

# Identifying the Key Factors to Re-Design a Sustainable Transportation Device for Postmen in Sri Lanka Postal Department

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**Abstract** – This study investigates the productivity challenges associated with the transportation methods currently used by postmen in the Sri Lanka Postal Department, focusing on their impact on efficiency, worker well-being, and operational sustainability. Despite evolving delivery demands, postmen continue to rely on general-purpose bicycles and motorbikes that are not optimized for postal work. These transportation methods contribute to inefficiencies, increased physical strain, and safety risks, ultimately affecting delivery speed and service reliability. Using a qualitative research approach that combines grounded theory and case study methods, this study examines key productivity-related factors in postal transportation. Data collection involved direct observation and open-ended interviews with postmasters and postmen in the Piliyandala region, a diverse postal jurisdiction in Colombo District. Findings highlight the need for an optimized transportation solution incorporating ergonomic improvements such as adjustable seating and structured storage compartments to streamline delivery processes. Additionally, integrating electric-assist technology and solar-powered charging stations is proposed to enhance efficiency and reduce operational costs. This research provides actionable insights for modernizing postal transportation, ensuring improved productivity, worker health, and sustainability within Sri Lanka’s postal services.

**Keywords:** Sustainable Delivery System; Human-Centered Design; User-Friendly Mobility; Vernacular Practice; Design for Efficiency

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## **I. Introduction**

The Sri Lanka Postal Department, established in 1798 (Department of Posts Sri Lanka, n.d), has long served as a vital public institution, connecting communities across diverse and often challenging terrains. Traditionally, the department has relied on bicycles for mail delivery—an affordable and environmentally friendly method. However, this approach has become increasingly unsustainable due to the physical strain on postal workers, who navigate long routes with heavy loads and repetitive motions, leading to musculoskeletal injuries. The reliance on outdated delivery methods not only affects worker well-being and productivity but also limits the department's ability to adopt global trends in sustainability and ergonomics. Modernizing delivery methods while maintaining reliable, community-centered service is crucial for improving both efficiency and employee welfare.

This study examines the operational, environmental, and ergonomic challenges of the department's current transportation methods and identifies key factors for designing a sustainable, ergonomic alternative. Using a qualitative research approach, the study integrates field observations, interviews with postal workers and postmasters, and an analysis of global postal service innovations. By exploring solutions such as electrically assisted bicycles, modular batteries, and customizable storage options, the research proposes a framework for a new delivery device that enhances worker comfort, safety, and efficiency while reducing environmental impact. Ultimately, these findings aim to support the department's modernization efforts, fostering a healthier and more sustainable work environment for Sri Lankan postal employees.

## **II. Research Problem**

The Sri Lankan Postal Department continues to rely on bicycles for mail delivery, a practice dating back to 1798, despite significant technological advancements in global postal services. Postal workers must navigate difficult terrains using outdated bicycles, resulting in physical strain, fatigue, and long-term health concerns. While international postal services have adopted eco-friendly vehicles and ergonomic solutions, Sri Lanka's system remains neither sustainable nor supportive of worker well-being. This study investigates alternative delivery solutions that balance environmental sustainability with improved working conditions, contributing to the broader discussion on modernizing Sri Lanka's public sector.

### **A. Importance of the Study**

This study addresses the growing need for sustainable and efficient postal delivery solutions in Sri Lanka. As global emphasis on environmental sustainability and employee welfare increases, the Sri Lankan Postal Department faces pressure to reduce its carbon footprint and enhance worker conditions without compromising service quality. Postal workers relying on traditional bicycles endure physical strain from covering long routes, leading to concerns about worker health and delivery efficiency. Despite the critical nature of these issues, no research has been conducted in this area. This study aims to fill that gap by identifying key factors that enhance postal worker efficiency through sustainable transportation solutions.

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## **B. Research Objectives**

To develop a sustainable and modernized transportation device for Sri Lankan postal workers, this study evaluates feasibility by considering infrastructure constraints, worker routines, and operational demands. Enhancing worker safety and health requires ergonomic design improvements such as posture support and better load distribution to increase efficiency and reduce strain. The proposed transportation method integrates worker-centric features that address physical and physiological comfort, human ergonomics, and sustainable design principles, ultimately enhancing productivity while promoting environmentally responsible practices.

## **III. Literature Review**

Sri Lanka's early communication methods were inventive and symbolic, relying on emissaries, stone inscriptions, drum signals, and messenger birds to convey messages. These systems played a key role in governance, diplomacy, and community engagement (Hettiarachchi & Wijesinghe, 2021). The formal postal system was introduced in 1798 under British colonial rule, streamlining communication and fostering connectivity across the island (Department of Posts Sri Lanka, 2022). Over time, the postal service evolved with milestones such as the introduction of the Traveling Post Office in 1892 and integration into the Express Mail Service (EMS) in 1999, improving efficiency and international reach (EMS Cooperative, n.d.). Despite digital advancements, Sri Lanka's postal system remains crucial for millions, particularly in rural areas (Samarasinghe & Gunasekara, 2019).

### **A. Evolution of Mail-Delivery Methods**

Sri Lankan postal workers, especially in rural areas, rely on outdated bicycles that lack secure storage, forcing them to carry mail in unbalanced canvas bags, leading to inefficiency and physical strain (Department of Posts Sri Lanka, 2022; Seneviratne, 2015). While tuk-tuks have been proposed, concerns regarding emissions and cost hinder their widespread adoption (Lanka News Web, 2023). Many global postal services have introduced electric-assist bicycles and ergonomic storage solutions, which offer sustainable and worker-friendly alternatives (Electrive, 2019; Electrek, 2023).

### **B. Current Operations and Challenges**

The Sri Lankan Postal Department operates an extensive network of 4,738 post offices, handling mail delivery for over 20 million citizens (Department of Posts Sri Lanka, 2022). However, it faces financial challenges, with expenditures nearly double its revenue in 2022, necessitating modernization and cost-cutting measures (EconomyNext, 2020; Samarasinghe & Gunasekara, 2019). While EMS Speed Post and mechanized logistics have improved service, outdated transport methods remain a key limitation. The proposed Postal Act aims to introduce reforms such as digitization and public-private partnerships to enhance efficiency and financial sustainability (UNDP, 2021).

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### **C. Bicycles as a Transportation Device for Postal Workers**

Since 1798, bicycles have been integral to Sri Lanka's postal service, offering flexibility in navigating narrow roads and remote areas (Department of Posts Sri Lanka, 2022). Despite their affordability and low maintenance, traditional bicycles lack ergonomic design, causing discomfort and inefficiency (Gunaratne & De Silva, 2023). Modernizing transport with sustainable alternatives is crucial for worker well-being and service optimization.

### **D. Health Risks of Long-Term Bicycle Use**

Prolonged cycling on non-ergonomic bicycles causes musculoskeletal strain, chronic fatigue, and joint pain among postal workers. The lack of proper load distribution exacerbates posture-related issues, impacting long-term health (López-García & Pérez-Rodríguez, 2022; PBS NewsHour, 2022). In addition to physical strain, exposure to extreme weather and time pressures contribute to stress and burnout. Introducing ergonomic electric-assisted bicycles could alleviate these issues, improving both physical and mental well-being (The MIT Press Reader, 2022; National Association of Letter Carriers, 2023).

### **E. Global Innovations in Postal Delivery**

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### **F. Future Directions for the Sri Lanka Postal Department**

Sri Lanka is exploring electric bicycles and low-emission vehicles as part of its modernization strategy (Lanka News Web, 2023). However, current reforms focus primarily on efficiency and cost-cutting, often neglecting ergonomic considerations and worker well-being. Sustainable modernization efforts must balance efficiency, environmental impact, and employee health to ensure long-term viability. Without addressing these factors, reforms may fail to deliver lasting improvements.

## **IV. Methodology**

This study explores the challenges faced by Sri Lankan postal workers, focusing on the Piliyandala region. It examines the physical and psychological impact of mail delivery, the efficiency of existing methods, and the sustainability of postal practices. A qualitative approach was adopted, combining primary data from observations and interviews with secondary data from literature and postal reports. The findings aim to inform improvements in working conditions, delivery methods, and overall service sustainability.

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## **A. Research Design**

A qualitative approach was chosen, incorporating grounded theory and case study methods to examine operational challenges in Piliyandala's postal system. Primary data was collected through observations and interviews with postal workers and postmasters, focusing on delivery methods, health risks, and efficiency. Secondary data from literature and postal reports contextualized findings. This approach ensures a comprehensive understanding of workers' experiences and potential improvements.

## **B. Site Selection**

Piliyandala was selected for its mix of urban and rural environments within Colombo District, offering diverse challenges in mail delivery. The region covers 528.5 km across 17 postal divisions, with both bicycles and motorbikes used for mail transport. Among the 17 postal workers, two handle EMS and Speed Post services. This diverse setting provides insights into various delivery methods, terrain-related challenges, and workload distribution.

## **C. Participant Selection**

Participants included active postmen delivering mail through different service categories, such as routine deliveries, EMS, Speed Post, and COD services. Both bicycle and motorbike users were included to compare delivery challenges across methods. Postmasters were interviewed to validate findings and offer a management perspective on operational constraints and policy considerations. This selection ensured a well-rounded view of challenges and potential improvements.

## **D. Data Collection Methods**

Participants included active postmen delivering mail through different service categories, such as routine deliveries, EMS, Speed Post, and COD services. Both bicycle and motorbike users were included to compare delivery challenges across methods. Postmasters were interviewed to validate findings and offer a management perspective on operational constraints and policy considerations. This selection ensured a well-rounded view of challenges and potential improvements.

### **1. Grounded Theory and Observation**

*Observations were conducted to document real-world practices, including mail transportation, handling, and ergonomic challenges faced by postal workers. This method helped identify recurring issues, such as poor bicycle design and storage limitations, guiding the development of interview questions.*

### **2. Interviews**

*Semi-structured interviews were conducted with postmen and postmasters. Postmen's questionnaires combined closed-ended questions (e.g., frequency of bicycle use, working hours, and health impacts) with open-ended inquiries to explore personal challenges, safety concerns, and long-term sustainability. Postmasters' interviews included more structured questions to assess service feasibility and operational challenges from a management perspective (Hotjar, 2024). This*

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*dual approach ensured a comprehensive analysis of issues from both worker and administrative viewpoints.*

### **3. Secondary Data Collection**

*Secondary data was obtained from postal department reports, government publications, and prior research on bicycle-based mail delivery. Literature on postal worker health, economic impacts, and sustainable delivery solutions informed the study, supporting primary data analysis. International comparisons provided insights into best practices for optimizing Sri Lanka's postal system.*

## **V. Analysis**

This section examines the transportation methods used by Sri Lankan postal workers, emphasizing their impact on productivity. The discussion covers historical practices, current challenges, and potential design improvements to enhance efficiency.

The Sri Lankan Postal Department historically relied on a layered system where trains and buses transported bulk mail between cities before postmen carried out the final delivery using bicycles or motorbikes. The adaptability of bicycles allowed them to remain a primary mode of delivery due to cost-effectiveness and accessibility in narrow or congested streets. However, modern challenges such as increasing workloads, urban congestion, and the financial burden of using personal motorbikes have raised concerns about efficiency and worker well-being.

### **A. Essential Role of Postmen in Sri Lanka's Layered Mail Delivery System**

The Sri Lankan Postal Department has historically used a multi-layered transportation system to deliver mail efficiently. Initially, trains transported large volumes of mail between major towns, where postal workers sorted letters in transit. Upon reaching primary sorting centers like the Colombo Head Post Office, mail was further categorized and distributed to local areas via delivery vans or Sri Lanka Transport Board (SLTB) buses. In remote areas, bus drivers would deliver sealed mail bags to sub-post offices. Postmen, familiar with local areas, then handled the final delivery, making them an essential part of the postal network, ensuring timely and reliable service.

#### **1. Bicycle Use in Mail Delivery**

*Bicycles have long been the preferred transportation mode for Sri Lankan postal workers due to their affordability, practicality, and suitability for the country's diverse terrain for more details explore Chapter 2, Section 2.3. They offer an economical solution, eliminating fuel and parking costs while providing flexibility in navigating narrow, congested streets and reaching areas inaccessible to larger vehicles. Despite some postmen opting for motorbikes to cover routes faster, bicycles remain the most cost-effective and environmentally friendly option. Their minimal maintenance requirements and ability to adapt to varying road conditions make them a reliable choice for the postal department, aligning with both operational efficiency and sustainability goals.*

#### **2. Transition and Adaptation of Practices**

*The introduction of bicycles in the Sri Lankan Postal Department led to the use of a distinctive bell sound for postmen to signal their arrival at homes, which became an iconic and reliable auditory cue*

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in local communities. Despite some postmen transitioning to motorbikes for faster deliveries, many continue to use the bell, preserving this traditional aspect of the postal system. However, as the service modernizes, the reliance on bell signaling faces challenges, such as noise in urban areas drowning out the sound and the need to balance tradition with efficiency in a changing postal landscape.

**Figure 1**

Traditional practice of using the bell for both devices. (Source: Author Creation)



## **B. Current Transportation Modes and Operational Challenges**

This section discusses the use of bicycles and motorbikes for postal delivery, highlighting their benefits and challenges, including efficiency, ergonomics, safety concerns, and operational impact on postal services.

### **1. Bicycles**

Bicycles became the primary transportation mode for Sri Lankan postal workers due to their practicality, affordability, and suitability for the country's diverse terrain. They are ideal for navigating narrow, winding roads in both urban and rural areas, allowing postmen to make quick stops and access hard-to-reach locations. Bicycles are cost-effective, requiring minimal maintenance, and eliminate fuel and parking costs, which makes them a reliable choice for daily use. While some postmen have switched to motorbikes for faster delivery, most continue to prefer bicycles due to their affordability, convenience, and alignment with the postal department's sustainability and operational goals.

### **2. Motorbikes**

Some postmen have switched to personal motorbikes to address the physical and logistical challenges of using bicycles. However, this shift introduces new problems. The postal department still officially considers bicycles the primary mode of transport, meaning postmen using motorbikes do not receive a fuel allowance and must pay daily fuel costs of 500 to 750 rupees,

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adding a financial burden. Additionally, frequent stops increase fuel consumption and wear on motorbikes, leading to higher maintenance costs. Safety concerns also arise, as postmen often lack proper storage for mail, forcing them to carry it with one hand while operating the bike, increasing accident risks. Some forego helmets to save time, further jeopardizing their safety. While motorbikes offer faster delivery, they bring new financial and safety challenges without addressing the underlying issues faced by postal workers.

**Figure 2**

*Postman delivering mail by Bicycle and Bike (Source: Author Creation)*



### **C. Key challenges Affecting to the Productivity**

Increased productivity is a key objective for the new transportation device, aiming to optimize delivery processes and reduce time on routes. While bicycles are cost-effective, they have limitations in storage capacity and range, which can slow down deliveries. A redesigned device should feature organized storage compartments to streamline mail sorting and carrying, reducing time spent adjusting packages. The device should also be able to navigate both urban and rural areas efficiently, allowing workers to access hard to reach locations quickly. Incorporating an electric assisted bicycle could enhance speed and reliability, providing a faster, more efficient alternative to traditional bicycles and motorbikes. Optimizing the design for better sorting, loading, and navigation would improve delivery speed and accuracy, boosting productivity for postal workers. Current transportation modes, including bicycles and motorbikes, pose operational challenges for postmen in Sri Lanka.

#### **1. Physical and Psychological Strain**

Prolonged use of bicycles and motorbikes for postal delivery poses significant physical health risks for postmen, such as chronic back pain, knee and hip joint stress, muscle cramps, and

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cardiovascular strain, primarily due to long hours spent riding with heavy mail bags and unbalanced weight distribution. The strain is exacerbated by repetitive stops, awkward postures, and rough terrains. Additionally, fatigue from navigating challenging routes, poor seat support, and the physical effort to maintain balance further reduces delivery efficiency. Beyond physical strain, postal workers face psychological health risks, including mental fatigue and stress from long hours, tight deadlines, and isolation. The pressure of managing heavy workloads, difficult weather, and busy streets, coupled with the monotony and lack of social interaction, can lead to burnout and depression. Moreover, postmen often struggle with hygiene issues due to a lack of amenities, such as access to water, which exacerbates discomfort, dehydration, and skin problems. These factors contribute to job dissatisfaction, emphasizing the need for improved working conditions, including better hydration and hygiene facilities.

## 2. Ergonomic Limitations

The prolonged use of bicycles and motorbikes for postal deliveries presents significant ergonomic concerns for postal workers. Long hours spent riding with heavy mail bags, repetitive stops, and awkward postures lead to chronic health issues such as back pain, joint stress, muscle cramps, and cardiovascular strain. These conditions are exacerbated by rough terrains and poor seat support. Fatigue, resulting from the physical effort required to maintain balance and navigate challenging routes, further impedes performance. Improving ergonomic design is crucial to alleviating these issues. For bicycles, enhancements such as adjustable seating, lumbar support, and improved handlebar positioning can help distribute weight more evenly and reduce joint stress. Similarly, motorbikes can benefit from optimized pedal positioning, better handlebar height, and cushioned seats, which would improve overall comfort and reduce physical strain, thereby enhancing the health and safety of postal workers.

**Figure 3**

*Poor posture causes long-term health, ergonomic, safety, and device-related issues. (Source: Author Creation)*



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### 3. Storage and Sorting Inefficiencies

The lack of structured storage solutions in current postal transportation methods creates inefficiencies that directly impact delivery speed and worker productivity. Postmen often carry letters in their hands while riding, which not only poses safety risks but also disrupts their ability to navigate efficiently. Additionally, the absence of designated compartments leads to frequent stops and manual adjustments to sort or retrieve mail, further delaying deliveries.

These inefficiencies are particularly problematic in high-density urban areas where quick maneuvering is essential. By incorporating well-organized, accessible storage compartments into transportation design, postmen can streamline their workflow, reduce unnecessary handling time, and enhance overall delivery efficiency. A structured system would enable faster retrieval of mail, minimize route interruptions, and significantly improve productivity while ensuring safer working conditions.

**Figure 4**

*Holding a stack of letters with their thumb while managing the handle and brake leads to long-term ergonomic issues, causing stiffness and strain in the thumb joint (Source: Author Creation)*



### 4. Sustainability and Operational Costs

The Sri Lankan Postal Department's reliance on bicycles and fuel-powered motorbikes presents sustainability challenges. While bicycles are eco-friendly and low-cost, their limited range leads many postal workers to rely on motorbikes, which contribute to greenhouse gas emissions and fuel costs, often paid by the workers. This reliance increases operational expenses and impacts the carbon footprint. Similar issues have led postal services worldwide, such as Royal Mail in the UK

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and Australia Post, to adopt electric vehicles, hybrids, and other technologies to reduce environmental impact and control costs (Royal Mail, 2023; Australia Post, 2022). These global shifts highlight the movement towards more sustainable and efficient delivery solutions.

#### ***D. Design Considerations for a More Productive Transportation Solution***

To enhance productivity in postal delivery, a redesigned transportation solution must prioritize ergonomics, efficiency, safety, and sustainability. Ergonomic improvements such as adjustable seating and optimized handlebar positioning can significantly reduce physical strain on postal workers, preventing chronic back pain and muscle fatigue. A balanced weight distribution system will ensure that heavy mail loads do not affect posture or handling, improving comfort during extended delivery routes. By incorporating these design elements, the new transportation solution can minimize work-related injuries and enhance overall efficiency.

Efficiency in postal delivery depends on a vehicle's ability to navigate various terrains quickly and seamlessly. A modernized transportation method, such as an electric-assisted bicycle, can reduce the physical effort required to cover long distances while maintaining speed and reliability. Such a system would allow postal workers to complete their routes more swiftly while reducing exhaustion from prolonged pedaling. Additionally, dedicated storage compartments will streamline mail organization, preventing the need to hold letters while riding. This improvement will not only increase safety but also ensure smoother delivery operations by reducing the time spent managing and sorting mail on the go.

Safety and sustainability must also be central to the new design. Enhanced stability through a well-balanced structure will help prevent tipping on uneven roads, while reflective materials and integrated lighting systems will improve visibility in low-light conditions. Retaining the traditional postal bell as an auditory signal will help maintain public awareness of postal workers on the road. In terms of sustainability, adopting electric-assisted bicycles powered by solar charging stations can significantly cut down on fuel costs and carbon emissions, aligning the Sri Lankan Postal Department with global trends in eco-friendly transportation solutions. A well-integrated design that prioritizes both worker well-being and environmental responsibility will lead to a more efficient and sustainable postal delivery system.

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## Conclusion

This study highlights the need for an improved transportation solution for Sri Lankan postmen, focusing on enhancing productivity while addressing key concerns. The current reliance on bicycles and motorbikes presents significant operational inefficiencies, with bicycles limiting speed and storage capacity, while motorbikes impose financial burdens and safety risks. To improve productivity, a more advanced transportation device must optimize delivery processes, allowing postmen to complete routes faster and with reduced physical strain.

A redesigned vehicle, such as an electric-assisted bicycle, can enhance productivity by reducing worker fatigue and improving delivery efficiency. Features such as adjustable seating, structured storage compartments, and a balanced weight distribution system will allow for better organization and ease of use, minimizing the time spent handling mail. Safety enhancements, including a stable design, integrated lighting, and reflective materials, will further support uninterrupted operations, ensuring smoother and safer navigation across diverse terrains. Additionally, transitioning to electric-powered bicycles with solar charging capabilities will not only reduce fuel costs but also ensure a more sustainable and cost-effective operation.

By implementing these productivity-focused design considerations, the Sri Lankan Postal Department can significantly improve efficiency in mail delivery while reducing operational costs. A modernized and well-structured transportation system will enhance service reliability, support worker well-being, and align with global trends in sustainable mobility. This approach will ultimately ensure that postal services in Sri Lanka remain efficient, adaptable, and future-ready in an evolving logistics landscape.

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