural Livelihoods Mission
EMC	Energy Management Centre
EMI	Equated Monthly Instalment
ES	Executive Summary
EV	Electric Vehicle
E-cycles	Electric Cycles
E-moped	Electric Moped
FGD	Focus Group Discussion
ICE	Internal Combustion Engine
kg	kilogram
km	kilometre
kmph	kilometre per hour
OEM	Original Equipment Manufacturers
SHG	Self-Help Groups
SPEM	State Poverty Eradication Mission
TCO	Total Cost of Ownership

Executive Summary

The availability of public transport is limited in many regions, specifically in rural areas, leading to increased use of private motorised vehicles for commuting. As economic conditions improve, the aspiration towards owning private modes increases, leading to increased fuel consumption and emissions. Hence, it becomes imminent to delink economic growth from emissions through clean alternatives.

Between March and June 2023, the Convergence Energy Services Limited (CESL) team conducted field visits in Raipur and its adjoining districts in Chhattisgarh, Lucknow in Uttar Pradesh, Nalanda in Bihar, and Trivandrum in Kerala. These visits aimed to assess the potential adoption of technologies such as electric bicycles among people who travel short distances (5-10 km). The team studied current trip durations, the frequency of on-demand trips, and transport-related expenditures to identify the target beneficiaries who could benefit from more convenient commute modes. Initial field visits indicated e-cycles as a viable commute mode to address their aspiration of owning a private vehicle while ensuring zero emissions.

The initial discussions hinted at women government employees, especially Anganwadi, Accredited Social Health Activists and women associated with Self-Help Groups (SHGs) as the potential users of e-cycle for their work travel. Subsequently, CESL and Council on Energy, Environment and Water (CEEW) collaborated with the Energy Management Centre (EMC) of Kerala to conduct an extensive survey and demonstration to assess the **viability of electric cycles (e-cycles) as a prospective alternative to the existing commute patterns** of the identified beneficiaries at Manikkal Gram Panchayat, known for being one of Kerala's net-zero Panchayats.

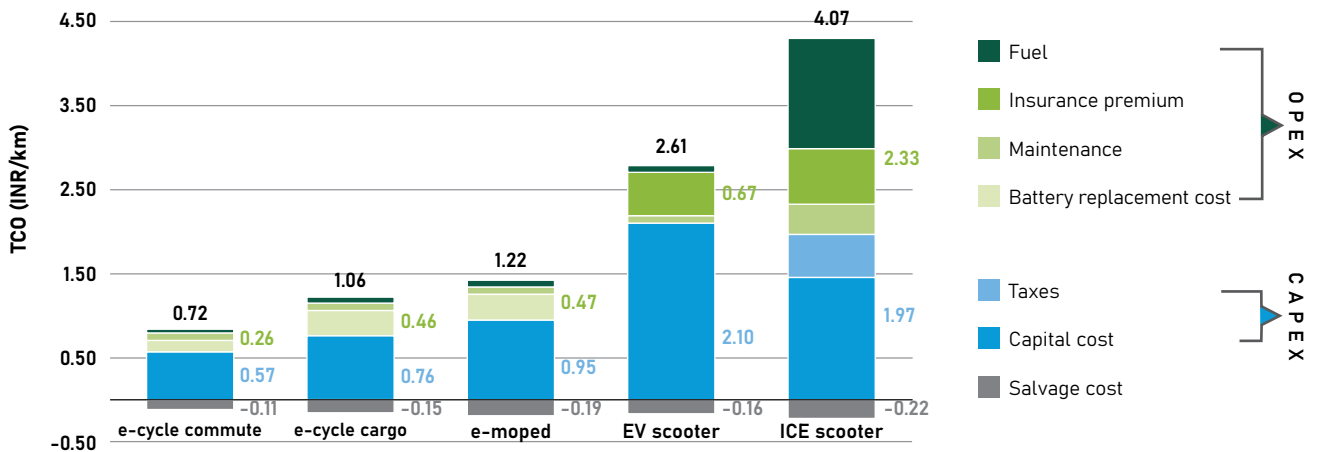
Three different models of e-cycles were made available at the Panchayat office in the month of July 2023. The demonstration of e-cycles conducted at Manikkal Gram Panchayat received enthusiastic response and the identified target groups took the opportunity to take a test ride and provide detailed feedback on their experience. **The majority of the beneficiaries (70-75 per cent) believed that e-cycles would reduce fatigue and improve work efficiency, resulting in higher wages.** Key findings from the survey and demonstration include:

- The target beneficiaries travel an average of **5-15 kilometres (km) per day**, with ASHA workers traversing the farthest distance (around 17 km).
- Monthly incomes of the target beneficiaries vary from **INR 6000 to 12,000**, with Anganwadi teachers earning the highest (INR 12,000).
- Among the identified beneficiaries, **ASHA workers and Haritha Karma Sena** members are most interested in owning e-cycles. This interest is despite some having limited experience riding traditional bicycles.

A detailed Total Cost of Ownership (TCO) was calculated to estimate the economic viability between Internal Combustion Engine (ICE) two-wheelers, electric two-wheelers, e-cycles and low speed e-mopeds. It was observed that the e-cycles and low speed e-mopeds are around 56-70 per cent cheaper than their ICE and EV counterparts. Despite having minimal operating costs, the upfront cost of the e-cycles and low-speed e-mopeds (INR 25,000 – INR 50,000) remain a significant barrier for the target groups, hindering their adoption.

An e-cycle or a low-speed e-moped can reduce the annual expenditure to INR 6500.

 **Figure 1: TCO comparison of different technologies**



Source: Authors' analysis

Considering their aspirations, repayment capacity, and specific requirements, the following e-cycle models are suggested for deployment:



A cargo e-cycle is most suitable for Haritha Karma Sena workers and the Kudumbashree members. This would result in a potential cumulative demand of around **35,560 e-cycles** across Kerala.



A low speed e-moped is most suitable for Anganwadi workers and ASHA workers. This would result in a potential cumulative demand of **41,000 e-mopeds** across Kerala.

Given the presence of the target beneficiaries across different government Institutions pan-India and the similarity in their monthly incomes and operational characteristics, there is a considerable potential demand of around 9.4 lakh e-cycles among ASHA workers, 7.4 lakh e-cycles among Anganwadi workers and 5-6 crore e-cycles among SHG members.

The following recommendations can be implemented to scale up the adoption of e-cycles pan-India:



Fiscal incentives and aggregation can increase viability: Targeted incentives from the national and sub-national governments can be deployed in two phases to ensure wide-scale adoption of the e-cycles:

- **Ecosystem enabler:** Dedicated fiscal incentives from the Government will be instrumental in reducing the high upfront cost of e-cycles and low speed e-mopeds. Fiscal incentives followed by awareness campaigns and educational programmes will inform the public about the benefits of these technologies such as reduced emissions, cost savings on fuel, minimal maintenance, and their contribution to a cleaner environment. This increased visibility creates a ripple effect, encouraging more individuals to consider and adopt these economic and clean alternatives for their existing travel modes.
- **Large scale adoption:** Interest-free loans offer crucial financial flexibility, allowing consumers to invest in e-cycles or low speed e-mopeds. Government-backed interest-free loans lower barriers to entry, encouraging widespread adoption. These fiscal incentives, by bolstering consumer benefits, simultaneously catalyse an upsurge in demand for such technologies. This escalating demand acts as a catalyst for innovations, driving technological advancements and fostering economies of scale in production. As a result of increased adoption due to incentives, the expanding market for e-cycles and low speed e-mopeds will solidify their viability and establish them as a sustainable transportation option for the future.



Design improvements in the existing e-cycles in accordance with the user requirements to cater their needs (see figure 2), while keeping costs in check.

Figure 2: Additional features requested by the beneficiaries, post e-cycle demonstration





Systemic data collection accelerates the adoption of e-cycles and low-speed e-mopeds by offering critical insights into their usage and impact on users' livelihoods. On-ground e-cycle demonstrations gather real-time operational data covering travel patterns, usage frequency, routes, and user input. Analysing this data informs decisions on infrastructure, incentives, and policies, optimising their incorporation into existing systems. This data-driven approach substantiates their potential positive impact, enabling more effective initiatives to support their widespread adoption.



Strengthening institutional structure ensures streamlined and transparent processes for disbursing funds, particularly interest-free loans. This enhanced structure guarantees efficient allocation of financial incentives while bolstering accountability and oversight. With improved channels, more women within SHGs gain access to financial support for e-cycle adoption, extending the benefits of sustainable transportation to a wider, more inclusive demographic. Empowering these women will not only enhance mobility but also promote economic independence and empowerment within their communities.

E-cycles emerge as an ideal solution for addressing individual mobility challenges while meeting social aspirations in rural and semi-urban areas. It also promotes energy efficiency and zero emissions targets, contributing to India's Net-Zero 2070 target. Moreover, e-micromobility technologies provide time-saving advantages, address mobility challenges, augment livelihood prospects, and promote an inclusive transition with women attaining greater self-sufficiency.

ASHA worker experiencing the e-cycle during the demonstration exercise in Manikkal Gram Panchayat



Potential of E-cycles in Indian Rural Institutions

1.1 Background

The Convergence Energy Services Limited (CESL) team conducted field surveys across different states in India, namely, Raipur and its adjoining districts in Chhattisgarh, Lucknow in Uttar Pradesh, Nalanda in Bihar, and Trivandrum in Kerala. The surveys aimed to identify target beneficiaries, understand their travel requirements, purchasing power, and gather feedback on the design and specifications of electric bicycles.

During the field visit, the team interacted with women affiliated with different SHGs and ASHA workers. These women commute daily for their work, covering an average distance of 5–15 km, using either conventional (ICE) two-wheelers or public transportation. Hence, the introduction of electric cycles could facilitate the transition from personal ICE two-wheelers and public transportation to similar small electric vehicles, resulting in a reduction in emissions and fuel consumption.

Accessible and cost-effective technologies like e-micromobility modes comprising e-cycles and low-speed e-mopeds can simplify commute needs while adopting a zero-exhaust emission technology. Subsequently, a comprehensive demonstration of e-cycles was conducted in Manikkal Gram Panchayat¹ in Trivandrum, Kerala to assess the viability of e-cycles among the target groups. Manikkal being a carbon-neutral Panchayat was chosen for the demonstration of e-cycles.

The purpose of the demonstration exercise was to give a hands-on experience of e-cycles to the target groups and collect detailed feedback from them, post-demonstration. The results from this demonstration exercise will be instrumental in preparing a template that can be replicated in other geographies. Additionally, the feedback from the users would be beneficial for the stakeholders from the Government and the Industry to implement relevant interventions that will enable the ecosystem for widescale adoption.

As of June 2022, about 8.39 crore rural poor women have been mobilised into more than 76.94 lakh SHGs

¹ Manikkal Gram Panchayat is a Rural Local Body in Vamanapuram Panchayat Samiti and is a part of Thiruvananthapuram Zila Parishad. There are two villages in this Panchayat, Manikkal and Koliyakode. The Panchayat constitutes 21 wards, with an area of 1634.33 hectare. According to the 2011 census, total population of the Panchayat is 37,906 with 19,943 males and 17,963 females. The literacy rate for Manikkal Panchayat is 92.6 per cent. Manikkal derived its name from the belief that the precious stone, Manikkam, was mined in the early days. Manikkal Gram Panchayat started a slew of initiatives to achieve carbon-neutral status. From conducting carbon audits to planning an extensive project to plant one lakh saplings within the Panchayat, Manikkal is setting a new model for social, economic and environmental development. Manikkal Gram Panchayat by understanding the environmental problems of each area, is finding solutions and implementing them rapidly.

Box 1: Vision of gram panchayats in Kerala towards a carbon-neutral future

There are 941-gram panchayats in Kerala, out of which Meenagadi panchayat in Wayanad has received the Ministry of Panchayat Raj's Carbon Neutral *Vishesh Panchayat Puraskar* for exemplary work towards achieving net-zero carbon emission. Additionally, the Haritha Kerala Mission has also recognised the net-zero carbon activities of Vadakara Municipality, Peelikode, Kannapuram, Cherukunn, Meenangadi, Vettam, Akatethara, Madakattara, Vallachira, Amballur, Manikkal, Veliyannur, Devikulangara, Kadampanad, Iraviperaur, Nedumbana, Poothakulam, Kollayil, and Kamakshi gram panchayats.

1.2 Methodology

Comprehensive baseline and feedback survey were undertaken in the month of June and July 2023 in Manikkal Gram Panchayat. A purposive sampling technique was used to identify the target groups comprising, ASHA workers, Kudumbashree CDS workers, Haritha Karma Sena, Anganwadi teachers, and Anganwadi helpers.

The survey was conducted in two phases:



Phase 1: A detailed baseline survey to establish the beneficiaries' current travel patterns, vehicle ownership details, current incomes, and initial perceptions towards the e-cycles.



Phase 2: Three different e-cycle models were provided to the beneficiaries for test rides (within the Panchayat) as an intervention, allowing them to experience the e-cycles and provide detailed feedback.

The three cycles deployed for the intervention were from different Original Equipment Manufacturers (OEMs) and varied in design, specifications, and features:



Cycle 1: Range of 40 km with a 12 Ah battery capacity, a headlight and a carrier at the back.



Cycle 2: Range of 30 km with a 5.8 Ah battery capacity and a basket in the front.



Cycle 3: Range of 85 km with a 14.5 Ah battery capacity and a headlight.

The entire population set of the target beneficiaries was approached, out of which, 82 per cent (145 samples) responded to the baseline survey. The respondents from the baseline survey were then invited to test drive the e-cycles and provide their feedback. 125 out of 145 respondents participated in this activity.

100 per cent of the target population was approached for the baseline survey, and a success rate of 82 per cent (145 samples) was achieved.

Table 1: Overview of the survey samples collected

Beneficiaries	Total population	Baseline survey respondents	Feedback survey respondents
Anganwadi teachers	34	34	33
Anganwadi helpers	34	29	21
ASHA workers	43	32	28
Haritha Karma Sena	44	36	32
Kudumbashree CDS Members	21	14	11
Total	176	145	125

In this study, 71 per cent of the samples (125 samples) was considered to compare the respondents' feedback pre and post-demonstration of e-cycles. The responses collected from each target group were compiled as specific case studies to estimate the demand for e-cycles.

Subsequently, the potential demand for e-cycles was calculated at the state and national levels, considering the similarity in the operational characteristics and monthly incomes of the target groups. The density of ASHA, Anganwadi, and SHG members was estimated across different Gram Panchayats in India. Based on the feedback from the Manikkal Gram Panchayat, the potential demand for e-cycles was estimated.

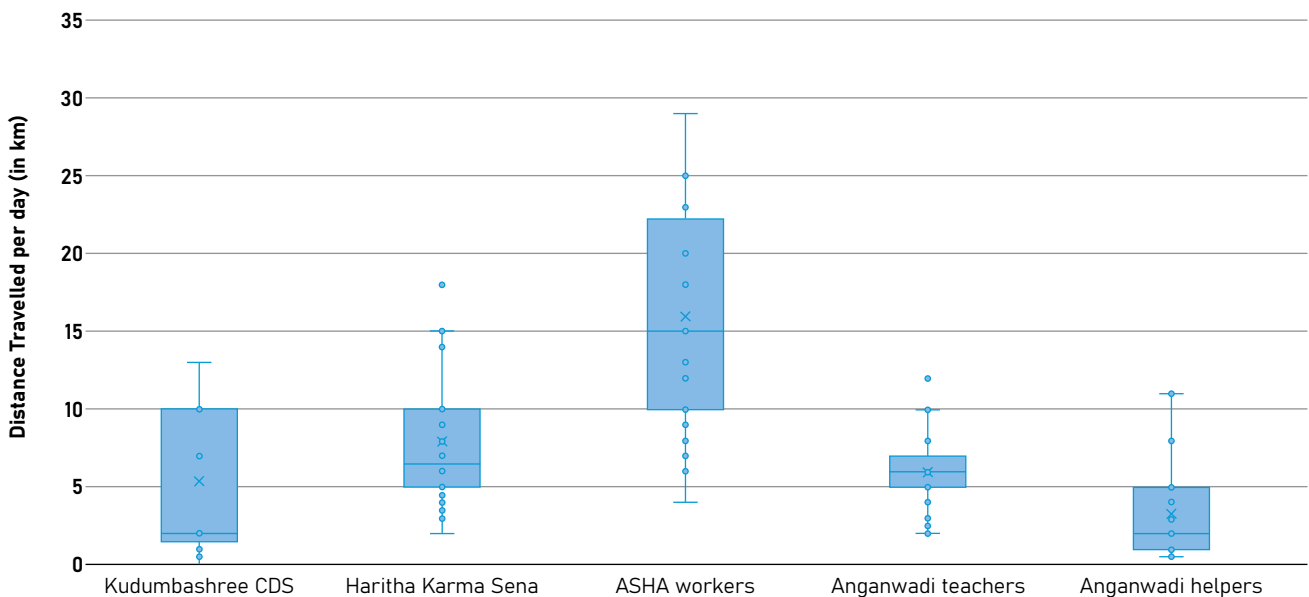
**Enumerator conducting the baseline survey of the ASHA workers**

Demand Estimation of E-cycles among Various Target Groups

The baseline and feedback survey data revealed that ASHA workers, on average, travel 50 per cent more per day for work-related trips compared to other target groups. They typically carry a register, lunchbox, and occasionally a vaccination kit, depending on their job requirements. The combined weight of these items ranges from 3 to 15 kg. On the other hand, Haritha Karma Sena workers, during the collection period, travel up to 15–20 km, carrying loads of up to 30 kg over their heads. The graphs presented below highlight the comparative travel behaviour of all the target groups.



Figure 3: Average travel distance of the target beneficiaries

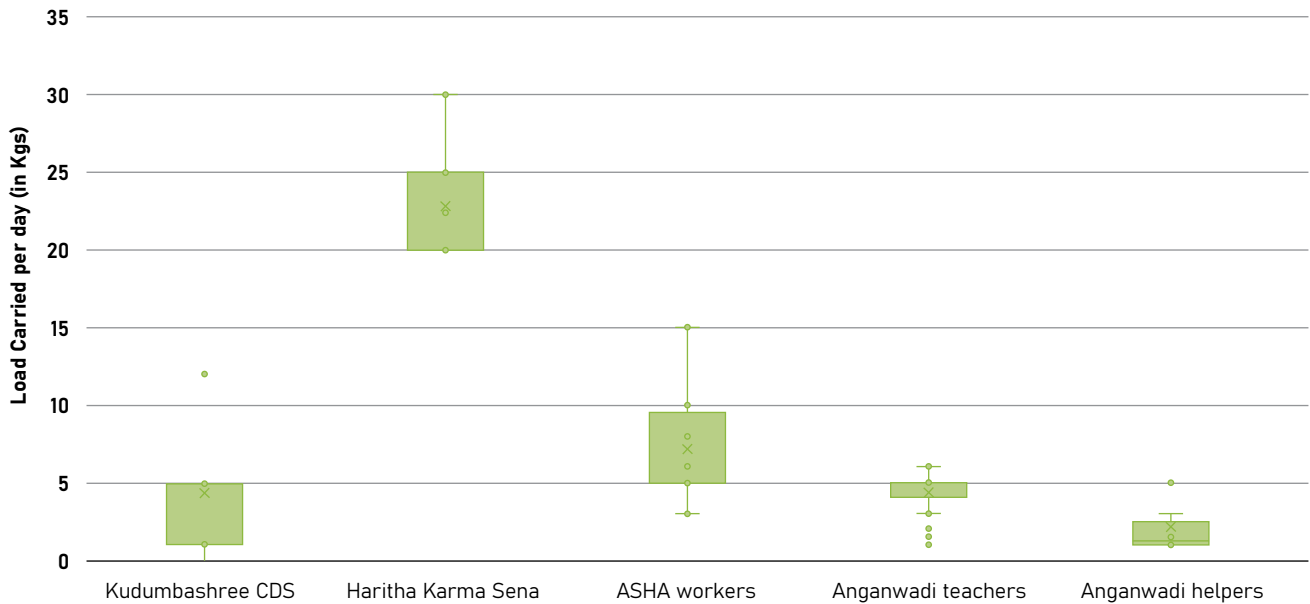


Source: Authors' analysis

Haritha Karma Sena members are identified as the primary potential users of e-cycles, given their work-related travel patterns involving frequent on-demand journeys and the nature of the loads they carry. Additionally, their inclination towards using e-cycles for their work trips is evident from their willingness to own an e-cycle and the financial commitment they are prepared to make, pre- and post-demonstration.



Figure 4: Average load carried by the target beneficiaries



Source: Authors' analysis

While the willingness to pay for e-cycles increased among ASHA workers, post-demonstration, it decreased among Haritha Karma Sena workers due to challenges faced in riding an e-cycle. Certain modifications to these technologies will nudge them to use the same for their existing work trips. An overview of the findings from the different target beneficiaries surveyed is presented in the subsequent section. The figures represent the questions asked during the survey; detailed questionnaires are included in Annexure 3.

2.1 Target Beneficiary – ASHA Workers

The Manikkal Gram Panchayat has a strong presence of ASHA workers. There are 21 wards with 43 ASHA workers dispersed across the wards. They operate as health activists to raise awareness related to health and its social determinants, encourage local health planning, and promoting greater use and accountability of the available health services. Specifically, there are three ASHA employees in five wards, two ASHA employees in twelve wards, and one ASHA employee in four wards.

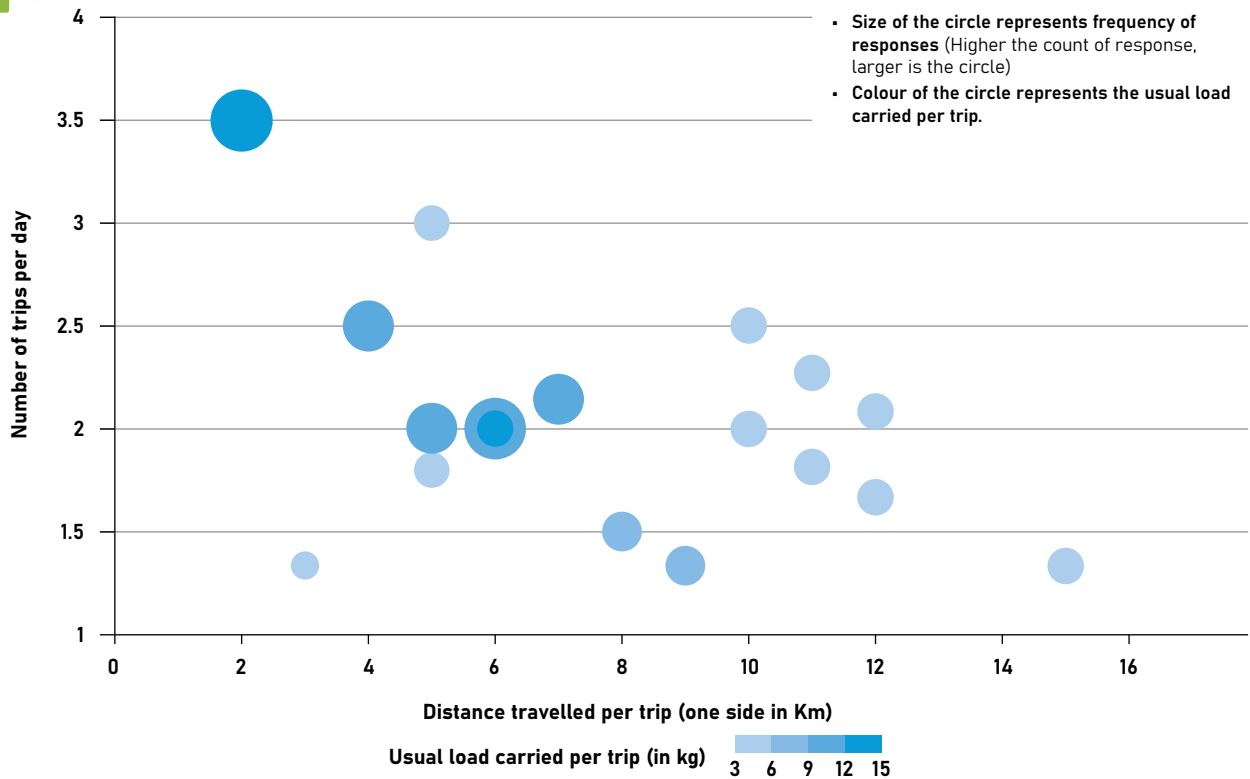
The age group of the ASHA workers range from 38 to 56 years, with the average age being 50 years. Forty percent of the women have completed their 10th grade education and other forty three percent have completed their 12th grade.

Travel characteristics of ASHA workers

Given the nature of their work, most of ASHA workers have to travel on-demand, without pre-planned or destined trips. Sometimes, they travel longer distances, covering **about 17 km**. On average, they make three such long-distance trips in a week. They carry their medical kits and, sometimes, other medical equipment, with weights ranging from **3 to 15 kg**.



Figure 5: Travel pattern of ASHA workers



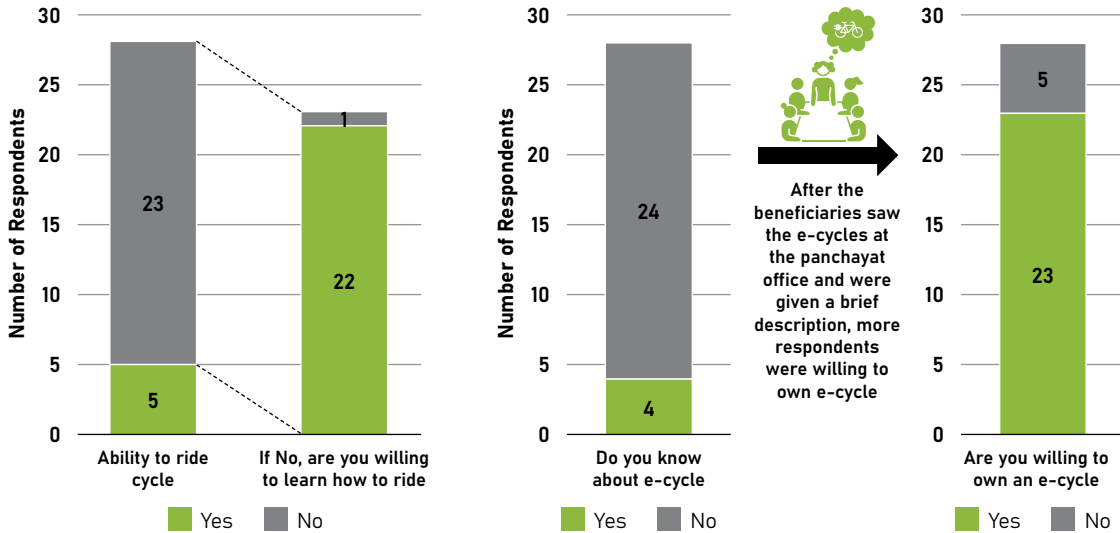
Source: Authors' analysis

Pre and post-demonstration responses of the ASHA workers

As per the baseline survey conducted, almost 81 per cent of ASHA workers either have no prior experience or are unsure about riding bicycles. Despite this challenge, all respondents expressed their interest in learning how to cycle. When asked about e-cycles, 80 per cent of them were not aware about e-cycles before its introduction at the Panchayat office. After a brief introduction about the e-cycles, 84 per cent of the women expressed interest and a desire to own e-cycles.



Figure 6: ASHA worker's perspective on e-cycles pre-demonstration



Source: Authors' analysis

The significant majority of women (63 per cent) expressed a preference for receiving the e-cycles for free of cost. Additionally, another 17 per cent expressed their willingness to pay INR 5,000 to 15,000 with a monthly EMI of approximately INR 500.

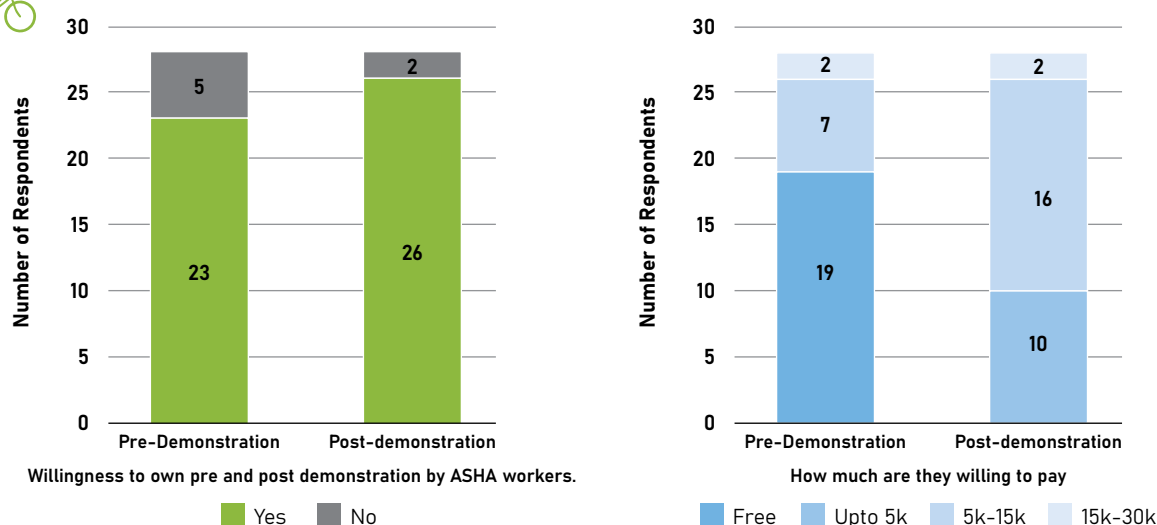


Women exploring the features of different e-cycle models before the test ride

However, post-demonstration feedback of the women highlighted their strong affinity towards owning e-cycles and using them for their work travel. **While nearly 60 per cent of them wanted the e-cycles for free in the beginning, post-demonstration, they were willing to pay between INR 5,000 and INR 10,000 for the e-cycles.** Furthermore, more than 90 per cent of them agreed that e-cycles would help improve their work efficiency.



Figure 7: ASHA worker's perspective on e-cycles post-demonstration



Source: Authors' analysis

Nearly 90 per cent of the ASHA workers post-demonstration believed that e-cycles would increase their work efficiency. More than 85 per cent of the women found electric cycles a viable alternative to their current modes of transportation. Around 70 per cent showed willingness to use e-cycles for their work trips.

Key findings:



Potential demand: At the Manikkal Gram Panchayat level, there is a potential demand for **39 e-cycles** which scales to an estimated potential demand of **23,400 e-cycles** for ASHA workers across the state of Kerala.



Vehicle characteristics: After the test ride, their preference lean towards a model with a broader seat for enhanced comfort and a lower ride height. They need a small storage unit for their medical equipment. Additionally, they prefer a lower footboard where they can keep their feet stationary while riding the vehicle.

Given their vehicle requirements and the paying capacity, **a low speed e-moped model with a broader seat and a storage unit** would be suitable for the ASHA workers to meet their existing work requirements.



Financial implications: A standard e-cycle and a low speed e-moped available in the market are priced between INR 25,000 and INR 50,000,

which is considered expensive by the beneficiaries. Considering the financial capacity of the beneficiaries, on average they will be able to cover only 50 per cent of the cost over a period of two years on an EMI basis. **Hence, a dedicated fiscal incentive is required from the government to cover the remaining 50 per cent of the cost.**

There is an estimated potential demand of 23,400 e-cycles for ASHA workers across the state of Kerala.

2.2 Target Beneficiary: Haritha Karma Sena Workers

There are 44 Haritha Karma Sena workers in Manikkal Panchayat. The Haritha Karma Sena is a group of Kudumbashree members who collect non-biodegradable waste from houses and establishments to deposit it to shredding units for recycling. The Haritha Karma Sena workers have specific tasks of collecting waste door to door for the first 15 days of every month, and the next 15 days are then utilised for waste segregation. Owing to their unique working conditions, this group was considered separately to assess the potential of e-cycles. Under the Manikkal Gram Panchayat, one ward has three Haritha Karma Sena employees, while the other 20 wards each have two.

Box 2: Overview of the Haritha Karma Sena

The Kudumbashree Mission, in alignment with the Haritha Keralam Mission, Suchitwa Mission, and Clean Kerala Company, formed the “Haritha Karma Sena”. This group is responsible for collecting non-biodegradable waste from households, which is then sorted and recycled. The waste is segregated into different sections based on its characteristics. Each Kudumbashree worker visits a minimum of 250 houses to collect non-biodegradable waste. The collection is based on a user fee. They are also engaged in activities such as producing environment-friendly materials, maintaining waste disposal mechanisms, promoting organic farming, offering environment-friendly equipment on rent, as well as compost production and associated works (Government of Kerala 2023).



Enumerator conducting the baseline survey of the Haritha Karma Sena workers

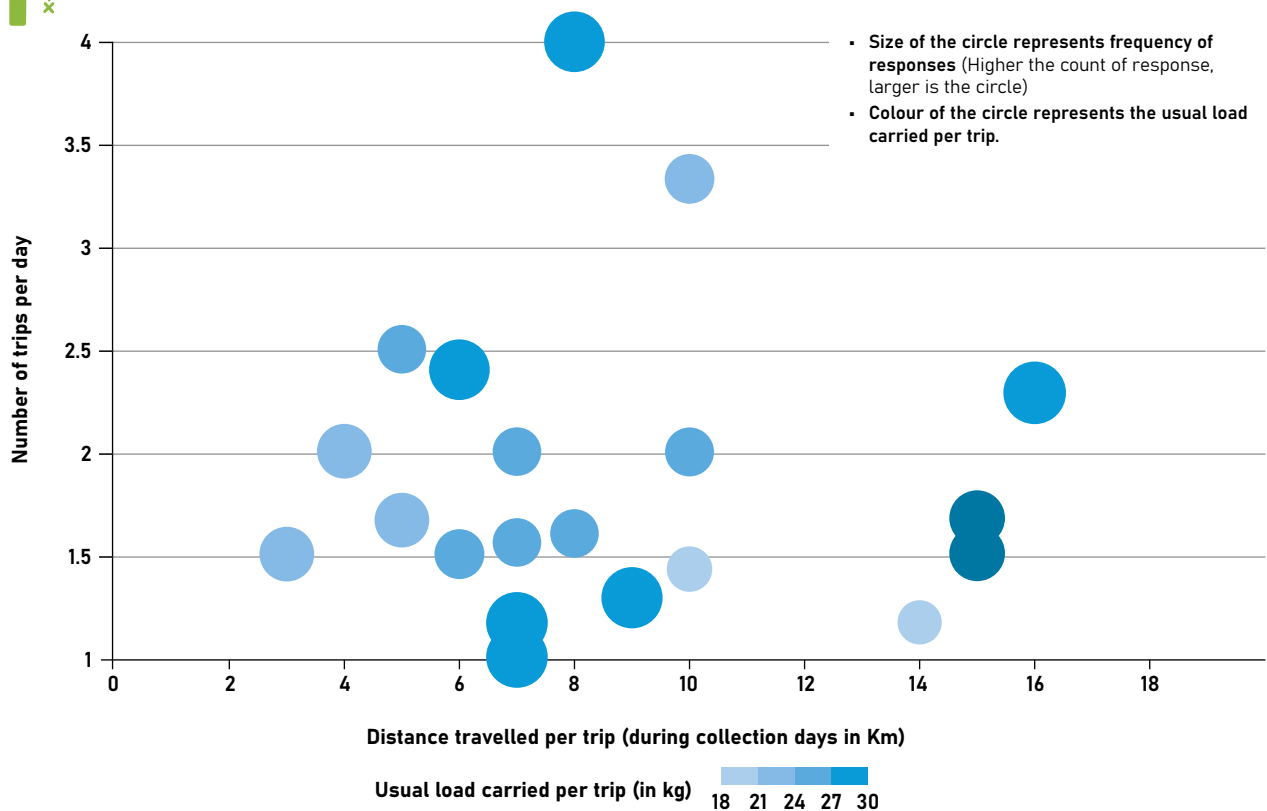
The age group of the Haritha Karma Sena workers ranges from 25 to 72 years, with the average age being 55 years. Almost 75 per cent of the women have qualifications up to 10th grade, and the remaining have completed 12th grade or higher.

Travel Characteristics of Haritha Karma Sena

They walk around 2–15 km every day to collect garbage from households during the collection days, carrying large-size bags that weigh between 18 and 30 kg.



Figure 8: Travel pattern of Haritha Karma Sena members



Source: Authors' analysis

Most of the Haritha Karma Sena workers come from families with low-income backgrounds. The ownership of private vehicles at the household level of these women is lesser than that of other target groups. It is observed that 40 per cent of these women own a motorised two-wheeler at home, but less than 20 per cent of the women have the availability to use two-wheeler for their work trips, and only 25 per cent can actually ride the two-wheeler.

They face specific challenges in their work trips, namely:

- Inconvenience due to heavy weight they carry overhead.
- Longer walking distances per day during the waste collection period.

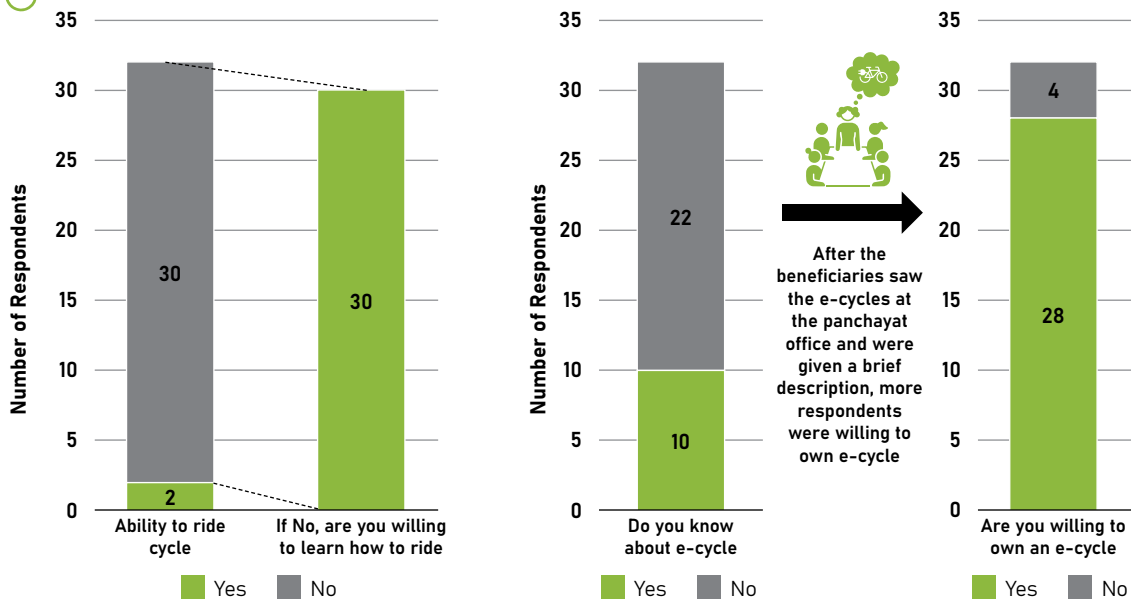
This tends to impact their work performance and monthly earnings as the wages depend on the number of houses covered and the quantity of waste collected.

Pre and post-demonstration responses of Haritha Karma Sena

When asked about e-cycles, 70 per cent of them became aware of these e-cycles after they were introduced in the Panchayat office. Subsequently, following a brief description of the e-cycles, 87 per cent of the women displayed interest and desired to own one. The majority of the women (90 per cent) showed willingness to pay up to INR 5000–15000 for e-cycles with an EMI option of around INR 500 per month.



Figure 9: Haritha Karma Sena worker's perspective on e-cycles pre-demonstration



Source: Authors' analysis

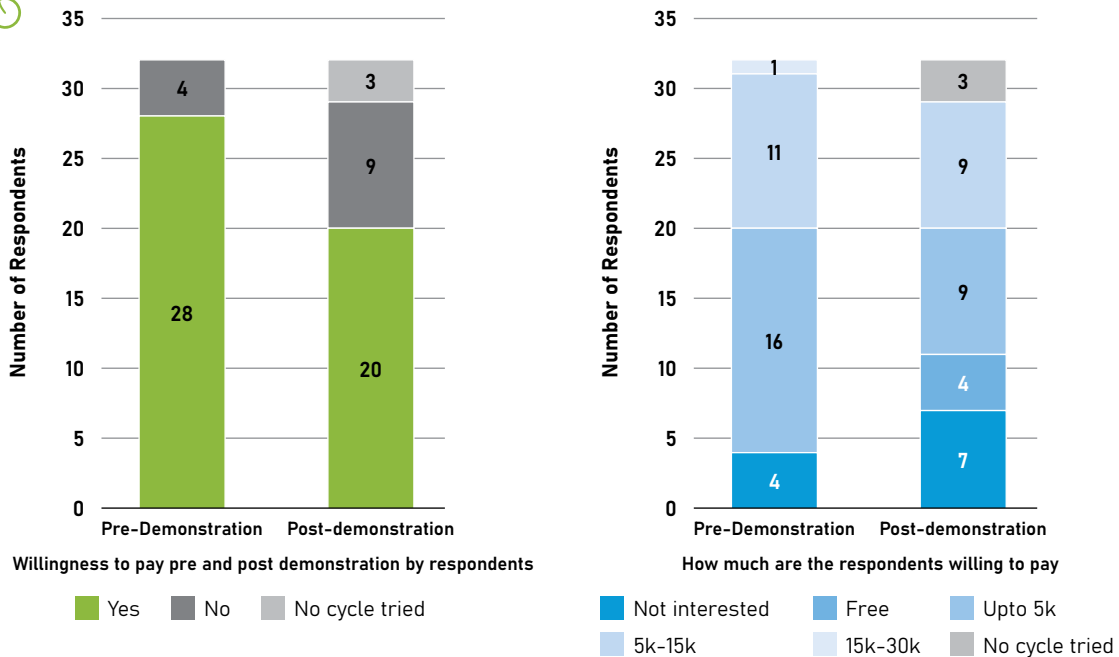
The majority of Haritha Karma Sena members felt that the addition of a storage unit to the e-cycles would make it easier for them to carry waste sacks and improve their work efficiency.



Women helping each other to balance the cycles during the demonstration



Figure 10: Haritha Karma Sena workers' perspective on e-cycles post-demonstration



Source: Authors' analysis

Post demonstration, almost 50 per cent of the Haritha Karma Sena workers felt that e-cycles would reduce their fatigue and enable them to cover more houses, improving their earnings.

Key findings:



Potential demand: At the Manikkal Panchayat level, there is a potential demand for **28 e-cycles**, which scales to a potential demand of **19,200 e-cycles** across Kerala for the Haritha Karma Sena workers.



Vehicle characteristics: Their typical work pattern necessitates the inclusion of a storage unit along with the e-cycles. Hence, a **cargo e-cycle** will be most suited for their work trips.



Financial implications: Considering the financial capabilities of the beneficiaries, they will be able to cover only 40 per cent of the cost over a period of two years on an EMI basis. **Hence, a dedicated fiscal incentive is required from the government to offset the remaining cost.**

2.3 Kudumbashree CDS (Community Development Society) Members in the Manikkal Panchayat

There are 369 Kudumbashree units with 5,499 Kudumbashree members in the Manikkal Panchayat. Kudumbashree units are distributed randomly in the Panchayat, ranging from a minimum of 10 units to a maximum of 27 units in one ward. The Kudumbashree neighbourhood system started functioning in 1998 by organising the poverty backward communities of the Panchayat. The unemployed

family members of the section have formed neighbourhood groups and are affiliated with the Kudumbashree Mission.

These CDS members are registered Kudumbashree members with varying occupations. Some are homemakers, some are part of SHGs, and the rest are involved in other occupations. In each ward, there is one Kudumbashree CDS member who acts as the coordinator of all Kudumbashree members of that ward. Coordinators are selected by the consensus of all the Kudumbashree members of that ward and act as their representatives for all purposes.

Box 3: Overview of the Kudumbashree Mission in Kerala

Kudumbashree is the poverty eradication and women empowerment programme implemented by the State Poverty Eradication Mission (SPEM) of the Government of Kerala. The name Kudumbashree, in the Malayalam language, means 'prosperity of the family'. The Kudumbashree community network was extended to cover the entire state in three phases during 2000–2002. Kudumbashree membership is open to all adult women, limited to one membership per family. In 2011, the Ministry of Rural Development, Government of India, recognised Kudumbashree as the State Rural Livelihoods Mission under the National Rural Livelihoods Mission (NRLM) (Government of Kerala 2023).



Enumerator conducting the baseline survey of the Kudumbashree CDS members and other target group members

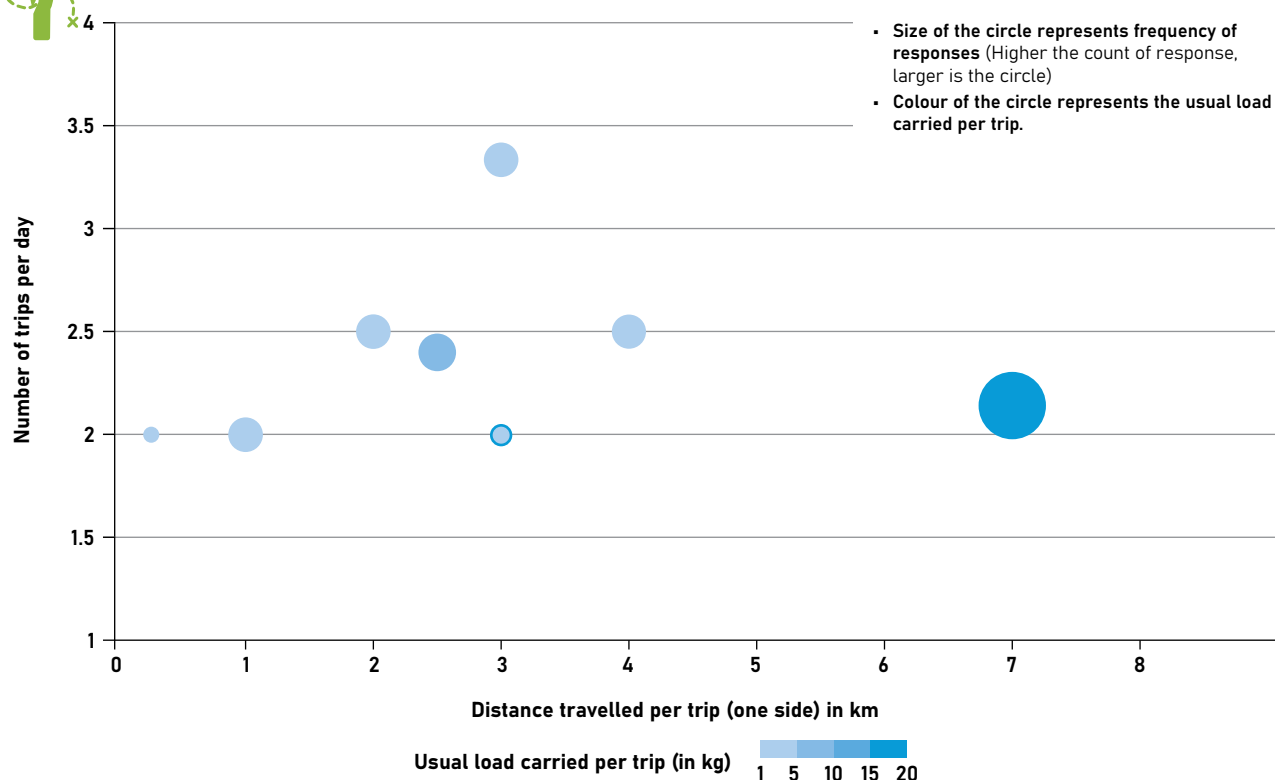
The age group of the Kudumbashree CDS members ranges from 25 to 55 years, with the average age being 45 years. Almost one-third of the women are 10th grade pass, 20 per cent are 12th grade and the remaining are graduates or hold a diploma.

Travel characteristics of Kudumbashree CDS members

Given the variation in the nature of their work, most of the Kudumbashree CDS members travel 2–15 km per day, with homemakers undertaking short trips and SHG members covering longer distances. Generally, they have short ad-hoc trips (less than 5 km) with varying frequencies, ranging up to three weekly visits. Homemakers usually carry a load ranging from 1 to 2 kg during their work trips, while SHG members carry 2–20 kg weight, with the average weight being around 5 kg.



Figure 11: Travel pattern of Kudumbashree CDS members



Source: Authors' analysis

The CDS members primarily rely on walking or privately-owned two-wheelers for work trips. Sometimes, they also use public transport, such as buses. It is observed that 60 per cent of these women possess a motorised two-wheeler at home, and around 50 per cent use the two-wheeler for their work trips.

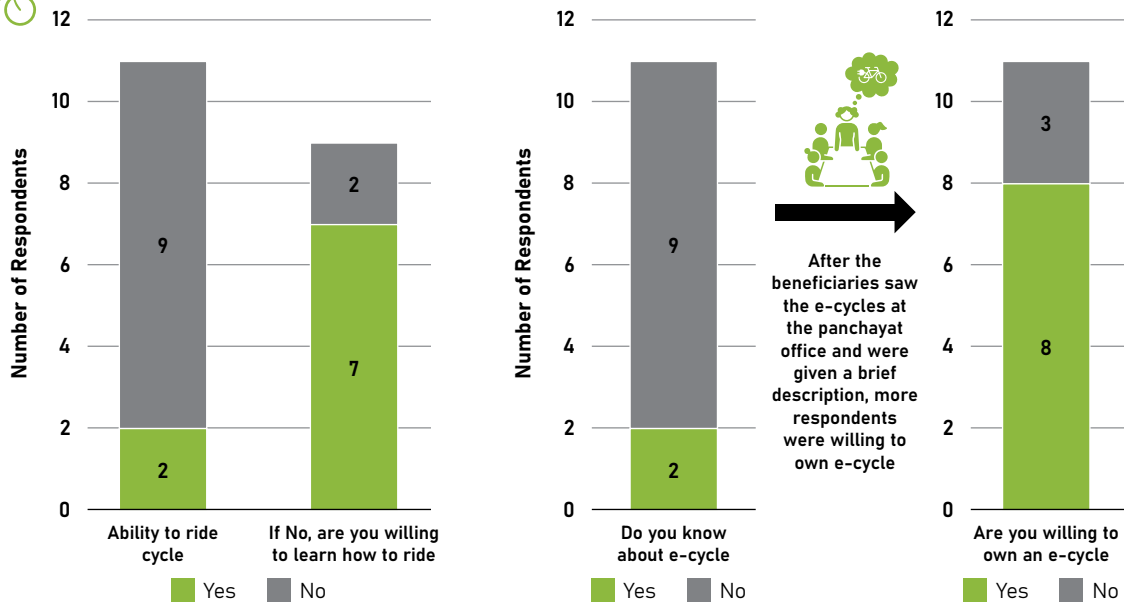
Most of the CDS members are dependent on public transport or their families, primarily their husbands for their travel requirements. Additionally, they face challenges related to their trips, such as long waiting time, difficulties with last and first-mile connectivity, and increased travel expenses. The monthly income of CDS members varies widely, ranging from INR 2000 to INR 12000.

Pre and post-demonstration responses of Kudumbashree CDS members

Around 80 per cent of the respondents either have no prior experience or are currently unsure about riding cycles, however, they expressed their interest in learning the same. When asked about e-cycles, 80 per cent of them learnt

about e-cycles after it was introduced in the Panchayat office. Following a brief description about e-cycles, 85 per cent of the women showed interest and expressed their willingness to own one.

Figure 12: Kudumbashree CDS members' perspective on e-cycles pre-demonstration



Source: Authors' analysis

Nearly 70 per cent women were willing to pay up to INR 5000-15,000 for e-cycles, with a monthly EMI option of approximately INR 650. Additionally, around 10 per cent of the CDS members were willing to pay up to INR 30,000 for an e-cycle.

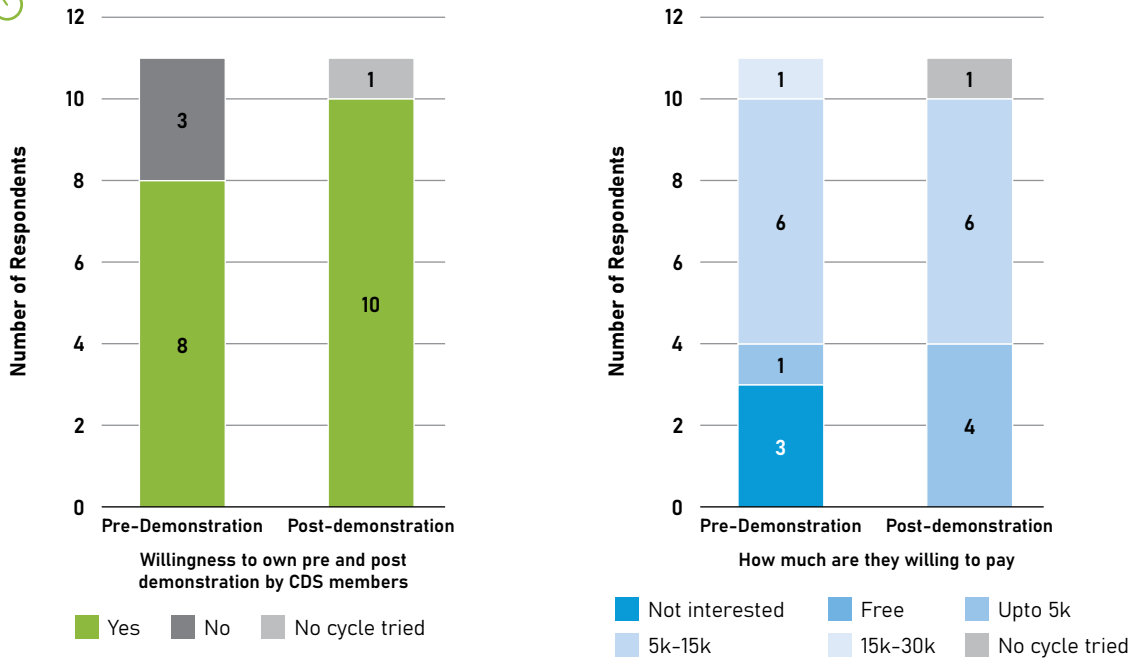


Kudumbashree women trying e-cycles deployed during the demonstration

The interest of these women in owning e-cycles was evident from their willingness to purchase an electric cycle. Some of the CDS members who were initially uninterested showed interest in owning an e-cycle with a willingness to pay up to INR 5,000 post-demonstration. They had a mixed response to the usefulness of e-cycles.



Figure 13: Kudumbashree CDS members' perspective on e-cycles post-demonstration



Source: Authors' analysis

Post-demonstration, 60 per cent of them showed a willingness to use e-cycles for their work trips. Almost half of the respondents believed that e-cycles would increase their work efficiency, and 50 per cent of the women felt that e-cycles were a good alternative to their existing commute modes.

Key findings:



Potential demand: At the Manikkal Panchayat level there is a potential demand for **16 e-cycles** among the Kudumbashree CDS members, which scales to a potential demand of **around 15,360 e-cycles** for the Kudumbashree CDS members across Kerala.



Vehicle characteristics: Their typical work pattern necessitates the inclusion of a storage unit with the e-cycles. Hence, a **cargo e-cycle** will be most suited for their work trips.



Financial implications: Considering the financial capabilities of the beneficiaries, they will be able to cover 60 per cent of the cost over a period of two years on an EMI basis. Hence, a dedicated fiscal incentive is required from the government to offset the remaining cost.

2.4 Target Beneficiary: Anganwadi Teachers and Helpers

Manikkal Gram Panchayat has 34 Anganwadi Centres (AWCs) across different wards. These AWCs are located as per the population of the ward. Some wards have one centre while some have two. In each AWC, there is one Anganwadi teacher and one Anganwadi helper.

The role of the Anganwadi teacher is to manage and provide supplementary nutrition, primary health check-ups, and immunisation, preschool education to kids, and education to people (in particular women) about family planning, their health, and well-being. The Anganwadi helper assists the Anganwadi teacher by maintaining cleanliness and hygiene of the AWC, cooking, serving food, and taking care of young children. Both are also responsible for carrying out government-assigned responsibilities. They receive fixed monthly incomes, with Anganwadi teachers earning between INR 10,000 and INR 12,000, and Anganwadi helpers between INR 6000 and INR 7000.

Anganwadi teachers and helpers travel 2-8 km per trip comprising fixed and ad-hoc trips.



Enumerator conducting the baseline survey of Anganwadi helpers

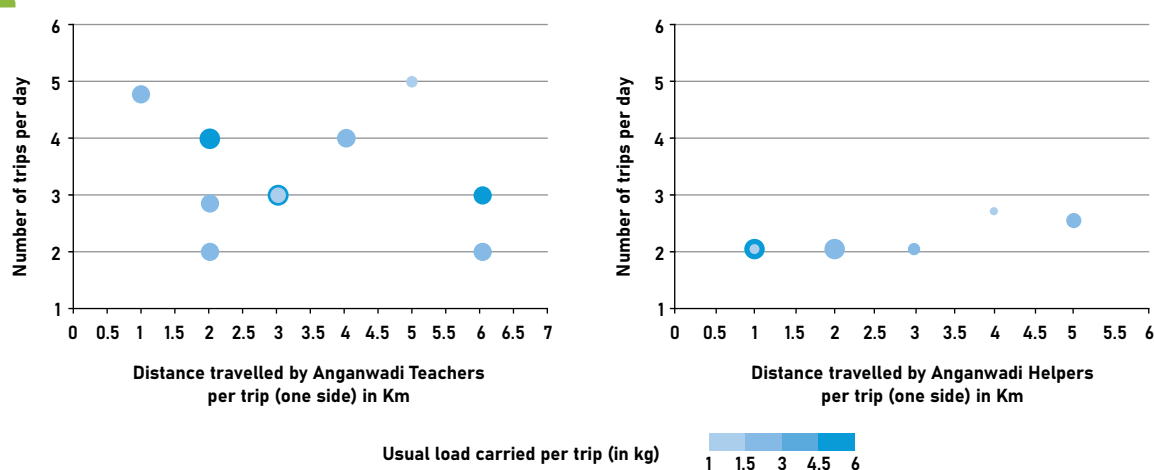
The age group of the Anganwadi workers ranges from 25 to 70 years, with the average age of teachers being 55 years and helpers being 40 years. Almost 65 per cent of Anganwadi helpers have education level below 10th grade, while the remaining have completed matriculation. Anganwadi teachers possess a minimum of matriculation education, with approximately one-third having completed their graduation or are holding a degree.

Travel Characteristics of Anganwadi Teachers and Helpers

Given the variation in the nature of their work, Anganwadi teachers and helpers travel fixed distances to AWCs (it ranges from 2 to 5 km) and perform certain ad-hoc trips, which may increase their trip lengths from 5 to 8 km. The purpose of these trips includes conducting surveys, spreading awareness, distributing essentials, etc. They make three to four such trips in a week. They carry posters, record registers, basic medical kits, and sometimes other equipment, which may weigh between 2 and 5 kg.



Figure 14: Travel pattern of Anganwadi Teachers and Anganwadi Helpers



- Size of the circle represents frequency of responses (Higher the count of response, larger is the circle)
- Colour of the circle represents the usual load carried per trip.

Source: Authors' analysis

Anganwadi Teachers predominantly walk or use their privately-owned two-wheelers for work related travels, while Anganwadi helpers largely rely on walking. Sometimes, Anganwadi teachers use public transport such as buses and shared transportation options. Notably, only one-third of Anganwadi teachers and 20 per cent of helpers have a motorised two-wheeler at home and possess the necessary riding skills. Others require the proficiency in riding a motorised vehicle or a bicycle.

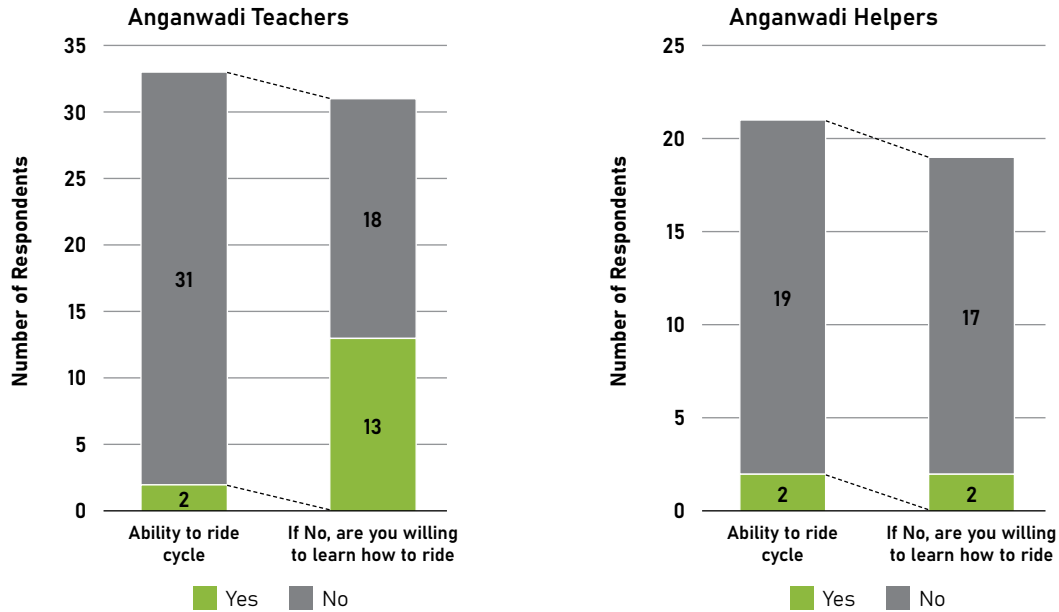
They face various challenges during their commute, such as the high cost of shared modes of transportation, longer waiting times and poor coverage of public transport. These difficulties lead them to rely on family members, particularly their husbands for their travel requirements. For ad-hoc trips, Anganwadi teachers travel a total distance of around 8 km, comprising a combination of multiple short trips within the neighbourhood. These inconveniences contribute to a growing inclination towards acquiring private ICE two-wheelers.

Pre and Post-demonstration response of the Anganwadi workers

Despite lacking cycling skills, almost 40 per cent of the Anganwadi teachers and 10 per cent of Anganwadi helpers expressed their interest in learning to ride a bicycle.



Figure 15: Travel pattern of Anganwadi workers

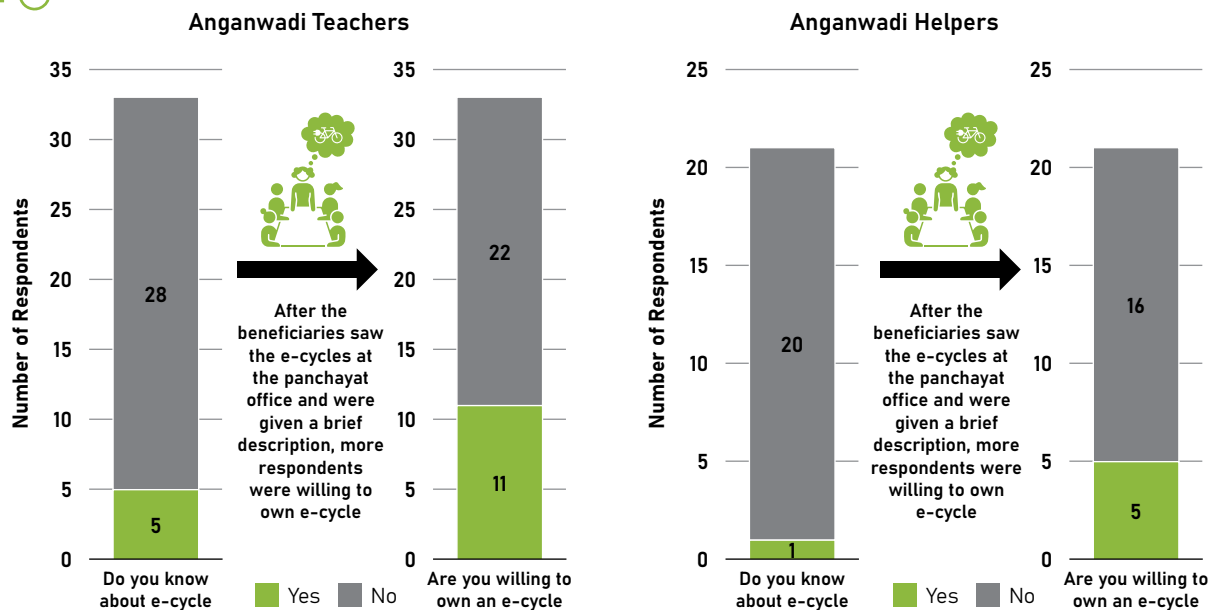


Source: Authors' analysis

When asked about e-cycles, 88 per cent of them became aware of e-cycles only after their introduction at the Panchayat office. Following a brief description, only 30 per cent of Anganwadi teachers and 25 per cent of Anganwadi helpers showed interest and expressed their willingness to own e-cycles. Additionally, 30 per cent of the Anganwadi workers indicated a willingness to pay between INR 5000 and INR 10,000 for e-cycles, with an EMI option of approximately INR 650 per month. Further, a few Anganwadi teachers (10 per cent) were willing to pay as much as INR 15,000–30,000 for an e-cycle.



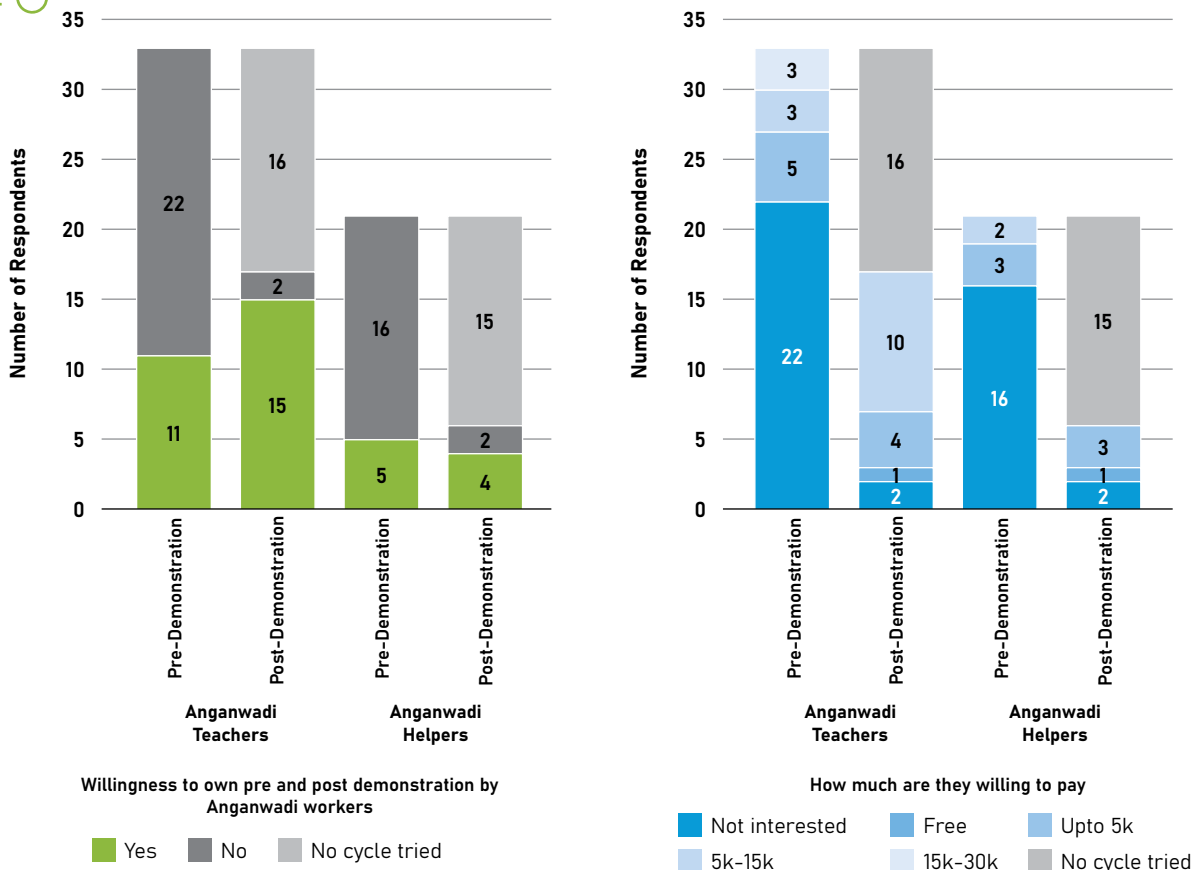
Figure 16: Anganwadi Workers' perspective on e-cycles pre-demonstration



After the demonstration, the majority of Anganwadi workers (54 per cent) expressed disagreement with the concept that an e-cycle would reduce their fatigue. Nevertheless, 53 per cent of Anganwadi teachers and nearly 30 per cent of helpers agreed that it would increase their work efficiency. Interestingly, 65 per cent of these women found e-cycles unsuitable for ad-hoc trips. Qualitative discussions with the beneficiaries indicated that their requirements might be better met by a low-speed electric moped.



Figure 17: Anganwadi Workers' perspective on e-cycles post-demonstration



Key findings:



Potential demand: At the Manikkal Panchayat level, there is a potential demand for **21 e-cycles**, which scales up to a potential demand of **19,500** e-cycles across Kerala.



Vehicle characteristics: Around 70 per cent of Anganwadi teachers are over 50 years old and require a more comfortable seat and a stationery floorboard in the vehicles. Hence, a **low speed e-moped** will be more suited for their functional needs.



Financial implications: Considering the financial capabilities of the beneficiaries, they can cover 60 per cent of the cost over a period of two years through EMIs. Hence, a dedicated fiscal incentive is required from the government to offset the balance cost.



Total Cost of Ownership (TCO) Comparison

Based on market review, various models are available in e-cycles and low speed e-mopeds (detailed in the annexures). These models differ in design but share the same technology with a maximum speed of 25 kmph, and a motor power under 250 watts. The classification of the three models is presented below.



Commute e-cycle: A bicycle with a supportive power unit, providing pedal assistance or fully throttle-controlled propelling force.



Cargo e-cycle: An e-cycle with a storage unit attached either on the back or the front of the cycle.



Low speed e-moped: A pedal-assisted two-wheeler typically seating a single person, having a broader and wider seat compared to a typical e-cycle.

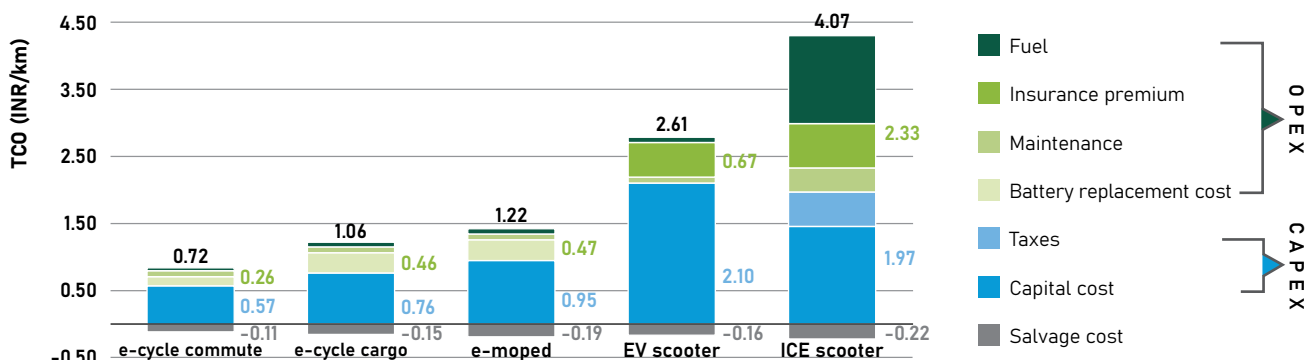
TCO calculations were conducted to assess the economic viability of different two-wheeler technologies, namely ICE two-wheelers, electric two-wheelers, and e-micromobility as potential commute options for the target beneficiaries. Based on the feedback collected from the on-ground surveys, it is evident that each target beneficiary has a distinct use case that determines which of these models would be most suitable for their needs.

A low-speed e-moped would be most suited for the ASHA and the Anganwadi workers due to their operational characteristics. A cargo e-cycle is more beneficial for Haritha Karma Sena and Kudumbashree workers.

Detailed assumptions considered for the TCO models are presented in the annexure, and the comparison is shown in Figure 18.



Figure 18: Overview of the TCO for different two-wheeler technologies



Source: Authors' analysis

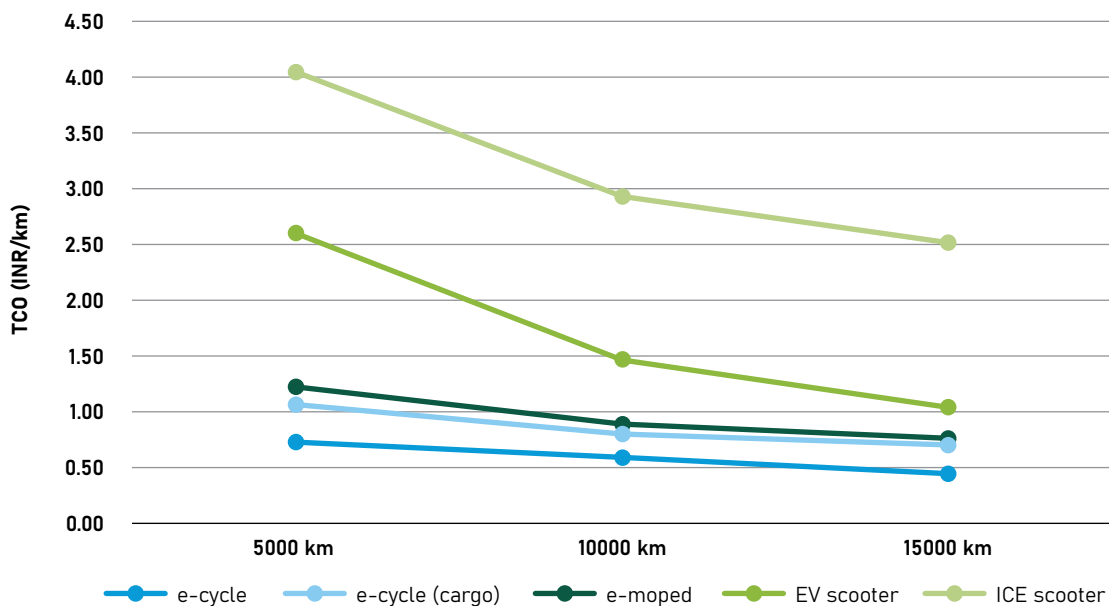
The TCO calculations revealed that e-cycles and low-speed e-mopeds are approximately 56 per cent cheaper than electric two-wheelers and almost 70 per cent cheaper than ICE two-wheelers. While the costs of operations are minimal (around 20 per cent of the TCO), the capital cost remains high (80 per cent) for e-cycles and low speed e-mopeds.

Subsequently, a sensitivity analysis was conducted to assess the economic viability of e-cycle and low-speed e-moped technologies across different use cases pan-India, considering higher operational kilometres. The variation of the annual kilometres was estimated by considering more working days and longer trip lengths.

The capital cost of e-cycles and low-speed e-mopeds comprise 80% of the total cost



Figure 19: Sensitivity analysis of the TCO with varying annual kilometres



From the TCO calculations, it is also evident that the upfront cost (INR 25,000 – INR 50,00) of the e-cycles and low-speed e-mopeds remain the largest share of the lifetime cost. Given the economic profile of the target beneficiaries, there is a need to reduce the upfront costs of the electric cycles to make it affordable.

Two mechanisms can be deployed to reduce the upfront cost:

1. Large-scale demand aggregation from various organisations, Government departments, Institutes, and e-commerce platforms.
2. Fiscal incentives from the Government side (national/sub-national).

The following chapter details the potential demand and financial plan to facilitate the uptake of e-cycles among the target beneficiaries.

Potential Demand for E-cycles

During the first phase, priority can be given to the identified beneficiaries, including **ASHA, Haritha Karma Sena workers, Kudumbashree CDS members, and Anganwadi teachers and helpers**, for the procurement of e-cycles. Based on the primary survey and on-ground discussions, **104 e-cycles can be procured for the target beneficiaries.**

Table 2: Potential e-cycle demand for key beneficiary groups at the Manikkal Gram Panchayat, state, and national level

Target Beneficiary	Potential demand in Gram Panchayat	Potential demand in Kerala*
ASHA workers	39 (90% of total)	23,400
Anganwadi teachers and helpers	21 (30% of total)	19,500
Haritha Karma Sena	28 (65% of total)	19,200
Kudumbashree CDS	16 (80% of total)	15,360
Total	104	77,460

Note: *The potential demand across Kerala is estimated using the response rate from our primary survey and the total number of beneficiaries obtained from the (Ministry of Women and Child Development 2023) and (Ministry of Health and Family Welfare 2020) and (Ministry of Rural Development 2022)

Box 4: Potential demand at the national level

Considering the widespread presence of ASHA and Anganwadi workers pan-India, there exists a significant potential for deploying e-cycles across the nation. There are nearly 10 lakh ASHA workers and 24 lakh Anganwadi workers pan-India.

The potential demand of e-cycles at the national level for the identified beneficiaries was estimated based on their similarity in operational characteristics and monthly incomes pan-India. However, to realise this potential, there is a need for active participation among nodal Institutions to aggregate demand and provide relevant fiscal subsidies to facilitate adoption.

With the government's initiative to improve rural livelihoods, there is a potential to leverage the existing funds to scale e-cycle deployment among SHGs, which could help improve their work efficiency and enhance livelihoods. However, a precursor to deploying the funds would require strengthening the existing institutional structures at the Gram Panchayat level to enable organised deployment of the funds. Kudumbashree Mission in Kerala is one such example that brought Institutional reforms by introducing new bylaws in the year 2008. Community Development Society (CDS) had faced bureaucratic hurdles before the introduction of the common bylaws. The bylaws clearly defined the relationship between Kudumbashree community network and local governments, which formalised the Kudumbashree CDS and set a three-tier apex body.

An overview of the potential demand at the national level amongst the identified beneficiaries is shown in the table below:

Target Beneficiary	Potential demand pan-India*
ASHA workers	9,37,000
Anganwadi teachers and helpers	7,40,000
Haritha Karma Sena, Kudumbashree CDS, etc.	5-6 crore**

*The potential demand pan-India is estimated using the response rate from our primary survey and extrapolating it to the total number of beneficiaries obtained from the (Ministry of Women and Child Development 2023), (Ministry of Health and Family Welfare 2020) and (Ministry of Rural Development 2022)

Note: **Considering the presence of formal SHG institutions pan-India and the willingness estimated from the on-ground surveys in Manikkal, there is a potential for 5-6 crore e-cycles pan-India. Other women comprising micro-entrepreneurs and other workers under National Rural Livelihoods Mission (NRLM) and National Urban Livelihoods Mission (NULM) can be targeted in the next phase for the e-cycle adoption.

Additional potential demand for e-cycles in Manikkal Gram Panchayat

Following the discussions with the President of the Manikkal Gram Panchayat, there may be potential demand for e-cycles among other segments. These particular target groups have not been included in the current comprehensive survey and hands-on trial of e-cycles. These target groups may be targeted in a subsequent phase to assess the potential demand for e-cycles.



500 e-cycles for Women with Annual Income below INR 1 lakh (Kudumbashree members):

There are 5,499 Kudumbashree members in Manikkal Panchayat, and 30 per cent are currently involved in jobs. At the State level, there is a dedicated Kudumbashree fund which could be leveraged to procure e-cycles for the beneficiaries. In addition to Kudumbashree members, other women with an annual income of less than INR 1 lakh can also be considered for inclusion in this category.

The cycles will be given individually to the beneficiaries. The Manikkal Panchayat can bear a 50 per cent subsidy from its fund “vanitha khataka padhathi” or the plan fund, depending on the availability and accessibility of this fund.



11 e-cycles for Government offices (Krishi Bhavan, Panchayat Office, Veterinary Hospitals and Health Centres):

The Panchayat intends to allocate e-cycles to Institutions including Krishi Bhavan, Health Centre, and its sub-centres, Veterinary Hospital and Panchayat Office. E-cycles can be allocated to these offices for their field work through a government order. However, these e-cycles cannot be allocated to individual officers.



300 e-cycles for students from Scheduled Castes, Scheduled Tribes and Financially Weaker Sections:

Currently, e-cycles can be provided free of cost to students between the ages 15 to 18 years who are associated with Scheduled Castes or Scheduled Tribes through a Children Empowerment Fund. Furthermore, the fund can also be utilised to procure e-cycles for students from other social classes. However, it is important to note that the Gram Panchayat will need a State Government order to utilise these funds for e-cycles' deployment.



200 e-cycles for Men from Financially Weaker Sections with Annual Income less than INR 1 lakh:

The Manikkal Gram Panchayat can provide a fiscal incentive to cover 50 per cent of the cost of e-cycles, while the remaining 50 per cent can be borne by the beneficiaries.

Additional target groups comprising financially weaker sections, Government offices and Students can be targeted to assess the potential demand for e-cycles.

ASHA Worker testing the e-cycle during the demonstration exercise



Financial Mechanisms to Deploy E-cycles

Based on the discussions with the President of the Manikkal Panchayat, it has been established that there is an inclination to utilise the existing funds to deploy e-cycles for the beneficiaries. Although they are willing to procure the e-cycles and distribute them to the beneficiaries, there exists a limit on the annual disbursement amount. Additionally, a Government order from the State Government will be required to allocate funds for e-cycle deployment.

Findings from the primary survey indicate that the beneficiaries are willing to pay INR 5000-15000 for the e-cycles. Additional support through various subsidies will be required to pay the remaining amount.

Two financial plans which can be considered for the deployment of e-cycles within a typical Gram Panchayat:



Financial Plan 1: The Gram Panchayat leverages available funds to procure e-cycles for individual beneficiaries in accordance with their specific demand.



Financial Plan 2: Individuals pay a share of the capital cost considering their capacity and willingness to pay. The remaining amount is borne by the Government through fiscal incentives.

Box 5: Overview of the funds available with the Manikkal Gram Panchayat

The Gram Panchayat has funds primarily from three sources: The Central Government, State Government, and own funds accrued from building permits, taxes, license fees, etc. An overview of the three funds for Financial Year (FY) 23-24 is highlighted below-

Central Government fund:

- Finance Commission basic grant of INR 69.3 Lakhs
- Central Finance Commission grants for a special purpose (water and cleanliness) of INR 1.4 crores

State Government fund/Plan fund of INR 3.5 crores. Additionally, the Manikkal Gram Panchayat also receives the following funds from the state government-

- *Vanitha khadaka padhathi* - INR 39.12 lakhs
- Fund for Child development & handicapped - INR 19.56 lakhs
- Fund for the backward community - INR 1.12 crores

Panchayat's own fund (collected against services from the Institutions and local public of the Manikkal Panchayat) - INR 1.3 crores

Table 3: Total e-cycle deployment cost for each beneficiary group at Gram Panchayat level – Manikkal in this case

Target Beneficiary	Financial Plan 1*	Financial Plan 2*
ASHA workers	INR 11.7 lakhs	INR 8.6 lakhs
Haritha Karma Sena	INR 8.4 lakhs	INR 5.6 lakhs
Kudumbashree CDS	INR 4.8 lakhs	INR 3.2 lakhs
Anganwadi teachers and helpers	INR 6.3 lakhs	INR 4.2 lakhs
Total	INR 31.2 lakhs	INR 21.6 lakhs

Note: *The cost of each e-cycle has been considered as INR 30,000. The total cost has been estimated basis the demand observed in Table 2. Under Financial Plan 1 there is no fiscal incentive. Under Financial Plan 2, a dedicated fiscal incentive of around 30 per cent is considered as per the discussions with Manikkal Gram Panchayat President.

The Panchayat can leverage its own fund or the funds allocated under the *Vanitha Khataka Padhathi*, dedicated to women's development and empowerment. However, there is no dedicated budget allocation for e-cycle deployment.

Bulk procurement mechanisms can be deployed to realise the widescale adoption of the e-micromobility modes by reducing their capital costs. Nodal agencies like CESL can play a pivotal role to facilitate bulk procurement basis the aggregated demand from different Government Institutions.

Respondents from the target groups considered in this study spend around INR 23,000 to INR 40,000 annually on their commute. Switching to alternate modes like e-cycles and low speed e-mopeds can reduce this expenditure to around INR 6,500 per annum owing to lower refuelling costs.

The perceived monthly payment capability of the target groups is INR 500 over a time frame of 2-3 years. However, the savings from lower refuelling costs would be around INR 900 to INR 2,300 per month which could potentially **increase the monthly payment to INR 1000 - 1500 instead of INR 500**. This would be sufficient to cover the cost of the e-cycles and low speed e-mopeds through zero interest rates over a period of 3 years.

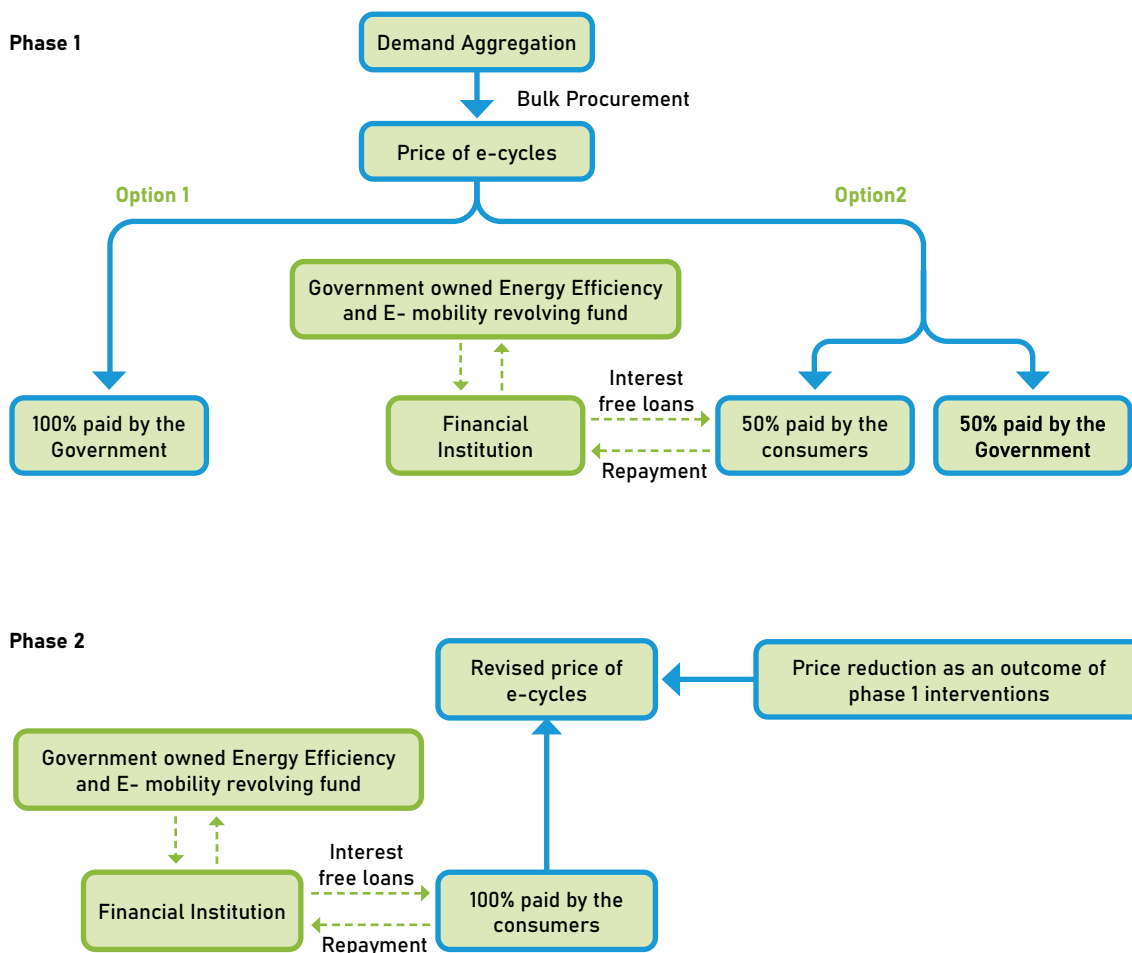
The incentives from the Government can be deployed in two phases-

Phase 1- Ecosystem enabler: Government incentives will play a pivotal role in mitigating the barrier posed by high initial costs for e-cycles and low speed e-mopeds. The incentives in the form of government subsidy and interest free loans through identified Financial Institutions, directly target the high capital costs of these technologies. The fiscal incentives along with comprehensive awareness campaigns and educational endeavours, would act as an ecosystem enabler. These initiatives effectively communicate the myriad benefits of using e-cycles and low-speed e-mopeds, encompassing reduced emissions, cost-effective fuel usage, lowered maintenance expenses, and their substantial contribution toward a cleaner environment. This heightened visibility triggers a ripple effect, fostering increased consideration and adoption of these eco-friendly alternatives among a wider audience.

Phase 2- Large scale adoption: Subsequent to the price reduction achieved as a result of the phase 1 interventions, the Government intervention in the form of interest free loans administered through identified Financial Institutions should be continued for a wider adoption. Fiscal incentives will not only benefit consumers but also stimulate the market for e-cycles and low-speed e-mopeds. This increased demand can further drive innovations, technological advancements, and economies of scale in production, leading to reduced costs in the long run. As more people adopt these technologies due to incentives, the market for these vehicles grows, making them a more viable and sustainable transportation option.

Nodal agencies like CESL can play a pivotal role in market transformations through bulk procurement thereby reducing the upfront costs.

Figure 20: Potential financial mechanisms to deploy e-micromobility technologies



Source: Authors' analysis

Recommendations

The following recommendations could help implement the e-cycles effectively in the Manikkal Gram Panchayat and across the Country.



Awareness campaigns for electric cycles: Presently, there exists certain perceptions among the target beneficiaries, labelling cycles as a mode primarily used by individuals with low-incomes. These social perceptions are primarily due to the lack of awareness and thereby would hinder the widespread adoption of e-cycles. Dedicated awareness campaigns can be designed to disseminate the advantages of e-cycles as an energy efficient and economical alternative. This would help nudge the users to consider e-cycles as an alternative to conventional private vehicles.



Ensuring e-cycle affordability: Some States such as Delhi, Punjab and Tamil Nadu provide fiscal incentives for e-cycles to bring cost parity through their Electric Vehicle (EV) policies. Replication of similar incentives in other States can further accelerate the adoption of e-cycles.



Design Improvisations: The following feedback from respondents can be incorporated to enhance the appeal and functionality of e-cycles.

- Most of the respondents requested a cycle with a smaller height. They would feel safer riding the cycles if their feet touched the ground while seated.
- The top bar in the cycles is inconvenient for women, particularly those wearing saree as their formal work attire. Lower bar e-cycles would provide greater comfort and accessibility.
- Around 40 per cent of respondents suggested adding supporting wheels for improved balance, as many of them have been out of practice for several years.
- Inclusion of accessories such as a mirror, a horn, a lock, a mobile phone holder, headlights and a mudguard on the e-cycles.
- A solid case basket in the front with a locking facility to protect their belongings.
- The addition of a carrier at the back, primarily requested by the Haritha Karma Sena workers, as it would be useful for waste collection tasks.
- A wider and broader comfortable seat with improved cushioning was a common request from the respondents.
- Respondents also expressed their preference for a more stationary platform for resting their feet while riding the e-cycles, especially considering their preference for throttle. This would alleviate the difficulty of placing their feet on the pedals while riding.



Systemic data collection: The operational data can be collected from the deployed e-cycles and low speed e-mopeds. Subsequently, the collected data can be used to estimate the impact on the individuals' livelihoods arising from the use of these e-micro-mobility technologies for their work-related trips. The dissemination of these findings can help generate awareness about these technologies and facilitate wide scale adoption. Additionally, other Government Institutes operating in rural areas can be targeted to replicate the demonstration exercise to assess the potential of e-cycle adoption among them.



Leveraging Institutional structures: While the preliminary assessment conducted in this report indicates a potential demand of around 5-6 crore e-cycles across the identified beneficiaries pan-India, it will be imperative to have institutional structures in place to realise this demand. The Kudumbashree programme established in Kerala is one such example where a formal community network has been established under the State Rural Livelihoods Mission (SRLM) to cover the entire state of Kerala. Such Institutional structures must be actively explored to expand the beneficiary base for e-cycle adoption.

The overarching suggestion aims to boost the widespread adoption of e-cycles by collaborating with key nodal agencies; this initiative can facilitate the consolidation of demand from the Government Institutions in rural and semi-urban areas, which in turn can result in cost reduction and enhancements in design and features.



Manikkal Gram Panchayat's committee member testing the e-cycle during the demonstration

Conclusion

The findings from the demonstration exercise conducted at the Manikkal Gram Panchayat reveal that after riding the e-cycles, a significant number of women felt that e-cycles could be a good alternative to their existing modes as it would help improve their work efficiency and reduce their fatigue. Post-demonstration, a greater number of beneficiaries, are willing to pay around INR 5000-15,000 to own e-cycles, who earlier wanted the same free of cost.

The surveys conducted with the primary beneficiaries revealed that they spend around INR 23,000 to INR 40,000 annually on their travel. However, with an e-cycle or a low-speed e-moped, this cost can be brought down to INR 6,500 annually, owing to the minimal cost of refuelling these modes. The economic benefits observed by the beneficiaries as a result of adoption of the e-cycle would also benefit their households. **The savings of around 70-80 per cent as a result of switching to e-bicycles would increase the disposable income of the beneficiaries, thereby leading to better education for the children, better healthcare opportunities and better family and social support.** Further, the enhanced mobility would also increase the livelihood/employment opportunities for the beneficiaries thereby increasing the overall household earnings.

However, the substantial initial cost of e-cycles remains a significant barrier to its large-scale adoption. In order to overcome this obstacle and promote broader adoption, it is imperative to implement targeted fiscal incentives. A national-level e-cycle programme can potentially target **2-3 per cent of the households across India**, leveraging the extensive network of various Government Institutions. This national level programme can potentially stimulate the demand and encourage the widespread adoption of this micro-mobility solution. The transition to e-cycles holds the promise of alleviating commuting inconveniences, reducing reliance on expensive shared transportation services, and enhancing work efficiency, ultimately leading to increased incomes, reduced energy consumption, and lower emissions.

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Annexures

Annexure 1: Assumptions for the TCO calculation-

Age of the vehicles: Average life of the two-wheelers is considered to be 10 years based on the analysis done by Goel et. al 2015. Fuel station surveys were employed across different geographies in India to collect the average age of the vehicles and basis that survival curves were estimated for different vehicle segments.

A sensitivity analysis has been conducted to analyse the variation of the TCO with the potential increase in operational kilometres across different states and geographies. Such sensitivity analysis has been used by major studies (for example - the IIT Kanpur study) to estimate the impact of varying annual kilometres on the TCO.

Other assumptions considered-

Table A1: Assumptions for e-cycles and low-speed e-mopeds

Cost and Range assumptions		
E cycle commute	Cost (in INR)	30000
	Charging cycles	1000
	Range (in km)	30
E cycle cargo	Cost (in INR)	40000
	Charging cycles	1000
	Range (in km)	45
E Moped	Cost (in INR)	50000
	Charging cycles	1000
	Range (in km)	45
Battery passive degradation rate per annum		2%
Distance assumptions		
	Daily distance (km)	No. of working days in a month
Commute	20	22
Cargo	20	22

Source: Primary stakeholder consultations conducted by the CESL team

Table A2: Assumptions for EV scooters

EV assumptions	Value
Capital Cost	1,11,000 INR
Borrowed amount	80%
Interest rate	11.51%
Loan repayment	3 years
Fuel economy - EV	0.020 kWh/km
Maintenance Expense	0.15 INR/km
GST	0%
Cess	0%
Discount rate	10%
Fuel cost	6.00 INR/l
Fuel cost escalation	0%






Table A3: Assumptions for ICE scooters

ICEV assumptions	Value
Capital Cost	1,01,000 INR
Borrowed amount	80%
Interest rate	11.51%
Loan repayment	3 years
Fuel economy - ICEV	0.021 l/km
Maintenance Expense	0.59 INR/km
GST	28%
Cess	3%
Discount rate	10%
Fuel cost	100.00 INR/l
Fuel cost escalation	0%

Annexure 2: Overview of the current available models in the market

Given the interest of the target beneficiaries in a scooter-like form factor, these low-speed 2W technologies can also be considered for the target beneficiaries in the Manikkal panchayat.

Table A4: Specifications of commute e-cycles available in the market






Company Name	Tata Stryder	Hero Lectro	Essel	Hero Lectro	Nexzu
Model Name	Voltic go	C4+	Energy GET 7	C9	Bazinga
Picture					
Range (km)	50 Kms	30 Km	70-80 Km	25 km	85 Km
Motor power (W)	250 W	250 W	250 W	250 W	250 W
Battery capacity (Ah)	5 Ah	5.8 Ah	16 Ah	8.7 Ah	14.5 Ah
Battery Size (KWh)	0.24 kWh	0.20 kWh	0.76 kWh	0.31 kWh	0.52 kWh
Cost	INR 27,599	INR 30,999	INR 45,500	INR 46,999	INR 48,999
Seating Capacity	1 person	1 person	2 person*	2 person*	1 person
Payload Capacity	100 kg	70 kg	-	70 kg	15 kg Max carry
Kurb weight	16 kg	18 kg	47 kg	15 kg	27 kg
Pedal	Yes	Yes	Yes	Yes	Yes
Dimensions (L x W)	-	-	-	-	1864*635mm
Height	adjustable	adjustable	-	adjustable	1061 mm

Source: CEEW - Market review

Table A4 shows some e-cycle models available in the market. These are cycles that operate on a motor and are controlled by a throttle along with pedal assistance. This type of form factor generally has a lesser load-bearing capacity and offers a seating capacity of one person. However, few models can accommodate two.

Along with these regular e-cycles, there are cargo e-cycles in the market that are specifically designed for carrying loads. This form factor offers a seating capacity of one person and is designed to carry a load of up to 50 kg more than the rider's weight. Table A5 shows an overview of low-speed cargo e-cycles available at different price ranges in the market.



Table A5: Specifications of cargo e-cycles available in the market

Company Name	Motovolt	eblu	Nexzu	Hero	Aurita
Model Name	HUM	SPIN	Roadlark Cargo	WINN	Trooper
Picture					
Range (km)	20-70 Km	40 Km	60-85 Km	55 km	75 Km
Motor power (W)	216 W	250 W	250 W	250 W	250 W
Battery capacity (Ah)	-	12 Ah	Primary: 5.2 Ah Secondary: 8.7 Ah	11.6 Ah	10.4 Ah
Battery Size (KWh)	0.576 kWh	0.432 kWh	Primary: 0.187 kWh Secondary: 0.313 kWh	0.4176 kWh	0.375 kWh
Cost	INR 33,049	INR 34,999	INR 47,999	INR 49,999	INR 51,250
Seating Capacity	1 person	1 person	1 person	1 person	1 person
Payload Capacity	120 Kg	20 kg Max carry	95 Kg	rider + 70 Kg	130 Kg
Kurb weight	25.6 Kg	-	27 Kg	-	25 kg
Pedal	Yes	Yes	Yes	Yes	Yes
Dimensions (L x W)	1850*645mm	1850*650mm	1866*635 mm	-	1800*635 mm
Height	1010 mm	1140 mm	1016 mm	1050 mm	950 mm

Source: CEEW Market review

Apart from e-cycles, there are some low-speed 2W with moped-type form factor, available in the market. These are the upgraded version of a typical moped which initially had a pedal along with a low-capacity engine. Most mopeds today do not have a pedal. The height of these vehicles is generally less than 1000mm (40") with few exceptions. The price range of some of these models (Velev VEV01 and Essel GET1) is comparable to e-cycles. Table A6 shows an overview of the market's low-speed (moped-type) models.

Table A6: Specifications of low-speed e-mopeds available in the market

Company Name	Essel	Motovolt
Model Name	GET 1	Urbn e-Bike
Picture		
Range (km)	40 km	120 km
Motor power (W)	250 W	250 W
Battery capacity (Ah)	11 Ah	20 Ah
Battery Size (KWh)	0.538 kWh	0.72 kWh
Cost	INR 41,500	INR 49,999
Seating Capacity	2 person	1 person
Payload Capacity	-	120 kg
Kurb weight	39 kg	40 kg
Pedal	Yes	Yes
Dimensions (L x W)	-	1700*645 mm
Height	adjustable	1010 mm

Source: CEEW Market review

Annexure 3: Baseline Questionnaire

PERSONAL DETAILS						VEHICLE OWNERSHIP DETAIL										
S.No	Name	Contact no.	Gender	Age	Qualification level individual	Occupations	Monthly Income	Vehicle owned (Y/N)	Ability to ride (Y/N)	If no, are you willing to learn how to ride	Access to ride (Y/N)	If no, mention to ride	Vehicle owned (Y/N)	Access to drive (Y/N)	If No, mention to ride	
					1. <10th 2. 10th passed 3. 12th passed 4. Graduate 5. ITI 6. Any other	1. Kudumbashree workers 2. Haritha Karma sena 3. Asha Workers 4A. Anganwadi teachers 4B. Anganwadi helpers 5. Students 6. Others (Mention)		Vehicle owned (Y/N)	Ability to ride (Y/N)	If no, are you willing to learn how to ride	Access to ride (Y/N)	If no, mention to ride 1. No ability to ride 2. Family restrictions 3. Feels unsafe 4. Others (mention)	Vehicle owned (Y/N)	Access to drive (Y/N)	If No, mention to ride 1. No ability to ride 2. Family restrictions 3. Feels unsafe 4. Others (Mentions)	
EXISTING TRIP PATTERN																
Trip Purpose: Work/study Related trips																
Trip Mode	Distance travelled per day	Number of working day per week	Distance travelled per trip (one side)	Travel time per trip (hrs)	Cost incurred per trip	Usual load carried per trip (in kgs)	Av. length of Ad-hoc trip (in km)	Frequency of these ad-hoc trip (in one week)	Existing Challenges	Types of discomfort due to trips	Trip Mode	Distance travelled per trip (one side)	Number of such trips in a week (One side)			
1. Bus/mini-bus 2. Jeep 3. Rickshaw/tempo 4. 2W (bikes/scooty) 5. Bi-cycle 6. Walk									1. Higher waiting time 2. longer last mile 3. Expensive 4. Safety concern 5. Dependent on family 6. Others (mention)	1. None 2. Stress 3. Anxiety 4. Poor work performance 5. Others (mention)	1. Bus/mini-bus 2. Jeep 3. Rickshaw/tempo 4. 2W (bikes/scooty) 5. Bi-cycle 6. Walk					

Baseline Questionnaire

EXISTING TRIP PATTERN		PERCEPTION SURVEY: BEFORE DEMONSTRATION										
		Do you know about e-cycles	If Yes,				Are you willing to own an e-cycle	If Yes, How much are you willing to pay	How much can you pay as monthly EMI for owning an e-cycle?	If No, what are the social barriers	Will you buy an e-cycle if govt. subsidy is provided	
Travel time per trip (week)	Cost incurred per trip	Usual load carried per trip (in kgs)	Yes/No	Expected Range of e-cycle (in km)	Expected speed of e-cycle (km/hr)	Expected charging time (min)	Do you feel it can replace your existing work trips (yes/no)	Yes/No	1. upto 5k 2. 5k-15k 3. 15k-30k 4. 30k-45k 5. more than 45k		Give answer in few words	Yes/No

Annexure 4: Feedback Questionnaire

GENERAL INFORMATION			E-CYCLE FOR DEMONSTRATION				FEEDBACK				
Name	Contact No.	Occupation	Which e-cycle was chosen for demonstration	Reason for choosing	Rate the overall e-cycle ride experience on a scale of 1 to 5	Was the test ride sufficient to give feedback	How safe is it in riding. Rate on a scale of 1 to 5	Features lacking in the model chosen for demonstration	Feature that were unnecessary is the chosen model	Challenges faced	Additional feature needed in an e-cycle
			1. E1 2. E2 3. E3	1. Only that model was available 2. It was attractive 3. Ergonomically perfect 4. Seemed to be comfortable 5. Easier to ride 6. Others (mention reason)	1 Being the last and 5 being the most	Yes/No	1 being the least and 5 being the most	Mention in few words	Mention in few words	Mention in few words	1. Single seater 2. Two seater 3. Head light 4. Small basket in front 5. Others (mention in works)





COUNCIL ON ENERGY, ENVIRONMENT AND WATER (CEEW)

ISID Campus, 4 Vasant Kunj Institutional Area,
New Delhi - 110070, India
Tel.: +91 (0) 11 4073 3300

info@ceew.in | ceew.in | [X@CEEWIndia](https://www.instagram.com/CEEWIndia) | [@ceewindia](https://www.instagram.com/ceewindia)

ENERGY EFFICIENCY SERVICES LIMITED

NFL Building, 5th & 6th Floor, Core - III,
SCOPE Complex, Lodhi Road, New Delhi - 110003
Tel.: +91 (011) 45801260

www.eeslindia.org