URBAN AGGLOMERATIONS
MASTER OF SCIENCE
Interdisciplinary Sustainable City-Regional Development

FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Exploring the Impact of Transitioning to E-Buses on the Public Transport Workforce

A Case Study of Metrobús Line 3 in Mexico City

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Master Thesis
MSc. Urban Agglomerations
Frankfurt University of Applied Sciences

January 2024

ABSTRACT

The global shift towards electrifying public transport as a response to climate change and air pollution introduces challenges for the workforce, particularly in developing countries where precarious working conditions are prevalent. This research focuses on the transition from diesel to electric buses in Mexico City's bus rapid transit - Metrobús Line 3, aiming to understand its impact on the public transport sector workforce. Through surveys with the workforce, expert interviews and secondary research, the study reveals positive and negative aspects of bus fleet electrification, emphasizing the importance of viewing this transition not solely as a technological change but as an opportunity to comprehensively address workforce issues. The research proposes a three-level categorization of measures for implementation, stressing the need for coordination between the levels to achieve a Just Transition, not only for the workforce of Metrobús Line 3 but potentially also for the entire public transport workforce in Mexico.

Keywords: electric buses, public transport workforce, Just Transition, Metrobús, Mexico City

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ABBREVIATIONS

APEC	Asia-Pacific Economic Operation
ATM	Alianza de Tranviarios de México [Alliance of Mexican Tramway-men]
BRT	Bus Rapid Transit
C40	C40 Cities Climate Leadership Group
C.I.S.A.	Corredor Insurgentes Sociedad Anónima
CFE	Federal Electricity Commission of Mexico
CFF	C40 Cities Financing Fund
CO2	Carbon dioxide
COP	United Nations Climate Change Conference
E-bus	Electric bus
EBRD	European Bank of Reconstruction and Development
GDP	Gross Domestic Product
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH [German Corporation for International Cooperation GmbH]
HR	Human Resources
ICCT	International Council on Clean Transportation
ICE	Internal combustion engine
IDB	Inter-American Development Bank
IHRB	The Institute for Human Rights and Business
ILO	International Labour Organization
IMDUT	Mobility and Urban Development Institute of Yucatán
IPCC	Intergovernmental Panel on Climate Change
ITDP	Institute for Transportation and Development Policy
ITF	International Transport Workers' Federation
JT	Just Transition
LCA	Lifecycle assessment
LFP	Lithium iron phosphate batteries

LGBTQIAPN+	Lesbian, Gay, Bisexual, Transgender, Intersex, Queer/Questioning, Asexual, Pansexual, Non-binary
MIVSA	Movilidad Integral de Vanguardia [Integral Mobility at the Forefront]
MTT	Ministry of Transportation and Telecommunications of Chile
NDC	Nationally Determined Contribution
P4G	Partnering for Green Growth and the Global Goals 2030
PPE	Personal protective equipment
RTP	Passenger Transport Network
SDG	Sustainable Development Goal
SEDATU	Secretaría de Desarrollo Agrario, Territorial y Urbano [Secretary of Agrarian, Territorial and Urban Development}
SENCE	National Training and Employment Service of Chile
SernamEG	National Service for Women and Gender Equity of Chile
SITEUR	Urban Electric Train System in Jalisco, Mexico
SLOCAT	Partnership on Sustainable Low Carbon Transport
TCO	Total costs of ownership
TUMI	Transformative Urban Mobility Initiative
U.S.	The United Sates of America
UC	University of California
UITP	International Association for Public Transport
UN	United Nations
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WEF	World Economic Forum
WRI	World Resources Institute
ZEBRA	Zero Emission Rapid-deployment Accelerator
ZeEUS	Zero Emission Urban Bus Systems

ACKNOWLEDGEMENTS

Firstly, I would like to express my sincere gratitude to my supervisors, Prof.Dr.-Ing. Dennis Knese and Dr. Jens Giersdorf for their invaluable guidance. I would also like to extend my thanks to all the professors at Urban Agglomerations for an inspiring master's program.

I am appreciative of the opportunity to intern at TUMI, an experience that not only influenced the topic of this thesis but also connected me with a network of experts and organizations, including Joselyn Delgado Miranda, Gabriela de la Torre Ríos and the dedicated staff of GIZ Mexico, whose support made this study possible.

A special thank you goes to the cooperative efforts of the staff at Metrobús and MIVSA. I also extend my appreciation to the interviewees, who remain anonymous for privacy reasons.

Last but not least, thanks to my friends and family for their support, love and encouragement throughout this academic journey.

1. INTRODUCTION

1.1 Background and problem

Transport is a major contributor to greenhouse gas (GHG) emissions, accounting for approximately one quarter of global emissions (UN, 2021, p.1). In response to this pressing issue, many cities are taking measures to reduce their carbon footprint, one of them being the electrification of bus fleets. Mexico City, with its significant public transport modal share of 50% (TUMI, 2022, p.1), heavy reliance on fossil fuels and vulnerability to the negative impacts of climate change, faces an even greater urgency to address this challenge.

The thesis explores the impact of this technological shift from diesel to electric buses (e-buses) for the public transport workforce. This sector is known on a global level for its precarious working conditions, including long working hours, high stress levels, physical discomfort and risks of exposure to accidents (Arias-Meléndez et al., 2021). Additionally, the lack of equity within the sector, which is predominantly male-dominated, poses another significant challenge. As cities set targets to mitigate climate change by transitioning to e-bus fleets, this innovative technology has significant implications for the workforce such as changes in job roles, the need for specialized training, workplace safety standards and job security (EBRD, 2021; ITF, 2022; UITP, 2019). In addition, it influences discussions and actions related to workforce well-being, gender equity, policy development and governance. The rapid implementation of the technology in response to climate change and pollution urgency risks legitimizing the persisting job precariousness in this profession, especially in developing countries, while overlooking the principles of a Just Transition (JT) such as inclusiveness, social dialogue and collective bargaining. As one of the first electric articulated bus lines in Latin America, currently operating with 60 e-buses since March 2023, Mexico City's bus rapid transit (BRT) - Metrobús Line 3 provides a suitable case study for exploring the effects of this transition on its public transport workforce.

1.2 Objective and research question

The objective of this thesis is to investigate the impact that the transition from diesel to e-buses has on the public transport sector workforce comprising of drivers and maintenance staff, related to salary, working hours, workload, job satisfaction, challenges, training requirements and overall quality of life at Metrobús Line 3, taking into consideration the

principles of a JT and broader challenges the public transport workforce in Mexico is facing.

The main research question is: How is the electrification of bus fleets impacting the public transport workforce of Metrobús Line 3?
Additional research questions: What are the challenges faced by the public transport workforce of Metrobús Line 3 associated with the electrification of bus fleets? What recommendations related to the electrification of bus fleets can ensure a JT for the public transport workforce of Metrobús Line 3?

1.3 Rationale and significance of research

The pressing issues of climate crisis and air pollution, together with global efforts to find solutions, highlight the significance of exploring the electrification of bus fleets, a key strategy in mitigating GHG emissions. As road transport is a major contributor to these emissions, understanding the impact of this transition on the public transport workforce, specifically drivers and maintenance staff, whose daily job is directly affected by it, is crucial. While existing studies highlight the benefits of transport electrification (Bloomberg L.P., 2018; EBRD, 2021; Sustainable Mobility for All 2022; UN, 2023), including for the workforce, the process is relatively new, particularly in developing countries. Investigating the complexities of the electrification process and its implications on the workforce is essential to understand and successfully address problems.

This study reveals the challenges faced by the workforce of Metrobús Line 3 in the context of bus fleet electrification and recommends measures for achieving inclusive and equitable working conditions, a fundamental aspect of a JT. Furthermore, the study not only presents the specific challenges faced by the targeted workforce but also addresses broader issues within Mexico's public transport system that impact the same workforce. Ultimately, the thesis offers recommendations at the company, Metrobús and institutional levels to mitigate these challenges, contributing valuable insights to the field.

The study is useful to Metrobús and its subsidiary company managing Line 3, Movilidad Integral de Vanguardia [Integral Mobility at the Forefront] (MIVSA), to assess employee satisfaction, address challenges and foster positive relationships, while policymakers can use the insights for incorporating JT elements to the ongoing energy transition in the public transport sector. Moreover, there is an interest from Metrobús to learn from the results and take action to improve working conditions. Thus, this study has the potential

to improve the overall well-being of the public transport workforce in Mexico, extending beyond the specific category of bus drivers and maintenance staff of Metrobús Line 3.

2. METHODOLOGY

2.1 Research design and methods

Research design

This study adopts an applied research approach, through a case study typology to investigate the effects of electrification technology on the public transport workforce and propose practical solutions to the challenges they face. The case study typology allows for an in-depth analysis of the context and the development of particular solutions to the identified issues. The chosen case study is Metrobús Line 3 in Mexico City.

Data collection method

The data collection method includes primary data that involves surveys and interviews found in the Appendix chapter and secondary data collected from the literature review. The material acquired from surveys and interviews was summarized and interpreted by the researcher using an indirect transcript approach for analysis.

I. Primary data

a) Surveys

Two surveys were distributed to the two target groups: one for e-bus drivers and one for maintenance staff, containing 20 and 19 questions, respectively. The survey questions include a mix of closed-ended and open-ended questions, with a mixed-methods approach used to collect both qualitative and quantitative data. This dual approach was chosen to ensure a comprehensive understanding of the target groups' experiences, perceptions and requests, recognizing that a solely quantitative method might lack depth and a solely qualitative method may make it difficult to generalize. The surveys were sent to MIVSA in July 2023 through two Google Form links and the responses from drivers and maintenance staff were received in an Excel sheet format in October 2023. The results were translated by the author from Spanish to English. The response rate for the e-bus drivers' survey was 70%, with 155 out of 221 drivers participating, while for the maintenance staff, it was 95%, with 20 out of 21 workers responding.

b) Interviews

Semi-structured interviews were conducted with four experts of the field and an additional interview was carried out with a representative from MIVSA's Human Resources (HR) department between July and November 2023. The four experts included a Metrobús representative, an e-mobility expert based in Mexico City, a representative from the International Association for Public Transport (UITP) Mexico, and a representative from the Mobility and Urban Development Institute of Yucatán (IMDUT). All interviews were conducted online, except for the one with the IMDUT representative, which took place in person. Responses were documented through note-taking. These interviews not only offered a deeper understanding of the Mexican context but also provided information beyond what the literature review could capture. The semi-structured interview format was selected for its flexibility, allowing for spontaneous questions and creating a conversational atmosphere, thereby delivering valuable insights.

II. Secondary data

To supplement the primary data, secondary research was conducted, utilizing relevant resources such as reports, articles and official documents by researchers, international organizations and local and national bodies of government. These materials covered topics such as e-buses, public transport in Mexico and Mexico City, the concept of JT and climate change. These sources helped contextualize the findings, supported the analysis of the primary data and served as preparatory sources before the interviews and surveys were conducted.

2.2 Scope and limitations

This research focuses only on battery electric buses, referred to as e-buses, despite the existence and implementation of other forms of electric public transport vehicles. Regarding the workforce, the focus is only on e-bus drivers and maintenance staff, excluding other job positions that may be influenced by the electrification of e-buses. Concerning the impact of the new technology, it is important to acknowledge underlying factors indirectly tied to the technology but still relevant and impactful on the workforce. The researcher decided to take these factors into consideration in order to have a comprehensive understanding of the challenges and offer effective recommendations.

In terms of limitations, firstly, a budget constraint prevented the researcher from traveling to Mexico City to conduct in-person interviews and surveys, potentially limiting the

ability to engage with more experts for a more comprehensive understanding of the context. Secondly, the surveys were administered by MIVSA, with some questions removed from the researcher's original survey in Google Form format and the survey was made non-anonymous, potentially compromising the honesty of responses from the target group. Nevertheless, despite these constraints, the survey data remained insightful, identifying crucial issues. Additionally, it is important to acknowledge that interviewee responses may have been influenced by their respective job positions.

2.3 Case study selection criteria and rationale

Metrobús Line 3 was chosen as the most suitable case study due to the absence of literature examining Metrobús as a case study in the JT context and the recent electrification of Line 3 in March 2023. Additionally, the researcher's network facilitated the implementation of surveys and interviews, while the absence of a language barrier, as the researcher is fluent in Spanish, contributed to seamless communication. The availability of information and literature on Mexico and Mexico City pertaining to the topic further supported the selection. Moreover, given the planned electrification of additional lines, this study can offer valuable feedback for Metrobús in future electrification plans.

2.4 Thesis outline

The literature review chapter provides a fundamental understanding on the study's key topics: e-buses and JT. The first section delves into the connection between public transport and climate change, highlighting the urgency of the climate crisis, the role of transport, alignment with Sustainable Development Goals (SDGs), and the issues with Nationally Determined Contributions (NDCs) concerning public transport. The second section explores bus fleet electrification, providing brief information on electric mobility's link with public transport, e-bus technology, global e-bus deployment and initiatives fostering e-bus adoption. It also addresses the benefits, challenges and implications for the public transport workforce. The third section focuses on JT and its correlation with the public transport workforce, offering a brief history, varied definitions of JT, concerns related to the transition to a green economy and the three factors impacting the workforce in connection with electrification. Strategies and specific measures for JT gathered from diverse sources are summarized in this section. The fourth section outlines best practices in JT within the public transport sector in Latin America, including gender-focused initiatives from five Latin American cities, the successful case of collective bargaining in

Chile and MetrôRio's initiatives concerning employee well-being and inclusive work culture.

The case study chapter begins with a broad perspective of the transport sector in Mexico, to then narrowing its focus to Mexico City, Metrobús, and finally, Metrobús Line 3. The first section offers an overview of Mexico's transport sector, addressing the impact of climate change, the country's decarbonization targets, federal funds allocation in transport, the electrification process and the involvement of international organizations like UITP in promoting sustainable mobility in Mexico. The second section shifts to Mexico City, providing a brief history of the city's public transport system, the current categorization of the local public transport system, the modal share, decarbonization targets and the city's transport electrification plan. The third section delves into the challenges faced by the public transport workforce in Mexico, not solely related to electrification, to comprehensively understand issues encountered by the entire sector's workforce. The fourth section presents an overview of Metrobús, offering general information, a brief history of the agency's formation, current operations, financial structure and JT initiatives. The fifth section narrows the focus to Metrobús Line 3, providing general information about the line and its operation. It continues by detailing the electrification process, explaining the selection of Line 3 and outlining the steps taken for implementation. The concluding part presents insights from the interview with the HR department of MIVSA, covering various employment aspects and findings from surveys conducted with the e-bus drivers and maintenance staff of Line 3, addressing aspects such as working hours, workload, job satisfaction, challenges, training requirements and overall quality of life.

The discussion chapter addresses the research questions based on the literature review and the findings from the interviews and surveys. It outlines both the positive and negative aspects of bus fleet electrification, as well as the challenges faced by the workforce of Metrobús Line 3. Additionally, it provides specific recommendations that aim to ensure a JT, categorized into three levels: operator, transport authority and policymaker, based on the primary actor responsible for their implementation.

The conclusion chapter summarizes the key findings of the study. It then proceeds to discuss the implications of these findings, explaining how this research can be used to improve the working conditions for the workforce of Metrobús Line 3 and how both the broader public transport workforce in Mexico and key stakeholders can benefit from it. Finally, it offers recommendations for future research.

3. LITERATURE REVIEW

3.1 The link between public transport and climate change

As a response to the pressing issue of global warming, the Paris Agreement established in 2015, expresses the urgent need to limit the global temperature increase below 2°C above the pre-industrial levels, with a goal of 1.5°C (UNFCCC, 2015, p.2). The 2023 report from the Intergovernmental Panel on Climate Change (IPCC, p.4) shows that despite the countries' commitments made under the NDCs to reduce GHG emissions, projections indicate that the 1.5°C threshold will be breached by the early 2030s and the planet will be two to three degrees warmer than the pre-industrial period by the end of the century. As the global mean temperature in 2022 was approximately 1.15°C above the pre-industrial average (UN, 2023, p.16), during the 2022 United Nations Climate Change Conference (COP 27), it was emphasized that an immediate and transformative shift in the energy system would be required to achieve a 43% reduction in GHG emissions by 2030, using 2019 levels as a reference, a concern highlighted by scholars over the past decade (Gambhir, et al., 2019, p.71; Sachs, Schmidt-Traub and Williams, 2016, p.799). The necessity for the implementation of additional policies by national governments is stressed by scholars and transport practitioners; the absence of such policies could hinder many countries from achieving their NDCs (Agora Verkehrswende, GIZ and WEF, 2020; Fekete et al., 2020).

The transport sector contributes significantly to global GHG emissions, accounting for approximately 25% of the total, with 95% of the sector's energy deriving from fossil fuels (UN, 2021, p.1). Among transport modes, road transport stands out as the largest emitter, responsible for over half of all transport-related GHG emissions (Zhang and Fujimori, 2020, p.1). This situation arises from the historical prioritization of car-focused investments in road infrastructure, rather than investments in public transportation. Consequently, there has been a heavy reliance on fossil fuels, unappealing public transport services, significant traffic congestion issues, environmental pollution, road safety challenges and unequal access to transportation options (Sustainable Mobility for All, 2022; Zhang and Fujimori, 2020). Therefore, public transport plays an essential role in the necessary transformation outlined in the Paris Agreement. Acknowledged for its energy efficiency and the reduction of GHG emissions per person, public transport, along with walking and cycling, is an equitable mode, providing access to social and economic opportunities independently of private vehicle ownership, effectively utilizing space and positively influencing public health and traffic safety (Sustainable Mobility for All, 2022).

Explicitly acknowledged as a contributor to SDG 11—Sustainable Cities and Communities, public transport aligns with the United Nation (UN) Agenda 2030's goal of providing safe, affordable, accessible and sustainable transport systems for all. However, this alignment extends to a range of SDGs:

- Poverty reduction (SDG 1): By granting access to economic opportunities and education.
- Improved health (SDG 3): Through the reduction of air pollution, increased physical activity and enhanced road safety.
- Empowerment of women and girls (SDG 5): By offering safe and independent mobility.
- Support for energy transition (SDG 7): Due to greater energy efficiency, facilitating the shift to affordable and sustainable energy.
- Contribution to economic growth and decent work (SDG 8): As an investor, job creator and facilitator of efficient urban mobility.
- Optimization of investments in resilient infrastructure (SDG 9)

(UN, 2015 in Sustainable Mobility for All, 2022).

Nonetheless, in their study examining the impact of public transport on reducing private motor vehicle usage and achieving decarbonization within the framework of NDCs, Kustar, Welle and Tun (2022, p.2) found that out of 163 submitted NDCs, 50% specifically address the reinforcement of public transport as a strategy for mitigating emissions. Reports from the Partnership on Sustainable Low Carbon Transport (SLOCAT) (2020) and Sustainable Mobility for All (2022) emphasize the issue of insufficient specificity in the NDCs regarding public transport. The majority of countries use vague language without setting clear quantitative targets, while 26 of the submitting countries recognize public transport's role in achieving development goals, with only 2 setting specific targets (SLOCAT, 2020, p.10). As a result, transport experts emphasize the necessity for acknowledging public transport as a climate action that contributes to broader SDGs and suggest linking public transport initiatives to both local and national climate investment plans (Sustainable Mobility for All, 2022).

3.2 Electrification of bus fleets

Electric mobility, which comprises of the systems, services and equipment facilitating the movement of passengers and freight through electric-powered means of transport, is recognized as crucial for achieving sustainable development and decarbonization targets (Sclar et al., 2019; Sustainable Mobility for All, 2021; Zhang and Fujimori, 2020). The appeal of electric vehicles lies in their capacity to produce zero tailpipe emissions. However, it's important to note that while CO2 emissions are lower during operation, lifecycle assessment (LCA) emissions may still be present, particularly in regions heavily reliant on coal-generated electricity (Bloomberg Finance L.P., 2018). Transport experts argue that simply acknowledging electric mobility for its potential to mitigate climate change is insufficient, because it could imply replacing the current vast fleet of approximately one billion conventional internal combustion engine (ICE) cars with electric vehicles, which would be ineffective in meeting climate targets or addressing critical global mobility challenges such as congestion, safety concerns and affordability (Sustainable Mobility for All, 2021). The combined efforts of electrifying land transport and enhancing energy efficiency are projected to contribute approximately 60% of the required reductions in the transport sector, while the remaining 40% is anticipated to be achieved through measures discouraging unnecessary motorized trips and fostering a shift to more efficient transport systems, such as public transport (Creutzig et al., 2021 in Sustainable Mobility for All, 2022, p.6). Thus, to meet this objective, the electrification of public transport, including bus fleets, a dominant mean of transport in developing countries, is an indispensable measure (Bloomberg Finance L.P., 2018; ZeEUS, 2017). This transition will require a rapid and large-scale implementation, involving the phase-out of ICE buses (Sustainable Mobility for All, 2021).

There are different types of electric buses on the market, such as full battery electric buses, plug-in hybrid buses, fuel cell electric buses and trolleybuses (ZeEUS, 2017). However, for the purpose of this thesis, the study focuses only on full battery electric buses, referred to as e-buses, which are entirely electric vehicles with an electric propulsion system that relies on chemical energy stored in rechargeable battery packs, eliminating the need for ICEs, fuel cells or fuel tanks; they typically employ lithium-ion batteries, with static charging facilitated by mechanical and electrical equipment (ASSURED, 2022; ZeEUS, 2017).

Reports from global organizations and projects tracking the deployment of e-buses show that the worldwide expansion of the e-bus market is fueled by the increasing focus on metropolitan areas where major cities, pressured to enhance air quality and reduce CO2 emissions, are transitioning their municipal bus fleets (Bloomberg Finance L.P., 2018; C40, 2023; ICCT, 2021; UITP, 2019; ZeEUS, 2017). The competitiveness of e-buses is growing due to advancements in battery technology, resulting in cheaper, lighter and more efficient power-storage batteries (Bloomberg L.P., 2018; EBRD, 2021). Research by the Institute for Transportation and Development Policy (ITDP) and University of California (UC) Davis (2021, p.5) estimates a global requirement of 14.3 million buses, electric and ICE cumulative, by 2050, with a shift to zero-emission buses from 2040 onward. Notably, China has a leading role by being the largest producer and user of e-buses. Major Chinese cities, such as Shanghai and Shenzhen, have ceased purchasing new ICE municipal buses, contributing to 99% of global e-bus sales by 2017 (Bloomberg L.P., 2018, p.4). India also presents a substantial market, with an expectation of over 50,000 e-buses by 2030 (UITP, 2022, p.1). Recent data from the e-Bus Radar, that monitors e-bus adoption in Latin America, reports a total of 3,934 battery e-buses in operation as of September 2023, meanwhile Brazil, Colombia, Chile and Mexico are estimated to account for 82% of the market until 2030 (C40, 2023, p.10). Countries such as Denmark, the Netherlands and New Zealand have committed to full decarbonization of their bus fleets until 2025, whereas Austria, the U.S. (United States of America) state of California, Cape Verde, Chile and Colombia have set a full decarbonization target year that varies from 2029 to 2035 (ICCT, 2021).

While e-bus adoption has surged globally, it still falls short of contributing significantly to long-term climate objectives. The movement needs to accelerate, with reports indicating a required doubling of investment in e-buses and low-carbon technologies over the next two decades to effectively combat climate change (Sclar et al., 2019, p.5). Initiatives like the C40 Fossil Fuel Free Streets Declaration, the Transformative Urban Mobility Initiative (TUMI) E-Bus Mission and the Zero Emission Rapid-deployment Accelerator (ZEBRA) Partnership are crucial in fostering global policy momentum and supporting the transition to e-buses, especially for developing countries. Projects such as Zero Emission Urban Bus Systems (ZeEUS) in Europe and guidelines provided by organizations like the World Resources Institute (WRI), Sustainable Mobility for All and TUMI E-Bus Mission offer valuable frameworks for successful e-bus adoption (Li et al., 2019; Sustainable Mobility for All, 2022; TUMI, 2023a; ZeEUS 2017).

3.2.1 Benefits

The adoption of e-buses brings about a spectrum of benefits, categorizable into environmental, economical and social dimensions, but also inextricably connected. Environmentally, utilizing electricity for transport aligns with the goal of reduced energy consumption and local pollution. Research shows that, globally, a profound shift to e-buses could result in 1.4 billion tons of CO2 and almost 30 million tons of particulate matter savings by 2050 (UNEP, 2022, p.2). However, multiple reports stress the significance of sourcing electricity from renewable means to attain zero carbon tailpipe emissions and promote low carbon economies (EBRD, 2021; Sustainable Mobility for All 2022; UN, 2023; Zhang and Fujimori, 2020).

From an economic perspective, e-buses include lower operational costs, reduced downtime due to lower maintenance requirements and the potential for job creation by building a domestic industry around the electrification of transport (Bloomberg L.P., 2018; EBRD, 2021). Moreover, a study conducted by the University of Central Florida (2018), suggests that the TCO for electric vehicles, including e-buses, could be substantially lower than ICE vehicles, especially when considering high vehicle usage levels. This cost advantage is expected to further improve with the ongoing decline in the price of lithium-ion batteries (Das, Sasidharan and Ray, 2019). While numerous studies and reports from ZEBRA show that e-buses are a financially viable option with the potential for significant job creation (Bloomberg L.P., 2018; C40, 2020), predicting the economic impact of e-bus deployment on both a national and global scale remains challenging due to the emerging state of this industry (ZEBRA, 2020).

The social benefits of switching to e-buses are numerous. Firstly, the reduction in noise pollution is notable, as e-buses operate more quietly than their diesel or compressed natural gas counterparts. Research indicates that high noise levels, prevalent in major cities worldwide, can lead to adverse health effects such as elevated blood pressure, coronary artery disease, hearing loss and even heart attacks (TUMI, 2023b). Furthermore, the insights provided by TUMI (2023b) indicate that the positive change in air quality due to the deployment of e-buses has tangible health benefits. Transitioning to e-buses is estimated to avoid numerous premature deaths and hospital admissions annually in cities like Jakarta and Delhi (UNEP, 2022). Furthermore, the electrification of transport serves as a path for industrial policy considerations. Governments recognize the potential to stimulate job creation through the establishment of a domestic industry centered around e-bus production and associated sectors (Bloomberg L.P., 2018; C40, 2020).

While an extensive body of literature highlights the economic and environmental advantages of e-buses, the same cannot be asserted for social benefits. Health effects and job creation emerge as the most widely discussed social benefits in studies, but a comprehensive perspective is lacking in the broader mainstream literature on e-buses.

3.2.2 Challenges

Switching to e-bus fleets brings significant advantages but faces various complex challenges, which can be categorized into four primary categories: financial, technological, institutional barriers and environmental considerations (Bloomberg Finance L.P., 2018; C40, 2023; EBRD, 2021; Sclar et al., 2019; Sustainable Mobility for All, 2022; UN, 2023; Zhang and Fujimori, 2020). The C40 study (2023) focuses on challenges specific to Latin America, whereas the others provide a global overview of e-bus adoption barriers.

1) Financial Barriers

Upfront costs
The greatest obstacle cited by all sources is the high initial cost of electric buses and the charging infrastructure. Addressing this requires financial support and alignment between public budgets and the actual costs of electrification (Bloomberg Finance L.P., 2018; Sustainable Mobility for All, 2022).

Financial support and business models
New business models and financing mechanisms are necessary. Collaborative efforts involving national governments, local authorities, bus manufacturers, operators and energy providers are essential to alleviate financial barriers (Bloomberg Finance L.P., 2018; Sustainable Mobility for All, 2022).

Traditional procurement practices
The existing rigid procurement practices, which incentivize low-cost and low-risk procurement, pose significant challenges (Sustainable Mobility for All, 2022). According to Sclar et al. (2019), these models frequently find it difficult to adjust to the particular cost structure and risks connected with e-buses.

2) Technological Barriers

Knowledge gaps

Cities face challenges due to a lack of information for decision-making, which include insufficient knowledge on the barriers and enablers of implementing e-bus fleets, especially at the early stages of planning e-bus projects (Sclar et al., 2019; Sustainable Mobility for All, 2022).

Operational limitations

Key technological barriers arise also from the current operational limitations of e-buses and charging infrastructure. Challenges include limited range and power and a learning curve in battery manufacturing (EBRD, 2021; Sclar et al., 2019).

Charging infrastructure standardization

The lack of charging infrastructure standardization creates obstacles in determining the residual value of e-buses, reducing flexibility and potentially increasing costs (Bloomberg Finance L.P., 2018).

3) Institutional Barriers

Policy and legislative gaps

The lack of comprehensive and integrated sustainable mobility visions, appropriate prioritization of modes and evidence-based policy-making poses institutional challenges (C40, 2023; Sustainable Mobility for All, 2022).

Regulatory framework

A solid regulatory framework is necessary to attract foreign investment, with updated legislation needed to promote incentives for the public transport sector (C40, 2023).

Operational challenges

Cities face institutional barriers related to the lack of leadership, pragmatic public policies and institutional capacity. Some cities lack the resources or jurisdictional authority to coordinate an e-bus project (Sclar et al., 2019). Furthermore, the absence of government access to land and property poses a major obstacle to improving and implementing the charging and grid infrastructure required for e-bus adoption (Ibid.).

4) Environmental Considerations

Power source and emission reduction
Ensuring that the electricity powering e-buses comes from renewable sources is vital to maintain their environmental benefits. Otherwise, the intended reduction in emissions might be compromised (Sustainable Mobility for All, 2022; Zhang and Fujimori, 2020).

Resource concerns
Challenges such as resource availability, labor rights and non-climate environmental impacts, highlight the need for sustainable practices and recycling in the production of batteries (Sustainable Mobility for All, 2022; UN, 2023).

3.2.3 Implications for the workforce

The significant implications of transitioning to e-buses are detailed in Table 1, taken from the International Transport Workers' Federation (ITF) report (2022), categorizing these impacts into operations, maintenance and charging. Drivers must undergo retraining to ensure safe operation, understand charging procedures, adapt to different braking and drive characteristics and adopt eco-driving practices for energy efficiency (ITF, 2022). Additionally, adjustments to drivers' pay and working hours are essential to accommodate charging schedules, as they would need to perform the so-called "dead" kilometers to and from charging stations (EBRD, 2021; ITF, 2022).

Maintenance processes are notably affected by the shift to e-buses. With approximately 80% fewer parts than traditional ICE buses, there is a reduced need for mechanical maintenance staff (ITF, 2022). Instead, the demand for electricians increases as the emphasis shifts to electric systems within buses, charging stations and associated monitoring and communication systems (EBRD, 2021; ITF, 2022;). Considering that numerous studies regarding energy transition emphasize the significant increase in job opportunities within the transport sector (Bloomberg L.P., 2018; C40, 2020; GIZ, 2022; ILO, 2020; ITF and C40, 2021; Jaeger et al., 2021), the ITF raises concern in their report (2022) about the potential displacement of older workers, which could result in a loss of jobs and exclusion of experienced staff from new bus operation and maintenance roles.

Charging processes undergo a transformation, shifting from traditional fueling and cleaning to charging and cleaning (ITF, 2022). Workers involved in these tasks require

retraining to manage charging stations efficiently, as operating with high-voltage equipment introduces different safety hazards (EBRD, 2021; ITF, 2022; UITP, 2019).

Issue	Implications for workers
Operation	Drivers will need to be retrained in:
	• Safe operation
	• Charging procedures
	• Different braking and drive characteristics
	• Eco-driving to reduce energy consumption
	Drivers pay and working time need to be renegotiated considering charging schedules.
Maintenance	Fewer mechanics, more electricians:
	• Less need for mechanical maintenance staff, higher need for electrical
	• Electrical work becomes more extensive and specialist, including high voltage power equipment
	• Overall staff numbers are expected to decrease for maintenance
Charging	Work process at terminal changes from 'fuelling and cleaning', to 'charging and cleaning'. Retraining needed for workers to manage charging stations
	Different safety hazards operating with high voltage equipment

Table 1. Important considerations for workers with the introduction of e-buses (Source: ITF, 2022)

3.3 Just transition and the public transport workforce

3.3.1 The concept of Just Transition

The concept of JT emerged in the 1970s, originating from the efforts of the U.S. trade unionist Tony Mazzocchi to address health and safety issues at Shell refineries, one of the largest multinational oil and gas companies, aligning trade union struggles with environmental concerns (IHRB and Wilton Park, 2022). Coined by the U.S. labor unions, JT gained political significance, advocating for labor protection in industries like oil, chemical and nuclear (TUMI, 2022).

The incorporation of JT into the UN Climate Change process has evolved significantly over the years. In 1997, the International Confederation of Free Trade Unions released a resolution emphasizing the importance of JT policies, which focus on the equitable recovery of economic and social expenses associated with climate change programs. This early lobbying established the groundwork for JT to later be included in international climate debates (IHRB and Wilton Park, 2022). It was first mentioned during the first Kyoto Protocol in 2010 and it quickly gained prominence and found its place in the final agreement at the COP16 in Cancún, Mexico. The Cancún Agreement's preamble

underlined the importance of a paradigm shift toward a low-carbon society, stressing potential for sustainable development and emphasizing the imperative of a JT for the workforce (Ibid.).

A milestone development occurred in 2015 with the Paris Agreement, which stands out as the first international treaty to explicitly refer to the imperatives of a JT. Beyond considerations for the workforce, it included references to human rights, gender equality, intergenerational equity and procedural justice (Abram et al., 2020). Thus, governments are obligated to incorporate JT into their NDCs (ITF, 2022). Furthermore, this commitment was reinforced by the Solidarity and Just Transition Silesia Declaration at COP24, drawing commitments from 56 parties as of 2019 (Abram et al., 2020; Glynn, Błachowicz and Nicholls, 2020).

Looking beyond the UN, other international organizations, notably the International Labour Organization (ILO), have played a crucial role in providing guidance on JT. The ILO's Guidelines for a Just Transition (2015) serve as a valuable framework for policymakers intending to facilitate negotiations and guide the transition process with a focus on social dialogue, collective bargaining, macroeconomic development, occupational health and safety and policies promoting social security and skills development (Glynn, Błachowicz and Nicholls, 2020; IHRB and Wilton Park, 2022; ITF, 2022). In the guidelines, JT is defined as *"a process of greening the economy in a way that is as fair and inclusive as possible to everyone concerned, creating decent work opportunities and leaving no one behind"* (ILO, 2015, p.4). Another definition is provided by the International Trade Union Confederation (ITUC), which characterizes JT as a comprehensive strategy at various levels to protect jobs, incomes and livelihoods affected by climate change policies (Glynn, Błachowicz and Nicholls, 2020). For the Movement Generation (2017, p.3), JT is "*fundamentally a framework for a fair shift to an ecologically sustainable economy, envisioning equitable livelihoods and pathways for workers transitioning from industries harmful to both people and the planet."* TUMI (2022) places JT in the context of the transport sector by identifying three essential dimensions that underscore the multifaceted nature of the concept: just access to mobility, fair and dignified jobs and climate-friendly mobility industries. Glynn, Błachowicz and Nicholls, (2020, p.5) conclude that JT "*involves the consideration, based on dialogue and consultation, of the needs of groups of workers, communities, consumers, and citizens who are vulnerable to the effects of the low-carbon transition and the provision of policies that support transition strategies."* According to ITF (2022), two primary meanings of JT emerge: a "worker-focused" approach, highlighting concerns about the impacts of climate policies on specific worker categories and a societal shift approach, representing broader socio-economic transformations required for a low-carbon economy. These approaches interact

and complement each other, reflecting the experiences, visions and aspirations of the labor movement and frontline communities affected by climate change (ITF, 2022). According to the ILO (2015), governments play a critical role in facilitating a JT by actively engaging in social dialogue. This involvement includes policy development, implementation and evaluation at various levels in accordance with relevant international labor standards. Governments must support the creation and formalization of dialogue mechanisms in order to foster consensus on strategies for national social, economic and environmental goals. The ILO (2013, p.12) defines social dialogue as *"negotiations and consultations among government, employer, and worker representatives on shared economic and social interests."* This inclusive dialogue is critical in establishing measures for industries to adopt environmentally sustainable practices that are also employment-friendly, requiring a detailed assessment of the social and economic implications of industrial transformations (ILO, 2012).

The transition to a more sustainable and green economy, as outlined by GIZ (2022), will significantly impact the labor market in four ways. 1) There will be a global increase in employment driven by the shift toward sustainable energy and circular economy practices. However, this positive growth will be accompanied by job losses in declining high-carbon industries, particularly impacting low-skilled workers. 2) Occupations will be reallocated to emerging industries. 3) Existing jobs will undergo transformation to incorporate new skill sets and work methods. 4) The uneven distribution of job growth and losses will vary across skill levels, regions and genders. Medium- and high-skilled occupations are expected to see the majority of new job opportunities, while low-skilled workers may face higher risks of redundancy. GIZ (2022) raises concern that the transition's effects will be particularly pronounced in developing countries, impacting labor markets more significantly due to their labor-intensive industries and energy-intensive economies.

Extending from this, in their critique to the JT debate, Abram et al. (2020) emphasize that the focus on job creation should consider the quality, pay and broader impacts of jobs, highlighting the importance of equal access to education and vocational training. They argue that the impacts of climate change and related policies vary significantly across socio-economic factors and regions, affecting vulnerable populations disproportionately. There is the possibility of social backlash and policymakers must recognize the transition's inherent political nature, encouraging debate rather than suppression. Additionally, market actors, both public and private, are identified as critical JT partners, with the necessity for their initiatives to be transparent and accountable to the public. On the other hand, Glynn, Bachowicz, and Nicholls (2020) observe a lack of agreement on the meaning

and application of the JT concept, which hinders its incorporation into policy. They emphasize the importance of increased capacity within governments and stakeholders, which is limited at the moment. In addition, their analysis reveals a lack of harmonization in proposed approaches, indicating difficulties in influencing policies, especially in developing countries. The key messages include the importance of stakeholder engagement, capacity building and responsive, context-specific models for implementing JT principles. Meanwhile, both Abram et al. (2020) and the ITF (2022) emphasize the risk of framing the debate on JT and climate change too narrowly. Abram et al. (2020) warn against a simplistic jobs versus climate viewpoint, claiming that it will exacerbate social divisions by creating perceived winners and losers in the transition. Conversely, the ITF (2022) criticizes governments' and corporate interests' vague references to JT, emphasizing that such ambiguity has depoliticized the concept.

3.3.2 Just Transition for the urban transport workforce

In 2022, ITF published a comprehensive report titled "A just transition for urban transport workers: Issues and experiences from unions in cities of the Global South." This report not only outlines the challenges faced by the urban transport workforce, but also provides a list of 10 critical points for a JT, as a result of engaging with workers and their organizations in six cities in developing countries. ITF (2022) identifies three interconnected factors impacting the urban transport workforce: 1) the influence of climate change, manifested by challenging weather conditions and extreme events, 2) technological solutions to climate change, with a focus on electric vehicles, particularly e-buses and 3) neoliberal practices. Importantly, these factors have disparate effects on developing countries, where walking is a popular mode of transport and the urban transport sector is highly informal, as highlighted by ITF (2022). This overview will provide insight into each of these three factors, drawing primarily from ITF's report (2022) and other relevant studies.

1) The influence of climate change

The severe impact of the climate crisis on urban transport workers, as highlighted in the ITF report (2022), reveals a complex web of issues:

- Workers face inadequate shelter and facilities in hot weather, leading to dehydration, a concern exacerbated for women due to limited access to sanitary facilities.

- High temperatures not only reduce overall productivity but also contribute to accidents and increased sick leave due to the absence of workplace adaptation policies.
- Air pollution emerges as a significant health risk for workers, motivating their support for electric urban transport as a solution to respiratory issues and broader pollution problems, particularly prominent in cities in developing countries.

However, the report underlines a paradox – while workers do advocate for cleaner and safer transport, government and employer rapid responses, focusing on electrification and automation, often result in job displacement, heightened precariousness, privatization and reduced community access. These unintended consequences stem from the urgent need for climate-friendly solutions, which inadvertently impact workers and communities. In essence, the report emphasizes that urban transport is about more than just infrastructure and technology advancements; it is also about the people who work in it and the communities it serves (ITF, 2022).

2) Technological solutions to climate change

Cities are increasingly turning to e-buses as a primary solution to climate change, seen as a technological remedy. However, this shift should also draw attention to the daily experiences of the individuals operating these buses, the bus drivers (ITF, 2022).

Arias-Meléndez et al. (2021) conducted a comprehensive literature review on the health and working conditions of public transport drivers, highlighting driving as one of the most precarious occupations globally and emphasizing the intertwining of environmental and work-related factors. According to their study, sedentary lifestyle, irregular working conditions and prolonged hours contribute to physical and psychological health risks for bus drivers, such as chronic diseases like hypertension, diabetes and musculoskeletal problems; stress that leads to negative driving behaviors and increased risk of accidents; overweight and obesity; anxious and depressive symptoms and sleep disorders. Furthermore, drivers are exposed to external factors, including noise, vibrations, environmental conditions and interactions with passengers, affecting their overall well-being (Arias-Meléndez et al., 2021). The report by ICF Consulting Services (2016) on the social conditions of urban public transport companies in Europe identifies fatigue as a significant risk factor that can lead to occupational diseases. However, it notes the absence of specific guideline regarding fatigue and its occurrence, leaving each transport operator to address the issue at the company level without standardized rules.

On a positive note, the emergence of e-buses has had a beneficial impact on bus drivers, as indicated by Delgado Miranda's study (2023). The introduction of new and efficiently

designed vehicles has improved drivers' quality of life by reducing stress levels and alleviating physical discomfort associated with traditional bus driving, such as back pain, neck pain, hip pressure, spinal health issues and foot cramps.

While e-buses appear to enhance the well-being of their drivers, the ITF highlights four concerns voiced by workers in the report's (2022) selected cities. These issues delve into the broader socio-political and economic context surrounding the introduction of e-buses, encompassing aspects beyond the technology itself. The identified areas of focus throughout the project are: a) jobs, b) technology sovereignty and c) access and services (ITF, 2022).

a) Jobs

The introduction of e-buses is often associated with the promise of job creation. Research by Jobs to Move America in 2019 revealed that for every one million-dollar investment in e-buses, approximately 5.7 jobs could be generated in the U.S. market along the value chain (Jobs to Move America in ITF, 2022, p.23). With this dual perspective on job creation, e-buses are positioned not only as a technological evolution, but also as an economic catalyst influencing the long-term employment scenario. However, the ITF report (2022) highlights a critical concern regarding the distribution of new jobs. While there is optimism about job creation through the introduction of e-buses, the report acknowledges that the benefits are not being distributed equitably. Older workers are frequently excluded from new bus operation and maintenance positions and the role of informal workers in public transportation is neglected. This was the case in Bogotá, where the transition to e-buses, completed in December 2021, resulted in the phasing out of traditional buses and the loss of jobs for around 6000 workers (ITF, 2022, p.24). Despite commitments to retraining and job fairs, many older workers were left unemployed. Another major issue pointed out by ITF (2022), is the fate of current maintenance staff and the necessary training for a transition to e-buses, which will require more electricians, fewer traditional mechanics and specialized training for drivers in areas such as recharging and managing high-voltage batteries.

In addition to job creation and training, the issue of gender imbalances in the public transport workforce is a significant concern. Traditionally a male-dominated sector, women represent less than 15% of the global public transport workforce, with a higher concentration in precarious and informal roles (ITF, 2022, p.26). In the EU, the representation of women in the public transport workforce was only 17.5% in 2011 (Sustainable Mobility for All, 2022, p.17). Similarly, Latin America reports an average of

15% women in the transportation sector's labor force (IDB and Colombian Ministry of Transportation, 2021, p.10). Furthermore, the challenges for women in the urban public transport sector go beyond job representation. Barriers include limited access to education and information, challenging work hours, inadequate sanitary facilities, gender stereotyping and discrimination. The issue of violence and harassment further exacerbates the vulnerability of women in this field (ITF, 2019; Sustainable Mobility for All, 2022).

b) Technology sovereignty

The challenge lies in the dependence of developing countries' e-bus systems on technology controlled by a small number of companies, extending to the supply chain for new parts. This concentration of power in a few, often private, entities can impact transport workers and the broader workforce involved in the e-bus supply chain. Consequently, local governments, lacking control, face limitations in influencing crucial decisions related to e-bus manufacturing and maintenance (ITF, 2022).

c) Access and services

ITF (2022) highlights a third concern, pointing out instances where the introduction of e-buses has resulted in a decline in services and staff, impacting the delivery of high-quality public transport. This outcome is attributed to poorly managed budget planning, primarily stemming from the substantial upfront cost associated with e-buses. The report cites examples, such as the replacement of bus fleets with e-buses in Bogotá, resulting in less accessible public transport and the jeepney[1] modernization in the Philippines, which led to increased fares and reduced transport accessibility (ITF, 2022).

3) Neoliberal practices

Neoliberalism signifies a transition from publicly devised strategies to those driven by competition and market orientation (Sager, 2011). In this framework, the state actively promotes the activities of private developers (Baeten, 2017). The concept of neoliberalism is pivotal in understanding global urban transformations, encompassing the commodification of urban spaces for consumption by the elite, aiming to stimulate economic growth (Sager, 2011). In the context of public transport, ITF emphasizes the significance of public ownership, contending that private companies, driven by profit

[1] A popular mode of transportation based on the jeeps left by the U.S. military after the Second World War (ITF, 2022, p.29).

motives, may prioritize financial gains over optimal working conditions and service quality (ITF, 2019). Dave and Dobrusin (2021) highlight instances of an unjust transition in the Philippines, Nairobi and Dakar, where predominantly informal workers face displacement without a JT to formal employment or alternative livelihoods (Dave and Dobrusin, 2021). Despite this, critics argue that publicly owned transport systems might suffer from perceived drawbacks such as low cost-effectiveness due to confused corporate objectives - service or profit?; low, sporadic, or inappropriate investment; and poor services (ITF, 2019). However, ITF advocates for public ownership, asserting that it provides the best framework for establishing a successful public transport system that caters to the needs of passengers and workers, aligning with the broader interests of society and the economy rather than focusing solely on profit-driven objectives (ITF, 2019). However, it is important to approach ITF's advocacy for public ownership with caution, considering the organization's inherent biases and interests. While public ownership may offer potential benefits for establishing a successful public transport system aligned with broader societal and economic interests, it does not guarantee improved working conditions, particularly in developing countries where public ownership remains a sensitive and controversial issue.

Several organizations and researchers have outlined strategies and specific measures for a JT aimed at tackling the challenges encountered by urban transport workers, which have been summarized in Table 2 below.

Strategies	Specific Measures
Improved working conditions	- Coordinate efforts to cover health and safety needs of urban transport workers, including protection shelters during extreme weather events - Ensure access to sanitation facilities, with particular emphasis for women workers - Increase social security coverage regarding air pollution - Commit to paid sick days for all urban transport workers - Manage the potential risks of higher stress levels and blurred boundaries between working time and private life

Strategies	Specific Measures
Job security and training	- Develop relevant educational and training programs to prepare workers for the challenges of future work - Guarantee job stability and prioritize retraining for current workers during the transition to electric vehicles - Implement ongoing training initiatives for up-skilling and re-skilling - Provide a bridge to pensions for urban transport workers nearing retirement, acknowledging their contributions and facilitating a smooth transition out of the workforce
Gender equity	- Incorporate a gender equity clause into institutional frameworks and funding agreements - Develop and implement affirmative actions to ensure equal access to employment opportunities across the transportation value chain - Focus on professionalization and specialized skills development in traditionally male-dominated roles such as drivers, mechanics, managers and construction - Implement policies that support work-life balance within transportation companies - Ensure fair wages, equal pay, social benefits and job security - Make adjustments in infrastructure, including improved bathroom facilities - Develop and implement awareness programs to prevent workplace harassment - Create intervention strategies to eradicate violence against women in the transportation sector - Emphasize re-education programs for men working in transportation to promote a respectful and inclusive workplace

Strategies	Specific Measures
Worker-led formalization	- Recognize rights to freedom of association and collective bargaining for informal transport workers - Ensure informal workers have a seat at the table in collective decision-making regarding changes to transport systems - Address core concerns of informal urban transport workers, including changing to fixed, decent and stable wages - Extend, in law and practice, social security, maternity protection, and decent working conditions to all workers in the informal economy - Regulate informal transport networks in coordination with workers
Worker-led governance	- Include genuine democratic participation from urban transport workers and trade unions in decision-making processes - Promote broad, deep and meaningful consultations with users and communities to ensure diverse perspectives are considered - Reverse privatization trends by bringing the urban transport sector back under public ownership - Actively involve the public sector as an operator, going beyond its role as a regulator and coordinator - Eliminate the profit motive from urban transport, prioritizing service over financial gains - Ensure workers have a comprehensive understanding and are actively consulted regarding the adoption of technologies affecting their work - Grant workers decision-making power over the extraction and use of data

Table 2. Strategies and specific measures for a JT (Source: Table compiled by author based on De la Torre Ríos and Delgado Miranda, 2023; European Commission, 2021; ITF, 2022; Sustainable Mobility for All, 2022)

3.4 Just Transition practices in the Latin American public transport workforce

This section provides examples of JT practices in the Latin American public transport workforce. Five of these cases address gender issues specifically, while two broader approaches, successful collective bargaining in Santiago and MetrôRio's diverse initiatives promoting employee well-being and inclusive work culture, provide comprehensive insights.

3.4.1 Initiatives with a gender focus

The studies by De la Torre Ríos and Delgado Miranda (2023) and the IDB in collaboration with the Colombian Ministry of Transportation (2021) focus on collaborative initiatives in the public transport sector, to promote gender inclusion in traditionally male-dominated domains. The research looks into projects in Santiago, Chile, Bogotá, Colombia, Jalisco, Mexico, Quito, Ecuador and Hidalgo, Mexico. Each initiative is briefly described, leading to the extraction of common lessons as valuable practices that can be applied in other cities.

Women labor inclusion in Santiago, Chile

In Santiago, Chile, the Ministry of Transportation and Telecommunications (MTT) pioneered a public policy for the inclusion of women in driving roles within the public transport system, Transantiago. Initiated in 2017, the policy aimed not only to address the driver deficit in the transportation sector but also to promote gender equality in the field. The MTT implemented various actions, including modifying licensing and course requirements to eliminate barriers for women seeking employment in Transantiago. One notable initiative was the "Premiación Anual a los Mejores Conductores y Conductoras" [Annual Award to the Best Drivers], encouraging alliances between operating companies and training institutions to create specialized driver professionalization courses for both men and women. This initiative spurred an inter-ministerial project involving the Ministries of Labor, Women's Affairs, and Transportation, the Metropolitan Public Transport Board, the National Training and Employment Service (SENCE) and the National Service for Women and Gender Equity (SernamEG). The partnership resulted in free professional driving courses for women and young people under the "Más Capaz" [More Capable] program implemented by SENCE. The program's

goal was to progressively incorporate more women into Transantiago. Efforts were made to promote and raise awareness about these courses, targeting women beneficiaries of the Jefas de Hogar Program [Women Heads of Households]. This collaborative effort marked a milestone in the training and inclusion of women in driving-related tasks, coordinating different public programs to maximize impact and creating incentives for transportation companies to invest in women's professional training. It also helped define processes for mainstreaming a gender approach in transportation policies. Results from these efforts showed a notable increase in female driver participation in Transantiago, from 1.53% in 2014 to 5.67% in 2021 (De la Torre Ríos and Delgado Miranda, 2023, p.13)

Women drivers for Transmilenio in Bogotá, Colombia

Since 2017, Bogotá, Colombia, has been integrating a gender perspective into its transport sector, notably through the establishment and adoption of the "Política de Mujer y Género" [Women and Gender Policy], addressing challenges like violence against women and fostering inclusion in traditionally male-dominated roles. This policy set the stage for the "Estrategia Integral para la capacitación y formación de mujeres en oficios no convencionales para el transporte urbano de Bogotá" [Comprehensive Strategy for the training and education of women in non-conventional trades for urban transport in Bogotá]. This strategy aimed at developing women's skills to enhance their inclusion, economic autonomy and employability while challenging gender roles and stereotypes in the transport sector. A pivotal component of this strategy was the "Eco-Conducción" [Eco-Driving] Program, a collaboration between the District Mobility Secretariat, District Secretariat for Women's Affairs, Transmilenio and the National Learning and Employment Service. The Eco-Conducción Program, launched in 2021, focused on training and incorporating approximately 450 women as drivers for an electric bus fleet within Bogotá's integrated public transport system. To overcome initial barriers, subsequent editions of the Eco-Conducción Program strengthened training processes and aimed to include over 300 women in the public transport system. Requiring an active B3 or C1 license, women initiated a recategorization process to obtain a C2 license[2]. The program offered stipends and covered administrative costs for obtaining a new license. After obtaining a C2 license, women were hired by the transit company, continuing a two to four months training process. As of March 2022, 2,605 women worked in Transmilenio concessionaires, with 328 as bus drivers (De la Torre Ríos and Delgado Miranda, 2023, p.15).

[2] A C2 type license is driver's license for public, collective and mass transportation services in Mexico, requiring a minimum of two years of seniority with any type of license for eligibility (De la Torre Ríos and Delgado Miranda, 2023).

The Mujeres Conductoras Program in Jalisco, Mexico

The Mujeres Conductoras [Women Drivers] Program in Jalisco, Mexico, is a public policy initiative, that addresses both the social and economic challenges faced by women in the region and is dedicated to advancing gender equality within the public transport sector. Implemented through a collaboration between the Jalisco government and private transport companies, the initiative utilizes a gender-sensitive approach to boost the number of female drivers. Through targeted scholarships, training and certification, it equips women with the skills needed to succeed in a traditionally male-dominated industry. The program's financial support is derived from the "Fideicomiso de Administración para la mejora de la Seguridad Vial" [Administration Trust for the Improvement of Road Safety], utilizing fines from traffic violations. This trust fund, part of the state's transportation policy, Mi Transporte [My Transport], focuses on improving public transportation quality and accessibility. The success of the program is evidenced by a substantial increase in the number of female drivers in Jalisco's public transportation sector. Results indicate that, after two years, 80 women drivers have been hired in the Urban Electric Train System (SITEUR), comprising 44% of public transport operators, with opportunities for promotions to higher-paying roles (De la Torre Ríos and Delgado Miranda, 2023, p.26). Beyond quantitative success, the Mujeres Conductoras Program has had positive socio-economic impacts, promoting economic empowerment and challenging traditional gender roles and stereotypes (Ibid.).

Quito Metro with a gender focus, Ecuador

The "Quito Metro with a Gender Focus" initiative in Ecuador is a comprehensive approach to integrate gender perspectives into the construction and operation of the Quito Metro, Quito's rapid transit system. This initiative aims to provide equal job opportunities for both men and women, ensure free and safe access to transportation for girls and women and create an inclusive space meeting international standards. The initiative's success is attributed to the commitment and collaborative efforts between Unidad Patronato Municipal San José [San José Municipal Board of Trustees] and Quito Metro. The gender focus is evident in the creation of jobs for women in various areas, including managerial, administrative and operational roles within the Quito Metro project. As of 2020, Quito Metro reported that 44.2% of its staff are women (IDB and Colombian Ministry of Transportation, 2021, p.29).

Bus drivers training initiative in Hidalgo, Mexico

The public transport system in the state of Hidalgo, Mexico, implemented a comprehensive training initiative through the Institute of Training for Work. This program targets both male and female drivers aspiring to obtain a public transportation permit (driver's license). The training encompasses various modules, including road safety education, human rights, gender equality, care for people with disabilities, first aid, basic mechanics, driving techniques and user service awareness. Completion of this training is a prerequisite for individuals seeking employment as public transport drivers, with a primary focus on fostering better treatment towards transport users, emphasizing gender equality and human rights. Since its inception from 2012 to 2019, the program has successfully trained 15,445 drivers (IDB and Colombian Ministry of Transportation, 2021). An impactful outcome was highlighted in the 2017 National Quality and Governmental Impact Survey, revealing that 58.3% of the population using public transportation in Hidalgo experienced friendly and respectful treatment by operators, surpassing the national average of 45% (Ibid., p.14).

Lessons Learned

Gender-sensitive approach
The success of the initiatives emphasizes the importance of adopting a gender-sensitive approach in policy development within traditionally male-dominated sectors.

Skill development for inclusion
All the initiatives highlight the effectiveness of skill development programs in promoting the inclusion of women in non-conventional roles.

Collaborative governance
The collaboration between multiple governmental bodies, private sector entities, educational centers and a national employment service demonstrates the effectiveness of collaborative governance in implementing gender-focused programs.

Public technical education institutions
Working with public technical education institutions rather than external entities can lead to substantial cost savings. This approach enables the allocation of capital to other needs, such as providing scholarships during the training process, attracting more female participants.

Financial innovation
The utilization of fines from traffic violations to fund the program, like in the case of the Mujeres Conductoras Program, showcases the potential for innovative financial mechanisms to support social initiatives.

Overcoming license barriers
The adjustments to license requirements, offering stipends and covering administrative costs are examples of proactive measures to overcome barriers that may limit women's access to training programs.

Socio-economic empowerment
The programs' impact on the economic empowerment of women demonstrate how targeted initiatives can create meaningful employment opportunities and financial independence.

Promotion of successful experiences
The success of the initiative, seen in the numbers of hired women drivers and their subsequent promotions, not only contributes to workforce diversity but also serves as positive publicity, attracting more women to the programs.
(De la Torre Ríos and Delgado Miranda, 2023; IDB and Colombian Ministry of Transportation, 2021)

3.4.2 Collective bargaining in Chile

In his 2022 article for ITF, Bruno Dobrusin, highlights the success of collective bargaining in Chile, which stands out as a radical example of a JT within the urban transport sector in the region. In 2021, FESIMETRO, the confederation of subway workers' unions in Chile, introduced JT clauses into their collective bargaining process, signifying a notable shift in discussions on climate change and emerging technologies in the workplace. Representing over 1,500 workers in Santiago's subway system, the union engaged in extensive internal consultations and coordinated with other public transport unions. The focus was to develop a JT strategy that considers the varied needs of workers involved in different modes of public transport. During the consultations, it became evident that the introduction of new technologies to enhance efficiency and environmental sustainability, while having potential benefits, was adversely affecting workers due to the lack of consultation and rapid implementation. In the collective bargaining round starting May

2022, the union placed climate change and JT at the core of negotiations. After two months of intense discussions, an agreement was reached in July 2022, marking the incorporation of the first-ever JT clauses in the subway's history. The clauses underscore climate change as a major concern, acknowledging its impacts on operations and working conditions. A Bipartite Just Transition Consultative Committee was established, ensuring the active involvement of workers and employers in major technological and process introductions. This committee serves as a consultative platform for workers to address concerns, challenges and propose ideas related to new technologies. The agreement, while initially focused on technology, provides a framework to address various climate-related issues within the subway's operations. Furthermore, it mandates gender parity among committee members, exemplifying radical and practical changes crucial for making JT a reality in the transport sector.

3.4.3 MetrôRio’s employee well-being initiative and inclusive work culture

MetrôRio, the public transport company that operates Rio de Janeiro’s metro system in Brazil, maintains a focus on employee engagement and satisfaction through well-structured development policies, recognition initiatives, benefit programs and ongoing training. In their 2022 report, they detail the company's initiatives and campaigns against discrimination based on gender, sexual orientation, race, abilities and age, along with a diverse range of services aimed at promoting employee well-being. As of December 2022, MetrôRio's workforce comprises 2156 employees, 43 interns and 60 young apprentices, with 22% being women, 54% people of color and 5% people with disabilities (MetrôRio, 2022, p.32). The key programs and initiatives include:

- Skills-based assessment, which is an annual competency-based assessment that evaluates employees' technical and behavioral performance, offering personalized feedback and development plans.
- Training programs covering technical skills, safety measures and leadership development.
- Safety initiatives, including an anomaly reporting platform, internal prevention week and vaccination campaigns.
- Quality of life program, that offers fitness classes, nutritional consultations and support for chronic diseases, emphasizing both physical and mental health.

- Employee support program, that provides psychological, financial, legal and social services guidance.
- MetrôRio's Diversity Program, addressing gender equity, race, LGBTQIAPN+, and disabilities, with initiatives, campaigns and representation figures highlighting their commitment to diversity.

(MetrôRio, 2022)

4. CASE STUDY: METROBÚS LINE 3

4.1 Overview of Mexico's transport sector and climate change

Mexico, being the second-largest economy in Latin America and playing a significant role in global oil exports, faces notable socio-economic challenges. Approximately 46% of the population resides below the poverty line, with 57% working in the informal economy, and only 7.4% receiving social protection, excluding health care. (Glynn, Błachowicz, and Nicholls, 2020, p.18).

The transport sector, a vital contributor to Mexico's economic growth, simultaneously constitutes a substantial environmental burden. As one of the top 10 global vehicle producers and exporters, Mexico experiences rising vehicle growth rates (CFF, 2018). The majority of vehicles in Mexico, including passenger transport, cargo transport and private cars, rely on gasoline and diesel from ICE and contribute to social, environmental and economic damage through emitted pollutants, congestion in cities, noise pollution and negative implications for public health. Other modes of transport, including air, maritime and rail, also rely on fossil fuels, but their emissions represent only 26.1% of the sector's emissions, compared to the significant 73.9% generated by motorized transport alone (SEDATU, GIZ, and IDB, 2018, p.82). The transport sector in Mexico generates nearly a quarter of CO2 emissions related to energy consumption and contributes to over 80% of air pollution in cities, resulting in premature deaths linked to respiratory diseases (SEDATU, GIZ, and IDB, 2018, p.82). The associated societal costs surpass 10% of the Gross Domestic Product (GDP) in developing countries (Ibid., p.82). Alarmingly, health costs due to pollution in Mexico reached almost US$40 billion as of 2016, with half directly attributable to the transport sector (APEC, 2022, p.4). Despite comprising only 5% of the on-road fleet, heavy-duty vehicles cause two-thirds of health impacts in Mexico, while

urban buses contribute 25% of black carbon emissions[3] from road transport (ITF, 2021, p.20).

Adding a layer to this challenge is Mexico's vulnerability to the negative impacts of climate change due to its geographical characteristics. The country has witnessed an increased number of extreme weather events such as tropical cyclones, floods and droughts, leading to loss of human life and incurring high social and economic costs. In response, Mexico has made commitments to address climate change. The General Law on Climate Change, enacted in 2012, positions Mexico as the first developing country with comprehensive legislation in this domain. The nation's NDC pledge to decouple carbon emissions from economic growth, aiming for a 50% reduction by 2050 and specific goals for generating clean energy; 35% by 2024 and 43% by 2030 (APEC, 2022, p.5; Glynn, Błachowicz, and Nicholls, 2020, p.18). However, there is a gap between these commitments and the practical implementation, with notable social development priorities but a limited focus on the elements of a JT such as social dialogue and collective bargaining (Glynn, Błachowicz, and Nicholls, 2020).

Moreover, a significant imbalance is showcased regarding the allocation of federal funds for transport, as it is reported that in 2015, 75% of federal funds in Mexico were allocated to private vehicle infrastructure, while only 11% was dedicated to public transportation, (ITDP, 2015 in SEDATU, GIZ and IDB, 2018, p.50). Analyzing spending trends, of the total mobility projects in 2015, 47% targeted road infrastructure, 33% focused on paving, 6% on public transportation, 1% on cycling infrastructure, 7% on public space and 5% on pedestrian mobility, revealing a disproportionate emphasis on private vehicle-oriented projects (SEDATU, GIZ and IDB, 2018, p.50). This highlights a prevailing pattern in Mexico, where a significant portion of federal funds is primarily used to support the expansion and maintenance of infrastructure that favors private automobiles (ITDP, 2015 in SEDATU, GIZ, and IDB, 2018).

Electrification has emerged as a key strategy in mitigating the impact of the transport sector. Both federal and local governments have established a range of measures aimed at promoting the transition to electric vehicles. At the federal level, electric vehicles have been exempt from the tax on new cars since 2015, fostering increased sales. Additionally, the Federal Electricity Commission implemented a program to install separate meters for chargers in homes with electric vehicles, offering users a differentiated electricity rate for

[3] Black carbon emissions are the black material released from sources like gas and diesel engines, contributing significantly to particulate matter air pollution (ITF, 2021).

charging batteries. Moreover, Mexico's Ministry of Energy signed the international pact "EV 30 by 2030", aiming to have 30% electric vehicles globally by 2030. At the state level, electric vehicles are often exempt from possession taxes, particularly in Mexico City, where they are exempt from the tax for the first five years and receive a 50% reduction for the subsequent five years. Moreover, electric vehicles are excluded from certain traffic restriction programs (SEDATU, GIZ and IDB, 2018). In Mexico City, formalized commitments include signing the C40 Declaration for Fossil Fuel Free Streets[4] and the procurement of only zero-emission buses from 2025 (ZEBRA, 2022). Initiatives like the "EV 30 by 2030" pact and incentives at federal and state levels aim to boost electric vehicle adoption, although challenges persist, such as resistance from private operators (SEDATU, GIZ and IDB, 2018). While the shift to electric vehicles is evident, it still remains a small fraction of the market (Sánchez et al., 2023). According to two of the interviewees, the representative of UITP Mexico and the e-mobility expert, in Mexico a comprehensive public policy with fiscal incentives is essential for widespread adoption, especially in public transport.

[4] The declaration, initiated in 2017 by C40 Cities under the Green and Healthy Streets Accelerator, commits signatory cities to procuring only zero-emission buses by 2025 and achieving a substantial zero-emission area in their cities by 2030 (C40, 2023).

4.2 Public transport and e-mobility in Mexico City

Mexico City, with an area of 1,495 km² connected to a metropolitan network of 60 suburban municipalities and a population of 9.2 million as of 2020 (APEC, 2022, p.3; Statista, 2023), contributes substantially to Mexico's economic landscape, constituting 16.4% of the national GDP, primarily driven by tertiary activities such as commerce, financial services, transportation and tourism (APEC, 2022, p.3). Moreover, it employs nearly one-fifth of the nation's working population, significantly impacting the country's overall growth (Municipality of Mexico City, 2021, p.14). However, beneath these economic dynamics is a more complex reality. In 2019, 30% of the city's workforce, or 1.3 million people, worked in the informal sector, highlighting income disparities and precarious employment conditions (Ibid., p.14). Moreover, gender-based labor force imbalances persist, with women having a labor force participation rate of 51%, notably below the rate for men at 76% (Ibid., p.30).

As one of the world's most populous cities, Mexico City has a complex and extensive public transport network, which began its formalization journey in the late 19th century (APEC, 2022; Martínez Trejo, 2015). Privately operated trams began operating in the city, initially authorized by the city council in 1896 (Martínez Trejo, 2015). State control expanded to trolleybuses in 1951, street cars in 1955 and the planning of the Metro Collective Transport System (Ibid.). State dominance in planning and management strengthened with the inauguration of Line 1 of the subway in 1969 (Ibid.). The establishment of R100 (Auto Transporte Urbano de Pasajeros, Route 100) [Urban Passenger Transportation, Route 100] in 1981, which operated 4,000 buses, marked a significant shift, but by 1995, its bankruptcy led to increased concessions, transforming public transport into a lucrative business (Martínez Trejo, 2018). The replacement of the 4,000 Route-100 buses with numerous combis and microbuses[5] resulted in setbacks for public transport progress, with them dominating user transport by the mid-1990s (Martínez Trejo, 2015; Martínez Trejo, 2018).

As showed in Figure 1, today in Mexico, the local transport service is categorized into freight and passenger. The passenger service further divides into public, commercial and private transport. Public transport includes mass transit like the metro, trolleybuses and

[5] Combis and microbuses are smaller buses, referred to as concessioned services, serving minor routes, owned and operated by private individuals, yet regulated, with drivers and vehicles requiring permits for operation (Municipality of Mexico City, 2023).

trams; collective transport such as RTP (Passenger Transport Network)[6], BRT (Bus Rapid Transit); combis, microbuses, and vans; individual taxi services; and adapted bicycles. Mexico City mandates that the provision of public transportation services is the responsibility of the Public Administration of the Federal District. These services are delivered through public entities, decentralized agencies or concessions granted to individuals or corporations (Martínez Trejo, 2015).

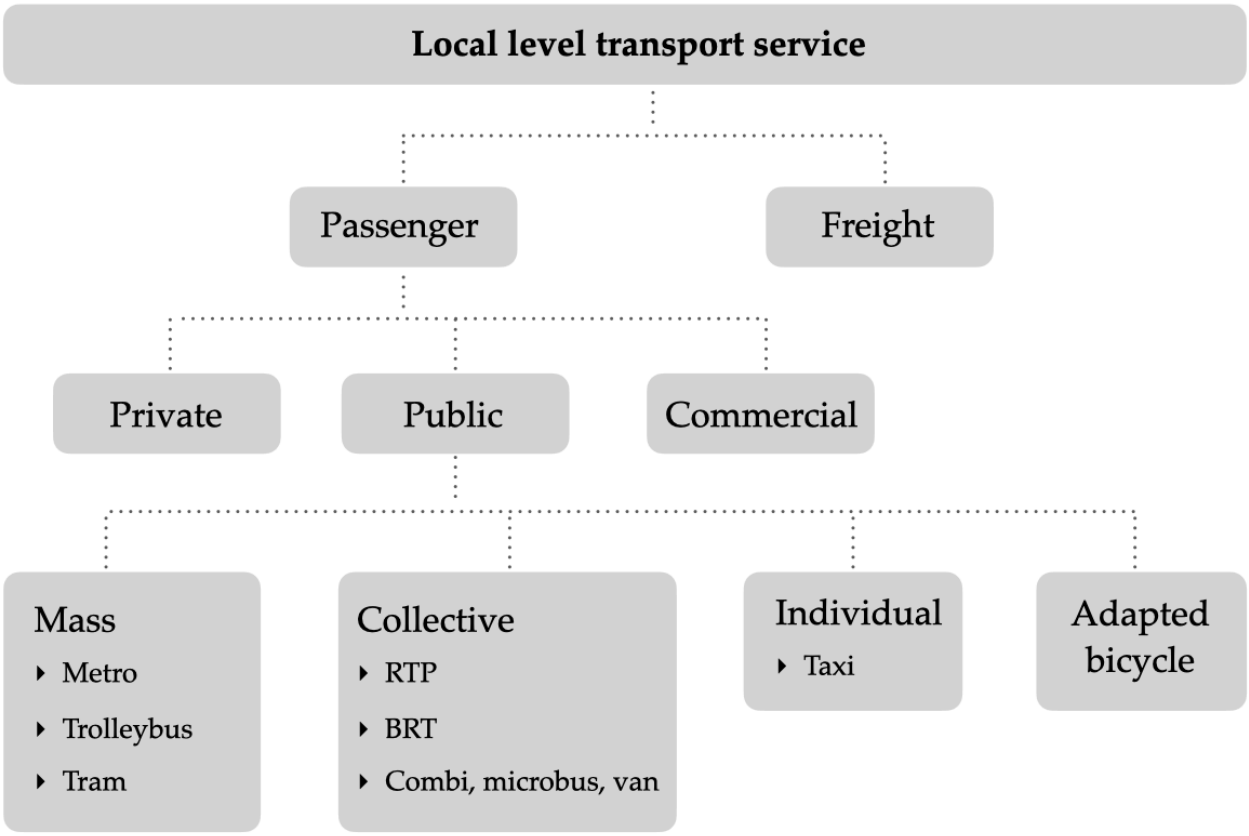

Figure 1. Local level transport service in Mexico (Source: Author based on Martínez Trejo, 2015)

In Mexico City, the population distribution is marked with 80% residing in the outskirts and 20% in the central areas, which house key services, public transport networks, work centers and schools (Martínez Trejo, 2018, p.187). Consequently, the peripheral population often relies on more than two means of transportation for mobility (Ibid.). There's a distinct socio-economic divide in transport choices generally in Mexico, but particularly in Mexico City, where 70% of the low-income population uses public transport compared to just 8% among wealthier individuals (SEDATU, GIZ and IDB, 2018, p.73). According to C40 transport data explorer from 2019, the modal share in the city includes 33% buses, both RTP and BRT, 26% walking, 23% private motorized transport, 11% metro, trolleybus,

[6] The urban bus service in Mexico City that is not BRT (Municipality of Mexico City, 2023).

tram, 5% taxis and 2% other modes. Unfortunately, a significant portion of concessioned collective public transport, such as combis and microbuses, operates under the man-truck model[7] characterized by low service quality, security concerns, high environmental costs and a non-transparent financial structure (SEDATU, GIZ and IDB, 2018). Furthermore, the vehicle occupancy level in 2017 was 1.5 people per vehicle, leading to notable traffic issues, with approximately 17.3 million trips occurring on weekdays for the population aged 6 years and older. (Municipality of Mexico City, 2021, p.84).

The transport sector in Mexico City significantly relies on fossil fuels, accounting for more than 60% of the city's total energy demand (APEC, 2022, p.i). GHG emissions from transport, primarily originating from on-road vehicle transport, contribute to 53% of the city's emissions (C40, 2023). Notably, gasoline plays a dominant role, representing 95% of the fuel mix in this sector (CFF, 2018, p.12).

Addressing this heavy reliance on fossil fuels, the city is working towards carbon neutrality by setting the goal of being carbon neutral by 2050 (ZEBRA, 2023) and embracing electric transport alternatives through a series of instruments and actions. Besides its commitment to having all acquired buses be zero-emission from 2025 onwards (ZEBRA, 2023), in 2018, the city unveiled its E-Mobility Strategy, outlining goals and actions for the years 2018 to 2030. However, according to the interviewed representative of UITP, there's a notable focus on private cars, aligning with Mexico's status as a major car manufacturer. For public transport, the strategy outlines targets:

- 20% of the collective public transport fleet to be electric by 2030.
- Achieving 30% electrification in the Metrobús fleet, equivalent to 300 electric buses.
- Electrifying 18% of the RTP bus fleet, requiring the integration of 2,300 electric buses.
- Incorporating 565 trolleybuses (CFF, 2018, p.30).

Although the strategy envisions Metrobús having 30% of its fleet electric by 2030, practical plans to achieve this remain unclear based on the interview with the Metrobús representative. While there have been commendable steps, such as electrifying a substantial portion of Line 3 and ongoing efforts for Line 4, a comprehensive plan to meet the E-Mobility Strategy's goals is lacking.

Currently, the most popular electricity-driven mode of transport in Mexico City is the metro, accounting for 18% of the city's trips and serving over 8 million passengers daily

[7] The man-truck model refers to the "hombre-camión" concept, where workers drive their own unit or rent one, engaging in informal labor without social security and relying on individual agreements with owners or concessionaires for income (Martínez Trejo, 2015).

(CFF, 2018, p.12). As part of the city's e-mobility initiatives, plans include implementing four lines of cable buses[8], with two already in operation. Notably, the city faces the challenge of an aging bus fleet, averaging 22 years old. The total bus fleet comprises 30,000 vehicles and the penetration of electric vehicles remains limited (interview with E-mobility expert). While there's a renewal effort underway for the trolleybus[9] fleet, consisting of 500 new e-buses with wires, concerns arise regarding the completion of this renewal due to the 2024 local elections (interview with UITP representative). According to the e-mobility expert, electrification is viewed as expensive and demanding extensive planning, with no subsidies for transport fares. Transport agencies prioritize maintaining low operational costs to ensure affordable fares and while accessibility and fair pricing are essential, e-mobility is not yet widely perceived as a social benefit (CFF, 2018).

4.3 Challenges of public transport workforce in Mexico

Based on the expert interviews and various studies, the public transport workforce in Mexico faces several challenges outlined below.

Shortage of drivers

Driver shortage is a major issue throughout the Latin American region and Mexico is no exception (De la Torre Ríos and Delgado Miranda, 2023). Currently, there is a negative perception of being a bus driver, which can be attributed to poor public transport service and unfriendly attitudes. Factors such as work overload, organizational climate, extended working hours, inadequate salaries and the imminent threat of job termination contribute to stress among workers (Lámbarry, Trujillo and Cumbres, 2016), making the profession unappealing.

Informality

Only 5.8% of the collective public service fleet is registered under formal economic units, with the majority, 87.76%, following the man-truck model (SEDATU, GIZ and IDB, 2018, p.3). This informal sector not only fails to meet quality standards for users, but also deprives operators of essential rights, including a stable income and access to labor, health, housing and safety rights (Ibid.).

[8] Cable bus is a cable car system in Mexico City introduced in 2021, featuring the world's longest public transport line at 10.6 km (Municipality of Mexico City, 2023).

[9] In this case, trolleybuses utilize battery-assisted technology to integrate the advantages of a traditional trolleybus with the flexibility of standard bus movement (Gregarious et al. 2019).

Old vehicle fleet

The issue of aging vehicle fleets extends beyond Mexico City to the entire country. The poor working conditions in these older vehicles pose difficulties for drivers and maintenance staff. Older vehicles cause increased physical discomfort, potential hearing loss and increased stress (Delgado Miranda, 2023). When compared to newer vehicles, the increased risk of malfunctions in older equipment reduces safety and comfort.

No career advancement opportunities

According to the representative of IMDUT, the conventional trajectory for bus drivers typically involves transitioning from public transport to touristic or cargo transport, with the majority returning to public transport in their later years. However, there are no opportunities for advancement or to take on managerial or guiding roles for bus drivers or maintenance workers.

Lack of state regulation and empowerment of private companies

Concessioned public transport operates without providing transparent information crucial for decision-making on aspects such as workforce requirements, labor conditions, financial performance and compliance with fiscal obligations. The absence of clear mechanisms for the government to regain control over transportation as a public service creates a significant barrier to transformation initiatives. This informational gap has allowed authorities to accept the idea that public service operations are private and beyond their oversight or regulatory authority, resulting in a concerning loss of the rule of law (SEDATU, GIZ and IDB, 2018). This not only creates challenges for effective governance, but also significantly impacts the well-being, job security and working conditions of the public transport workforce.

Lack of professionalization

The representative of UITP Mexico highlighted a prevalent issue where individuals in administrative or managerial roles in public transport do not have the necessary qualifications, experience or continuity in their positions. This absence of professionalization can hinder effective decision-making, planning and the implementation of long-term strategies, as well as the ability to address challenges and make meaningful improvements within the sector.

Limited involvement of women in the labor force

In Latin America, 8.1% of the male labor force is employed in the transport sector, while women constitute only 1% (De la Torre Ríos and Delgado Miranda, 2023, p.10). This gender divide leads to a concentration of men in decision-making, managerial, technical,

driving, maintenance and operational roles, with women mostly occupying administrative or service-oriented positions (Ibid.). Agencies in Mexico City like Metro and Metrobús have higher proportions of women in operational positions, 71% and 46% respectively, although the percentage of female drivers remains low (Ramírez and Pérez, 2020). Challenges faced by women include a lack of supportive policies, flexible working conditions, limited access to professionalization courses and inadequate infrastructure (De la Torre Ríos and Delgado Miranda, 2023).

The rapid introduction of new technologies

The urgency to electrify public transport has caused dissatisfaction in the workforce due to the lack of consultation on decisions directly impacting them. An illustrative case is the controversial 2016 proposal by the local government to replace Mexico City's old trolleybus fleet with e-buses on the Eje 8 Sur corridor. Workers expressed legitimate concerns about potential job losses, changes in operational models and the automation of certain roles, with significant implications for both male and notably, female employees (Wright, 2018). In response, the Alianza de Tranviarios de México (ATM), a trade union organization collaborating with ITF, launched the "Save the trolleybuses" campaign to advocate for workers' rights. The campaign was successful, leading to the replacement of the old trolleybuses with battery trolleybuses instead of e-buses (Salvemos al trolebus, 2020). The case highlights the often overlooked challenges associated with electrification and underscores the critical role that trade unions play in giving a voice to the workforce.

4.4 Overview of Metrobús

4.4.1 General information about Metrobús

Metrobús, a public entity managing the BRT network in Mexico City, operates with 239 stations across 7 lines (APEC, 2022, p.12). Established on October 26, 2004, the first company to provide a BRT service in Mexico City, C.I.S.A., aimed to optimize demand coverage and integrate with various public transport modes (Martínez Trejo, 2015). In 2005, the system was officially named the Metrobús Decentralized Public Organization (referred as Metrobús), created to bring about a more organized, competitive and profitable transportation scheme, ensuring legal and financial guarantees, eliminating inefficiencies and enhancing job security and conditions for workers who previously drove combis and microbuses (Ibid.).

Metrobús, as a typical BRT, operates exclusively in lanes reserved for public transport, with predetermined stops and infrastructure for passenger ascent and drop-off (APEC, 2022). It consists of a group of transportation service companies, collection companies and a decentralized public agency responsible for managing, planning and controlling the transportation corridor system (Martínez Trejo, 2015). Metrobús operates seven permanent and one temporary bus routes, with a total fleet of 733 buses, including 60 e-buses (APEC, 2022, p.12). On average, it transports 1,800,000 passengers daily, and as of September 2023, the ticket price is $0.35 USD (Metrobús, 2023). The fleet has an average age of 5.4 years, with 80% of the fleet being less than 10 years (APEC, 2022, p.12; Metrobús, 2023).

Metrobús employs a trunk-only system[10], canceling former bus routes to reduce mixed-traffic congestion. This design aims to increase passenger numbers on Metrobús without substantially impacting informal service providers (ITF, 2019). The BRT trunk routes are complemented by feeder routes, connecting passengers from areas beyond the BRT network (Ibid.). Part of the infrastructure are also standard stations, transfer stations and terminals. Standard stations have raised platforms exclusively for BRT use, with fare collection areas, sales kiosks, fare gates, turnstiles and system information; transfer stations enable passengers to access other BRT routes, feeder routes, informal operations, or other systems; and terminals, serving as endpoints, integrate feeder and trunk lines and other services for passenger transportation (ITF, 2019). Metrobús provides five payment methods for passengers: cash recharge, contactless banking card, electronic wallet, CoDi[11] and a regular bank card (Metrobús, 2023).

Regarding demographic composition, gender representation within Metrobús' employees remains uneven, with women constituting 32% of the staff, primarily holding middle management positions (Secretary of Mobility of Mexico City, 2019, p.22). Notably, only 1% of operators across the seven Metrobús lines are women and some lines lack women operators entirely (Ibid.). While Metrobús has established the Secretary of Women as a channel for women to report workplace discrimination or harassment, according to the Metrobús representative, its effectiveness is limited in practice, as traditionally women are not inclined to report such incidents. Concerning Metrobús' involvement in the implementation of JT strategies and measures by the transport companies, the representative emphasized that Metrobús can solely provide advisory support. Their role

[10] The trunk-only system in BRT involves large-capacity buses exclusively using designated trunk roadways, while feeder routes connect passengers from areas beyond the BRT network, either operated by existing informal services or non-BRT standard buses managed by the BRT company (ITF, 2029).

[11] An electronic payment system in Mexico (Metrobús, 2023).

is to offer guidance on the implementation or facilitation of these measures if the transport companies choose to pursue such initiatives.

4.4.2 Financial scheme

Outlined in the document by Partnering for Green Growth and the Global Goals 2030 (P4G), ZEBRA and Dalberg (2020), Metrobús' financial structure, as depicted in Figure 2, involves the public transport authority, Metrobús, overseeing the BRT infrastructure, including route planning, operations and expansions. Each private operator is assigned a corridor, owning, operating and maintaining buses under a public concession. The operation is funded through the *fideicomiso*, the trust fund comprising passenger fares, station advertising and real estate income[12]. Government subsidies to Metrobús and bus advertisements contribute to the revenue. Payments to operators from the Metrobús account are based on kilometers operated as required in the 10-year concession contract. If operators fail to achieve the intended operational criteria, they risk fines. The fideicomiso covers 80% of the operator's bus credit, with operators paying 20% upfront, partially obtained from scrapping old buses. Operating expenses, including fleet maintenance and employee salaries, are covered by this financial structure. According to the representative of IMDUT, there was no increase in subsidies with the introduction of e-buses.

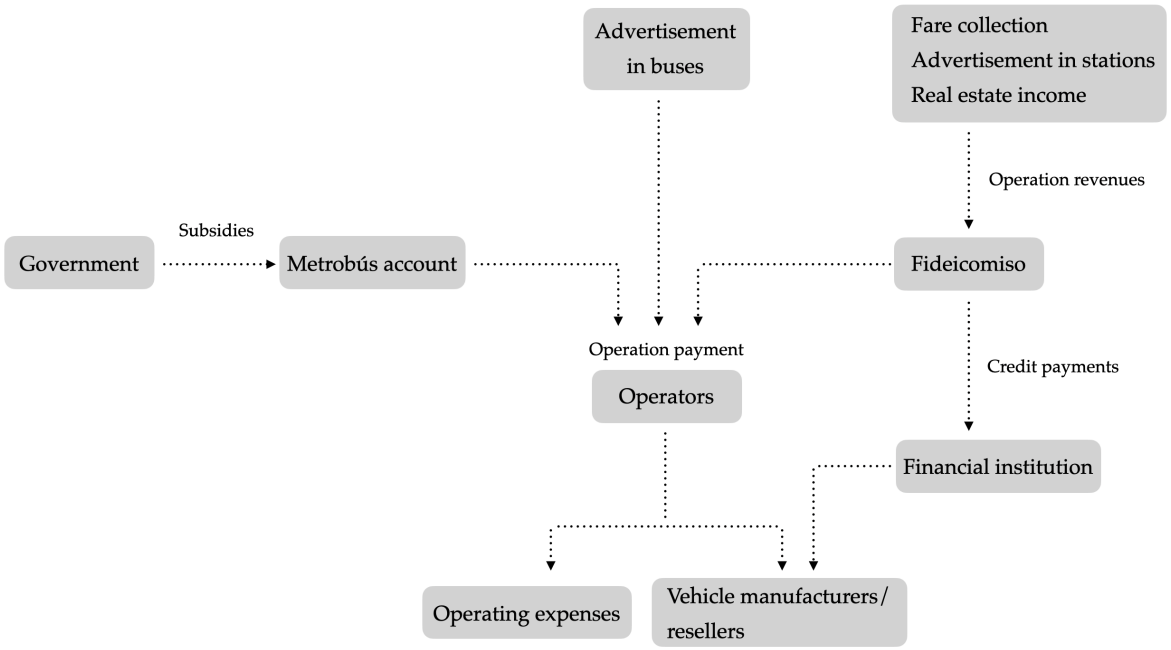

Figure 2. Financial scheme of Metrobús (Source: Author based on P4G, ZEBRA and Dalberg, 2020)

[12] Income generated by renting space in bus stations and terminals (P4G, ZEBRA and Dalberg, 2020).

4.5 Metrobús Line 3: The transition from diesel to electric buses

4.5.1 General information about Line 3

Metrobús Line 3, operating through Mexico City's Western Axis 1 as shown in Figure 3, began its operations on February 8, 2011 (Metrobús, 2023). Over the years, it has undergone significant expansions and developments. Currently spanning 20.4 km with 38 stations and two depots, it caters to around 200,000 passengers on a working day (Velázques and Cavazos, 2023, p.4). Operating between 04:30 and 24:00, the line offers five routes covering 160 to 330 km (Ibid.). The line's fleet comprises a total of 72 buses, with 60 being electric and 12 diesel, covering 6.1 million kilometers annually making up for an average of 330 kilometers per day without the need for recharging or refueling (APEC, 2022, p.17).

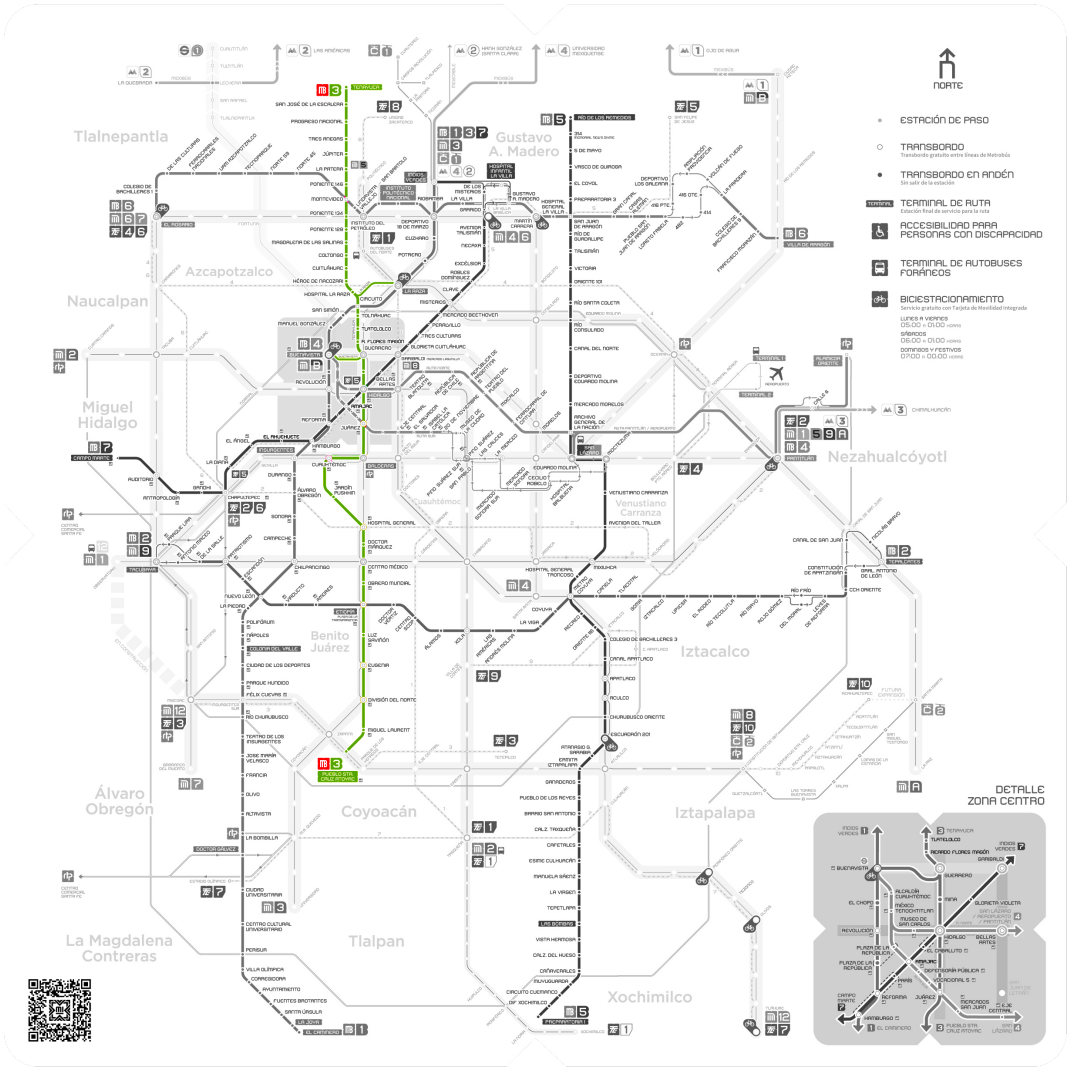

Figure 3. Map of Metrobús routes, Line 3 in green (Source: Metrobús, 2023)

4.5.2 Electrification process

Selection of Line 3 for electrification

The decision to electrify Line 3 was a strategic choice influenced by several factors. Firstly, it operates under a single concession transport company, MIVSA, subsidiary of Mobility ADO, a private transport company that has several bus fleet electrification projects in Mexico, which simplifies the planning and execution of fleet replacement stages during the transition (ZEBRA, 2023; APEC 2022). Secondly, it is the second busiest line in terms of passengers transported per kilometer traveled, surpassed only by Line 1 (APEC, 2022). Thirdly, the fleet's average age of 7.75 years, well beyond the BRT's average, required an immediate upgrade in order to comply with current operational rules demanding replacements after a decade of service (APEC, 2022, p.17). Notably, 54 units would have been phased out of operation in 2021, emphasizing the appropriate timing of the electrification initiative (Ibid.). According to this plan, bus replacements with e-buses will total 508 units by 2030, accounting for 65% of the current Metrobús fleet (ZEBRA, 2023, p.2). The timeline of the electrification process is shown in Figure 4.

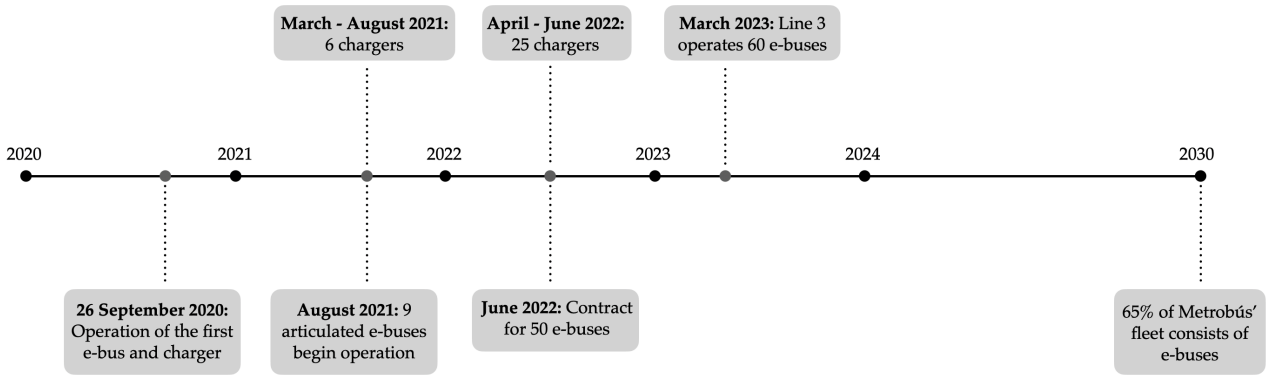

Figure 4. Timeline of the electrification process for Line 3 (Source: Author based on Velázques and Cavazos, 2023)

The pilot phase

The pilot phase, aimed to provide operational insights, began in September 2020 with the operation of one articulated e-bus and one charger and then expanded in 2021 with 6 chargers and 9 other articulated e-buses (Velázques and Cavazos, 2023). The city's electric power distribution company, ENGIE took the lead in making the initial investment for the pilot phase (ZEBRA, 2023). Metrobús collaborated with ZEBRA to define the technological criteria necessary for the pilot phase's success: 1) the capacity of e-buses to reach a minimum distance of 330 km without recharging, ensuring that the operation was similar to existing diesel buses; 2) a maximum acceptable annual battery deterioration rate of 20%,

which is essential to maintaining optimal battery load capacity over the required ten years of operation (APEC, 2022, p.18; ZEBRA, 2023, p.21). The ZEBRA team's analysis of the necessary operational requirements concluded that buses with an electric propulsion system powered by a battery system with regenerative braking systems and other electric components are the most suitable vehicles for the Metrobús system (APEC, 2022; ZEBRA, 2023). The 18m articulated e-buses[13] manufactured by the Chinese brand Yutong, have a pack of lithium iron phosphate batteries (LFP), two electric motors and an estimated range of more than 300 km. Considering the climatic conditions of Mexico City, the e-buses are not equipped with air-conditioning or heating systems to reduce electricity demands and battery size (ZEBRA, 2023). During the evaluation period, the e-buses operated under normal conditions in Line 3. Subsequently, the success of the pilot led to the confirmed purchase of 50 additional articulated e-buses in 2022, which began their operation in March 2023 (Ibid.).

Charging infrastructure

Metrobús prioritized depot charging systems[14], stressing operational continuity without altering service hours. The Federal Electricity Commission (CFE) collaborated with Metrobús to define technical requirements and financial schemes for charging stations. This coordinated effort with CFE ensured that the charging infrastructure is compatible with the capabilities of local power distribution networks. Depot recharging, typically conducted at night during off-service hours, emerged as the preferred option, allowing for a slow and efficient recharge taking 3.5 to 5 hours per bus (APEC, 2022).

The benefits of the electrification of Line 3

The shift to e-buses has numerous benefits. According to Metrobús records, the chosen e-bus units reduce energy costs by 80% compared to their diesel counterparts (APEC, 2022, p.19). In a span of 10 years, they prevent the emission of 300,000 tons of CO2 equivalent, contributing significantly to environmental sustainability (Ibid.). The operational benefits include a reduction in maintenance costs due to the simpler and less complex nature of e-buses. Additionally, e-buses stand out for their efficiency, producing lower costs per kilometer traveled, zero tailpipe emissions and minimal noise pollution (Ibid.).

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[13] An articulated bus consists of two sections connected by a flexible joint. Currently, Metrobús has 303 articulated buses with a length of 18m and a capacity of 160 passengers (Metrobús, 2023).

[14] Charging alternatives for e-buses comprise two options: 1) depot charging at terminal stations; and 2) opportunity charging with small, fast-charging batteries for frequent daytime recharging (APEC, 2022).

Challenges and future prospects

Despite the evident benefits, transitioning to a fully electric bus system demands substantial capital investment. Challenges include the upfront costs associated with vehicle acquisition and charging infrastructure implementation. Notably, the electrification process poses the challenge of increased electricity demand, requiring careful planning and management. The results highlight the need for increased charging infrastructure to effectively capture renewable energies while maintaining a balance between growing transport electrification and grid stability (APEC, 2022; ZEBRA, 2023). Currently, there are ongoing efforts to extend the electrification initiative to Metrobús Line 4.

4.5.3 The public transport workforce of Metrobús Line 3

Findings from the interview with the HR department of MIVSA

MIVSA's Human Resources (HR) Department provided insights into various aspects of employment related to e-bus drivers and maintenance staff as below:

- There is no specific salary increase associated with driving and maintaining e-buses; however, annual negotiations with the trade union allow the workforce to request higher salaries.
- Health insurance is part of the employee benefits.
- The working day for e-bus drivers and maintenance staff is 8-9 hours, with the option to work more for additional payment. There is a 20-30 minute break included for eating or resting.
- Adequate sanitary facilities, including bathrooms in each terminal and a dormitory, are available for drivers, with plans to extend these facilities to women. There are no shelters provided for extreme weather conditions.
- "Dead km" hours, the trip to and from charging stations, are counted as working hours.
- The initial selection of the first 10 electric bus drivers in 2021 involved choosing experienced individuals from existing diesel bus drivers, followed by a one-month capacitation process.
- While there isn't a specific strategy to encourage women's inclusion, the company is open to applications from women. The women that have been employed in driving roles have quit due to not agreeing with the salary or work conditions.

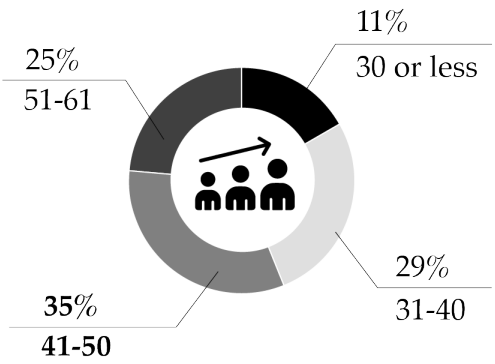
- The feedback system involves regular communication between drivers, maintenance staff and their superiors, offering an open channel for expressing problems and complaints during weekly sessions.

Survey findings

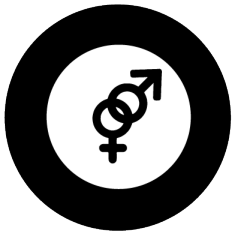
The following section will present the results of the survey conducted from August to October 2023 for the e-bus drivers and maintenance staff of Metrobús Line 3. The two surveys consist of 20 questions for the drivers and 19 questions for the maintenance staff, collectively covering various aspects of their experiences and challenges with the transition to e-buses and general job conditions. The response rate is 70% for the drivers, including 155 out of 221 drivers and 95% for the maintenance staff, including 20 out of 21 workers. The following findings provide a detailed overview of their perspectives on several aspects of this transition, shedding light on both positive experiences and areas for improvement.

E-bus drivers of Metrobús Line 3 (155 out of 221 respondents)

1. How old are they?

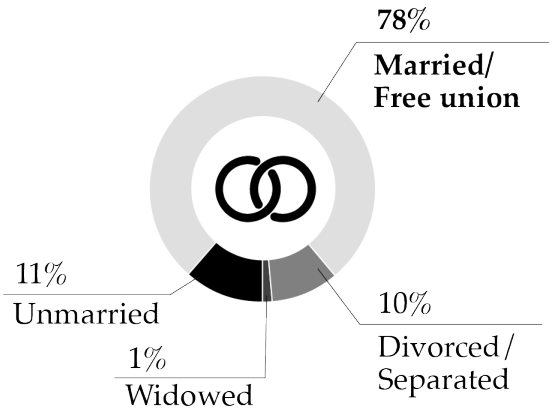


2. What is their gender?

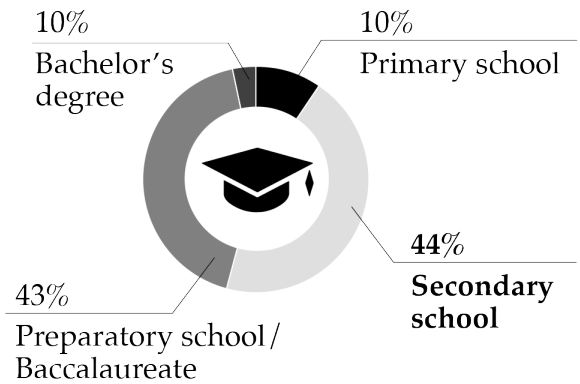


100% of the e-bus drivers are men.

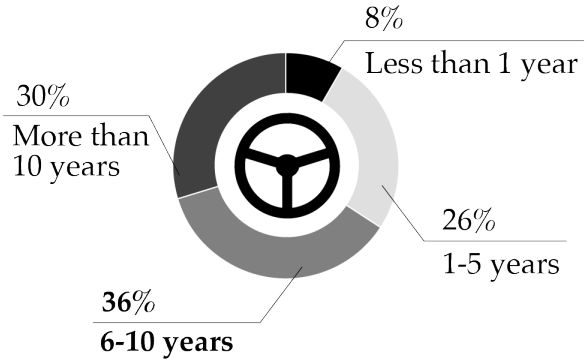
3. What is their marital status?



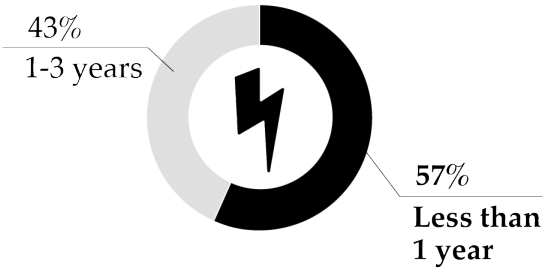
4. What is their academic level?



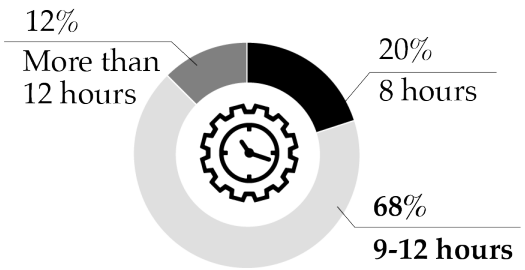
5. How much experience do they have as a bus driver?



6. How much experience do they have as an e-bus driver?



7. How many hours per day do they work?



8. Do they have any time to eat or rest?

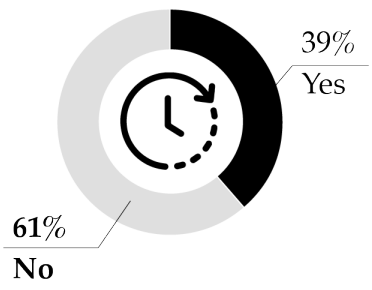


Figure 5. E-bus drivers of Metrobús Line 3 (Source: Author based on the e-bus drivers' survey)

9. Did they face any challenges related to their work during the transition to e-buses?

 Yes 28%  **No 72%**

From those who said yes:

- Difficulty in adjusting to the regenerative braking method.
- Problems with people jamming doors due to the adding of sensors, causing operational delays especially in peak hours.

10. Have they experienced any changes in your physical health since driving e-buses?

 Yes 24%  **No 76%**

From those who said yes:

Positive changes	**Negative changes**
• Improved attentiveness to road details due to reduced engine noise. • Enhanced driving comfort due to automatic gear. • Reduction in fatigue and stress. • Comfort and reliability of driving electric vehicles. • Alleviation of back and leg pain. • Cooler and fresher work environment.	• Stress, particularly concerning slower door operation affecting travel times. • Spinal pain due to insufficient seat cushioning. • Increased fatigue due to the regenerative braking driving method.

11. Do e-buses have any equipment that diesel buses don't have, that affects their daily work?

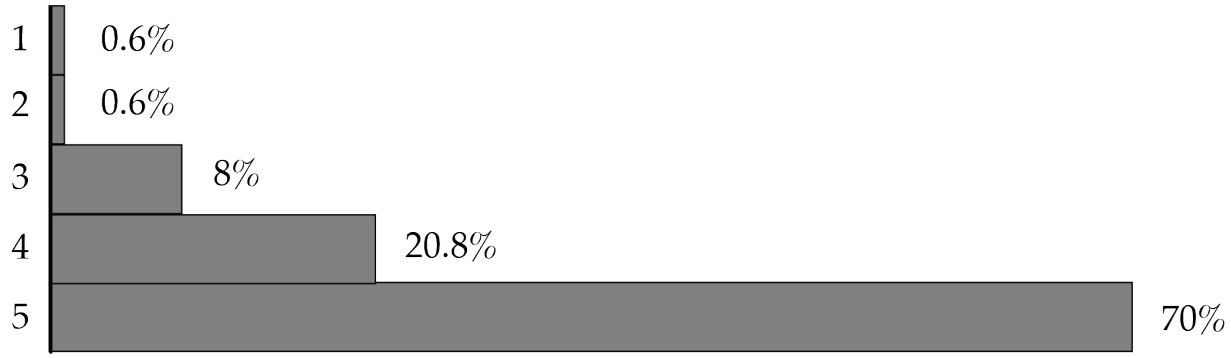
Yes 30% **No 70%**

From those who said yes:

Positive effect	**Negative effect**
• Electric engine providing a noise-free operation, leading to increased comfort and safety. • More comfortable driver's seat equipped with lumbar massage, heating, and various positions. • Appreciation for the side shutter, which helps with sunburn.	• Negative impact of door sensors, causing delays during peak hours, leading to increased stress levels. • Privacy invasion due to video surveillance cameras. • General dissatisfaction with the warmth inside the bus.

12. How satisfied are they with driving e-buses?

(Scale: 1-5, where 1 is very dissatisfied and 5 is very satisfied)



13. Have they experienced any changes in job satisfaction since the transition to e-buses?

Yes **55%** No 45%

From those who said yes:

Positive effect	Negative effect
• Gaining experience in electrical technology. • Improved image of public transport. • Pride and excitement for driving state-of-the-art buses. • Grateful for the opportunity to grow professionally.	• Pressure to meet parameters and adhere to Metrobus schedules.

14. Do they feel more motivated or committed to their job as an e-bus driver?

Yes **50.3%** No 49.7%

From those who said yes:

- Desire for continuous learning about e-buses.
- Sense of higher responsibility for passenger safety and comfort.
- Motivation from positive acknowledgment by users.

15. Do they have any concerns related to the transition to e-buses that affect their daily work or their overall quality of life?

Yes 6% **No** **94%**

From those who said yes:

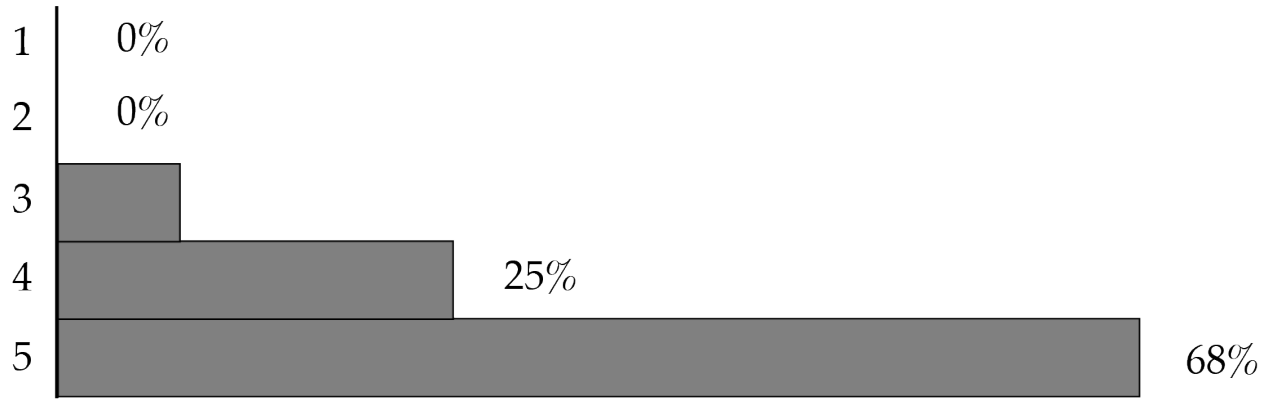
- Fear of unintentional errors.
- Increased stress due to the meticulous care required.
- Uncertainty about applying training received for e-buses.

16. Did they receive adequate training and support during the transition to e-buses?

Yes **95%** No 5%

17. How would they describe the overall impact of driving e-buses on their quality of life?

(Scale: 1-5, with 1 being very negative and 5 being very positive)



18. What specific aspects of their quality of life have improved or worsened since the transition to e-buses?

- Enhanced comfort but coupled with increased responsibility.
- More time available for family.
- Appreciation for e-buses contributing to a reduction in environmental pollution.

19. Do they think the introduction of e-buses has changed the passenger experience?

 **Yes** **83%**  No 17%

From those who said yes:

Positive effect	Negative effect
• Increased comfort. • Improved service quality and comfort. • Enhanced safety perception. • Positive reception of amenities like USB charging ports. • Friendlier atmosphere, including the sound of the horn.	• Ventilation issues causing discomfort, especially when the bus is crowded.

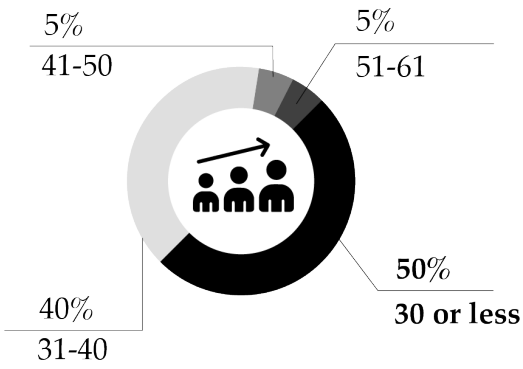
20. Based on their experience, do they have any suggestions to further improve the quality of life for e-bus drivers?

- Continuous training in technical knowledge and human relations.
- Providing designated time for meals and rest.
- Addressing the short turnaround times in terminals for drivers to have sufficient time for personal needs.
- Improving bus ventilation.
- Adjusting travel times and route logistics for better synchronization.
- Advocating for more realistic schedules that consider external factors beyond the driver's control.
- Adding more padding to driver's seats for enhanced comfort.
- Addressing concerns about privacy invasion from surveillance cameras, aiming to alleviate stress related to surveillance.

E-bus maintenance staff of Metrobús Line 3

(20 out of 21 respondents)

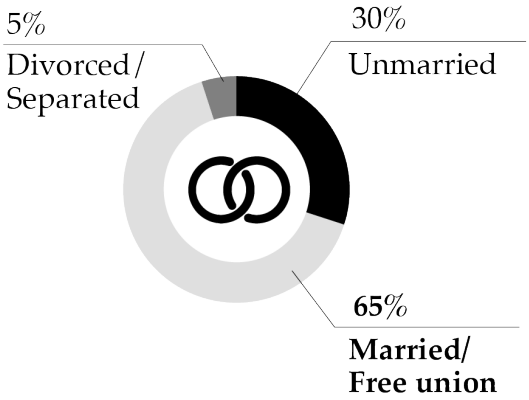
1. How old are they?



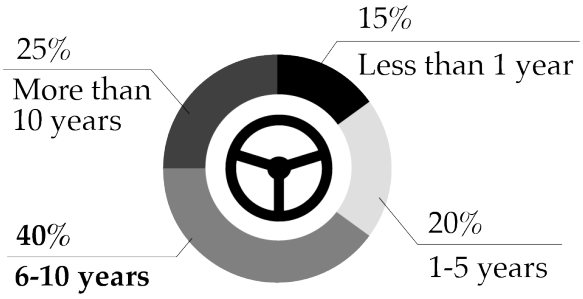
2. What is their gender?

100% of the maintenance staff are men.

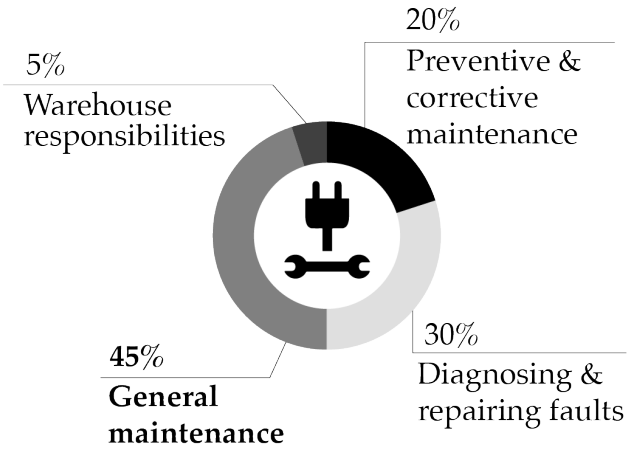
3. What is their marital status?



4. How much experience do they have maintaining buses?

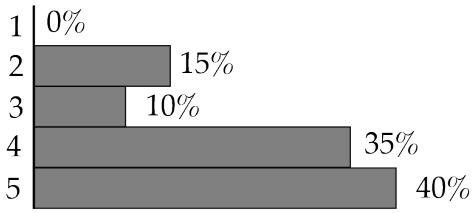


5. What are their main responsibilities and tasks?



6. How familiar are they with the specific maintenance requirements and procedures for e-buses?

(Scale: 1-5, with 1 being not at all and 5 being quite familiar)



7. How would they rate the overall work environment since the transition to e-buses?

(Scale: 1-5, with 1 being very negative and 5 being very positive)

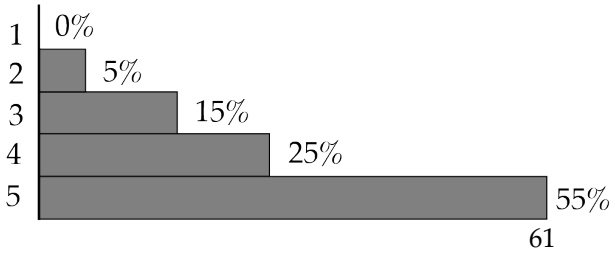


Figure 6. Maintenance staff of Metrobús Line 3 (Source: Author based on the maintenance staff's survey)

8. Have they received any specialized training related to e-bus maintenance?

Yes **85%** No 15%

The training covers various aspects, including direct training from the Chinese e-bus brand Yutong, load handling, lighting, static electricity, high voltage caution and understanding the components and necessary repairs for e-buses.

9. In their experience, what are the main differences in maintenance requirements between diesel and e-buses?

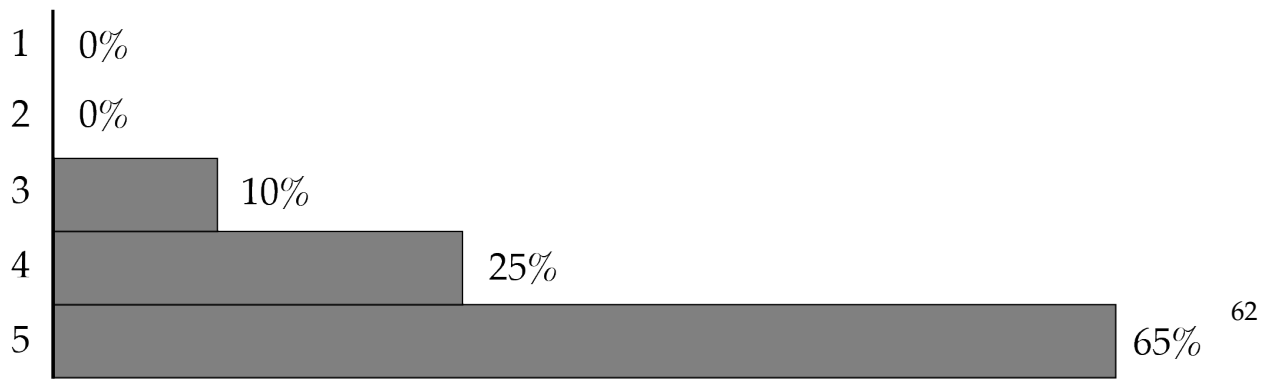
- E-buses are more environmentally friendly, avoiding the use of fuel and lubricants.
- Knowledge of specialized electronics and high-voltage systems is required.
- Maintenance requires a scanner for electrical components.
- Spare parts for e-buses are different from those of diesel buses.
- Special tools (dielectric) and personal protective equipment (PPE), such as antistatic uniforms and insulated tools are required for high-voltage maintenance.
- Consideration of safety measures to avoid accidents is essential.

10. Have they faced any challenges or difficulties in maintaining the e-bus fleet?

Yes 5% **No** **95%**

11. How would they rate the overall reliability and performance of e-buses in terms of maintenance needs?

(Scale: 1-5, with 1 being not at all reliable and 5 being very reliable)



12. Have there been changes in the frequency of maintenance activities or the time required for maintenance tasks since the transition to e-buses?

Yes 60% No 40%

- Maintenance is less frequent, but with slightly more complex procedures.
- Time efficiency has improved, reducing the time buses are out of operation.
- Preventive maintenance time is decreased.
- Maintenance processes are faster and simpler, focusing on checking fluid levels and battery condition.

13. Are there specific tools, equipment or resources that they feel are missing or would be beneficial for effective e-bus maintenance?

Yes 30% **No 70%**

From those who said yes:

- Programs for diagnostics and information for repair tasks.
- High voltage equipment for discharging batteries for future repairs.
- PPE for self-protection, including insulated tools.

14. How satisfied are they with their daily work?

(Scale: 1-5, being 1 very dissatisfied and 5 very satisfied)

15. Have they experienced any changes in job satisfaction since the transition to e-buses?

Yes 30% **No 70%**

From those who said yes:

- A new learning experience.
- A positive change and a shift toward cleaner and more efficient mobility.
- Reduced maintenance workload.
- Acknowledgment of being part of a significant change in Metrobús Line 3 with the introduction of e-buses.

16. Do they have any concerns related to the transition to e-buses that affect their daily work or their overall quality of life?

Yes 0% **No 100%**

17. How would they describe the overall impact of the transition to e-buses on their quality of life?

(Scale: 1-5, with 1 being very negative and 5 being very positive)

18. What specific aspects of their quality of life have improved or worsened since the transition to e-buses?

- Application of acquired knowledge for professional growth.
- Reduced maintenance workload.
- Enhanced knowledge in electrical units.
- Elimination of handling lubricants that could cause diseases.
- Perceived benefit in fighting global environmental pollution.
- Less fatigue and a positive outlook for the future.

19. Based on their experience, do they have any suggestions to further improve the quality of life for e-bus maintenance staff?

- Regular feedback for continuous improvement.
- Emphasis on more training opportunities for the maintenance staff.
- Workshop equipped with dielectric elements and PPE, such as antistatic uniforms and insulated tools.

Summary of findings from the e-bus drivers survey

In the e-bus drivers survey, it was observed that the majority of drivers, mainly aged between 31-50 years, are all male and predominantly married or in a free union. Their educational backgrounds vary, with most having completed secondary or preparatory school. Experience in bus driving ranges widely, with a significant portion having 6 to more than 10 years of experience, yet 57% have less than 1 year of experience in driving e-buses. A considerable number (68%) work 9-12 hours a day, and the majority (61%) reports not having time to eat, rest or using the restroom during their working day.

In terms of their experience with e-buses, positive aspects include quieter operation, more comfortable seating and improved ventilation inside the driver's cabin. However, there are negative aspects such as stress related to slow door operation, adapting to different driving techniques and potential health impacts. Responses regarding the impact on physical health were mixed, with some reporting less stress and others mentioning issues like back pain due to the lack of cushioning in the driver's seat and increased fatigue due to the adjustment to the regenerative braking method. Concerns were raised about surveillance cameras invading privacy.

Overall satisfaction with driving e-buses is high, with 70% rating it a 5 on a scale of 1-5. Many drivers feel more motivated and committed due to the novelty and positive aspects of e-bus driving. In addition, the reduced engine noise enhances road safety, as they report an increase in attentiveness to road details.

Regarding the passenger experience, drivers believe e-buses have positively changed it by offering more comfort, safety and additional features like USB inputs. However, some passengers complain about heat and the lack of ventilation.

In terms of suggestions for improvement, drivers request more training, especially in technical knowledge and human relations. Concerns were raised about physiological needs during the workday, such as time for eating, resting and using the restroom. Recommendations include improvements in air conditioning, scheduling by Metrobús, more comfortable driver's seats and better functionality of doors and rear-view mirrors. There was also a call to address the concerns about the invasion of privacy by surveillance cameras.

Summary of findings from the maintenance staff survey

The majority of respondents from the maintenance staff are mainly aged between 21 to 40, all male and predominantly married or in a free union. They possess varied experience levels in maintenance, with 40% having 6-10 years of experience in maintenance work in public transport. Their primary responsibilities include general maintenance, diagnosing and repairing faults, preventive and corrective maintenance and warehouse responsibilities.

In terms of their experience with e-buses, most staff is familiar with the specific maintenance requirements and procedures for e-buses. The overall work environment since the transition to e-buses is positively rated, with a majority giving it a 5 on a scale of 1-5. Notably, 85% of them received specialized training related to e-bus maintenance. Identified differences between maintenance requirements for diesel and e-buses include knowledge of electronic diagnostic tools, specialized electronics, high-voltage systems, elimination of lubricants and safe working procedures.

Concerning challenges and reliability, no challenges were reported in maintaining the e-bus fleet. The overall reliability and performance of e-buses in terms of maintenance needs are highly rated, with a majority giving it a 4 or 5 on a scale of 1-5.

Regarding changes in the frequency of maintenance activities, a majority reported changes in the frequency of maintenance activities and less time required for maintenance tasks since the transition to e-buses. Maintenance is less constant but more complex when performed.

The staff express high overall satisfaction with their daily tasks, as indicated by 80% assigning it the highest rating of 5 on a scale from 1 to 5. Notably, no concerns affecting daily work or overall quality of life have been reported. The overall impact of the transition to e- buses on quality of life receives a positive rating from 75% of respondents, with key improvements identified in a healthier work environment, attributed to the absence of lubricants, opportunities for personal growth, positive environmental contributions and an emphasis on continuous learning.

In terms of tools and resources, some staff feel that specific tools, equipment or resources are missing or would be beneficial for effective e-bus maintenance. Requests include diagnostic programs, high-voltage equipment, antistatic uniforms and insulated tools. In addition, the need for more training opportunities and regular feedback sessions is expressed.

5. DISCUSSION

5.1 The impact of the electrification of bus fleets in the public transport workforce of Metrobús Line 3

This section focuses on the main research question: “How is the electrification of bus fleets impacting the public transport workforce of Metrobús Line 3?”. In exploring the workforce implications of the new electric technology, the first additional research question is also answered: “What are the challenges faced by the public transport workforce of Metrobús Line 3 associated with the electrification of bus fleets?”. Based on the findings from the literature review, the expert interviews and the surveys with the workforce of Metrobús Line 3, e-bus technology has a dual impact on the workforce, comprising both positive and negative aspects.

Positive effects of e-bus technology

Improved work environment through comfort and safety

- Healthier work environment due to the electric engine's emission-free operation, reducing pollution.
- Lower heat emission compared to ICE buses, ensuring a fresher environment for the drivers.
- Reduced engine noise promotes attentiveness, lowering the risk of accidents and enhancing safety.
- Automatic gears improve physical comfort by decreasing pressure on body muscles while in use.
- Elimination of lubricants for maintenance staff contributes to a healthier work environment.

Increased satisfaction and motivation

- Decreased workload for maintenance staff, optimizing operational processes.
- Pride and excitement among the workforce for operating and maintaining state-of-the-art buses.
- Improved public image of public transport positively influences the perception of drivers.
- Workforce motivation for environmental responsibility, contributing to a healthier public space.

- Continuous learning about new technology promotes a motivated and skilled workforce.

Challenges related to the electrification of the Metrobús Line 3 bus fleet

Several issues emerge from the survey, resulting from both the buses' innovative electric technology and their newness. It is crucial to distinguish between concerns directly related to e-bus technology, challenges deriving from the buses' newness and broader challenges experienced by Mexico's public transport workforce that affect Metrobús Line 3. While this study focuses primarily on the challenges connected with e-bus technology, it is critical to recognize and address issues from the other two categories. Exclusively addressing issues directly linked to e-bus technology unnecessarily limits the scope and poses the risk of overlooking other aspects that, initially appearing unrelated, are, in fact, indirectly connected to the technology. Since e-bus technology aims to tackle pollution and climate change, a comprehensive understanding of workforce issues is critical in order to effectively provide recommendations for change.

a) Challenges directly linked to the electrification of the bus fleet:

Adjustment issues to the new driving method
The adjustment to the regenerative braking driving method poses challenges for e-bus drivers, resulting in heightened stress and fatigue for some.

Lack of safety equipment
There is a notable lack of dielectric elements and PPE, such as antistatic uniforms and insulated tools. Given the nature of maintenance tasks involving high-voltage systems, proper equipment is crucial for safety.

Lack of ongoing training
Both e-bus drivers and maintenance staff express a need for more extensive and continuous training. Drivers, in particular, highlight the necessity for training not just on the technology but also in human relations. Thus, the one-month capacitation training appears insufficient.

No salary raise initiated by the company

The company does not initiate salary raises for driving and maintaining e-buses which have a more advanced technology than diesel buses, unless requested by the workforce during annual trade union negotiations.

Potential job displacement and loss

The majority of surveyed maintenance staff being under 30 and e-bus drivers falling within the 31 to 50 age group, suggests a preference for younger workers, particularly in maintenance. This raises concerns about potential job displacement and losses during the transition, although intentional exclusion of older workers from the selection process during the electrification of Line 3 is unknown.

b) Challenges associated with the new e-buses:

Addition of door sensors

A common complaint among e-bus drivers is the addition of sensors to the doors. During busy hours, passengers take advantage of the sensors to board, causing severe delays. Metrobús purposefully kept the same bus schedule as diesel buses, increasing stress levels for drivers who feel obligated to stick to the old timetable. As a result of this delay, important physiological demands such as eating, resting and using the restroom are impacted, with the majority of drivers indicating a lack of time for these activities.

Uncomfortable driver's seats

Another common concern among e-bus drivers is uncomfortable driver's seats due to insufficient padding, which causes spinal discomfort.

Lack of air conditioning and ventilation

The choice not to equip the new e-buses with air conditioning, based on the climatic circumstances in Mexico City and the convenience of electricity demand and battery size reduction, results in reported issues with high temperatures and insufficient ventilation within the buses, a concern shared by passengers.

Invasion of privacy

The introduction of surveillance cameras on the new e-buses prompts some drivers to voice privacy concerns, expressing discomfort with being under constant surveillance throughout their workday.

c) Broader challenges impacting the public transport workforce in Mexico and their indirect effects on the workforce of Metrobús Line 3:

Institutional challenges

- The federal government's investment priorities mainly favor private motor vehicles, with only a small portion allocated to public transport. Even when electrification strategies are drafted, the emphasis is on private electric vehicles, due to Mexico's major automobile manufacturing sector.
- Lack of professionalization in administrative or management positions in public transportation, resulting in an overall lack of qualifications, experience and continuity. Political transitions, such as the 2024 municipal elections, cast doubt on electrification plans since changes in local government cause shifts in hierarchical positions, preventing meaningful changes from happening.
- Absence of JT clauses, such as collective bargaining and social dialogue, in official policies concerning transport and climate change.

Lack of labor policies

- Metrobús has a limited role in decisions concerning employee working conditions. Salaries, work conditions, benefits and the adoption of JT measures are all determined independently by each company, enabling them to provide minimal work conditions in order to maximize profits.
- Given that government subsidies are based on kilometer performance, the financing scheme incentivizes the companies to prioritize profit over labor conditions.
- MIVSA's unnecessary takeover of survey administration, making workforce responses pass through the HR department before reaching the author, highlights the company's controlling work culture. This might be indicative of similar practices in other transport companies as well.

Climate crisis

Mexico's vulnerability to climate change-induced events, like tropical cyclones, floods and droughts, poses a challenge due to the lack of shelters for drivers, who are most exposed in case of emergencies.

Driver shortage and gender imbalance

- Widespread driver shortages across Latin American countries, stemming from unappealing job conditions, lack of career prospects and a negative professional reputation.

- Low representation of women, especially in driving and maintenance roles, contributes to the driver shortage. The absence of women in the surveyed workforce of Metrobús Line 3, coupled with the company's lack of strategies or measures to employ women in these roles, is exacerbated by reports from MIVSA's HR department indicating that past female bus drivers left due to inadequate salaries or work conditions.

The technology itself has a predominantly positive impact on the workforce, aligning with findings from the ITF (2022) study, where the workforce generally embraced the technology but expressed concerns about its implications. Similar dynamics are observed within the Metrobús Line 3 workforce, where challenges directly tied to the new e-buses are manageable. However, while delving into the specific challenges posed by the technology, it is imperative to step back and consider the broader issues confronting the public transport workforce in Mexico. Addressing these overarching challenges is crucial, as the rapid implementation of the technology in response to climate change and pollution urgency risks legitimizing the persisting job precariousness in this profession. The transition to electrification should be viewed not merely as a technological response but as a window of opportunity to fully analyze and address all factors influencing the public transport workforce, ensuring a comprehensive resolution of their issues rather than using the transition as a veil for underlying problems.

5.2 Recommendations

This section addresses the second additional research question: "What recommendations related to the electrification of bus fleets can ensure a JT for the public transport workforce of Metrobús Line 3?". Drawing insights from the literature review, surveys and interviews, it provides recommendations for implementing measures aimed at achieving a JT for the workforce of Metrobús Line 3. These proposed measures aim not only to alleviate the challenges faced by this specific workforce but also provide larger benefits for the public transport workforce in Mexico as a whole. The recommended measures are categorized into three levels, based on the primary actor responsible for their implementation: a) operator level; b) transport authority level; and c) policymaker level, referring to measures led by either federal or local government entities. It is critical to emphasize that effective implementation of these measures requires coordination at all three levels and cooperation is essential for their success.

a) Operator level

Ongoing training
It is recommended that ongoing training, extending beyond a month-long capacitation, be established to improve the competency of e-bus drivers and maintenance staff. The surveys revealed a mutual desire for continuous training from both driver and maintenance staff, acknowledging their ongoing adaptation to new driving methods and high-voltage systems.

Ensuring workplace safety
The provision of PPE such as antistatic uniforms and insulated tools for the maintenance staff, is crucial in order to ensure a safe working environment. Additionally, considering Mexico's existing vulnerability to climate change, with future impacts expected to intensify, it is necessary to implement shelters for drivers during extreme weather events. This precautionary measure is particularly important as drivers are more exposed to danger in such circumstances.

Greater engagement with the trade union or other forms of workforce participation
During significant transitions like the current one from diesel to e-buses, it is recommended to exceed the annual frequency of meetings with the trade union. Given the substantial impact on the workforce, genuine consultation sessions should be conducted when the company contemplates electrification, not solely after its completion. Inclusivity

at every stage is crucial, ensuring an iterative transition process that incorporates workforce feedback.

Enhancing gender inclusivity in driving and maintenance roles
To foster greater gender diversity in the workforce, it is recommended to adopt a proactive approach, extending beyond mere openness to women applicants. Specifically targeted actions should be taken to increase the representation of women in traditionally male-dominated professions like driving and maintenance. Taking advantage of the benefits introduced by electrification, companies can make these roles more appealing for women by implementing measures such as improving work-life balance, offering flexible working hours, ensuring equal pay and benefits, providing dedicated sanitation facilities and establishing an effective system to counter workplace discrimination and harassment.

Promoting employee well-being
Inspired by MetrôRio's initiative on employee well-being and fostering an inclusive work culture, this broader measure is applicable to any transport company, regardless of its technology. However, given the significant change the workforce is undergoing as a result of the transition to electric technology, its relevance is reinforced. Adopting measures similar to MetrôRio's, such as personalized feedback and development plans, support for physical and mental health, guidance on psychological, financial, legal and social services and advocating for workplace diversity, becomes especially valuable in the context of a newly electrified bus fleet workforce.

b) Transport authority level

Strengthening the authority of Metrobús
To address the current limitation of Metrobús in influencing decisions on employee working conditions, it is recommended to enhance Metrobús's authority in supervising and ensuring companies' compliance with JT measures. This might be accomplished by providing companies who electrify their bus fleets with additional government subsidies through the Metrobús account, provided that they meet the JT conditions for the workforce. To qualify for the extra subsidy, companies should meet conditions formulated in collaboration with trade unions and stakeholders to accurately capture workforce challenges and effectively address them. This financing approach serves as a mechanism to incentivize companies to implement JT measures, moving beyond profit as the sole driving factor. Moreover, it reduces the potential sovereignty effects of certain companies that currently hold the capacity for electrification, thereby limiting neoliberal practices.

Collaborative efforts to address driver shortage and gender imbalance

Addressing the challenges of driver shortage and the underrepresentation of women in the public transport sector requires a collective effort. Metrobús, as a key participant, should collaborate with governmental bodies, private companies, the trade union and various stakeholders to enhance the attractiveness of professions like bus driving and maintenance. The emergence of new electric technology gives an ideal opportunity, with e-buses offering numerous positive aspects. It is imperative for all involved parties to take coordinated actions, mirroring best practices with a gender focus. This includes initiatives such as providing specialized training exclusively for women, overcoming licensing barriers, partnering with public technical education institutions and employing innovative financial mechanisms like the cases in Bogotá and Jalisco.

Establishing a Just Transition Committee

Drawing from the successful model of collective bargaining in Santiago, Chile, where workers and the company actively participated in the transition process, it is recommended to establish a Just Transition Committee. This committee would serve as a consultative platform for workers to discuss concerns and challenges, as highlighted in the surveys regarding the technology of e-buses and other new bus equipment. Additionally, it would provide space for proposing ideas to enhance daily work conditions and overall quality of life.

c) Policymaker level

Increasing subsidies for the electrification of bus fleets

To address the challenge of insufficient federal funding for public transport, especially in the context of transitioning from diesel to electric processes, a reallocation of funds is essential. Given the current bias towards allocating funds to private vehicle infrastructure, it is crucial to prioritize public transport. For instance, as mentioned one of the measures on the Metrobús level, the government should increase subsidies for concessioned companies implementing electric mobility through the Metrobús financing scheme. This approach ensures that the government initiates the action chain by providing additional funds. Subsequently, Metrobús would supervise and ensure that companies adhere to the prescribed conditions, facilitating the implementation of JT measures for their workforce.

Tackling the gender imbalance in the sector

To mitigate the underrepresentation of women in the public transport sector and effectively address the challenges faced by employed women, it is imperative to adopt a gender-sensitive approach in policy development. This involves incorporating gender

equity clauses into institutional frameworks and funding agreements. An effective mechanism for this is exemplified in the government's proposed subsidy increase for the electrification of bus fleets, where gender equity clauses should be integrated into the JT clause. This becomes a requirement for companies to be eligible for the extra government subsidies, guaranteeing a proactive approach to gender balance in the sector.

Prioritizing public transport electrification on official strategic documents

Prioritizing public transport electrification on official strategic documents is essential for ensuring a JT. Emphasis should be placed on prioritizing the electrification of public transport over private vehicles, not only to effectively address climate change and pollution but also to signal a clear priority to all stakeholders in the mobility sector. For example, the "E-mobility Strategy for Mexico City 2018-2030," which predominantly focuses on electric cars, illustrates the need to align strategic priorities with principles of JT, ensuring equitable outcomes for workers impacted by the shift to electric mobility.

Incorporating JT clauses into official strategic documents

Building on the preceding recommendation of prioritizing public transport electrification, official documents related to this topic should also integrate JT clauses for the workforce. Currently, these clauses, including elements like social dialogue and collective bargaining, are notably absent.

Establishing an independent body for public transport oversight

To tackle the issue of the lack of professionalization, the establishment of an independent body solely dedicated to public transport should be considered. This body should consist of local stakeholders and engaged organizations, ensuring decision-making remains uninfluenced by political factors such as elections or other potential political influences.

6. CONCLUSION

6.1 Summary of key findings

The need to address climate change is pressing, given the Paris Agreement's commitment to limit temperature increase to 1.5°C. Despite worldwide efforts, projections indicate potential breaches of this threshold by the early 2030s, with the transport sector, especially road transport, playing a crucial role. Public transport is identified as a key solution aligned with SDGs, but challenges in NDCs' specificity persist. The electrification of public transport, including bus fleets, is an essential measure critical for meeting sustainable development and decarbonization goals. While benefits include economic, environmental and social aspects, challenges involve financial barriers, technological limitations and workforce implications such as retraining and potential job displacement.

When exploring the concept of a JT for the urban transport workforce, originating in the 1970s, the ILO serves as a guide, prioritizing inclusive strategies and social dialogue. Definitions highlight its complex nature, addressing both worker-centric issues and broader societal changes. Challenges involve engaging stakeholders, capacity building and adopting context-specific models, with warnings against oversimplified views on jobs versus climate. The urban transport workforce faces challenges from climate change, e-bus technology shifts and neoliberal practices, with strategies proposed for improved working conditions, job security, training, gender equity and worker-led formalization.

The Latin American public transport workforce demonstrates JT practices, illustrated by initiatives in Santiago, Bogotá, Jalisco, Quito and Hidalgo, specifically addressing gender inclusion through skill development, collaborative governance and overcoming barriers for women in traditionally male-dominated roles. Additionally, collective bargaining in Chile led by FESIMETRO, incorporate JT clauses to tackle the impacts of climate change on workers, while MetrôRio in Brazil serves as an exemplary model, demonstrating comprehensive initiatives that enhance employee well-being, diversity and inclusion.

The transport sector in Mexico, a crucial driver of economic growth, contributes to environmental and health risks through air pollution. Despite legislative commitments and support for electrification, challenges persist, including resistance from private operators, aging bus fleets and workforce issues. The lack of a comprehensive plan for achieving electrification targets in Mexico City highlights the need for inclusive strategies addressing regulatory gaps, professionalization, gender imbalances and the rapid integration of new technologies.

Metrobús, established in 2004 to optimize demand coverage in Mexico City, transitioned Line 3 from diesel to electric buses, operating 60 electric buses by March 2023. This transition, strategically selected for operational efficiency, passenger load and fleet age, is expected to yield substantial benefits, including an 80% reduction in energy costs, prevention of 300,000 tons of CO2 emissions over a decade and operational advantages, despite initial challenges and upfront costs.

The Metrobús' Line 3 public transport workforce's perspectives on the transition, as gathered from the surveys, provide insights into their experiences, challenges and suggestions for improvement. The findings highlight overall satisfaction among e-bus drivers and maintenance staff, with positive aspects such as an improved work environment. However, challenges arising from innovative electric technology, the newness of buses and broader challenges affecting the workforce are identified. The study recommends adopting a comprehensive approach to prevent the overlooking of interconnected factors, highlighting that concentrating exclusively on challenges related to e-buses could worsen job precariousness. Table 3 provides a summary of the identified challenges the workforce faces that are related to the electrification of the Metrobús Line 3.

Drawing insights from the literature review, particularly the best JT practices in Latin America, the research provides a three-level categorization of proposed measures—operator, transport authority and policymaker—emphasizing the need for coordinated implementation for success in achieving a JT and broader benefits for the entire public transport workforce in Mexico. Table 4 provides a summary of these recommendations related to the electrification of bus fleets that ensure a JT for the public transport workforce of Metrobús Line 3.

a) Challenges directly linked to the electrification of the bus fleet
- Adjustment issues to the new driving method - Lack of safety equipment - Lack of ongoing training - No salary raise initiated by the company - Potential job displacement and loss
b) Challenges associated with the new e-buses
- Addition of door sensors - Uncomfortable driver's seats - Lack of air conditioning and ventilation - Invasion of privacy
c) Broader challenges
- Institutional challenges - Lack of labor policies - Climate crisis - Driver shortage and gender imbalance

Table 3. Challenges related to the electrification of the Metrobús Line 3 bus fleet (Source: Author)

a) Operator level
- Ongoing training - Ensuring workplace safety - Greater engagement with the trade union - Enhancing gender inclusivity in driving and maintenance roles - Promoting employee well-being
b) Transport authority level
- Strengthening the authority of Metrobús - Collaborative efforts to address driver shortage and gender imbalance - Establishing a Just Transition Committee
c) Policymaker level
- Increasing subsidies for the electrification of bus fleets - Tackling the gender imbalance in the sector - Prioritizing public transport electrification on official strategic documents - Incorporating JT clauses into official strategic documents - Establishing an independent body for public transport oversight

Table 4. Recommendations related to the electrification of bus fleets that ensure a JT for the public transport workforce of Metrobús Line 3 (Source: Author)

6.2 Implications of the findings and recommendations for future research

While solutions like the electrification of bus fleets appear ideal for addressing climate change and air pollution, it is critical to thoroughly examine the side effects of this energy transition, as changes in urban contexts have an inevitable effect on society, with direct implications for the public transportation workforce. This study has implications not only for the workforce selected for Metrobús Line 3, but also for the whole public transportation workforce in Mexico, requiring policymaker—level actions. It can be utilized by Metrobús and MIVSA to assess employee satisfaction with the energy transition and formulate strategies to address challenges and in addition, to foster a positive employer-employee relationship. The surveys offer workers a platform to voice their needs, influencing future e-bus procurements to align with workforce requests thus, directly benefiting the workforce, impacting their daily jobs. Furthermore, it provides valuable insights for policymakers aiming to incorporate social dialogue and collective bargaining, crucial JT elements for effecting meaningful and lasting changes during the ongoing technological transition. Consequently, this study can inspire actions that contribute to the well-being of the public transport workforce as a whole and not merely the specific group of bus drivers and maintenance staff of Metrobús Line 3.

As the transition from diesel to e-buses for Metrobús Line 3 is still relatively new, with most of Line 3 being electrified for less than 1 year, new concerns may arise among the workforce over time. Therefore, ongoing surveys and consultation sessions are crucial for staying updated on the challenges of the transition. Additionally, the survey methodology can be adapted for application in other cities in Mexico or worldwide that have electrified their bus fleets, with careful consideration of contextual differences. Addressing gender imbalance remains a persistent issue and further research incorporating specific measures would be beneficial in tackling this challenge. Furthermore, as informality is a key concern in Mexico's public transport, conducting in-depth research on how this transition impacts the informal workforce could provide valuable insights for addressing this issue.

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APPENDIX

I. Surveys

Questions of the survey for the e-bus drivers of Metrobús Line 3

[Translated from Spanish to English by the author]

- Full name:
- Employee ID number:
- Age:
- Gender:
- Marital status:
- Level of schooling:
- Years/months of experience as a bus driver:
- Years/months of experience driving electric buses:

- How many hours a day do you work?
- Do you have meal or rest time during your working hours?
- How would you rate the overall work environment since transitioning to electric buses? (Scale: 1-5, with 1 being very negative and 5 being very positive)
- Did you face any challenges related to your job prior to transitioning to electric buses? If yes, please describe the challenges.

- Have you experienced any physical health changes since driving electric buses? If yes, please specify the changes and their impact on your overall well-being.
- Have you noticed any changes in noise levels inside the bus compared to diesel buses? If yes, please describe the impact of the changed noise levels on your work experience.
- Do electric buses have any equipment that diesel buses don't have that impact your daily work? If yes, please specify the equipment and its impact.

- How satisfied are you with driving electric buses? (Scale: 1-5, with 1 being very dissatisfied and 5 being very satisfied)
- Have you experienced any changes in job satisfaction since transitioning to electric buses? If yes, please elaborate on the changes and their impact on your overall job satisfaction.
- Do you feel more motivated or engaged in your work as an electric bus driver? If yes, please explain how electric buses have affected your motivation and engagement.

- Do you have any concerns related to the switch to electric buses that impacts your daily work or your quality of life in general? If yes, please specify your concerns.

- Did you receive adequate training and support during the transition to electric buses?

- How would you describe the overall impact of driving electric buses on your quality of life? (Scale: 1-5, with 1 being very negative and 5 being very positive)
- What specific aspects of your quality of life have improved or worsened since transitioning to electric buses?

- Do you think that the introduction of electric buses has changed the user experience of the passengers? If yes, please specify how the user experience has changed for passengers.
- Have you had any direct feedback from passengers riding on electric buses? If yes, please describe the feedback.

- Based on your experience do you have any suggestions to further enhance the quality of life for e-bus drivers?

Questions of the survey for the maintenance staff of Metrobús Line 3

[Translated from Spanish to English by the author]

- Full name:
- Employee ID number:
- Age:
- Gender:
- Marital status:
- Level of schooling:
- Years/months of experience working as a maintenance staff member in the public transport sector:

- What are your primary responsibilities and tasks as a maintenance staff member?
- How familiar are you with the maintenance requirements and procedures specific to electric buses?

- How would you rate the overall work environment since transitioning to electric buses? (Scale: 1-5, with 1 being very negative and 5 being very positive)

- Have you received any specialized training related to the maintenance of electric buses? If yes, please describe the specialized training you received.
- In your experience, what are the main differences in maintenance requirements between diesel and electric buses?
- Have you faced any challenges or difficulties in maintaining the electric bus fleet? If yes, please specify.
- How would you rate the overall reliability and performance of the electric buses in terms of maintenance needs?
- Have there been any changes in the frequency of maintenance activities or the time required for maintenance tasks since transitioning to electric buses? If yes, please specify.
- Are there any specific tools, equipment, or resources that you feel are lacking or would be beneficial for the effective maintenance of electric buses? If yes, please specify.

- How satisfied are you with your daily job? (Scale: 1-5, with 1 being very dissatisfied and 5 being very satisfied)
- Have you experienced any changes in job satisfaction since transitioning to electric buses?If yes, please elaborate on the changes and their impact on your overall job satisfaction.
- Do you have any concerns related to the switch to e-buses that impacts your daily work or your quality of life in general? If yes, please specify your concerns.

- How would you describe the overall impact of the transition to electric buses on your quality of life? (Scale: 1-5, with 1 being very negative and 5 being very positive)
- What specific aspects of your quality of life have improved or worsened since transitioning to electric buses?

- Based on your experience do you have any suggestions to further enhance the quality of life for the e-buses maintenance staff?

II. Interview questions

Interview questions for the HR department of MIVSA

- Is there a salary increase associated with the operation and maintenance of electric buses?
- Is health insurance provided as part of the employee benefits?
- Are breaks included within the working hours of electric bus drivers and maintenance staff?

- Are there adequate sanitation facilities exclusively for the drivers? And shelters in case of extreme weather conditions?
- Are “dead kilometers" hours (the round trip to charging stations) counted as working hours?
- How were the initial 10 electric bus drivers selected in 2021?
- Are there specific strategies or initiatives to encourage greater inclusion of women in the workforce?
- Is there a continuous feedback system to gather experiences and suggestions from drivers and maintenance staff regarding electric buses?

Interview questions for the e-mobility expert based in Mexico City

- What are some of the key political discussions going on in Mexico regarding the transition to e-mobility?
- What would you say are some of the challenges faced by the public transport workforce that are unique for Mexico / Mexico City?
- Are there any challenges that arise with this transition in regard to the drivers and maintenance staff?
- How do you consider that this technology can improve working conditions for drivers and maintenance staff compared to diesel buses?
- Could you share any specific examples or strategies you have witnessed or been involved in that have successfully addressed gender disparities in the public transport workforce during the transition to e-buses in Mexico / CDMX?
- Can you share your observations regarding public transport agencies' interest in embracing a just transition?

Interview questions for the representative of Metrobús

- What are some of the key political discussions going on in Mexico regarding the transition to e-mobility?
- What are Metrobús's future plans in terms of expanding and upgrading its electric bus fleet? Does Metrobús plan to electrify completely its fleet or will it deploy new diesel buses?
- What legal and administrative strategies have been implemented to ensure a fair transition for the public transport workforce, including drivers and maintenance

personnel? Are these strategies or policies unified for all transportation companies or each company has their own?
- What is the representation of women in management and decision-making positions within Metrobús?
- What are the specific challenges facing women in the public transport sector, especially in operational or technical roles?
- What policies or programs does Metrobús have in place to promote a safe working environment free of gender discrimination for its staff? Does this also apply to the private transportation companies it oversees or they are independent in this aspect?
- Since electric buses have lower operating costs, do you have any knowledge if some of the money from these savings will be invested into improving employee benefits and training programs? If not, do you know what this amount of money will be invested to?

Interview questions for the representative of UITP Mexico

- What are some of the key political discussions going on in Mexico regarding the transition to e-mobility? Is it being supported and promoted by politicians and other actors or is it facing resistance? What are the arguments opposed to it?
- Which companies (stakeholders) are members of UITP Mexico? What is the process or criteria to become a member?
- What are the main challenges that UITP has identified in relation to the public transport workforce and how are they being addressed?
- How is UITP Mexico engaging with public transport operators? Are the workforce well-being and social equity topics of the collaboration?
- What is UITP's role in the electrification of bus fleets in Mexico? If it’s providing trainings, how does the process work?
- From UITP's perspective, how can we ensure that the transition to electric buses is fair and equitable for public transport workers?
- What role does UITP play in the development and promotion of policies that ensure fair and safe working conditions for public transport workers?
- What specific actions or projects has UITP undertaken in Mexico to address gender and equity challenges in the public transport sector?
- Are you aware of any successful practices of a just transition for the public transport workforce in Latin America?
- Is it possible to have a set of criteria regarding workforce benefits to oblige the transport companies to fulfill them?

Interview questions for the representative of IMDUT Yucatán

- What are some of the key political discussions going on in Mexico regarding the transition to e-mobility? Is it being supported and promoted by politicians and other actors or is it facing resistance? What are the arguments opposed to it?
- What would you say are some of the challenges faced by the public transport workforce that are unique for Mexico?
- Are you facing any challenges that arise with the transition to e-mobility in regard to the drivers and maintenance staff?
- Are you implementing or planning to implement any strategies that ensure a fair transition for the public transport workforce, including drivers and maintenance staff?
- Since drivers and the maintenance staff need training for this switch to electric mobility, how does this process work? Do you select some drivers and staff to train and then do they work meanwhile? Who organizes the training?
- I read that you had a meeting with Metrobús last year to learn from their experience. During this exchange, what were your key takeaways regarding the workforce? Is the workforce part of the discussions in the case of peer-to-peer exchange?
- Since transport is a traditionally male-dominated sector, could you share any specific examples or strategies you have witnessed or been involved in that have successfully addressed gender disparities in the public transport workforce during the transition to e-buses in Mexico?
- Do you think that this technological transition is helping the entire public transport sector to become more just?
- Since electric buses have lower operating costs, do you have any knowledge if some of the money from these savings will be invested into improving employee benefits and training programs?