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Environmental Policy Perspectives: Bridging the Gap in Recycling Used-Lead Acid Batteries in Bangladesh

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Abstract

Electric rickshaws, also known as E-rickshaws, have become essential components of Bangladesh's transportation infrastructure, significantly impacting the country's socio-economic fabric. Despite contributing approximately US $871 million to the local economy, concerns persist regarding the environmental and health implications of the used-lead-acid batteries (ULABs) industry, especially concerning battery recycling practices. This study undertakes a comprehensive examination of Bangladesh's national regulatory policies and standards, focusing primarily on ULABs. It identifies the various stakeholders involved in the e-rickshaw and battery industry and evaluates relevant national policies and standards. The study's main findings highlight significant disparities within the regulatory framework, primarily stemming from the lack of harmonization and comprehensive integration of ULABs-related policies at both national and international levels.

Recognizing the crucial roles played by both the informal and formal sectors, the study emphasizes the need for formalization accompanied by appropriate subsidies and support to ensure occupational health and safety standards. Such measures are imperative to enhance industry compliance, competitiveness in local and international markets, and overall safety. Furthermore, the study identifies notable gaps in standards aimed at ensuring the minimum quality and performance of batteries produced from informally recycled lead-acid batteries. Ambiguity surrounding the legal status of the e-rickshaw sector due to a lack of clear mandates from regulatory bodies further complicates the regulatory landscape. The dispersion of ULABs-related regulations across multiple policies and acts exacerbates integration challenges, creating loopholes that may lead to mismanagement. In response, the study proposes a set of recommendations to address these challenges.

Achieving a balance between economic imperatives and environmental stewardship in ULABs management requires the establishment of a harmonized regulatory framework, proactive engagement with stakeholders, and robust enforcement mechanisms. Implementing these recommendations has the potential to cultivate a more sustainable e-mobility ecosystem in Bangladesh, safeguarding both public health and environmental integrity.

Keywords: lead-acid battery, informal recycling, e-mobility, policy review, Bangladesh

Introduction

E-rickshaws have emerged as integral components of Bangladesh's transportation sector, offering a cost-effective and accessible mode of travel, particularly for short distances. Their affordability, coupled with benefits such as reduced emissions and noise pollution, has contributed to their popularity and widespread adoption (Rana et al., 2013; Ullah & Islam, 2017).

The transition towards electric-powered transportation, particularly electric rickshaws (e-rickshaws), has been notable in Bangladesh, reflecting advancements in socio-economic factors and technology adoption. E-rickshaws, primarily powered by lead-acid batteries (LABs), have become emblematic of this shift, yet they face challenges including regulatory ambiguities and exclusion from mainstream electric vehicle policies, hindering their potential to contribute to green public transport (Van der Straeten, 2022).

E-rickshaws, operating as intermediate public transport systems, play a crucial role in urban mobility, particularly in densely populated areas. The global electric three-wheeler market, driven largely by the Asia Pacific region, is poised for significant growth, with Bangladesh emerging as a key market alongside countries like India, China, and Thailand (Coherent, 2024; FBI, 2023; Saxena, 2019). The proliferation of e-rickshaws has not only met transportation needs but has also created employment opportunities, contributing to economic development and poverty alleviation (Cervero & Golub, 2007; Al-Amin & Sahabuddin, 2023).

According to the Bangladesh Home Ministry's parliamentary speech, around 3-4 million e-rickshaws are operated in the country (The Daily Star, 2024) and around 112 million passengers commute daily using e-rickshaws (UNCTAD 2024). With the surge in e-rickshaw demand, there is a parallel increase in the demand for batteries; about 4 to 6 batteries are needed to operate rickshaws and easy bikes, depending on the type and size of the vehicles. In a recent study conducted by the Standford Business School and Georgetown University in collaboration with Pure Earth Bangladesh, the e-rickshaw battery market is estimated to be around 8710 crores BDT, equivalent to US $871 million (UNCTAD 2024).

This rise in demand has fueled the growth of informal battery recycling operations, leading to environmental degradation and health hazards (Rahman, 2023). Regulatory challenges further compound the situation, with conflicting government directives regarding e-rickshaw operations and informal sector proliferation exacerbating the problem (TBS, 2021; The Daily Star, 2024). In light of these challenges, this study delves into the regulatory and policy landscape surrounding the recycling of used-lead-acid batteries (ULABs) in Bangladesh, aiming to identify gaps and propose solutions to ensure sustainable management practices.

Roles and dilemma of E-rickshaws in Bangladesh

In Bangladesh, e-rickshaws serve as vital components of the transportation sector, offering cost-effective and accessible travel for short distances (Rana et al., 2013). Their popularity, driven by factors like affordability and comfort, is further boosted by ride-sharing platforms like "Pathao," making them a preferred choice (Ullah & Islam, 2017). Additionally, e-rickshaws have become crucial sources of income for low and middle-income individuals, highlighting their socioeconomic significance (Cervero & Golub, 2007; Al-Amin & Sahabuddin, 2023).

E-rickshaws play diverse roles in Bangladesh's e-mobility landscape. Firstly, they reduce the country's reliance on fossil fuels, enhancing energy security and conservation efforts (Rana et al., 2013). However, this transition increases electricity demand, necessitating a shift to renewable energy sources. Secondly, they offer cost-effective transport with lower operational

costs, facilitating potential income growth for drivers (Cervero & Golub, 2007). Thirdly, e-rickshaws create employment opportunities, fostering economic development and benefiting marginalized communities (Al-Amin & Sahabuddin, 2023).

Moreover, they contribute to noise pollution reduction and traffic decongestion in urban areas, enhancing residents' well-being and improving traffic flow (Rana et al., 2013). Additionally, they enhance rural connectivity and drive technology transfer and innovation in the transportation sector (Cervero & Golub, 2007). Lastly, by aligning with global environmental commitments like the Basel Convention and the Paris Agreement, Bangladesh demonstrates proactive efforts to reduce emissions and combat climate change through e-rickshaw adoption (Rana et al., 2013).The improper recycling of ULABs presents significant environmental and health risks, underscoring the need for stringent regulations and sustainable management practices. Alternative battery technologies like lithium-ion batteries offer promising solutions, emphasizing the importance of transitioning towards environmentally friendly alternatives (The Daily Star, 2024).

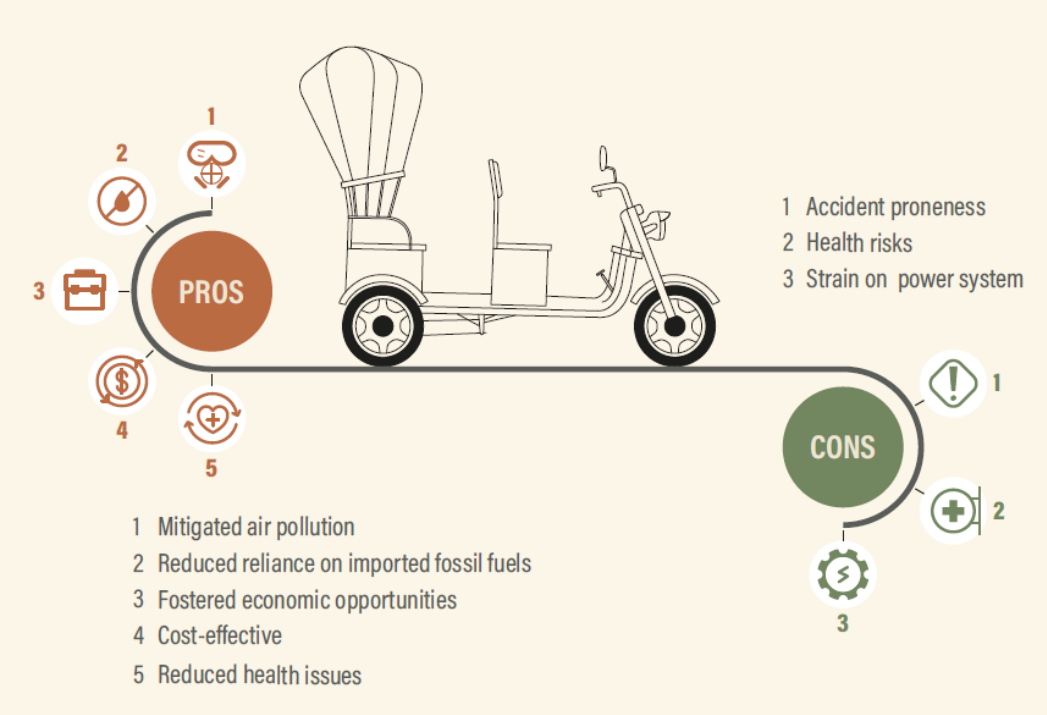

Fig. 1. Selected advantages and disadvantages of e-rickshaws in Bangladesh (credit: Lia Tostes)

E-rickshaws, vital for socioeconomic growth, strain the energy grid, consuming 4660 MWh of electricity daily, particularly during peak hours (Al-Amin & Sahabuddin, 2023), posing challenges to sustainability and macroeconomics. Safety concerns, including inadequate braking systems, heighten accident risks (Alamgir, 2022). Unsustainable lead-acid battery recycling in e-rickshaws poses grave health risks, especially to children in low- and middle-income countries like Bangladesh, due to lead pollution (UNICEF & Pure Earth, 2020). Lead exposure during childhood is linked to various health issues, demanding urgent attention (Pure Earth & UNEP, 2020). Exploring alternatives like lithium-ion batteries shows promise for sustainability, offering higher energy density and longer lifespans (Nair & Garimella, 2010; Li et al., 2010; Grey & Tarascon, 2017), despite initial cost disparities. Government support for replacing lead-acid

batteries with lithium-ion batteries highlights the potential of alternative technologies in addressing environmental concerns (The Daily Star, 2024).

Methods

The objective of this policy review is to assess the regulatory framework governing the recycling of ULABs in Bangladesh, focusing on policy analysis. The study employs qualitative analysis to examine existing policies and identify gaps in ULAB recycling regulations. The regulatory landscape comprises laws, rules, guidelines, and government orders pertaining to ULABs, both at the national and international levels, including the Basel Convention. Additionally, local government practices and international regulations influence ULAB recycling policies in Bangladesh.

This desktop study identifies and analyzes policies from various stakeholders involved in ULAB management. Furthermore, it reviews standards for lead-acid batteries (LABs) through the Bangladesh Standards and Testing Institution (BSTI) catalogue, supervised by the Ministry of Industries.

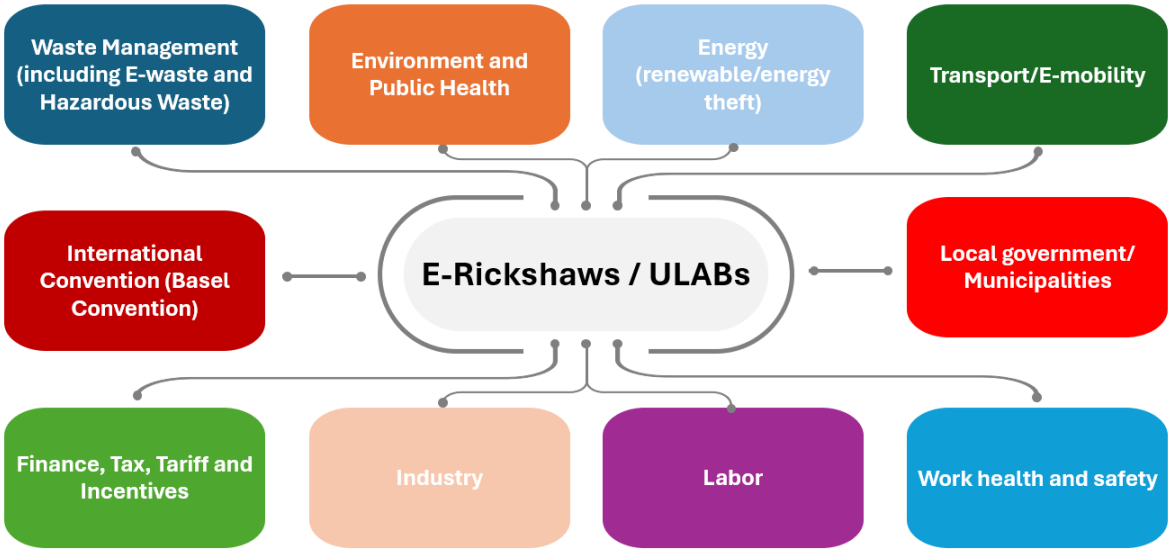

Fig. 2. Relevant policies around ULABs in Bangladesh

Figure 2 illustrates pertinent policies concerning ULABs in Bangladesh, encompassing household waste management, public health and environmental exposure, e-mobility, labor, and import/export regulations. It also highlights special tariffs and policies enforced by local authorities such as city councils and municipalities, alongside international regulations like the Basel Convention.

Results and Discussions

Available Standards related to ULABs in Bangladesh

Under the Ministry of Industries, Bangladesh Standards and Testing Institution (BSTI) develops different standards for the local context. After reviewing the Bangladesh Standards catalogue, the study identified a total of 16 standards related to LABs, as shown in Table 4. Out of 16 standards, only two standards (BDS 1778:2006 and BDS IEC 61430:2010) cover some form of performance characteristics and the performance of devices designed for reducing explosion

hazards. No standards and specifications are available for benchmark performance and standards for batteries manufactured from recycled LABs in Bangladesh.

Table 1. The available standards related to lead-acid batteries in Bangladesh (BSTI, 2023)

Bangladesh Standards No	Title and Requirements	Standard's Brief
BDS 1549 (Part-1):1995	Stationery lead acid batterie (Vented types)- General requirements	Applicable to lead-acid batteries, which are designed for services in a fixed location, and which are permanently connected to the load to the DC power supply.
BDS 1549 (Part-2):1995	Test conditions and test methods	Applicable to vented types-test conditions and test methods.
BDS 206 (Part-1): 2002	Lead acid starter batteries - General requirements and methods of test (Second Revision)	Applicable to lead-acid batteries with a nominal voltage of 6 V and 12 V. It is used primarily as a power source for passenger cars and vehicles for normal and severe use.
BDS 206 (Part-2): 2002	Lead acid starter batteries – Dimensions batteries and dimension and marking of the terminal (Second Revision)	Describe the dimensions of batteries and dimensions and markings of the terminals of lead-acid batteries.
BDS 206 (Part-3):2002	Lead acid starter batteries – Dimensions of batteries for heavy commercial vehicles (Second Revision)	Applicable to lead-acid batteries for starting, lighting and ignition of agriculture machines, buses, coaches and lorries.
BDS 479:1999	Rubber and plastics containers for lead-acid storage batteries (First Revision)	Requirements and methods of test for rubber and plastic containers of single cell or monobloc construction for all types of lead-acid batteries.
BDS 1741:2005	Synthetic separators for lead-acid batteries	Covers the requirements and the methods of tests for synthetic separators used in lead-acid storage batteries.
BDS 1778:2006	Valve-regulated sealed-type lead-acid stationary batteries	Specifies requirements for valve-regulated lead-acid cells and batteries intended for use in stationary applications. The Standard specifies the main performance characteristics and specifies corresponding test methods.
BDS 1992:2021	Lead-acid traction batteries – Dimensions of cells and terminals and marking of polarity on cells	This part of IEC 60254 is applicable to lead-acid traction batteries used as power sources for electric propulsion.
BDS IEC 60254-1:2018	Lead-acid traction batteries – Part 1: General requirements and methods of test	Applicable to lead-acid traction batteries used as power sources for electric propulsion.
BDS IEC 60254-2:2018	Lead-acid traction batteries – Part 2: Dimensions of cells and terminals and marking of polarity on cells	Applicable to lead-acid traction batteries used as power sources for electric propulsion.
BDS IEC 60896-11:2016	Stationary lead-acid batteries – Part 11: Vented types – General requirements and methods of tests	Applicable to lead-acid cells and batteries which are designed for service in fixed locations and which are permanently connected to the load and to the DC power supply. Batteries operating in such applications are called "stationary batteries".
BDS IEC 60896-21:2015	Stationary lead-acid batteries – Valve regulated types – Part 21: Methods of test	It applies to all stationary lead-acid cells and monobloc batteries of the valve-regulated type for float charge applications in a static location and is incorporated into stationary equipment.
BDS IEC 60896-22:2015	Stationary lead-acid batteries – Valve-regulated types – Part 22: Requirements	It applies to all stationary lead-acid cells and monobloc batteries of the valve-regulated type for float charge applications in a static location

		and is incorporated into stationary equipment or installed in battery rooms for use in telecom, UPS, utility switching, and emergency power.
BDS IEC 61430:2010	Secondary cells and batteries – Test methods for checking the performance of devices designed for reducing explosion hazards – Lead-acid starter batteries	Gives guidance on procedures for testing the effectiveness of devices which are used to reduce the hazards of an explosion, together with the protective measures to be taken.
BDS IEC TR 62060:2010	Secondary cells and batteries – Monitoring of lead acid stationary batteries — User guide	Applicable to lead-acid vented and valve-regulated batteries for use in stationary battery applications. The objectives of this technical report are: – to assist users in the selection of methods to obtain sufficient information to indicate the state of health of an operating stationary lead-acid battery; – to achieve this by describing characteristics that can be electrically measured and remotely interrogated on a regular basis; – to indicate the sensitivity and reliability of the measured data and to provide the user with methods of interpretation; – to provide users with good operating characteristics and general guidelines.

Relevant Regulatory Policies for ULABs in Bangladesh

Similar to many developing countries, the recycling of Used-Lead Acid Batteries (ULABs) often takes place through informal channels in Bangladesh, where safety and environmental regulations are not effectively enforced. Improper disposal of ULABs has led to significant environmental pollution by releasing toxic substances like lead, sulfuric acid and other hazardous chemicals into soil and water bodies. To address these challenges, several policies have been implemented.

Table 2. Relevant Regulatory Policies in Recycling ULABs in Bangladesh

Types of regulations	Relevant regulatory policies	Scopes and notes
Laws/Acts	Bangladesh Environment Conservation Act 1995, amended in 2010	The Act is to provide for the conservation of the environment, improvement of environmental standards and control and mitigation of environmental pollution.
	Bangladesh Environment Court Law 2010	This Act allows the government to take necessary legal action against any parties who create environmental hazards/ damage to environmentally sensitive areas as well as human society.
	The Bangladesh Labour Act, 2006 (ACT NO. XLII OF 2006)	It covers health, safety, welfare and working conditions and the environment of workers and apprenticeship.
	Electricity Act, 2018 (No. 7 of 2018 Law)	It outlines the penalty for electricity theft, which is about 3 years of jail or double the payment of electricity price and/or 50,000tk for non-commercial and industrial use, and it could be about 3 years of jail or double the payment of electricity price and/or 5,00,000tk for industrial and commercial purposes.
	Bangladesh Public-Private Partnership Act, 2015 (Act No. 18 of 2015)	An Act to provide for the legal framework for the creation of public-private partnerships by involving private sector participation along with public sector and attracting local and foreign investment upon connecting Bangladesh.
Rules	Environment Conservation Rules, 2023 (SRO No. 53)	This Rule aims to ensure sustainable development and prevent environmental degradation in Bangladesh by regulating activities that may adversely impact the environment and human health.
	Solid Waste Management Rules 2021	Specific sub-clauses have been added to the Solid Waste Management Rules 2021 to properly manage solid waste. Extended Producers Responsibility (EPR) has been included in the rules for the first time in Bangladesh.

	Hazardous Waste (e-waste) Management Rules 2021	The Rules set a goal of managing at least 50% of e-waste in 5 years and negotiating with the World Trade Organization (WTO) since the rule required the manufacturer and importer to collect and manage e-waste.
	Hazardous Waste and Ship-Breaking Waste Management Rules 2011	Which lists the hazardous waste, including Used Lead acid batteries whole or crushed (A1160) or any lead and lead compound.
Guidelines	EIA Guideline for Industries	An Initial Environmental Examination (IEE) and EIA study have been made regulatory need under certain categories of projects as specified in the Environment Conservation Rule, 1997 for obtaining an Environmental Clearance Certificate.
	Lead-Acid Battery Regeneration Circulation	The circulation put conditions for relevant stakeholders, actors to follow the regulations.
Govt Order/ Circulation	The Lead Acid Battery Preparation, Regeneration, Import, and Utilization Regulations Circulation (S.R.O. No. 45-Law 2021)	The circulation put conditions for relevant stakeholders, actors to follow the regulations.
	Hazardous Waste (e-waste) Management Circulation 2021 (SRO 187, Act 2021)	The circulation put conditions for relevant stakeholders, actors to follow the regulations.
International Laws	The Basel Convention and the Rotterdam Convention	Comply with the Basel and Rotterdam requirement and to prepare a coherent national strategy and action plan for the Environmentally Sound Management (ESM) of ULAB in Bangladesh. The Basel Convention Training Manual for the preparation of National Plans for the ESM of ULABs (including licensing, assessment of H&S, medical surveillance and site assessment.
Local Government	DNCC/ DSCC/ City Councils/Municipalities etc.	The local governments' waste management practices and initiatives. Local government policies to register non-motorized rickshaws and often motorized-rickshaws
Others	Integrated Energy and Power Master Plan 2023	The Integrated Energy and Power Master Plan (IEPMP) 2023 (MPEMR, 2023) developed by the Ministry of Power, Energy and Mineral Resources outlines 50% of electric vehicles by 2050.
	Policy Regarding Special Tariff and Benefits	The Ministry of Industry policy aims to transition the majority of passenger cars, buses, trucks, and 3-wheeler auto rickshaws to Electric Vehicles (EVs) by 2030.
	BRTA Draft Policy (2021) to expedite the import and domestic manufacturing of EVs	However, e-rickshaws do not fall under the e-vehicle category due to their lack of safety measures.

The Environmental Conservation Act (1997) serves as a comprehensive regulatory framework safeguarding Bangladesh's environment against various developmental challenges, with most regulatory policies deriving from its provisions. Below is a succinct analysis of pertinent policies concerning e-rickshaws and ULABs:

- Policy Regarding E-waste and Hazardous Waste:

In February 2021, the Ministry of Environment, Forest and Climate Change (MoEF) issued an order (S.R.O No. 45-Act/2021) under the Bangladesh Environment Conservation Act, 1995, mandating companies involved in lead-acid battery production and recycling to designate agents and obtain necessary clearances from the Department of Environment (DoE). Furthermore, the Hazardous Waste (e-waste) Management Rules, 2021, issued by the DoE in

June 2021, delineate the responsibilities of stakeholders in managing e-waste, including lead-acid batteries.

- Public Health and Environmental Exposure:

Amendments to the Bangladesh Environmental Conservation Act, 1995, in 2010 incorporated provisions for ULABs recycling and lead phase-out, emphasizing record-keeping and product inventory. The Bangladesh Environment Court Law 2010 enables legal action against entities causing environmental harm. Additionally, the Environmental Conservation Rules, 1997 (Amended 2011), set emission standards and waste management guidelines.

- Policy Regarding e-mobility in Bangladesh:

E-mobility policies focus on establishing charging infrastructure, defining tariffs, and simplifying registration processes for electric vehicles, including three-wheelers.

- Energy and Power Master Plan:

The Integrated Energy and Power Master Plan (IEPMP) 2023 outlines targets for electric vehicles, excluding e-rickshaws, aiming for 50% EV penetration by 2050.

- Policy Regarding Special Tariff and Benefits:

Policies incentivize EV adoption through tax holidays, subsidies, and financial incentives, alongside promoting local assembly and charging infrastructure development.

- Policy Regarding Labor:

Employers are required to ensure safe waste disposal and provide hazard mitigation measures, in line with labor laws and the National Child Labor Elimination Policy 2010.

- BRTA Draft Policy (2021):

The draft policy aims to facilitate EV import and manufacturing but does not cover e-rickshaws.

- International- Basel Convention:

Bangladesh, a signatory to the Basel Convention since 1993, regulates the transboundary movement and disposal of hazardous waste, including lead-acid batteries.

Gaps in Policies and Standards

The policy landscape concerning e-mobility in Bangladesh exhibits critical gaps, particularly in the regulation and enforcement of Lead-acid batteries (LABs) and Used Lead-Acid batteries (ULABs). The Lead-acid Battery Recycling and Management Rules of 2006 contain loopholes, necessitating a more comprehensive regulatory framework. While the Bangladesh Environment Conservation Act 1995 empowers authorities to address these gaps and imposes penalties for violations, their enforcement remains sporadic, necessitating stricter monitoring.

Inadequate regulation of ULABs management poses environmental and public health risks due to the presence of toxic substances like lead and sulfuric acid. Current recycling practices lack eco-friendliness and safety, urging the need for stringent regulations. The 2021 Statutory Regulatory Order (SRO) on ULABs recycling lacks clarity on quality standards and verification methods, potentially compromising recycling standards.

The Hazardous Waste (e-waste) Management Rules of 2021 overlook e-waste from transportation sectors like e-rickshaws, focusing mainly on household e-waste. Inadequacies in

labor safety and health, including the absence of an age limit for workers, highlight the need for implementing measures outlined in the National Child Labour Elimination Policy of 2010.

The Bangladesh Road Transport Act of 2018 and the Integrated Energy and Power Master Plan of 2023 overlook e-rickshaws, hindering their integration into sustainable transportation targets. The BRTA Draft Policy of 2021 excludes e-rickshaws from electric vehicle categories, citing safety concerns, further impeding their role in urban transportation.

Conflicting actions by authorities regarding e-rickshaws exacerbate confusion, hampering the development of coherent policies. The study identifies broad gaps in regulatory policies and standards related to ULABs in Bangladesh, necessitating comprehensive reforms.

Thus, the study identifies the following broad gaps in regulatory policies and standards related to ULABs in Bangladesh:

- *Discrepancies in the regulatory policies and standards:* Currently, e-rickshaws are not recognised e-rickshaws in the BRTA and national EV policy, which is needed for mandatory registration and recognition of the formal transport solutions in Bangladesh. The management of household batteries is listed under the national hazardous e-waste policy but not ULAB from transport which shows the weakness and silo approach of the regulatory policies. Finally, there is no minimum quality benchmark and standards on the efficiency and performance of batteries manufactured from recycled lead-acid-batteries.
- *A lack of harmonisation and integration:* ULABs link with multiple regulatory bodies; however, they have no harmonization and integration.
- *Oversight of the informal sector:* The role, activities and opportunities of the informal sector are widely oversight in the current policies
- *A lack of monitoring policy requirements:* The entire sector lacks strict and continuous monitoring and compliance assurance. Without regular monitoring systems, it would not be easy to achieve the sustainability benefits in the sector.

Bridging these policy gaps demands collaborative efforts between government agencies, industry stakeholders, financial institutions, and environmental organizations to establish and enforce regulations prioritizing sustainability, safety, battery quality, human health, and environmental well-being in Bangladesh's e-mobility sector. The available standards lack significant gaps in ensuring the quality and performance of the battery manufactured from recycled ULABs in Bangladesh. The sector needs to overcome the identified gaps in policies and standards to ensure confidence and trust in securing funds and long-term investment from MFI and traditional banking not only to improve current ULABs sectors but also to create alternative battery markets such as lithium-ion batteries in Bangladesh.

Conclusions

The contrast of e-mobility, notably e-rickshaws, as a vital informal economy for Bangladesh's marginalized poor, alongside the inadequate management and informal recycling of used lead-acid batteries (ULABs), presents a dual challenge. While millions rely on the lead-acid battery supply chain for their livelihoods, encompassing manufacturing, use, recycling, and re-manufacturing, this dependence poses significant risks to public health, particularly for vulnerable groups such as women and children.

Despite its integral role in livelihoods, the informal recycling sector significantly contributes to environmental pollution due to improper practices and the use of low-quality lead. This inefficiency exacerbates the country's energy demand compared to the more structured formal and industrial-grade lead-acid battery sector. The complexity of the ULABs sector is heightened

by the involvement of diverse stakeholders, including manufacturers, retailers, consumers, recyclers, regulatory bodies, funding agencies, and local communities.

Operating under both formal and informal systems, with participation from local and international entities, the ULABs sector faces challenges in implementing sustainable practices in manufacturing and recycling. Despite policies addressing ULABs-related issues, substantial gaps in administration and implementation persist, resulting in environmental degradation and health hazards. Balancing the economic importance of the ULABs sector with the imperative for sustainable and responsible practices remains a critical challenge for Bangladesh.

To address these challenges and fulfill the research aims, the following recommendations are proposed:

- Establish a harmonized regulatory framework: Develop a homogeneous and integrated regulatory framework incorporating all policies related to lead-acid battery management, including the energy sector, transportation, and child labor, to promote sustainable e-mobility while managing ULABs effectively.
- Recognize e-rickshaws in national e-mobility policy: Acknowledge the role of e-rickshaws in the national e-mobility policy and provide clear guidance to overcome current challenges, such as energy theft and safety issues.
- Communicate clear messaging to stakeholders: Provide clear communication to relevant stakeholders on the future plan for e-rickshaws and ULABs management through digital platforms, including relevant regulations, guidance, and penalties for both formal and informal sectors.
- Prohibit child labor and protect vulnerable women: Enforce regulations prohibiting the involvement of children under 18 and vulnerable women, such as pregnant women, in ULABs recycling to ensure their safety and well-being.
- Support business opportunities for sustainable recycling: Foster business opportunities for both informal and formal ULABs recycling with support and incentives for sustainable practices from governmental bodies while promoting the availability and use of higher-quality batteries in Bangladesh's internal market.

Though the study focused on regulatory policies and standards related to e-rickshaws and the battery industry in Bangladesh, it suggests alternative business opportunities, such as lithium-ion batteries, and highlights public health concerns. Implementing these recommendations would contribute to a more sustainable and inclusive e-mobility ecosystem in Bangladesh, balancing economic growth with environmental protection and public health concerns.

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