



República Democrática de Timor-Leste

TECHNOLOGY NEEDS ASSESSMENT REPORT

Barrier Analysis and Enabling Framework

MITIGATION

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TNA TECHNOLOGY
NEEDS
ASSESSMENT



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TECHNOLOGY NEEDS ASSESSMENT REPORT

Author:

National Directorate of Climate Change

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Foreword

Timor-Leste is a member of Small Island Developing States (SIDS) and the Least Developed Country (LDC) which is very vulnerable to the effects of climate change and has been experiencing the negative impacts of extreme weather events, including intense storms and sea-level rise. The impacts of climate change are already undermining its development. Hence, without addressing the drivers of climate change and providing support for the most vulnerable sectors, these impacts will continue to worsen.

As a party to the UNFCCC, the Government of Timor-Leste is fully committed to developing and implementing measures that make its major development sectors climate-resilient and reduce greenhouse gas emissions from potential sectors. For example, the Nationally Determined Contribution (NDC) listed a number of mitigations and adaptation measures to enable sustainable low-carbon development and to build climate resilience in Timor-Leste. To support the implementation of its NDC and other national strategies, Timor-Leste is currently conducting a Technology Needs Assessment (TNA) to identify priority technology transfer investments and determine which environmentally sound technologies (EST) are the most effective in adapting and mitigating climate change.

The Minister of Tourism and the Environment (MTE) acknowledges that the TNA project is the first thorough national exercise undertaken toward assessing our needs for climate change technology. It was carried out by MTE through National Directorate for Climate Change (NDCC) in collaboration with the United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC) and the Asian Institute of Technology (AIT) and was funded by the Global Environment Facility (GEF). The Climate Change Working Groups (CCWG), key stakeholders, and local experts were all consulted during the TNA process.

Timor-Leste is proud to have completed the second phase of the TNA, Barrier Analysis and Enabling Framework (BAEF) Report, following the completion of the first phase of TNA, Identification and Prioritisation of Technologies Report. The BAEF Report for Mitigation was completed with the assistance of relevant line ministries, international agencies, non-governmental organizations (NGOs), private sectors, academia, and youth organizations. Through this collaboration, barriers for adoption and deployment of selected technologies in mitigation along with their measures were identified.

I look forward to seeing deployment and diffusion of selected technologies based on analysis, findings, and recommendations from this BAEF report.

A blue ink signature of Francisco Kalbuadi Lay is written over a circular official seal. The seal contains the text 'VICE-PRIMEIRO-MINISTRO' at the top and 'REPUBLICA DEMOCRATICA DE TIMOR-LESTE' around the bottom edge. The signature is a cursive, flowing line.

Francisco Kalbuadi Lay

**Vice-Prime Minister, Coordinating Minister for Economic Affairs,
Minister of Tourism and the Environment**

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Abbreviations

ADB	Asian Development Bank
AFOLU	Agriculture, Forestry, and Other Land Use
ANE	National Authority for Electricity
ACCESS	Accelerating Clean Energy Access
BAEF	Barrier Analysis and Enabling Framework
BAU	Business as Usual
CA	Conservation Agriculture
CBNRM	Community-based Natural Resources Management
CDM	Clean Development Mechanism
CH ₄	Methane
CO ₂	Carbon Dioxide
CCWG	Climate Change Working Group
CTCN	Climate Technology Centre and Network
DFAT	Department of Foreign Affairs and Trade
DGFCIP	Directorate General for Forestry, Coffee and Industrial Plants
DNTT	National Directorate of Land Transportation
DPs	Development Partners
DRBFC	Directorate of Roads Bridges and Flood Control
EDTL	Eletricidade de Timor-Leste
EU	European Union
EV	Electric Vehicle
FAO	Food and Agriculture Organization
FFS	Farmer Field School
FOLU	Forestry and Other Land Use
GEF	Global Environment Facility
GHG	Greenhouse Gases
IFI	International Financial Institutions

INDC	Intended Nationally Determined Contribution
INGO	International Non-governmental Organization
IPP	Independent Power Producer
IVA	Integrated Vulnerability Assessment
JICA	Japan International Cooperation Agency
KOICA	Korea International Cooperation Agency
LCD	Low Carbon Development
LTA	Land Transport Authority
MAF	Ministry of Agriculture and Fisheries
MOTC	Ministry of Transport and Communication
MPs	Micro Programs
MPW	Ministry of Public Works
MTE	Ministry of Tourism and Industry
NAMA	Nationally Appropriate Mitigation Actions
NDC	Nationally Determined Contribution
NDCC	National Directorate for Climate Change
NCCP	National Climate Change Policy
NDF	National Directorate of Forestry
NGO	Non-governmental Organization
N ₂ O	Nitrous oxide
OJT	On-Job-Training
PLUP	Participatory Land Use Planning
PPP	Public-Private Partnership
PSAF	Partnership for Sustainable Agroforestry
PV	Solar Photovoltaic
SALT	Slopping Agricultural Land Technology
SLM	Sustainable Land Management
SNC	Second National Communications

SSE	State Secretariat for the Environment
TAP	Technology Action Plan
TNA	Technology Needs Assessment
TOMAK	To'os ba Moris Di'ak
TSMP	Transport Sector Master Plan
UN	United Nations
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WB	World Bank

Executive Summary

The Technology Needs Assessment (TNA) is a country-driven participatory process aiming to identify and prioritise climate technology priorities for mitigation and adaptation through existing policies, programmes, short- to long-term plans, and strategies of the country. During the first phase of TNA, two sectors were selected in mitigation, namely: (1) transportation sector; (2) agriculture, land use, and forestry sector. The transportation sector prioritised four technologies: (i) developing a pollution control decree-law; (ii) a low-carbon development strategy; (iii) research on installing solar system-based charging stations; and (iv) public transport maximisation. Meanwhile, the agriculture, land use, and forestry sectors prioritised four technologies, namely: (i) agroforestry, (ii) participatory land use planning (PLUP), (iii) slopping agricultural land technology (SALT), and (iv) cover crops.

This Barrier Analysis and Enabling Framework (BAEF) report is the second phase of the TNA process, which covers barrier analysis on the transfer and diffusion of the prioritised mitigation technologies in the selected sectors, including the enabling framework and measures for overcoming barriers. The process of identifying barriers and potential solutions included a literature review, experts' interviews, and consultation workshops.

Key stakeholders in the transportation sector included the Ministry of Transport and Communications (MOTC), the Ministry of Tourism and Environment (MTE), the Secretary of State for Electricity, Water, and Sanitation, and the Secretary of State for Land and Property. While the agriculture, land use, and forestry sector included pertinent departments within the Ministry of Agriculture, Livestock, Fisheries, and Forestry. They were consulted individually and brought together during consultation workshops to determine the barriers to the transfer and diffusion of these technologies and suggest potential actions to overcome these barriers.

For mitigation, the eight technologies in the transportation and agriculture, land use, and forestry sectors were categorised as non-market goods that require public sector support for their successful deployment at different implementation scales. During the consultation workshop, the long list of barriers was grouped into two different categories: (i) financial and economic barriers and (ii) non-financial barriers.

Based on the analysis, it was found that economic and financial barriers in the transportation sector were highly associated with limited fund allocation and high initial capital investment due to their low priority among other national development priorities. While the non-financial barriers were mostly related to the limited institutional capacity and political will. The shifting of the government this year may cause disruptions in the deployment of technologies. Also, the lack of human resources with the necessary skillsets is one of the main factors contributing to the limited institutional capacity. Another barrier is the lack of data and information, including awareness regarding the potential benefits of technology in dealing with climate change.

In the transportation sector, barriers can be overcome by providing financial and technical resources for the deployment of these technologies. The non-financial barriers can be addressed through building and strengthening political coordination and institutional capacity by investing in human resources, adjusting, or reforming institutional systems, preventing over-bureaucracies, and using existing laws and policies to develop synergies between all levels of government and stakeholders.

In the agriculture, land use, and forestry sectors, financial and economic barriers were strongly associated with sustainability. There is no reliable source of long-term funding for programmes in this sector. This is also due to a lack of markets, which makes projects and programmes difficult to sustain. In the non-financial barriers, there appears to be a lack of institutional collaboration mechanisms and a continued lack of institutional capacity from the national to the municipal levels. In addition, the absence of laws and ineffective law enforcement mean that communities continue to carry out unsustainable forestry, agricultural, and land use practices. Water shortages and poor road access are also barriers in this sector.

Identified barriers in the agriculture, land use, and forestry sectors can be overcome through engagement and collaboration with development partners and relevant stakeholders involving joint planning, resource mobilisation, planning, monitoring, and evaluation. Additionally, use existing laws and policies to identify clear roles and responsibilities for coordination between ministries. Meanwhile, village regulations must be institutionalised, and assistance to farmers in providing technical skills, market access, and information must be strengthened. Furthermore, road infrastructure, water availability before the project begins, and water conservation must be considered when selecting a location.

The barrier analysis and enabling framework (BAEF) was prepared through a consultative and gender-inclusive process with the participation of stakeholders from the government, public institutions, public enterprises, non-governmental organisations, UN agencies, the private sector, and youth organisations in the relevant sectors.

1 Sector 1: Transportation Sector

1.1 Preliminary targets for technology transfer and diffusion

The transportation sector generates GHG emissions through fuel combustion, such as gasoline, diesel oil, and jet or kerosene fuel. It is common to use gasoline for road transportation, whereas diesel oil is more common for waterborne vehicles as well as for a few vehicles on the road.

In 2015, the GHG emissions from transportation in Timor-Leste were 251 GgCO₂-e, which represented a 67% increase in emissions from 2005. According to SNC, GHG emissions from transportation in Timor-Leste are projected to increase over the period from 2015 to 2030 by 1357 percent under the BAU scenario and 457 percent under the mitigation scenario. Road transportation and water transportation account for most of those increases.






Technology Transfer and Diffusion to mitigate climate change in the transport sector will be guided by the goals enshrined in the National Climate Change Policy (NCCP). Timor-Leste's policy for mitigating GHG emissions in transportation is primarily focused on reducing emissions from private and public vehicle fleets while promoting public transport within and between urban areas. It also includes establishing vehicle emission standards as well as promoting and implementing a Decree Law (No. 30/2011) on used vehicle imports.

The aforementioned policies are also in line with the Timor-Leste Nationally Determined Contribution (NDC), which states that activities enabling the energy-efficient transport sector's growth are vehicle standards and a transport system master plan to promote climate-friendly public transport options.

In 2018, the government developed the Transport Sector Master Plan (TSMP) to ensure Timorese people have access to a sustainable and safe transport system for reasons of commerce, employment, and social service. Additionally, the Timor-Leste 2023 Public Transport Master Plan is now being developed with ADB's assistance to enhance public transport services. The vision of the Public Transport Master Plan is: *"Public transport in Timor-Leste is an attractive, accessible, inclusive, and future-ready transport mode that supports economic growth, urban development, and quality of life across the country."*

The following five major pillars will assist in establishing the Public Transport Master Plan's objectives in support of this vision:

Table 1: Vision and Five Key Pillars for Timor-Leste’s Public Transport System (Timor-Leste 2023 Public Transport Master Plan- Draft)

Five Key Pillar	Description
 Economic Growth	The public transport system supports economic growth and the growth of urban Centers. It connects Dili with other strategic Centers and enables the movement of people and goods to support the economy.
 Access for All	The public transport system provides the entire community with better access to jobs and services. Affordable, reliable services meet people’s needs, are inclusive of marginalized groups like women and the disabled and improve social mobility.
 Livable Cities	The public transport network and facilities are integrated with urban activity Centers. The system underpins healthy, safe, and connected places that improve livability in urban Centers and beyond.
 Mode of Choice	The public transport network provides seamless and integrated journeys that encourage sustainable travel choices, attracting more users and reducing private vehicle use and congestion.
 Sustainable Future	The public transport system plays a key role in meeting the goals of the Paris Agreement including by encouraging mode shift to reduce the emissions intensity of travel and harnesses new technologies and innovative features to support climate mitigation and resilience.

The Ministry of Transport and Communications (MOTC) is the government agency in charge of developing, implementing, coordinating, and evaluating the policy for the transport and communications sectors that has been determined and approved by the Council of Ministers.

The TNA will seek to address these goals and objectives in part. By reducing barriers and proposing enabling frameworks for the diffusion of transportation technologies, this process aims to maximise the use of public transport and solar system-based charging stations to reduce GHG emissions, as well as to develop the Control Pollution Decree-law and Low Carbon Development Strategy to control pollution and emissions from different sectors, particularly transportation.

1.2 Barrier analysis and possible enabling measures for Pollution Control Decree-Law development

This section describes the barrier analysis and enabling framework that were conducted for the development of the Pollution Control Decree-Law. The problem tree was used to assist with the selection of barriers and measures. A number of key stakeholders were interviewed through one-on-one consultation within a month prior to a stakeholder workshop on BAEF held on 20 July 2023, to finalise the selection process. The selected barriers and measures are fully described in the following sub-sections.

1.2.1 General description of Developing Pollution Control Decree-Law

The Pollution Control Decree-Law is considered a non-market good as it is a legal framework to protect the environment against pollution and reduce existing pollution. Article 33 of the Environmental Basic Law (Decree-Law No. 26/2012) states that "the release of greenhouse gases and other polluting substances into the atmosphere shall be reduced, controlled, and maintained within the limits of quality and environmental emissions standards and other legislation in force."

Many countries throughout the world have passed legislation to control different types of pollution as well as to lessen the negative consequences of pollution in order to preserve the environment from its harmful effects. The government of Timor-Leste is also committed to ensuring its citizens have clean and safe air as the population grows. Therefore, having a Pollution Control Decree-Law in place will enable the government to introduce regulations for controlling air, water, and soil pollution, as well as noise pollution. The Decree-Law will also permit the government to regulate polluters and make them pay for the environmental damage they cause.

Regarding pollution control in the transportation sector, Timor-Leste does not have vehicle emission standards to limit the amount of pollution that can be emitted by vehicles or engines. Currently, there is only Decree-Law No. 13/2011 that prohibits the import of light passenger and mixed vehicles that are more than 5 years old (from the date of their original manufacture to the date of import). Therefore, the proposed Pollution Control Decree-Law will also consider the provision of a vehicle emission standard programme that aims to reduce emissions and control pollution from motor vehicles in use.

1.2.2 Identification of barriers for Developing Pollution Control Decree-Law

The National TNA team used a participatory approach in identifying the barriers to the deployment and diffusion of the technology. Also, several national policies and reports were reviewed to identify barriers to the deployment of the technology. The team further conducted one-on-one consultations with key stakeholders such as the National Directorate for Pollution Control, the Legal Department, and the National Directorate of Land Transportation to identify barriers and possible measures to expand on the details of the barriers.

During the consultation workshop, the long list of barriers was compiled under six headings: economic, institutional, legal/regulatory, technical/capacity, resources/information, and social/cultural. Later, they were grouped into two different categories: Financial and economic barriers and non-financial barriers.

Table 2: List of barriers identified for developing pollution control decree-law

Economic and Financial Barriers	
Economic	Limited funding allocated to the National Directorate for Pollution Control
Non-Financial Barriers	
Institutional	Limited institutional capacity and political will
Legal/regulatory	Low priority among other national development priorities
Technical/Capacity	Limited Human resource capacity
Resources/information	Lack of data to support the need to have the law.
Social and Cultural	Lack of support from the community

1.2.2.1 Economic and financial barriers

1.2.2.1.1 Economic

The requirement for financial commitment in developing the Pollution Control Decree-Law and information dissemination has been cited as the main challenge for the technology in its implementation. Available financial resources to promote research and development of the decree-law were assessed as inadequate.

According to Ministerial Order No. 54/2019 approving the Regulation of Secretary of State for Environment (SSE), the National Directorate for Pollution Control is responsible for examining, executing, and monitoring policies for the development and conservation of the environment, as well as elaborating, implementing, and supervising pollution control standards and regulations. In spite of this, the directorate receives limited funding to perform its functions and responsibilities; therefore, no state budget is allocated for developing decree-law due to the high financial cost.

1.2.2.2 *Non-financial barriers*

1.2.2.2.1 Institutional

Limited institutional capacity and political will tend to be the main barriers to develop the Pollution Control Decree-Law. As part of the assessment, various sectoral institutions in silos were assessed for these barriers. Although there was an institutional arrangement in place with clear roles and responsibilities for each national institution and a defined institutional hierarchy, an inter-institutional coordination mechanism appeared to be lacking in the case of a specific issue that attracted a number of stakeholders. One of the key causes of the limited institutional capacity shortage is a lack of human resources with skillsets.

In addition, the National Directorate for Pollution Control was established in the previous government (from 2018 to 2023), but the changes in government from this period may disrupt the process of development due to the inconsistency of political priorities and institutional ego.

1.2.2.2.2 Legal/regulatory

The development of the Pollution Control Decree-Law may be considered a low priority among other national development priorities. There has not been a strong focus on reducing pollution at the source in national policies up to now; even the TSMP has been developed but does not mention reducing vehicle pollution. Additionally, as stated in the NDC, although the National Directorate for Pollution Control is responsible for enforcing the Polluter Pays Principle, the government does not have a law that requires the party responsible for pollution production to pay for the damage done to the environment.

To date, there is only one decree-law to control plastic pollution, which is Decree-Law No. 37/2020, which regulates the sale, import, and production of bags, packaging, and other plastic objects.

1.2.2.2.3 Technical/Capacity

Experts in pollution control who have relevant experience and credentials are needed to develop an efficient legal and regulatory framework. The National Directorate of Pollution Control still has limited human resource capability due to the complexity of pollution control, which covers several environmental aspects. This also includes the language barrier in understanding the technical words for developing the decree-law. Technical assistance is still not widely available because this National Directorate was only recently established during the previous administration.

1.2.2.2.4 Resources/information

Pollution Control is a cross-cutting issue that requires a cross-sectoral contribution to support the data in developing the decree-law. In Timor-Leste, access to data and information has been a problem. The majority of data and reports are not easily accessible by the general public or other government organisations. Additionally, the SNC of Timor-Leste's national GHG inventory only has data for the

years 2005 through 2015 and has not been updated since then. There have been several recent claims that pollution from transport and waste is steadily increasing, but no data supports those claims. Therefore, prior to the development of the decree-law, pertinent study is required.

1.2.2.2.5 Social and Cultural

There is a lack of awareness of the benefits of having a Pollution Control Decree-Law. Some communities may not cooperate in sharing the information to support the development of the decree-law because they fear it may impact their source of income. For instance, the majority of older cars, some of which are still in use as public transportation, have been demonstrated to contribute significantly to air pollution, yet many owners of these vehicles typically lack the resources to replace their vehicles with modern versions.

1.2.3 Identified measures for Developing Pollution Control Decree-Law

The measures proposed for the development of the Pollution Control Decree-Law (Table 3) were suggested and selected based on the desk review, one-on-one interview, and stakeholder workshop. The problem tree process was used to assist with the selection.

Table 3: Measures to overcome the barriers to the diffusion of the development of Pollution Control Decree-Law

Economic and Financial Measures	
Economic	Create awareness of financial support through meeting with different potential donors.
Non-Financial Measures	
Institutional	Strengthen the political coordination and the institutional capacity of National Directorate of Pollution Control.
Legal/regulatory	Enforce existing law to reflect clear lines of authority among various relevant institutions.
Technical/Capacity	Identify potential partners and individuals to provide technical services.
Resources/information	Strengthen coordination and consultation.

Social and Cultural	Community education and awareness about the benefits of the pollution control

1.2.3.1 Economic and financial measure

1.2.3.1.1 Economic

With the new government coming in this year, the National Directorate of Pollution Control is now under the Ministry for Tourism and Environment (MTE); hence, strengthening coordination within the ministry to support funding can be an option. Additionally, the directorate can also raise awareness of financial support by interacting with several possible donors, including UN agencies, DFAT, ADB, EU, USAID, KOICA, JICA, and GCF Readiness through NDCC or GCF.

1.2.3.2 Non-financial Measure

1.2.3.2.1 Institutional

Strengthening the political coordination within the Ministry of Tourism and Environment is one of the steps taken to overcome institutional barriers in the development of the Pollution Control Law. This also includes improving institutional, human resource, and information management capacity in the pollution control sector in relation to climate change.

There is an institutional arrangement in place with clear roles and responsibilities for each directorate; hence, the directorate is responsible for creating awareness among line ministries of the importance of having the Pollution Control Decree-Law.

1.2.3.2.2 Legal/regulatory

Some important environmental legislation has come into force, such as the Decree-Law on Environmental Licences, which regulates the provision of environmental licences for any projects (such as construction works and other interventions that have a direct impact on the environment), as well as its supervision, which ensures the prevention of negative environmental impacts and pollution control.

Additionally, Article 16 of the Basic Environmental Law also states that "*it is incumbent upon the State to create a transparent, comprehensive, and decentralised system of environmental monitoring that can implement integrated pollution control, assess the quality of environmental components, the state of use of natural resources, and environmental impacts caused by economic activities, and gather the information necessary to comply with the present law*".

On the other hand, under the MOTC, there is a law to help regulate the import and export of certain goods, which includes the prohibition on the importation of vehicles over five years old. Therefore, the responsible entity can enforce these existing laws to reflect clear lines of authority among various relevant institutions and consider the Pollution Control Decree-Law as one of the high priorities in the national development plans.

1.2.3.2.3 Technical/Capacity

The relevant entity can identify potential partners and individuals to provide technical training to the directorate's staff. Regarding the development of the Pollution Control Decree-Law, the national entity can hire both international and national technical staffs to develop the decree-law and simplify it for public usage. Furthermore, there is also a need to build the capacity of human resources in the area of environmental quality control, including the methodology or tools used for environmental testing. This will include the establishment of an environmental laboratory to test and complete environmental monitoring audits and actions and to assess pollution from all activities in the municipalities.

1.2.3.2.4 Resources/Information

A number of mechanisms can be used to strengthen coordination and consultation on the development of the Pollution Control Decree-Law: the working group on climate change, transportation working group, and other cross-sectoral.

In addition, the government can conduct environmental studies to locate sources of different pollutants. This will include an analysis of hotel, restaurant, office, and market activities, as well as private and public modes of transport. The Pollution Control Decree-Law will require polluters to pay a fine for the environmental damage caused by their actions.

1.2.3.2.5 Social Cultural

Community education and awareness about the benefits of pollution control are essential before, during, and after the development of the Pollution Control Decree-Law. This includes creating pamphlets and brochures for socialisation, providing training and capacity knowledge to individuals who will be impacted by the law, and simplifying the decree-law.

1.3 Barrier analysis and possible enabling measures for Low carbon development strategy

Barriers were analysed by conducting a problem tree study for the Low Carbon Development (LCD) strategy involving various stakeholders. This tool provided valuable context for potential enabling measures. A month before the workshop, a number of key stakeholders were individually consulted. The next sub-sections provide a detailed description of both the barriers and the measures.

1.3.1 General description of Low Carbon Development Strategy

Low-carbon development (LCD) strategy can also be called as green growth plans, climate change plans and strategies, or low-carbon development plans. The LCD strategy guides countries down a path towards low-carbon, green growth. Establishing national targets and goals for low-carbon green growth sends a signal of credibility and reliability, attracts investment, promotes technology innovations, improves energy efficiency, encourages clean energy adoption, and stimulates job creation and business opportunities.

The Nationally Determined Contribution (NDC) states that Timor-Leste is fully committed to taking more ambitious climate action on a low-carbon development path with no target for reducing emissions. The ambition will focus primarily on enhancing strategies, plans, and actions for low carbon development reflecting its national circumstances based on Article 4.6 of the Paris Agreement, which include:

1. Establishing an enabling environment for Low Carbon Transition
2. Scaling up renewable energy technologies
3. Oil and gas industry regulation
4. Energy efficiency improvements
5. Enabling the energy efficient transport sector growth
6. Waste management and waste minimization

The LCD strategy will support the Timor-Leste's development goals in alignment with the Paris Agreement and the 1.5 degrees Celsius temperature goal. The components of the strategy will include the following elements:

- **Vision** - a long-term and shared vision is required to guide policies over the long run and to gather actors around a common purpose.
- **Assessments** – this may include greenhouse gas inventories and projections to understand which are the major emitting sectors, vulnerability assessments to understand what the impacts of climate change and mitigation potential and costs would be.
- **Short- to long-term targets and goals** (economy wide or sector specific)
- **Policy measures**
- **Specific programmes and projects**
- **Implementing plans**

- **Funding mechanisms**
- **Investment plans**
- **Institutional capacity and coordinating mechanisms**
- **Monitoring and evaluation plans**

The LCD strategy will be developed and implemented in a multi-step approach that involves numerous stakeholders.

1.3.2 Identification of barriers for the Low Carbon Development Strategy

Similar to the previous case, barriers to the Low Carbon Development Strategy were identified based on the desk review and key stakeholders such as the National Directorate for Climate Change, the National Directorate for Pollution Control, the National Authority for Electricity, and UNDP Timor-Leste. The selected barriers were grouped into two different categories: Financial and economic barriers and non-financial barriers.

Table 4: List of barriers identified for the Low Carbon Development Strategy

Economic and Financial Barriers	
Economic	No financial support available
Non-Financial Barriers	
Institutional	Limited institutional capacity and political commitment
Legal/regulatory	No policy of LCD strategy of the previous government
Technical/Capacity	Limited Human resource capacity
Resources/information	Lack of data and information

1.3.2.1 Economic and financial barriers

1.3.2.1.1 Economic

There is no financial support available to promote research and development of the Low Carbon Development (LCD) Strategy. The NDCC is responsible for coordinating the development of Timor-Leste's national climate change policy and has a task to coordinate the actions mitigating the effects of climate change, in particular in the framework of Nationally Appropriate Mitigation Actions (NAMA) and the Climate Technology Centre and Network (CTCN). Hence, the LCD strategy is also under the control of the NDCC.

The NDCC is divided into three departments: mitigation, adaptation, and ozone. Since these departments have different priorities, the state budget allotted for this directorate is typically split among them, making it insufficient to fund the development of the LCD strategy.

1.3.2.2 Non-financial barriers

1.3.2.2.1 Institutional

One of the key barriers to developing the LCD strategy is limited institutional capacity and political commitment. Inter-ministerial coordination mechanisms are lacking because many sectoral agencies work in silos. Additionally, due to conflicting political agendas, government changes could disrupt the research and development process.

1.3.2.2.2 Legal/regulatory

There was no LCD strategy in the previous government, despite the need to take more ambitious climate action to reduce emissions in the NDC. The inconsistency and incompleteness of policies and regulations, including the lack of inter-ministerial participation, may hamper the development of the LCD strategy. The absence of a policy may lead to over-bureaucratic procedures in terms of the collection of baseline data.

1.3.2.2.3 Technical/Capacity

The development of LCD strategy requires cross-sectoral involvement in providing data, information, plans, and expertise. However, there is still a lack of human resource capacity for the development, as technical assistance is not widely available.

1.3.2.2.4 Resources/information

One of the greatest barriers is a lack of data and information due to a lack of past reports and strategies. Another barrier is a lack of resources and awareness of low-carbon technologies.

Due to the fact that the LCD will cover a variety of low-carbon transition, renewable energy, oil and gas sector, energy efficiency, transportation, and waste management activities, it necessitates a vast amount of data and information to support the development of the LCD strategy. Most data, however, have not been updated and aren't publicly available; for instance, the national GHG inventory and projection only covered 2005 to 2015, and they have not been updated since then. Furthermore, overly bureaucratic procedures in terms of baseline data collection can also be barriers.

1.3.3 Identified measures for the Low Carbon Development Strategy

The measures proposed for the LCD strategy (Table 5) were suggested and selected based on the desk-review, one-on-one interview, and the stakeholder workshop. The problem tree process was used to assist with the selection.

Table 5: Measures to overcome the barriers to the diffusion of the Low Carbon Development Strategy

Economic and Financial Measures	
Economic	Create awareness of financial support through meeting with different potential donors.
Non-Financial Measures	
Institutional	Strengthen the political coordination and the institutional capacity of National Directorate of Climate Change and the relevant institutions.
Legal/regulatory	Enforce existing law or strategy to reflect clear lines of authority among various relevant institutions.
Technical/Capacity	Identify potential partners and individuals to provide technical services.
Resources/information	Strengthen coordination and consultation.

1.3.3.1 Economic and financial measure

1.3.3.1.1 Economic

As mentioned in Ministerial Order No. 54/2019 approving the Regulation of the State Secretariat for the Environment (SSE), the National Directorate for Climate Change (NDCC) is the government entity to coordinate government participation in international organisations and prepare and issue positions on environmental topics that can be adopted in bilateral relations as well as international organisations on the promotion of sustainable and environmentally friendly development. Hence, the NDCC can create awareness of financial support through meetings with different potential donors and Green Climate Fund projects. The funding will be used for research for the development of the LCD strategy.

1.3.3.2 Non-financial measure

1.3.3.2.1 Institutional

One of the measures to overcome the institutional barrier is to build and strengthen the political coordination and institutional capacity of relevant institutions (such as Ministry of Tourism and Environment, Ministry of Transportation and Communication, Ministry of State Administration, Ministry of Petroleum and Mineral resources, and Ministry of Public Works), including conducting capacity-building programmes for organisations and institutions to monitor GHG in relevant sectors. NDC can be used to strengthen political coordination.

The NDCC is responsible for raising awareness among line ministries of the significance of having the LCD strategy since there is an institutional system in place with clear duties and responsibilities for each line ministry.

1.3.3.2.2 Legal/regulatory

A low-carbon development strategy must be developed and implemented using a multi-step process involving numerous stakeholders. As mentioned above, every ministry has an institutional arrangement with clear roles and responsibilities. Hence, the responsible entity can use and enforce the existing law or strategy to reflect clear lines of authority among various institutions and support the development of the LCD strategy.

In the meantime, new laws are required to build the necessary regulations and enforcement mechanisms. By establishing robust legal and governance frameworks to manage climate risks, it will support the achievement of the LCD strategy.

1.3.3.2.3 Technical/Capacity

When it comes to the LCD strategy, a climate risk assessment and national climate information service are needed for Timor-Leste to improve understanding and assessment of climate risks. Hence,

identifying potential partners and individuals to provide capacity-building programmes for relevant institutions to conduct research relating to the six main activities mentioned in the general description of the Low Carbon Development Strategy. The research should include sector-specific actions, which will also increase national GHG accounting transparency and accuracy. The information and data can be obtained through publicly funded research.

Additionally, there is also a need for training to strengthen institutional capacity through the development of climate-related information systems, information management, and monitoring operations, including other components of the LCD strategy.

1.3.3.2.4 Resources/Information

The Climate Change Working Group (CCWG) and other cross-sectoral groups can all be used to improve coordination and consultation when developing the LCD strategy. The CCWG is composed of ministries with a role in climate change policies and programmes, as well as international organisations, donors, universities, and others.

There is a need for one-on-one and workshop consultation across relevant line ministries to gather data and information to support the development of the strategy. It can also use existing national documents such as SNC, NDC, IVA reports, and cross-sectoral reports and strategies as a source of information.

1.4 Barrier analysis and possible enabling measures for the research on installing solar system-based charging station

Barriers and enabling measures were identified based on the problem tree for the research on installing solar system-based charging stations. It was helpful to visualise key barriers and potential measures to address them. A few significant stakeholders were individually consulted a month before the workshop. The Barriers and measures are both thoroughly described in the following subsections.

1.4.1 General description of the research on installing solar system-based charging stations

According to the SNC data, gasoline-consuming cars are predicted to grow about 8% between 2010 and 2017 and 5% between 2020 and 2030; diesel-oil-fuelled cars will grow 5%; motorcycles will rise 8%; waterborne navigation will grow 6.5%; and aviation will also increase 6.5%. With more cars on the road, it is anticipated that overall fuel consumption will reach 677.4 million litres in 2030, with gasoline accounting for 59.7%, diesel for 36.7%, and jet kerosene for 3.7%. Therefore, as mentioned in the NDC, the government's intervention will focus on enabling energy-efficient transport sector growth.

Electric vehicles are now becoming immensely popular, and Timor-Leste is now slowly moving towards the use of electric vehicles. A number of electric motorcycles (ojek) have been operating in various

municipalities, primarily in Liquiça, Manatuto, and Lautem, serving as public transportation. Also, the use of electric scooters and bicycles is about to become common in the capital city. Hence, Specific solar-system-based charging stations should be developed to encourage the use of renewable energy and lower CO2 emissions.

Electricity comes from a variety of sources, and it is essential that electric vehicles be powered by renewable energy sources. Timor-Leste has a range of renewable energy resources, such as solar, wind, hydro, and bioenergy. If properly managed, these resources could greatly contribute to Timor-Leste's energy supply and consumption. Solar panels are considered to be the most replicated technology in Timor-Leste. The Ministry of Public Works, responsible for the area of electricity, is installing 3,000 units of solar panels in family homes in remote and isolated areas of the country during the period from 2020 to 2021.

Combining solar energy with electric vehicles is crucial to reducing fossil fuel dependence. Solar panels can generate electricity that can be used to charge an electric vehicle (EV). The energy used in the recharging process at a solar charging station is 100% renewable thanks to a photovoltaic energy generation infrastructure and a battery energy storage system, providing the necessary power to supply ultra-fast recharges to electric vehicles that need them. A solar-system-based charging station is a type of service station for recharging electric vehicles (charging stations) with a distinguishing feature that makes it unique.

Before installing a PV charging station, the charging station's feasibility must be studied. The proposed study will analyse the power reliability, energy cost, and CO2 emissions of a PV-powered charging station. The system's outcomes will be compared to the other existing approaches to see whether there is a reduction in greenhouse gas (GHG) emissions, including CO2. Furthermore, the technical, economic, social, and environmental impacts of solar system-based charging stations will be taken into account.

1.4.2 Identification of barriers for the research on installing solar system-based charging station

The national TNA team used a participatory approach to identify barriers to the deployment of the technology. This includes reviewing relevant documents, conducting interviews with key stakeholders such as the National Authority for Electricity and the National Directorate of Land Transportation, and holding consultation workshops with relevant entities.

As shown in Table 6, the extensive list of barriers was organised into six categories during the consultation workshop, which later were grouped into two different categories: financial and economic barriers and non-financial barriers.

Table 6: List of barriers identified for the research on installing solar system-based charging station.

Economic and Financial Barriers	
Economic	Lack access to finance for the research
Non-Financial Barriers	
Institutional	Lack of Political commitment
Legal/regulatory	Low priority among other national development priorities
Technical/Capacity	Limited Human resource capacity
Resources/information	Lack of data to support the research
Social and Cultural	Lack of public awareness of the technology

1.4.2.1 Economic and financial barriers

1.4.2.1.1 Economic

The requirement for financial commitment in research and demonstration has been cited as the biggest barrier to the technology's deployment. The associated cost includes research (study), required materials and tools, consultants, workshops, consultations, and consumables. However, there are no financial resources available to support the total cost of researching the solar system-based charging station. By far, the study of technology is not planned to be covered by any relevant institutions.

1.4.2.2 Non-financial barriers

1.4.2.2.1 Institutional

Similar to previous technology, political commitment can be a big barrier to deploying the research on installing solar system-based charging stations. Since the beginning of the TNA process, the national team has been consulting the National Authority for Electricity (known as ANE or IP) for information and data, but the current government has abolished the institution and included it under the Secretary of State for Electricity, Water, and Sanitation. Therefore, government changes can impede the research and development process due to different political agendas.

Due to the new technology, the lack of institutional capacity to carry out the research and the absence of legislation can disrupt the process as well. Institutional development for solar charging stations has

not been approached in a coordinated manner. Institutions involved in the sector do not have enough human and financial capital, nor do they have the necessary technical capabilities for evaluating, constructing, running, and maintaining solar installations. There are unclear definitions of roles and responsibilities inside institutions.

1.4.2.2.2 Legal/regulatory

There is no law or regulation to support the deployment of charging infrastructure due to its low priority among other national development priorities. The absence of the regulation will also lead to a lack of inter-ministerial participation to support the implementation.

Regulations, codes, and rules must be clear and enforceable to ensure economically sustainable solar PV generation, grid stability, reliability, and security of supply for all consumers. The government of Timor-Leste, through the National Authority of Electricity, has developed the draft Renewable Energy Decree-Law, but it has not been approved by the council minister. The draft decree-law will require Timor-Leste to give preference to the use and production of renewable energy over any other source of energy. It is also intended to ensure that the electricity institutional framework is effective in delivering the energy investment required to generate national revenue.

1.4.2.2.3 Technical/Capacity

There is still a lack of technical expertise in assessing, installing, operating, and maintaining solar projects. Conducting studies on solar system-based charging stations requires a number of experts from different sectors to analyse the power reliability, energy cost, and CO₂ emissions. It also includes the analysis of economic, social, and political impacts. However, there is a limited availability of human resources trained to do this extensive work.

1.4.2.2.4 Resources/information

Timor-Leste is relatively new to the technology, and there is still limited technical knowledge and practise; thus, there are no reports or information on solar-based charging stations, nor does Timor-Leste have any prior study or information on electric vehicles. Limited scientific data on a solar-powered electric vehicle charging station model can hinder the implementation of the technology.

1.4.2.2.5 Social and Cultural

A solar-powered charging station is designed so that devices can be charged outdoors in an environmentally friendly way. As this is a new technology, most people, especially EV users, do not have awareness of the operation and benefits of solar-system-based charging stations. Some communities may not cooperate in sharing the information to support the development of this research because they fear it may affect their source of income. In addition, there is a lack of institutional capacity, and there is no guarantee of the safety and operation of the charging system, which will affect their movement.

1.4.3 Identified measures for the research on installing solar system-based charging station

During the consultation workshop, experts have discussed potential measures (see Table 7) to overcome barriers for each category of factors for each prioritized technology based on their knowledge of the stakeholders and a solution tree of the research on installing solar system-based charging station.

Table 7: Measures to overcome the barriers to the deployment of the research on installing solar system-based charging station

Economic and Financial Measures	
Economic	Resource mobilization through international partners
Non-Financial Measures	
Institutional	Strengthen the political coordination and the institutional capacity.
Legal/regulatory	Update clear national legal framework for renewable energy.
Technical/Capacity	Identify potential partners and individuals to provide technical services.
Resources/information	Strengthen coordination and consultation.
Social and Cultural	Develop and implement public awareness initiatives.

1.4.3.1 Economic and financial measure

1.4.3.1.1 Economic

There are several international agencies and donors supporting clean energy access in Timor-Leste. Therefore, related institutions such as the Secretary of State for Electricity, Water, and Sanitation can mobilise financial resources either through international partners or donors to conduct research on the installation of solar system-based charging stations.

Since 2020, Korea International Cooperation Agency (KOICA) has been providing funding to UNDP's 'Accelerating Clean Energy Access to Reduce Inequality' (ACCESS) project to support the most vulnerable communities to have equitable and sustainable access to essential services, including affordable renewable energy, in Bobonaro, Manatuto, and Atauro municipalities. On the other hand, the Timor-Leste Electricity Company (EDTL, E.P.) is now opening tenders for more than 70 companies

to bid for the PV solar power in the Manatuto municipality. The EDTL uses the Independent Power Producer (IPP) modality in this project, meaning that the private sector invests its funds for construction so that they are resold, and then the EDTL, E.P. will buy their products or energy.

Based on these examples, different modalities can be used to fund the research and development of solar charging stations for EVs.

1.4.3.2 Non-financial measure

1.4.3.2.1 Institutional

Building and strengthening political coordination is a must in order to carry out the research on installing solar system-based charging stations, including the development of the technology. The measure includes strengthening institutional capacity in financial resource mobilisation, skilled workers in renewable energy projects, and a clear legal framework.

In addition, the Secretary of State for Electricity, Water, and Sanitation is responsible for ensuring clean definitions of roles and responsibilities within the institutions, including coordination with other line ministries.

1.4.3.2.2 Legal/regulatory

Despite the lack of a legal framework for renewable energy, the Readjusted National Strategic Plan of Timor-Leste 2011–2030 views renewable energy as a crucial component with the potential to significantly contribute to economic growth and poverty alleviation, particularly in helping to reduce poverty levels in remote rural areas. Hence, it has been on the government's agenda to replace some of the high-cost generation of electricity by more cost-efficient solar power.

Therefore, the competent authority can enforce current plans to encourage the approval of the decree-law on renewable energy. This decree-law will improve inter-ministerial engagement in its implementation by providing enabling environmental conditions for renewable investment.

1.4.3.2.3 Technical/Capacity

The relevant organisation can find suitable partners and people to provide technical services in conducting research on building solar system-based charging stations by collaborating with pertinent line ministries. International and national specialists are required to undertake studies that examine technical aspects like power reliability as well as economic, social, and environmental factors, including energy costs and CO₂ emissions.

In addition, it is necessary to increase the number of certified technicians. In this case, the relevant entity can cooperate with the Climate Technology Centre and Network (CTCN) to increase capacity building in renewable energy, including the installation and maintenance of PV solar cells at a technical level and management. Apart from that, there are several donors and international agencies (such as UNDP, ADB, and KOICA) providing capacity building to Timorese. In 2020, around thirty participants

from Timor-Leste were set to participate in a training programme in Indonesia on operating renewable energy equipment conducted by UNDP's Access project. They learned the basics of the installation of Solar PV Water Pumps provided for 11 locations in Bobonaro, Manatuto, and Atauro Municipalities. The same training can be carried out through potential donors to ensure the study and development of solar-based charging stations can be operated and managed by the local community with representatives of both genders to ensure effectiveness on the ground. Also, there must be training for electric vehicle users, especially those that are part of public transportation.

1.4.3.2.4 Resources/Information

The solar panel is thought to be the renewable energy source that Timor-Leste uses the most frequently. There has been research and development about Timor-Leste's potential for solar energy for many years, despite the lack of particular information and statistics regarding EVs and solar charging stations. The National Authority of Electricity (which is now under the Secretary of State for Electricity, Water, and Sanitation) has conducted research in energy efficiency with the support of ADB. There are many ways to strengthen coordination and consultation to gather more information on installing solar-powered charging stations, which include the CCWG and other cross-sectoral working groups. Apart from that, in-depth interviews with all key stakeholders, including EV consumers, should be performed.

1.4.3.2.5 Social Cultural

Develop and implement public awareness campaigns at all levels, notably in the municipalities of Manatuto, Liquica, and Lautem, where there are a lot of EV users. In order for the community to comprehend and participate in the research, community education and an awareness campaign on the technology itself, including its advantages and operation, are necessary. This entails producing pamphlets and brochures for socialisation and providing training and capacity knowledge to individuals who will be benefited by the development of this technology.

1.5 Barrier analysis and possible enabling measures for public transport maximization

A problem tree has been developed with the assistance of stakeholders to identify the causes of inadequate public transportation. During the workshop consultation, the stakeholders were asked to provide solutions based on their problem tree to determine what measures should be taken to maximise public transportation. The following sub-sections provide in-depth descriptions of both the barriers and measures of public transport maximisation.

1.5.1 General description of the public transport maximization

One effective way to reduce GHG emissions is by encouraging more people to opt for public transportation instead of driving their own cars. Public transportation is more environmentally friendly than a personal vehicle because it uses up a lot less area and produces fewer emissions per person, including smoothing the operation of any city, town, or rural area. As cities get denser and more crowded, space will become a valuable commodity, so it is crucial to preserve natural resources and maintain living standards.

According to Decree-Law 2/2003 Article 3.2, public transport is defined as “transport that is carried out by enterprises qualified to run activities related to the provision of transport services, on a regular or non-regular basis, and is intended to meet, through remuneration, the needs of users”.

The public transport system in Timor-Leste has a vision for meeting the goals of the Paris Agreement, including by encouraging mode shift to reduce the emissions intensity of travel and harnessing new technologies and innovative features to support climate mitigation and resilience.

Mass transit improvements are essential to promoting public transportation (at present, Microlet provides the service) and reducing the modal shift towards private cars. According to the TSMP, around 60% of all passenger trips in Timor-Leste involve public transport such as taxis, buses, microlets, and angguna. The balance of 20% is made up of cars and trucks, and a further 20% is made up of motorcycles.

The public transport system in Timor-Leste is still largely undeveloped. Approximately sixty percent of all intercity journeys in Timor-Leste are made via public transport, but the service is poor, seats are not guaranteed, departure and arrival times are arbitrary, and passenger comfort is not a top priority. It is common practise for drivers to overload their vehicles in order to maximise revenue. Along the itineraries, neither terminals nor waiting areas are provided. Also, taxis are of poor quality and offer poor service; no identification is provided in taxis, the price structure for travel is not displayed, and emergency contact information is not provided. In addition, Dili does not have a central bus station. There are three big terminals, but none of them have good facilities. Some are on the side of the road, while others do not have waiting areas.

Based on these problems, public transport optimisation technology will be focused on the operation of public transport, facilities, institutions, and supporting infrastructure. Details of these interventions are shown in Table 8, which was adopted from the draft Timor-Leste Public Transport Master Plan 2023. Currently, ADB is providing assistance to the National Directorate of Land Transportation (DNLT) to develop the Timor-Leste Public Transport Master Plan 2023.

The Vision of the Timor-Leste Public Transport Master Plan is: "*Public Transport in Timor-Leste is an attractive, accessible, inclusive, and future-ready transport mode that supports economic growth, urban development, and quality of life across the country.*"

Table 8: Timor-Leste Public Transport Facility and Infrastructure Phasing for short-term 2023 – 2025 (Timor-Leste 2023 Public Transport Master Plan - Draft)

No.	Strategic Intervention	Discipline	Location	Initiatives	Rationale	Lead party
1	Microlet route restructuring	Operation	Dili	Restructure Dili microlet routes and operate 200.9 km with 13 routes serving key generators/activity centers in Dili.	Improve the efficiency and performance of microlet services through expanding, truncating, rerouting, or combining routes that are currently underperforming.	DNTT
2	Microlet service refinements	Operation	Dili	Refine Dili microlet services (headway/required vehicles) to meet demand, while improving performance for each route.	Improve the efficiency and performance of microlet services through the adjustments of service frequencies and vehicles deployed to provide the appropriate level of service for each route given its existing and future demand characteristics.	DNTT
3	Provincial bus service refinements	Operation	Country-wide	Refine provincial bus services (trips per day/required vehicles) to meet demand, while improving performance for each route.	Improve the efficiency and performance of microlet services through the adjustments of trips operated per day and number of vehicles required to provide the appropriate level of service for each route given its existing and future demand characteristics.	DNTT
4	Airport express service	Operation	Dili	Operate 19.1 km Airport Express from Dili Airport to Tourist Information Center.	Expand the scope of urban public transport services to cover the needs of airport visitors to increase passenger convenience and facilitates the growth of the tourism industry.	DNTT
5	Bus stops	Facility	Dili	Provide 29 bus stops across Dili in key demand-generating locations.	Bus stop infrastructure (including clear pole and signage; shelter and seating) as well as pedestrian improvements benefit both passengers and operational efficiency.	MOTC, MPW
6	Existing law enforcement	Institutional	Country-wide	Organize specialized training programs for law enforcement officials on traffic and public transport laws, strengthen	Improve the efficiency of current operations - including reducing travel time, improving route adherence and maintaining safe vehicles. These initial	MOTC

				interagency collaboration, and promote public awareness campaigns on traffic and public transport laws.	actions provide preparation for a more coordinated and professionalized sector in the medium and long term.	
7	Timetable for provincial bus	Operation	Country-wide	Introduce a timetable of provincial bus services including providing training sessions to public officials and consulting with bus drivers and passengers.	Timetables for public transport service adds to the reliability of the system - while broad scale timetables (e.g., microlet) will require further planning and development of the operating sector - introducing a basic timetable for provincial bus services aligns with passenger preferences and will improve the user experience of the system.	DNTT
8	Establishment of Land Transport Authority	Institutional	Country-wide	Outline and implement the Public Transport Department of the Land Transport Authority as part of the Transition Plan of the LTA.	Further specificity around a public transport department of the LTA is needed to clearly define roles and responsibilities for public transport within the broader LTA functions.	MOTC
9	Professionalization of Private Sector Operators	Institutional	Country-wide	Facilitate operator forums to discuss establishment of operator association.	The current individual owner-operator model in Timor-Leste creates individual operator incentives that limit the overall passenger focus of the network - establishing an operator association is the first step in a more coordinated and professionalized operator sector.	MOTC
10	Road Improvement and Maintenance	Supporting infrastructure	Country-wide	Engage with MPW on road improvement / maintenance to improve travel times and reliability of inter-city services.	Road quality is essential for shorter public transport travel times and greater reliability of services, particularly for provincial routes.	MOTC
11	Design Guidelines	Facility	Country-wide	Establish design guidelines for public transport facilities.	Clear design guidelines linked to passenger outcomes will contribute to quality design and implementation - resulting in comfortable, safe and operationally efficient facilities.	MOTC

1.5.2 Identification of barriers for the public transport maximization

Barriers were identified through a review of existing national documents such as the TSMP, draft Public Transport Master Plan, Dili Master Plan, National Land Use Plan, and other policy documents. This was followed by one-on-one consultations with several experts from the National Directorate of Land Transportation and ADB. During the consultation workshop with all stakeholders, the barriers selected were grouped into two different categories: financial and economic barriers and non-financial barriers (Table 9).

Table 9: List of barriers identified for the public transport maximization

Economic and Financial Barriers	
Economic	High initial capital investment
Non-Financial Barriers	
Institutional	Weak institutional capacity
Legal/regulatory	Lack of existing law enforcement and public transport regulations
Technical/Capacity	Lack of technical capacity in maximizing public transport
Resources/information	Lack of resource and information
Social and Cultural	Lack of awareness of intended and long-term benefits of such technology

1.5.2.1 Economic and financial barriers

1.5.2.1.1 Economic

One of the main barriers identified during the consultation was the high initial capital investment. The investment is required for vehicle procurement, depot provision and operation, infrastructure and facility operation and management, and passenger information and media. Currently, there is no control or authority over financial resources for capital investment or appropriate support for operations throughout the asset lifecycle. In addition, access to capital is often a significant barrier for individual operators looking to upgrade their services or vehicles.

1.5.2.2 Non-financial barriers

1.5.2.2.1 Institutional

The lack of performance in maximising public transport over the years was largely due to the weakening of institutional capacity. The government must not only have access to funds and debt financing to build successful rapid transit infrastructure but also have robust institutional capacity to plan, finance, design, and build it. As of now, there is no robust lead regulatory institution for public transport, either as a stand-alone entity or as a unit or department within a larger agency.

The implementation of public transport maximisation requires coordinated efforts from several entities from the national to the local. But there is a lack of government strength at all levels. Additionally, there is no government control over service delivery. The government maintains minimal oversight over fixed microlet services. For instance, the government approves routes but does not specify or monitor service levels, service quality, or vehicle specifications.

1.5.2.2.2 Legal/regulatory

In Timor-Leste, the legal framework is not enforced effectively due to DNTT's lack of resources and capacity-building programmes. Because of this, there is a lack of transparency for stakeholders like operators, and the network's coordination and quality are inconsistent.

The Lack of existing law enforcement and public transport regulations can hamper the deployment of public transport maximisation. Although Decree-Law 2/2003 established the fundamentals of public transportation, it is still largely lacking in the legal framework, making its implementation highly challenging.

There are three fundamental laws that apply to transportation, including:

1. Basic Law on the Road Transport System - Decree-Law No. 2 /2003
2. Highway Code - Decree-Law No. 6/2003
3. Road Transport Contracts - Decree Law No. 18/2003

The laws lay the groundwork for transport services, but they do not offer the tools to implement them. The responsible entities usually rely on regulations to implement control, safety, and management legislation. In many cases, those regulations have not been written and enacted.

Hence, the current policy framework does not have an adequate vision or objectives for improving public transit, nor are there any specific initiatives defined to do so. As a result, there is less clarity and predictability for important stakeholders; DNTT lacks a clear operating direction; DNTT and MOTC are less able to get funds for strategic initiatives; and public transport is prevented from having a distinct identity in the community.

1.5.2.2.3 Technical/Capacity

According to the DNTT human resources database, the directorate has little direct experience in public transit planning. The majority of the knowledge is more interdisciplinary, such as in fields like public administration, law, and economics. Additionally, there is a shortage of highly qualified people who can undertake analytical and crucial efforts.

In addition to a lack of personnel to carry out the necessary duties, both in Dili at a centralised level and in the municipalities (where this situation is exacerbated), DNTT also lacks personnel with the necessary expertise to create and implement public transport schemes.

Also, language limitations between institutions make it difficult to grasp references and papers related to the importation of vehicles, and technology awareness is still poor. With the level of expertise and resources now available, the issue of ongoing operation and maintenance may be challenging to solve.

1.5.2.2.4 Resources/Information

There is a lack of information and data to understand the demand and supply of public transport. The process of determining the demand for public transit in cities is complicated and influenced by a number of factors. Planners and communities must take a number of factors into account when deciding which transit options are best for a given location, which include cost, population density, and whether there is space to build a terminal and dedicated lane for large buses. However, analysis of the supply and demand for public transport is lacking. There is also no data on the social and economic impacts of replacing buses with existing modes of public transport, such as microlets.

1.5.2.2.5 Social and cultural

The benefits of investing and how to obtain this technology are not widely known by the general public. Existing public transport operators may not accept this new technology, as switching large buses to microlets (operated by a single owner) could result in a loss of their income, and drivers may lose their jobs. Hence, a lack of awareness of the intended and long-term benefits of such technologies can be a challenge for their implementation. In addition, there is still a lack of awareness about promoting the use of public transport.

1.5.3 Identified measures for public transport maximization

During the consultation workshop, experts have been discussing potential measures to overcome barriers for each category of factors for each prioritised technology based on their understanding and experiences. These prospective measures have been outlined in Table 10.

Table 10: Measures to overcome barriers to the deployment of public transport maximization

Economic and Financial Measures	
Economic	Meeting with different partners and donors to identify possible fund sources.
Non-Financial Measures	
Institutional	Build and strengthen institutional capacity to maximalize the public transportation.
Legal/regulatory	Enforce existing law and establish public transport regulations.
Technical/Capacity	Promote capacity building and training
Resources/information	Conduct study and strengthen coordination among relevant line ministries.
Social and Cultural	Public education and new policy to change behaviour

1.5.3.1 *Economic and financial measure*

1.5.3.1.1 Economic

In relation to financing, considering the funding and financial consequences of regulatory and business models, as well as related investment plans that are currently under discussion, including the question of whether the public or private sector is taking on the revenue risk of public transport services, and ensuring that reforms are financially sustainable.

In this regard, it is important to ensure adequate budgets and financial management plans for public transport, as well as deciding on and managing public subsidies if necessary. Facilitating access to loans or subsidies can assist operators in purchasing more environmentally friendly, comfortable, and economical cars, improving the overall service quality.

The relevant government institution, such as the Ministry of Transport and Communication, can create awareness of financial support through meetings and coordination with various partners and donors to identify possible sources of funds. Numerous national documents have identified public and private funding sources as potential sources of money for the deployment of public transport, as indicated in the section on economic constraints.

It is also possible to obtain public funds through the World Bank, regional development banks, or bilateral development cooperation arrangements. Additionally, climate change funding mechanisms, such as the Clean Development Mechanism (CDM) and the Global Environment Facility (GEF), may finance transit projects.

1.5.3.2 *Non-financial measure*

1.5.3.2.1 Institutional

The implementation of public transport maximisation will depend on competent, committed, and skilled people who have the drive and initiative to change Timor-Leste. It is vital to build and strengthen individual and institutional capacity across all components of the transport sector through sustained commitment to staff training, on-the-job mentorship, institutional reform and upgrading, international support, and the addition of new trained staff where demand warrants. The training for institutions should also involve disability studies as a common unit to enable people to understand disability.

The strengthening of institutional capacity should consider the national and local government dimensions, with devolution of public transport tasks to the lowest practical level as appropriate, subjecting human and organisational capacity locally, as well as wider debates around municipal decentralisation of powers and resources.

In addition, having a reputable regulatory organisation is essential. Find and develop a strong primary regulatory organisation for public transport, either as a stand-alone organisation or as a division or department within a larger transport agency, with efficient organisational, technological, and human capabilities. This institution must also have continuity and institutional memory. A comprehensive and diverse organisational development and transition plan should be used to advance the agency and achieve a certain level of preparedness relative to the stated targets of the operating model.

The Timor-Leste 2023 Public Transport Master Plan advises adopting a "big bang" approach (see Figure 1) to gradually strengthen the public and private sectors as Timor-Leste's public transport system modernises over the coming decades.

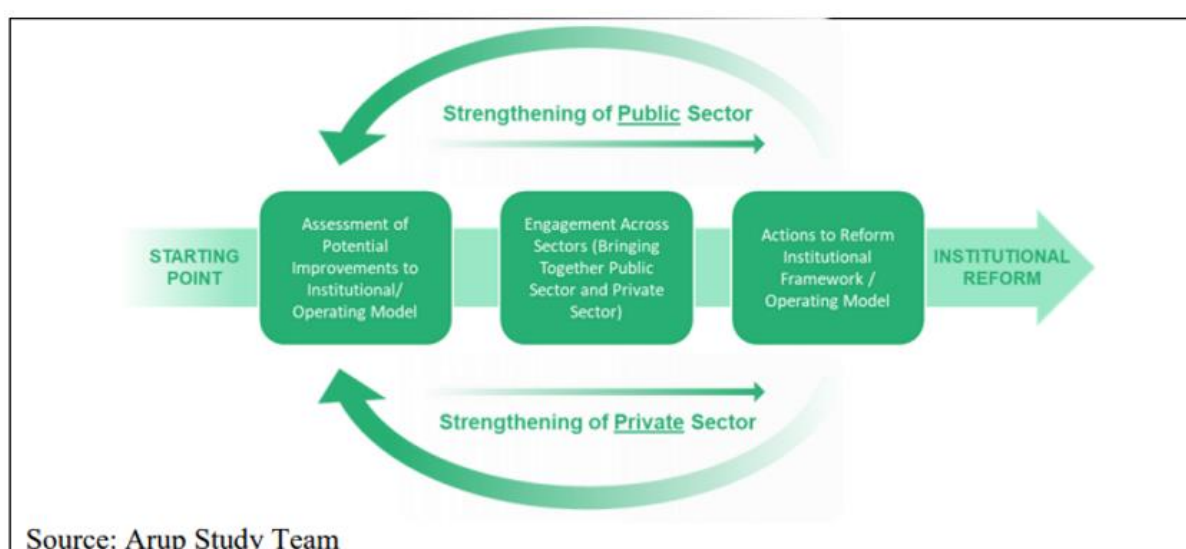


Figure 1: A model for the incremental reform of the institutional model governing public transport in Timor-Leste (Public Transport Master Plan – draft)

1.5.3.2.2 Legal/regulatory

Enforcing existing laws and establishing public transport regulations are a must. The existing rules and regulations should be kept, but they do need to be revised to provide more clarity, which will make it possible to create regulations and establish organisations that will put those laws into effect.

In this regard, a strong regulatory framework that encourages professionalism and uniformity in public transport operations must first be established by the government. This covers rules pertaining to safety, the environment, fares, and service expectations. A framework like this will serve as a roadmap for the transition and ensure that the reorganised transport system meets societal demands and goals.

Clear policy principles are needed to define the governments and private sector's roles in asset ownership, organisation, delivery, and control of transport services. Planning for the development, operation, and management of public transport should be guided by national policy. This includes establishing national policy to form Public Transportation organisations (for different types of public transport modes), starting from the national to local levels.

In addition, there should be a regulation to make vehicles and systems accessible and reliable to people with disabilities, older people, children, and pregnant women to ensure their mobility.

1.5.3.2.3 Technical/capacity

Investment in training and capacity building is necessary for professionalisation. This could include technical training for drivers, management training for operators, and customer service training for frontline staff. Raising the level of service and professionalism in the industry requires improving the skill set of the employees.

In addition, the relevant government institutions should identify potential partners and individuals to provide technical services regarding the planning, implementation, and operation of the technology. There is a need for capacity development in all sector institutions, whether they are current, new, or transitioning to statutory agencies. The capacity development through training should involve the upgrading of training in asset management, maintenance programming, project preparation, safeguards, project implementation, regulatory functions, monitoring, financial management, planning, and policy development.

Development of skills and recruitment of new personnel as required in the areas of management, planning and budgeting, engineering, and technical abilities, as well as maintenance. The pertinent institution should ensure balanced gender representation and active participation in capacity building.

1.5.3.2.4 Resources/information

For urban transportation to be built and developed sustainably, a thorough understanding of the link between supply and demand for public transport is essential. Hence, the improvement of microlet and the introduction of buses must have a feasibility study, including the formation of an organisation and public transport facilities and infrastructure.

ADB is currently assisting the Ministry of Transportation and Communication in developing a Public Transport Master Plan to better understand the opportunities and needs for providing citizens with public transport services that meet their needs and expectations for safety, accessibility, comfort, and the environment. By the end of this year, the Public Transport Master Plan is expected to be completed and approved.

Also, it is crucial to do a feasibility study to comprehend the transportation requirements of various social groups in cities, such as the elderly, minorities, and those with disabilities. The survey should involve public transport operators as well to understand their perspectives on maximising public transport.

1.5.3.2.5 Social/cultural

Encourage existing public transport operators to participate in the adoption of new technologies by providing knowledge and technical support on the operation and management of public transport facilities. For people who lost their jobs as a result of this intervention, the government should also offer alternate sources of income. Additionally, consulting and including users of public transport and communities, particularly vulnerable groups, and making sure that there are immediate and ongoing processes in place to inform important choices, comprehend the effects of reforms, and guarantee public support.

In a similar vein, public education, and a new policy to change behaviour (a behaviour change programme) should be encouraged to promote the use of public transportation. It should also include more community awareness about people with disabilities and attitudinal changes (a disability awareness programme) among the drivers and the public in general.

1.6 Linkages of the barriers identified

The majority of the barriers identified in the analysis apply to all technologies, with just a small number being specific to particular technologies.

The common barriers to all four technologies are:

1. Limited funding sources
2. Limited institutional capacity and political will
3. Low priority and lack of law enforcement
4. Limited human resource capacity
5. Lack of data and information
6. Lack of public awareness.

Due to its low priority among other national development priorities, limited funding tends to be the most common barrier to the deployment of all technologies. In some technologies, the high capital investment causes a delay in implementation.

In Timor-Leste, institutional capacity and political will are also the main common barriers. Due to the inconsistent political agendas, the shifting of the government this year may cause disruptions in the technology implementation process. The lack of human resources with the necessary skillsets is one of the main factors contributing to the limited institutional capacity.

In addition, the fact that several sectoral institutions function independently contributes to the lack of an inter-ministerial coordination system. As a result, it has been difficult for the general public and other government bodies to simply access the majority of data and reports. This barrier also led to a lack of awareness of the benefits of technologies due to the limited information available and the lack of a public awareness programme.

1.7 Enabling framework for overcoming the barriers in transportation sector

The Ministry of Transportation and Communication, through the National Directorate of Land Transportation (DNLT), in collaboration with the Secretary of State for Electricity, Water, and Sanitation, the National Directorate for Pollution Control, and the National Directorate for Climate Change, needs to mobilise resources by meeting with different partners and donors to identify possible fund sources for the deployment of all technologies.

There is an institutional arrangement in place with clear roles and responsibilities for each line ministry. Hence, the relevant institutions need to build and strengthen political coordination and institutional capacity by investing in human resources, adjusting, or reforming institutional systems, preventing over-bureaucracies, and using existing laws and policies to develop synergies between all levels of government and stakeholders.

In order to have robust information to implement all technologies, a number of mechanisms can be used to strengthen coordination and consultation among pertinent line ministries, which include the Climate Change Working Group, transportation and energy stakeholders, and other cross-sectoral.

The entities responsible for deploying these technologies must design a communication strategy and education campaign to change cultural attitudes towards transportation innovations that mitigate climate change and advance sustainable development.

Finally, capacity training and public engagement related to technology application should include marginalised groups such as women and persons with disabilities.

Table 11 below compiles the barriers that were identified, and the measures suggested by key stakeholders for the transportation sector.

Table 11: Barriers and measures of technologies in transportation sector

Barriers	Measures
Develop pollution control Decree-Law	
<ul style="list-style-type: none"> - Limited funding allocated to the National Directorate for Pollution Control - Limited institutional capacity and political will - Low priority among other national development priorities - Limited Human resource capacity - Lack of data to support the need to have the law - Lack of support from the community 	<ul style="list-style-type: none"> - Create awareness of financial support through meeting with different potential donors. - Strengthen the political coordination and the institutional capacity. - Enforce existing law to reflect clear lines of authority among various relevant institutions. - Identify potential partners and individuals to provide technical services.

	<ul style="list-style-type: none"> - Strengthen coordination and consultation. - Community education and awareness about the benefits of the pollution control
Low carbon development strategy	
<ul style="list-style-type: none"> - No financial support available - Limited institutional capacity and political commitment - No policy of LCD strategy of the previous government - Limited Human resource capacity - Lack of data and information 	<ul style="list-style-type: none"> - Create awareness of financial support through meeting with different potential donors. - Strengthen the political coordination and the institutional capacity. - Enforce existing law to reflect clear lines of authority among various relevant institutions. - Identify potential partners and individuals to provide technical services. - Strengthen coordination and consultation. - Coordinate and consult with cross-sectoral groups to collect data and information.
Research on installing solar system-based charging stations	
<ul style="list-style-type: none"> - Lack of access to finance for the research - Lack of Political commitment - Low priority among other national development priorities - Lack of Human resource capacity - Lack of data to support the research - Lack of public awareness of the technology 	<ul style="list-style-type: none"> - Resource mobilization through international partners - Strengthen the political coordination and the institutional capacity. - Update clear national legal framework for renewable energy. - Identify potential partners and individuals to provide technical services. - Strengthen coordination and consultation. - Develop and implement public awareness initiatives. - Coordinate and consult with cross-sectoral groups to collect data and information.

Public transport maximization	
<ul style="list-style-type: none"> - High initial capital investment - Weak institutional capacity - Lack of existing law enforcement and Public transport regulations - Lack of technical capacity in maximizing public transport - Lack of resource and information - Lack of awareness of intended and long-term benefits of such technology 	<ul style="list-style-type: none"> - Meeting with different partners and donors to identify possible fund sources. - Build and strengthen institutional capacity - Enforce existing law and establish public transport regulations. - Promote capacity building and training - Conduct study and strengthen coordination among relevant line ministries. - Public education and new policy to change behaviour

2 Sector 2: Agriculture, land use and forestry

2.1 Preliminary targets for technology transfer and diffusion

Agriculture was a major source of GHG emissions. According to the estimate, total emissions of the three major GHGs (CO₂, CH₄, and N₂O) totaled 665.76 GgCO_{2e} in 2015. They increased by 19.63% from 2005 to now, by 8.29% from 2010 to now, and by 3.87% from the year before. Enteric fermentation from livestock makes up the majority (47.03%) of the agriculture sector's sources. Followed by emissions from burning grassland biomass with 17.74%, 16.04% from managing manure's direct N₂O emissions, 10.84% from manure's methane emissions, and 5.84% from rice cultivation.

Moreover, the majority of farmers still engage in unsustainable agricultural practices such as cultivation on steep slopes, shifting cultivation or slash-and-burn, uncontrolled grazing on public land, and recurring forest fires.

On the other hand, Timor-Leste has one of the highest rates of deforestation and forest degradation in South Asia and Southeast Asia, with an estimated annual deforestation rate of 1.7% and an estimated forest degradation rate of 5.8%, respectively. In the past few years, the forest and land-use sectors of Timor-Leste have transitioned from carbon emission sources to carbon sinks. According to the SNC, Forestry and Other Land Use (FOLU) sector emissions were 279.38 GgCO_{2e} in 2010, rising to 2858.84 in 2012, but by 2014, they were -1438.8.

At the moment, there are still a lot of dense forests, but they are rarely in large areas. Instead, the remaining dense forests are mostly spread out across the country. Almost half of the land is classified as "mosaic," which means that it has a mix of forest and non-forest land, such as grasslands, farmland, and residential areas. Since most forest regions, including the dense forests in Timor-Leste, are accessible and consequently vulnerable to logging, extensive logging, overgrazing, farmland expansion, rising demand for fuelwood and charcoal, and urbanisation have contributed to deforestation and forest degradation. It also affected the indigenous trees of Timor-Leste. This situation also degrades soil, reduces groundwater, endangers wildlife, and reduces food sources.

Timor-Leste's soils have been getting worse for many years because of long-term "slash-and-burn" agriculture, in which almost all organic waste on the surface of the soil is burned before planting. In general, farmers cutting down trees so they can grow more crops are the main cause of forest loss and changes in land cover.

The technology transfer and diffusion to mitigate climate change in agriculture, land use, and the forestry sectors will be guided by nature-positive growth and the transition commitment declared in the NDC. The Timor-Leste NDC focuses on key activities such as improving sustainable forest management, reducing forest degradation and deforestation, and other key activities for enhancing carbon sinks and promoting sustainable and climate-smart agriculture.

These activities are in line with the National Climate Change Policy. The policy to reduce GHG emissions from forests and other land uses is concentrated on expanding the use of forests as carbon

sinks. While the mitigation policy in agriculture is focused on the introduction of permanent agriculture, emission reduction from slash-and-burn techniques, and promotion of climate-smart agricultural practises.

The Readjusted National Strategic Plan of Timor-Leste 2023–2038 has a vision that "*by 2038, Timor-Leste's agriculture, forestry, livestock, and fisheries will be developed and modernised with high and sustainable productivity to ensure all citizens produce or have access to sufficient and high-nutrient food, helping strengthen food security and food sovereignty in Timor-Leste, and contributing to job creation, poverty reduction, and increasing non-oil State income*".

Approximately 40% of the 15,000 km² of land area is suitable for crops and/or cattle, while only roughly 80% of this arable land is now in use. The Ministry of Agriculture, Livestock, Fisheries, and Forestry is the government department responsible for the design, implementation, coordination, and evolution of policy in the areas of agriculture, forests, fisheries, and livestock.

In this section, the TNA will seek to address the policies and goals mentioned above. By reducing barriers and proposing an enabling framework for the diffusion of agriculture, land use, and forestry technologies, this process aims to promote agroforestry, participatory land use planning, SALT (sloping agricultural land technology), and cover crops to mitigate GHG emissions and increase food security.

2.2 Barrier analysis and possible enabling measures for agroforestry

The agroforestry technology diffusion barrier and enabling measures were discussed and prioritised during the consultation workshop with stakeholders in the agriculture and forestry sectors, including the national directorate of agriculture and forestry, local NGOs, INGOs, youth groups, and other relevant stakeholders. In order to obtain a more in-depth understanding of the forestry and agriculture sectors, interviews with experts and a review of relevant laws were both carried out. In the meantime, the problem tree was developed to assist with the selection of barriers and measures.

2.2.1 General description of agroforestry

Agroforestry is a land management method that combines trees, agricultural crops, and animal farming to deliver a wide range of ecosystem services. Trees are integrated into farms and agricultural landscapes as part of a dynamic, ecologically oriented natural resource management system that enhances social, economic, and environmental advantages for a diverse variety of land users in agroforestry. Agroforestry has a high capacity for carbon sequestration, which contributes to climate change mitigation outcomes.

Timor-Leste, the newest country and one of the least developed, has encountered multifaceted land use management difficulties, including deforestation, land degradation, and poverty. The agroforestry

system is seen as one of the possible choices for combining Timor-Leste's socioeconomic needs with the natural functions of the land. Farmers in this country have always used this system.

According to the UNDP, four different agroforestry models are common in Timor-Leste:

1. Alley cropping involves planting in the alley between rows of hedges/trees arranged according to contour lines.
2. The trees-along border pattern involves planting trees/shrubs along the border (hedgerow).
3. Random mixers involve irregularly spacing trees while planting and simultaneously growing the annual crop in stratum underneath.
4. Alternate rows involve planting trees in regular alternate rows and seasonal cultivation done in the space in between the rows.



Alley cropping pattern



Tree along border pattern



Alternate row pattern



Irregular pattern

Figure 2: Various agroforestry models in Timor-Leste (Paudel et al., 2022a)

Agroforestry has been around in Timor-Leste for many years. For example, the Xpand Foundation and its local partner, the Ho Musan Ida (HMI) Foundation, established the Ho Musan Ida (With One Seed) model over the course of the last nine years. It is a self-sustaining community involvement programme that helps rural Baguia administrative post's subsistence farmers reforest their land, store carbon in new trees, and sell the carbon on the global carbon market.

Another example is the Ai ba Futuru (Partnership for Sustainable Agroforestry) project, co-financed by the EU and the German Federal Ministry for Economic Cooperation and Development in

collaboration with the Ministry of Agriculture and Fisheries (MAF). This 5-year project (from 2017 to 2022) is targeting 4,000 marginalised households in 4 municipalities (Manatuto, Baucau, Viqueque, and Lautem) to practise agroforestry and afforestation.

2.2.2 Identification of barriers for the agroforestry

The approach for identifying barriers was the same as in previous technology. The barriers were classified in two types: economic and financial barriers and non-financial barriers (Table 12).

Table 12: List of barriers identified for the agroforestry

Economic and Financial Barriers	
Economic	Lack of financial access and cash flow
Non-Financial Barriers	
Institutional	Lack of institutional capacity
Legal/regulatory	No specific policy and strategy on agroforestry development
Technical/Capacity	Lack of technical expertise in agroforestry
Social and Cultural	Land rights and lack of awareness of intended and long-term benefits of such technology
External Factors	Lack of infrastructure

2.2.2.1 Economic and financial barriers

2.2.2.1.1 Economic

The department of agroforestry requires more financial resources to adequately implement agroforestry initiatives and monitor progress. The significant barriers to agroforestry practise are a lack of financial access and cash flow. There have been several agroforestry projects across the country funded by international donors but sustaining them seems to be the hardest part.

According to the UNDP project's experience, communities were encouraged to practise agroforestry if they were given free seedlings in addition to financial incentives for planting trees (25 cents per plant). Additionally, they anticipated financial incentives for protecting and caring for the plants. Such

incentives for farmers have been offered by a few donor-funded projects, but the sustainability of this strategy has been questioned. In addition, cultural norms related to gender also present additional barriers for women.

2.2.2.2 *Non-financial barriers*

2.2.2.2.1 Institutional

There is weak institutional capacity among government institutions and leading organisations to facilitate most of the proposed agroforestry programme. Relevant institutions tend to work in silos, and an inter-institutional coordination mechanism appears to be lacking. Additionally, there is implementation overlap between several government institutions, despite the fact that each national organisation has a specified institutional arrangement with distinct functions and responsibilities.

2.2.2.2.2 Legal/regulatory

In Timor-Leste, there is a National Policy on Forests that aims to protect at least 70% of the forest area by 2030 in order to maintain its ecological integrity and biological diversity. However, there is no specific policy or strategy for agroforestry development. Additionally, the lack of a suitable agroforestry model as an alternative instrument to enhance community livelihood and the forest area and the absence of legal rights for community-based forest management are major barriers to the development of agroforestry in Timor-Leste.

2.2.2.2.3 Technical/capacity

The wider implementation of an agroforestry system in the country is hampered by a lack of knowledge and experience in enhanced agroforestry systems. There is limited knowledge from beneficiaries on specific topics (such as economic development and carbon farming).

The growth of agroforestry in Timor-Leste has also been hindered by the government's inability to provide technical assistance to local farmers. The limitations include understanding the differences between forestry and agroforestry, technical skills in crop selection, and market information.

These barriers are in line with Paudel et al. (2022), who stated that a lack of human resources and a low level of formal education are important barriers to the development of agroforestry in Timor-Leste. The agricultural extension services provided by Ministry of Agriculture and Fisheries (MAF) personnel and donor initiatives in Timor-Leste encountered challenges due to the high expectations of landowners, limited educational attainment, a lack of trust in the government, and inadequate proficiency among extension agents.

2.2.2.2.4 Social and cultural

The unclear and complicated land tenure system discouraged private investors from investing in large-scale agroforestry in Timor-Leste. There is still a significant gap between those who want to preserve customary rights and ensure that they are adequately protected by the law and others who want to abolish them in favour of other types of ownership, such as governmental control and private property. In addition, there is the possibility of land disputes occurring when investments are made in the places that have been identified.

On the other hand, a portion of the population continues to engage in the practise of slash-and-burn. They have no interest in utilising the land for a longer period of time. Even though 80% of households in Timor-Leste rely heavily on livestock for food and revenue, the practise of allowing free grazing in the forest poses a serious threat to agroforestry. This difficulty has previously been confronted by several agroforestry projects, and as a result, many have fallen short of their goals.

2.2.2.2.5 External factors

Limited infrastructure for economic development, particularly in remote areas. Rural areas rely on rain-fed agriculture since they lack infrastructure like water storage and irrigation systems that would enable them to improve agricultural production. Farmers have also had trouble selling their agricultural products because 80% of the country is difficult to access due to a lack of effective road networks. Farmers are no longer able to receive fair pricing for their agricultural products due to the participation of middlemen. This has demotivated farmers from investing in improved agricultural systems, including agroforestry practises.

2.2.3 Identified measures for agroforestry

On the basis of their knowledge and experiences, experts have been talking about potential ways to get over barriers for each category of criteria for each prioritised technology throughout the consultation session. Table 13 provides an overview of these potential measures.

Table 13: Measures to overcome barriers to the deployment and diffusion of agroforestry

Economic and Financial Measures	
Economic	Ensure access to funding and improve market access

Non-Financial Measures	
Institutional	Strengthen agroforestry departments, including the coordination among lines ministries and NGOs.
Legal/regulatory	Develop policy and strategy on agroforestry
Technical/Capacity	Increase number of extensionist with relevant degree, and training to advance their knowledge and skills.
Social and Cultural	Land tenure law reform and develop education and awareness programme
External Factors	Improved skills of construction companies and municipality management of rural roads

2.2.3.1 Economic and financial measure

2.2.3.1.1 Economic

Agroforestry may generate money and employment in local communities and municipalities by embracing a value chain strategy and encouraging cash crops. According to the proposed project by the ADB, helping smallholder farmers gain access to formal financial institutions would allow them to accumulate savings and obtain credit on more favourable terms. This would support and strengthen efforts to boost smallholder productivity.

To enhance the value chain approach, there is a need for in-depth market analysis, a business plan, infrastructure investment, commitment from beneficiaries, a minimum size of production, and reliability. An additional choice is to use a carbon credit or farming scheme for trees planted, which can generate regular and sustainable income.

In order to improve access to the market, at least 60 kilometres of rural roads servicing targeted agroforestry areas must be refurbished and maintained. In addition, private businesses and communities will have the opportunity to develop market linkages and find employment opportunities.

Agroforestry and carbon farming can benefit both men and women farmers by increasing income, facilitating access to financial services, and challenging gender conventions.

2.2.3.2 *Non-financial measure*

2.2.3.2.1 Institutional

Strengthen agriculture and forestry departments, including the coordination of government line ministries and other organisations for an enabling environment and support services. Using the existing law to identify clear roles and responsibilities for each ministry or department and reinforce inter-ministerial coordination in agroforestry project implementation.

Additionally, conduct an institutional evaluation of Timor-Leste's private and public providers of agroforestry support services. Collaboration with a university or other international organisation will be used to accomplish this.

2.2.3.2.2 Legal/regulatory

Policy and law provide direction and enable the development of local knowledge, capability, resources, and good practises. For the development and implementation of an agroforestry strategy, Timor-Leste can learn a lot from its neighbouring country, Indonesia.

Indonesia created a national strategy for agroforestry research (2013–2030) focusing on smallholder production systems and markets, community-based forest management on state forest lands, agroforestry practises that are in line with climate change, and agroforestry practises that are improved for environmental services. Using the knowledge gained from Indonesia's adoption of agroforestry on public lands, farmers may be encouraged to improve the sustainability of their land by securing their tenure rights.

2.2.3.2.3 Technical/capacity

Increase the number of extensionists with relevant degrees and training to advance their knowledge and skills. In order to strengthen the capacity of the identified service providers, a capacity development programme will be designed to update their knowledge and skills for implementing the National Agricultural Extension Strategy.

In addition, technical assistance is needed to create an environment that is favourable for agroforestry operations along the value chain, as well as to promote the growth of agroforestry, the management of land and natural resources, the development of technical skills, and market connections.

Overall, the keys to success are to provide training for both men and women at all levels, to actively include extension services, to coach farmers, and to support lead farmers. It also includes using modern tools such as digital apps for implementation, operation, and monitoring.

2.2.3.2.4 Social and cultural

For long-term private investment encouragement, land tenure law reform is essential. The Land Law (Ministry of Justice) regulates land rights and has provisions for community property and community protection zones, for which regulations have not yet been established. To ensure that the requirements linked to customary rights on forests are incorporated in the rules for community property and community protection zones, follow-up coordination with actors in the forestry sector will be required.

In addition, developing and implementing education and awareness programmes on the needs and benefits of agroforestry are essential. This includes conducting a comprehensive consultation process with communities to ensure the proposed projects are aligned with farmers' interests. Agricultural conditions and farmers' demands will vary depending on geography, agro-climatic conditions, and societal customs. Hence, agricultural extension services should preferably be determined locally.

Participatory Land Use Planning (PLUP) can be used to avoid potential land disputes, including free grazing and slash-and-burn practices.

2.2.3.2.5 External factors

Improved construction company and municipality administration of rural roads where the programme is operational, including capacity building of local training institutes, construction companies, and government, central, and local agencies responsible for rural public work. Similar initiatives have been implemented by the Enhancing Rural Access Agro-Forestry Project (ERA Agro-Forestry). Through this project, support has been provided to the Ministry of Public Works Directorate of Roads, Bridges, and Flood Control (DRBFC) and Municipalities, as well as strengthening local training institutions to train local construction companies to repair and maintain rural roads serving agroforestry areas in order to facilitate market access.

Additionally, elements for site selection should be taken into account, such as road infrastructure, ensuring water availability before the project is launched, and implementing water conservation initiatives. Collection centres, infrastructure, and feeder roads to connect markets will also be further developed.

2.3 Barrier analysis and possible enabling measures for Participatory Land Use Planning (PLUP)

The participatory land use planning (PLUP) technology barriers and measures were discussed during the consultation workshop with key stakeholders. Prior to the workshop, a comprehensive analysis was done, which included interviews with experts from relevant organisations and thorough desk assessments. Meanwhile, the problem tree was created to help with the identification of barriers and measures.

2.3.1 General description of PLUP

Participatory Land Use Planning (PLUP) is an interactive process in which local communities may discuss and decide how to manage their community's land and other natural resources. The same process has been implemented in a number of community-based forest and/or natural resource management initiatives in various countries, resulting in the adoption of sustainable forest and natural resource management at the village level.

What makes PLUP unique in the Project is that it: i) encourages local communities to develop written village regulations and by-laws, including natural resource management rules, in addition to a future land use plan; ii) assists local communities in holding a traditional ceremony to institutionalise the village regulations in a traditional manner; and iii) assists village leaders in monitoring the enforcement and implementation of the village regulations and future land use plan.

The fundamental goal of PLUP is to help target villages adopt a land use plan and community ordinances to sustain natural resource management. PLUP would also identify supports and interventions needed for a future land use plan.

Based on JICA and MAF's project experience, PLUP constitutes the following 10-step activities in the target villages:

- Step 1: Formation of a working group and preparation of a work plan
- Step 2: Exposure visit to village
- Step 3: Present land use mapping
- Step 4: Future land use planning
- Step 5: Review of traditional rules in the past
- Step 6: Preparation of draft village regulations
- Step 7: Consultation with local communities about a future land use plan and draft village regulations
- Step 8: Coordination with the relevant government offices for approval/endorsement
- Step 9: Traditional ceremony to announce the village regulations and future land use plan to local communities in and around the village

- Step 10: Monthly monitoring of the enforcement and implementation of the village regulations and future land use plan

Implementation of PLUP has resulted in a number of successful initiatives relating to converting farmland to permanent terrace farming, replacing open grazing with a livestock system based on households, and designating areas for forest conservation. These activities contribute to mitigation measures in Timor-Leste. Forest conservation reduces the GHG impact, while sustainable terracing reduces emissions by not burning. Given climate-change-related rainfall inconsistencies in a country where nearly all crops are rain-fed, crop variety diversity also mitigates monoculture losses. Forests mitigate soil degradation, runoff, and landslides, which Timor-Leste is susceptible to in extreme weather.

According to the MAF, PLUP is a valuable planning tool for land-based interventions. Hence, PLUP should come before development. Prioritising PLUP implementation above development activities can lower the risk of undesirable outcomes. Examples include reforestation projects where local community members' trees are eaten by animals brought by other community members. Implementing PLUP first can prevent this issue by promoting community consensus on tree planting locations and understanding their importance before reforestation.

2.3.2 Identification of barriers for the PLUP

Barrier identification was the same as with earlier technology. The barriers were classified in two types: economic and financial barriers and non-financial barriers (Table 14).

Table 14: List of barriers identified for the PLUP

Economic and Financial Barriers	
Economic	Limited access to the funding
Non-Financial Barriers	
Institutional	Lack of institutional capacity
Legal/regulatory	Lack of enforcement of existing laws and policies
Technical/Capacity	Lack of technical expertise in PLUP
Social and Cultural	Lack of regulation/enforcement and women participation
External Factors	Lack of monitoring after project

2.3.2.1 Economic and financial barriers

2.3.2.1.1 Economic

Limited access to funding was identified as the main barrier because PLUP had not yet become part of the government's agenda. There is no reliable long-term funding source for initiatives or programmes connected to Sustainable Land Management (SLM). Depending on the type of work being done and where the village is located, the cost might be between US\$ 15,000 and US\$ 20,000 for Steps 1 through 9, and US\$ 10,000 for 2-year monitoring and evaluation (Step 10) if national NGOs are being used for implementation.

2.3.2.2 Non-financial barriers

2.3.2.2.1 Institutional

PLUP has been scaled up as a result of initiatives from many DPs, including JICA, FAO, the World Bank, and the EU. Although the government has been a partner in these projects, further engagement from the government is necessary to ensure their sustainability and future growth. However, the institutional capacity of the government to help and facilitate PLUP remains limited and ineffective.

2.3.2.2.2 Legal/regulatory

The National Policy on Forests of Timor-Leste (May 2017) identifies PLUP as an effective means of community-based forest and watershed management as well as reforestation and land recovery. It states that current land use and resource conditions are mapped, and future land use is negotiated with the community. For land use planning at the local level, PLUP approaches have been developed and are ready for wider application. However, there is a lack of enforcement of existing legal frameworks to set PLUP as a national priority. Additionally, there is no legislative framework requiring project implementers to incorporate PLUP in their efforts or projects related to sustainable natural resource management.

2.3.2.2.3 Technical/capacity

Field facilitators for PLUP must possess knowledge of participatory planning and real-world NRM experience. The PLUP working group needs competent field facilitators who can guide members of the community in carrying out the 10-step activities. These facilitators could be international or national NGOs, Development Partners, or government organisations with adequate PLUP experience. However, there are relatively few skilled facilitators available in Timor-Leste. Besides, local leaders also have limited knowledge and information regarding the use of PLUP in sustainable forest and natural resource management.

2.3.2.2.4 Social/cultural

The major barrier is to sensitise the whole community and the neighbouring villages to the village regulation and monitor its implementation. If the neighbouring villages do not have Tara Bandu, then it becomes a nagging problem for the village with Tara Bandu. There are instances of threats to the forest (illegal felling, forest fires, land disputes, etc.), which come from the neighbouring villages.

On the other hand, social and cultural standards shape gender roles in patriarchal Timor-Leste. Men are expected to make household decisions and earn the most in the formal economy. Therefore, there is usually a lack of participation by women in the PLUP process.

2.3.2.2.5 External factor

Monitoring the use of village regulations is most critical. PLUP makes the best use of the traditional knowledge possessed by rural communities in Timor-Leste, which is Tara Bandu. Tara Bandu is important for launching local regulations. Publicly appealing, it attracts institutions like DPs. Due to this, DPs tend to think PLUP support ends with the Tara Bandu ceremony, forgetting the need for monitoring after the ceremony. In some cases, there is also no flexibility with the project or alignment with the interests of the farmer.

2.3.3 Identified measures for the PLUP

During the stakeholder consultation and discussion, experts have been talking about potential ways to get over barriers for each category of criteria for each prioritised technology. Table 15 provides an overview of these potential measures to overcome barriers to the deployment and diffusion of PLUP.

Table 15: Measures to overcome barriers to the deployment and diffusion of PLUP

Economic and Financial Measures	
Economic	Ensure access to funding from national and international
Non-Financial Measures	
Institutional	PLUP as national program
Legal/regulatory	Strengthen legal framework
Technical/Capacity	Promote On-Job-Training (OJT)
Social and Cultural	Awareness program and promote women participation
External Factors	Enhance Monitoring and flexibility

2.3.3.1 *Economic and financial measure*

2.3.3.1.1 *Economic*

The MAF Strategic Plan ensures that MAF and relevant services are strengthened and appropriately configured and equipped to deliver the MAF Strategic Plan, especially sustainable increases in production and forest productivity; improving and increasing access to markets; and improving the market value addition environment (legislation, policies, institutions, and infrastructure). Therefore, strengthening coordination within the ministry to secure funding from the state budget can be an option. Additionally, the pertinent directorate can also raise awareness of financial support by engaging with several possible donors.

With the help of JICA, FAO, and other Development Partners (DPs), PLUP has been implemented in 35 villages. Additionally, it will be extended to another 100 villages by 2022 (e.g., with support from the EU's *Ai ba Futuru* and the World Bank's SAPIP).

2.3.3.2 *Non-financial measure*

2.3.3.2.1 *Institutional*

The coordination among relevant stakeholders should be strengthened to support the recognition of PLUP as a national priority or programme. In this case, the budget could be easily secured and used for various purposes, including human resource development for field facilitators. In order for community leaders to govern a village and become accustomed to the new system, institutionalising village regulations is also necessary. This can be done through monthly monitoring meetings at the village level, quarterly information sharing meetings at the sub-village level, and annual evaluation meetings at the village level.

2.3.3.2.2 *Legal/regulatory*

The taskforce of the Directorate General for Forestry, Coffee, and Industrial Plants (DGFCIP) and relevant DPs such as JICA should develop the policy recommendations for institutionalisation of the CBNRM in conjunction with the CBNRM roadmap. In the context of Timor-Leste, CBNRM consists of Participatory Land Use Planning (PLUP) and Micro Programmes (MPs), which are actual undertakings of development activities for sloping agriculture, forestry, and livelihood development. At the municipal level, the legal framework for land use planning is currently being developed. MAF staff should actively participate in developing and implementing land use plans. Additionally, the relevant government institutions can use the existing laws and policies to promote the adoption of PLUP in sustainable natural resource management-related projects.

2.3.3.2.3 Technical/capacity

MAF, JICA, NGO Raebia, and other experienced organisations should provide on-the-job training (OJT) on PLUP to field officers of NGOs and Development Partners (DPs) and issue certificates to them. The training covers project management skills such as planning, monitoring, evaluation, and reporting. It is recommended that they be utilised for the implementation of the PLUP. Beyond their institutional ties, they could collaborate as a consortium. In a similar vein, a mid-term performance assessment should be conducted for OJT trainees through a facilitation skill test, a comprehension test, and a report-writing skill test. On top of that, it is important to receive training on the basics of GIS, which should include examples of how to use it for CBNRM activities like mapping DPs engaged in watershed management and tracking changes in the country's forest cover.

On the other hand, improving local leaders' abilities for governance at the village and post-administrative levels for sustainable management of forests and other natural resources is also necessary for the successful implementation of PLUP.

2.3.3.2.4 Social and cultural

In order to consistently remind communities and leaders to observe and uphold village regulations, socialisation and sensitization must be conducted. It is essential to have the support of local NGOs, MAF Extension Staff, and other Departments in order to effectively socialise and execute village regulations. Also, negotiating village regulations, or Tara Bandu, with neighbouring villages can help safeguard, regenerate, and manage forests and other natural resources.

The role of the church in sensitising communities to village regulation and reinforcing village regulation needs to be more emphasised. According to the JICA CBNRM Project's experience, the Church has been crucial in influencing village regulations in the Faturasa and Tohumeta villages. During routine Sunday services, the priest used to remind the communities to obey the regulations.

In terms of women's participation, the PLUP guideline emphasises that there should be 40% female engagement in the process. Moreover, livelihood improvement among women should also be encouraged. For example, the women groups of Fadabloco and Hahutoho villages have been supported by the project to produce cassava chips and canna chips for sale in supermarkets in Dili.

2.3.3.2.5 External factors

In order to ensure long-term monitoring after project completion, communities need to be capacitated on the operationalization of their own village regulations by coping with the incidence of illegal acts, such as how to track cases, find solutions, and take collective actions. Moreover, the government should provide support to the communities for the implementation of village regulations. MAF should provide uniforms to the forest guards and also recognise them as protectors of the forest.

On the other hand, the implementation of PLUP must be flexible to accommodate community needs and understanding, for example, while deciding whether to hold a traditional ceremony to inaugurate village regulations (i.e., the Tara Bandu ritual) or not.

2.4 Barrier analysis and possible enabling measures for slopping agricultural land technology (SALT)

The consultation workshop with departments of agriculture, forestry, local NGOs, INGOs, youth groups, and other stakeholders discussed and prioritised the Slopping Agricultural Land Technology (SALT) technology diffusion barrier and enabling measures. Expert interviews and legislative reviews were conducted to better understand the agriculture and forestry sectors. The problem tree was created during the consultation workshop to help choose barriers and measures.

2.4.1 General description of SALT

In many areas of the country, especially in the uplands, soil erosion caused by deforestation and frequent rainfall is a very critical issue. Around 80% of the population lives in rural areas and is engaged in subsistence upland farming as their main source of income. Historically, Timorese farmers used slash-and-burn in their mountains and hills to maintain soil fertility. With fewer people and large areas forested, it offers short-term gains. Despite this, Timor-Leste's population has doubled to 1.1 million in the last 50 years, and forest cover has disappeared in many municipalities. SALT is a package solution for food production and soil conservation that combines various soil conservation techniques in a single location.

SALT basically consists of contoured rows of nitrogen-fixing trees and 3-5 m-wide zones of field and permanent crops. To create hedgerows, the nitrogen-fixing trees are densely planted in double rows. A hedge is cut when it reaches a height of 1.5–2 m, or around 75 cm, and the cuttings (tops) are then spread out in the alleyways to serve as organic fertiliser.

SALT is a diverse farming method that can be classified as agroforestry due to the scattered placement of rows of evergreen bushes like coffee, chocolate, citrus, and other fruit trees. The strips that are not used for permanent crops, however, are alternately planted with legumes (soybean, mung bean, peanut, etc.), cereals (corn, upland rice, etc.), or other crops (sweet potato, melon, pineapple, etc.). The farmer receives a harvest from this cyclical cropping throughout the year. SALT also includes planting trees around adjacent boundaries for fuel and timber. For the "boundary forest" in SALT, some examples of tree species include mahogany, casuarina, sesbania, cashew, etc.

Table 16: Characteristic of various SALT Models

Production sys	SALT 1	SALT 2	SALT 3	SALT 4
Also called		Small Agro-livestock Land Technology	Sustainable Agroforest Land Technology	
Base crop	Staple food crops	Fodder crops	Trees	Fruit crops
Major product	Food grains	Meat, milk, manure	Fodder, fuel, timber	Fruits
Planting area				
a. Staple food crop	75%	20%	20%	40%
b. Cash crop	25%	20%	20%	60%
c. Forage, fodder	-	40%	-	-
d. Forestry	-	20%	60%	-

Source: Pratap & Watson (1994)

There are four characteristics shared by different SALT models, as shown in Table 16. SALT-3 is appropriate for the mitigation sector. SALT-3 is a cropping system in which a farmer can include food production, fruit production, and forest trees that can be marketed. Hence, SALT-3 is made up of three different models (such as SALT-1 and SALT-2) and a separate plot of land to produce valuable timber crops in the alleys. Farmers owning landholdings of about two hectares can practise it.

2.4.2 Identification of barriers for the SALT

The procedure for determining the barriers was exactly the same as in earlier technologies. The barriers were divided into two categories: Economic and financial barriers and non-financial barriers (Table 17).

Table 17: List of barriers identified for the SALT

Economic and Financial Barriers	
Economic	Limited access to the funding and cash flow
Non-Financial Barriers	
Institutional	Lack of institutional capacity
Legal/regulatory	Unclear policy on the expansion of SALT
Technical/Capacity	Lack of technical expertise

Social and Cultural	Limited awareness of technology
External Factors	Water shortages

2.4.2.1 *Economic and financial barriers*

2.4.2.1.1 Economic

There is a lack of financial access and cash flow that is preventing SALT practise from being carried out adequately, and the pertinent departments within the MAF require more financial resources to monitor its progress. Additionally, the lack of market access makes it difficult to sustain the practise of SALT.

The cost of implementing SALT will depend on the type of land, especially the slope of the land and the form of SALT being implemented. The cost varies from USD 100 to USD 200 per hectare. Besides implementation, appropriate funds are required for the purposes of capacity development and technology diffusion.

Based on JICA's experience with CBNRM projects, a series of training courses targeting 30 farmers would cost around US\$5,000, assuming that each training course included food and snacks. Additionally, expenses for trainers and other operational expenditures will be needed for conducting the training courses. Meanwhile, according to the experience of the NGO Raebia, the estimated cost is around \$20,000–\$30,000 for a two-year project implemented in five villages.

2.4.2.2 *Non-financial barriers*

2.4.2.2.1 Institutional

SALT has been around for a long time. However, the ability of the government, from the national to local levels, to assist and support the implementation of SALT is constrained and ineffective. Despite the existence of the policy, the National Directorate of Forestry (NDF) of the Ministry of Agriculture and Fisheries (MAF) still finds it difficult to implement the recommendations in the policy due to inadequate institutional arrangements and a lack of human resources. In addition, there is also a lack of institutionalisation of village regulations to control illegal forest fires, free grazing, and land disputes.

2.4.2.2.2 Legal/regulatory

The Agricultural Policy and Strategic Framework highlights some success stories related to sloping agricultural land technology (SALT), but there is unclear policy to support the expansion of SALT. The government of Timor-Leste has not given upland farming systems enough attention, despite their importance for food security and poverty reduction. This is because the majority of food production-

related policies and actions have focused on irrigated rice and mechanisation, even though 70% of farmers lack access to rice fields.

2.4.2.2.3 Technical/capacity

SALT has been introduced in Timor-Leste for some time, but technical staff from NGOs and MAF extension workers lack the skills to practise SALT. Some people may confuse SALT with terrace farming. In addition, to date, there are no guidelines or manuals for SALT that reflect the Timor-Leste context for technical staff and farmers to follow.

2.4.2.2.4 Social and cultural

Salt should be introduced in hilly and mountainous areas where subsistence upland farming prevails. However, most people who are engaged in upland farming are not aware of SALT. Some farmers are not adopting SALT because of a lack of information and skills to implement it step by step.

2.4.2.2.5 External factors

Farmers are interested in implementing the programme, but limited water resources have become the main barrier. In some places, water is readily accessible in the rivers and springs during the rainy season. However, during the dry season, farmers are unable to have a second or third agricultural season due to a lack of water.

2.4.3 Identified measures for the SALT

Experts have discussed potential approaches to overcome barriers for each category of criteria for each prioritised technology during stakeholder consultation and discussion. These potential measures are listed in Table 18.

Table 18: Measures to overcome barriers to the deployment and diffusion of SALT

Economic and Financial Measures	
Economic	Ensure access to funding and improve market access
Non-Financial Measures	
Institutional	Build and strengthen institutional capacity to monitor SALT implementation
Legal/regulatory	Establish clear national policy

Technical/Capacity	Promote information and technical support
Social and Cultural	Promote awareness on SALT
External Factors	Ensure water availability

2.4.3.1 *Economic and financial measure*

2.4.3.1.1 Economic

Mobilisation of financial resources through the state budget and donors is the key to implementing and monitoring SALT. It is possible for SALT to generate money and jobs in local municipalities by adopting a value chain strategy and promoting fodder, fuel, timber trees, and cash crops. Market access must be secure for farmers. It is crucial to encourage farmers to form small groups for group marketing and buying (to improve connections with larger consumers and supermarkets). In this regard, thorough market studies, business plans, infrastructure investments, as well as commitments from beneficiaries, minimum production levels, and dependability, are required to enhance the value chain approach. SALT can benefit both men and women farmers by increasing income and facilitating access to financial services.

2.4.3.2 *Non-financial measure*

2.4.3.2.1 Institutional

The coordination among relevant stakeholders should be built and strengthened, including improved agricultural sector institutional development for an enabling environment and support services. Additionally, a framework for extending SALT practises in Timor-Leste's agriculture and forestry sectors should be developed, together with an institutional set-up to monitor the project. Enhancing leadership capacity at the local level is also necessary for the successful implementation of SALT.

2.4.3.2.2 Legal/regulatory

The Minister of Agriculture, Livestock, Fisheries, and Forestry should establish a clear national policy to support the expansion of the SALT technique, which includes strategies and actions to achieve the desired outcomes.

2.4.3.2.3 Technical/capacity

The Government of Timor-Leste should provide policy and financial support for the expansion of the SALT technique through the capacity building of MAF extension officers and NGOs. Several agencies (such as USAID and TOMAK) have used SALT in their agricultural projects. Hence, the government can

coordinate with potential partners to develop the SALT manual and provide training to the NGOs and MAF extension officers. The trainers of the training courses should also have sufficient knowledge of SALT and facilitation and guiding skills. At least two years of training with continuous technical assistance are required.

2.4.3.2.4 Social and cultural

Community education and awareness about the benefits of SALT should be promoted to those who are engaged in subsistence upland farming. It would take time for rural farmers to learn and acquire SALT techniques. Therefore, it is important to provide continuous training and technical assistance to farmers and those participating in the training courses.

2.4.3.2.5 External factors

Ensuring water management and availability for cultivation by improving water supply systems can encourage farmers to increase local production and productivity. In addition, protection and conservation of water at the source must be encouraged. Water conservation systems will restore the natural economy by building small dams for water conservation. The local NGO Permatil has been working extensively on creating small traditional dams to conserve water in the hills during the rainy season. As a result, they have a new spring through this practise.

2.5 Barrier analysis and possible enabling measures for cover crop

Similar to previous technologies, barriers and measures were identified through a literature review, including interviews and discussions with key stakeholders such as departments of agriculture, local NGOs, INGOs, and youth groups. Problem trees were created during consulting workshops to help select barriers and measures for cover crops.

2.5.1 General description of cover crop

The most common farming method is shifting or slash-and-burn agriculture. Using this technique, vegetation is cut and burned during the dry season, primarily in October and November. As a consequence, Timor-Leste's soils have deteriorated over time. According to the preliminary FAO analysis, slash-and-burn and uncontrolled fires are potentially major contributors to Greenhouse Gas (GHG) emissions in Timor-Leste. In addition to contributing to climate change, slash-and-burn and uncontrolled fires have been identified as major contributors to land and environmental degradation, deforestation, loss of biodiversity, and soil erosion. Timor-Leste adopted conservation agriculture (CA) practises, which involve cover crops, in 2013, aiming to modify slash-and-burn agriculture practises and sustainably increase production. The CA is founded on the three principles of no burning, no ploughing, and growing a cover crop. In this section, we will focus on cover crops.

Cover crops are fast-growing crops that are planted between periods of regular crop cultivation. They prevent soil from eroding by covering the soil's surface, and if they are leguminous, they also fix nitrogen. When ploughed under, they provide humus and carbon to the soil, as well as nitrogen for the subsequent crop.

In tropical climates like Timor-Leste, organic matter decomposes quickly, so it is important to produce very significant amounts of slowly decomposing soil surface cover materials (biomass) in order to produce enough continuous organic mulch.

Various cover crops have been tested by MAF in Timor-Leste with the support of FAO. Based on the tests, Velvet bean (*Mucuna pruriens*), locally known as Lehe (in Tetum), is the only plant capable of producing adequate biomass to serve as a permanent soil cover (mulch). As a result, Lehe is the main cover crop promoted in its efforts to scale up the technology.

This technology involves cultivating subtropical legumes like velvet beans. Lehe is a robust vine that grows in the area. It has been proven to provide effective ground cover and organic mulch for subsequent crops, which can significantly cut down on weeding time. The vines and leaves also provide organic matter to the soil, while the beans are a normal part of the Timorese diet. Additionally, the leaf can serve as a source of protein for animal feed.

Lehe performs well in low-lying areas with lots of rainfall. The southern lowlands, where the rainy season is longer and there are two cropping seasons, produce the finest results. Lehe produces well in these agroclimatic zones when planted during the first cropping season or intercropped or relay cropped prior to the cycle's conclusion.

These practises increase labour productivity. Based on FAO's experiences, the productivity per unit of labour has grown by 67% while labour time has decreased by 30%. With the time saved from working in the fields, women can undertake a range of other activities, such as working at home, raising children, tending livestock, preparing, and selling produce, and investing in new businesses.

These are the three main steps to consider when cultivating Lehe to open a grassland into cultivation without burning or ploughing.

1. December - January: Lehe seeds are planted (50 cm x 50 cm) at the beginning of the main rainy season into soko grassland, when the soil is already humid - Lehe grows fast and vines rapidly cover and suppress the soko grass.
 - Without sunlight, the grass eventually dies
2. May-June: Lehe field is rolled using a 2-wheel or 4-wheel knife blade roller or slashed, when all the soko grasses have been suppressed.
 - Lehe grass dies and provides a thick mulch cover
3. June: A food crop such as corn, beans or vegetables can be planted through the mulch (June).

In this sequence, a grassland can be opened for cultivation without burning or ploughing. When main crops are not cultivated, they can absorb carbon and reduce emissions compared to keeping land fallow. Hence, cover crops help mitigate climate change as this practise eliminates the need to burn forests for the purpose of food production.

2.5.2 Identification of barriers for the cover crop

Table 19 shows the barriers which are divided into two categories, namely economic and financial barriers, and non-financial barriers.

Table 19: List of barriers identified for the cover crop

Economic and Financial Barriers	
Economic	Limited farmer access funding and market
Non-Financial Barriers	
Institutional	Limited institutional capacity
Legal/regulatory	Ineffective law enforcement
Technical/Capacity	Limited knowledge and skills
Social and Cultural	Free grazing and farmer's mindset

2.5.2.1 *Economic and financial barriers*

2.5.2.1.1 Economic

Based on the FAO experience, one of the main barriers is that farmers have limited funds to purchase and maintain adequate cover crop equipment, particularly hand-tractors and 2-wheel knife-rollers. Another key barrier is the marketing of their agricultural products. Imported rice is an important component of the urban diet. As a result, the amount of corn sold in wholesale and retail markets is limited. The agrifood chains are also less developed. Under cover crop practises, the rapid and continuous increase in productivity results in volumes that cannot be absorbed by the local market. Consequently, this can lead to reduced process or field losses due to the poor storage conditions.

2.5.2.2 *Non-financial barriers*

2.5.2.2.1 Institutional

There is limited institutional capacity among government agencies and leading organisations to facilitate most of the proposed cover crop programmes. The coordination and standardisation of the processes are still weak. Despite the fact that the policy already exists to discourage slash-and-burn practises, the National Directorate of Forestry (NDF) of the Ministry of Agriculture and Fisheries (MAF) still finds it difficult to implement the recommendations in the policy due to weak institutional arrangements and a lack of human resources.

2.5.2.2.2 Legal/regulatory

The cover crop through conservation agriculture and climate-smart agriculture is reflected in the agriculture policy and strategic framework, but there is no allocation in the state budget for the adoption of this practise. Deforestation and widespread destruction of forest ecosystems have been difficult for the government to control and stop, mainly because of ineffective law enforcement, weak forestry policies, and inadequate human resources. This has been made worse by a difficult socio-economic environment, the features of post-conflict populations, complex customary rules, poor land use planning, and ultimately a lack of coordination between the relevant ministries.

2.5.2.2.3 Technical/capacity

Limited knowledge and skills on maize are associated with various legume seeds and agroecological zones that require intensive field testing and knowledge management. Farmers grow other crops such as rice, tubers, vegetables, or fruit trees, which can also be grown under cover crops. However, specific knowledge of this plant is still lacking. Also, there is a paucity of studies across Timor-Leste's various agroecological zones to understand the potential for adopting cover crops in different climate zones.

2.5.2.2.4 Social/cultural

Free grazing of animals has become a major barrier in the agricultural sector. Most Timorese livestock are free to graze wherever their owners direct them, so unless farmers fence off their fields, they will eat crop residue and mulch, which is important for conservation agriculture. Another one is the farmer's mindset. Most Timorese farmers have used the same methods for generations (e.g., slash-and-burn, grazing and burning crop residues, and ploughing, digging, and hoeing) and are unwilling to change, despite increasing land degradation and extreme weather.

2.5.3 Identified measures for the cover crop

In the interview and consultation workshop, potential measures to overcome barriers for each category were addressed, and those prospective measures are shown in table 20 below.

Table 20: Measures to overcome barriers to the deployment and diffusion of cover crop

Economic and Financial Measures	
Economic	Ensure access to funding and improve market access

Non-Financial Measures	
Institutional	Build and strengthen institutional capacity
Legal/regulatory	Enforce existing law and strengthen coordination among relevant ministries
Technical/Capacity	Promote technical supports
Social and Cultural	Promote customary law and farmer field school (FFS)

2.5.3.1 *Economic and financial measure*

2.5.3.1.1 Economic

Private-public partnerships are necessary to increase farmers access to equipment. Farmers must develop their skills in cover crop farming. The market for new equipment and equipment maintenance needs to be expanded by local artisans and equipment importers. Additionally, market and value chain development are very important for agricultural development. The encouragement of farmers to form small groups for group marketing and purchasing is essential to strengthening ties with larger consumers and supermarkets. There must be policies and institutions to support the import of potential cover crop seeds and the right tools and machines, as well as domestic marketing and service provisions. Also, the government and donors should improve food storage facilities.

2.5.3.2 *Non-financial measure*

2.5.3.2.1 Institutional

It is vital to build and strengthen institutional arrangements by improving the coordination and standardisation of procedures and technical packages in cover crops. This also includes collaborating with more partners who implement cover crops in their agricultural operations and improving agricultural sector institutional development for an enabling environment and support services.

2.5.3.2.2 Legal/regulatory

Several important policies and laws (such as agricultural policy and strategic framework and the Final Country Report of the Land Degradation Neutrality Target Setting Programme in Timor-Leste) have already entered into force, promoting the adoption of conservation agriculture to reduce soil disturbance, minimise permanent soil cover, and promote crop rotation. Therefore, the responsible entity can enforce these existing laws to reflect clear lines of authority among the various relevant agencies and consider cover crops as one of the top priorities in national development plans. This

includes strengthening national capacity to address the negative impacts of fires in Timor-Leste and providing an information base to inform policy and action. Moreover, coordination between different ministries and sectors to enable favourable policies in agricultural mechanisation is important to overcome regulatory and institutional-related barriers.

2.5.3.2.3 Technical/capacity

Promotion of cover crops in various agroecological zones requires field testing and intensive knowledge management, including more research. As a result, the MAF should work with academic institutions and agricultural research centres to facilitate the technical assistance needed for the deployment of the cover crop.

2.5.3.2.4 Social and cultural

Free-grazing animals and wildfires require local expertise. Live-fences can safeguard cover crop fields from free-grazing animals, but community land-use planning and tara bandu customary rules should be supported when scaling up cover crops to become the dominant 'non-shifting' farming method at the village level.

In order to influence farmers' mindsets, the demonstration, testing, and replication of the cover crop through conservation agriculture practises techniques should be maximised through farmer field school (FFS) to help farmers see the benefits of zero or minimum tillage, cover crop/mulching, and crop rotation.

2.6 Linkages of the barriers identified

The majority of the barriers that were identified through the analysis are ones that are applicable to all technologies. Only a small number of the barriers are unique to individual technologies. The common barriers for all technologies are:

- Lack of finance access and cash flow
- Lack of institutional capacity
- Lack of policy
- Lack of technical expertise
- Lack of awareness
- Lack of infrastructure

All technologies require financial resources to implement and monitor initiatives related to agriculture, land use, and forestry. There have been many projects funded by governments and international donors across the country but sustaining them seems to be the hardest part. There is no reliable long-term source of funding for programmes in this sector. It is also due to the lack of a market that makes projects and programmes difficult to sustain.

Institutional capacity in related government is still weak, and cooperation mechanisms between institutions seem to be lacking, from the national to local levels. One of the main reasons for inadequate institutional capacity is a lack of human resources with the necessary expertise. Moreover, lack of awareness is the biggest barrier when it comes to social and cultural barriers because most farmers still have limited knowledge and understanding of available technology. There are still farmers who practise unsustainable forestry, agriculture, and land use methods. Also, women's participation is still lacking.

Additionally, limited infrastructure in remote areas is also a major barrier to the spread of the agricultural, land use, and forestry sectors, mainly due to a lack of water storage, irrigation systems, and poor road access.

2.7 Enabling framework for overcoming the barriers in agriculture, land use and forestry sector

The Ministry of Agriculture, Livestock, Fisheries, and Forestry and other mandated ministries need to be committed to playing a leading role in the management of agriculture, land use, and the forestry sectors for an enabling environment and support services. Engagement and collaboration through development partners and other stakeholders are necessary, which includes joint planning, resource mobilisation, planning, monitoring, and evaluation.

Additionally, using the existing law and policies, such as the Agricultural Policy and Strategic Framework and the National Policy on Forests of Timor-Leste, to identify clear roles and responsibilities for each ministry or department and inter-ministerial coordination, Forest guard and agricultural Extension workers will need to be trained or receive refresher courses in agriculture, land use, and forestry management, including leadership, coordination, and project management skills. Local farmers need access to technical skills, market access, and information.

Institutionalising village regulation is also required in order for community leaders to run a village and get used to the new system. Socialisation and sensitization must be carried out in order to remind communities and leaders to adhere to and uphold village regulations. It is important to have support from local NGOs, MAF extension staff, other departments, and the church to socialise and implement village regulations effectively.

Forty percent more women should be encouraged to participate in all stages of the engagement process, from planning to implementation. Women's efforts to enhance their livelihoods should also be supported.

Site selection must also consider road infrastructure, water availability before the project starts, and water conservation. Further development will include collection centres, infrastructure, and feeder roads to connect the markets.

Table 21 below summarizes the identified barriers and suggested measures by key stakeholders in the agriculture, land use and forestry sector.

Table 21: Barriers and measures of technologies in agriculture, land use and forestry sector

Barriers	Measures
Agroforestry	
<ul style="list-style-type: none"> - Lack of financial access and cash flow - Lack of institutional capacity - No specific policy and strategy on agroforestry development - Lack of technical expertise in agroforestry - Land rights and lack of awareness of intended and long-term benefits of such technology - Lack of infrastructure 	<ul style="list-style-type: none"> - Ensure access to funding and improve market access - Strengthen agroforestry departments, including the coordination among lines ministries and NGOs. - Develop policy and strategy on agroforestry - Increase number of extensionist with relevant degree, and training to advance their knowledge and skills. - Land tenure law reform and develop education and awareness programme - Improved skills of construction companies and municipality management of rural roads
Participatory Land Use Planning (PLUP)	
<ul style="list-style-type: none"> - Limited access to the funding - Lack of institutional capacity - Lack of enforcement of existing laws and policies - Lack of technical expertise in PLUP - Lack of regulation/enforcement and women participation - Lack of monitoring after project 	<ul style="list-style-type: none"> - Ensure access to funding from national and international - PLUP as national program - Strengthen legal framework - Promote On-Job-Training (OJT) - Awareness program and promote women participation - Enhance Monitoring and flexibility
Slopping agricultural land technology (SALT)	
<ul style="list-style-type: none"> - Limited access to the funding and cash flow - Lack of institutional capacity - Unclear policy on the expansion of SALT - Lack of technical expertise - Limited awareness of technology - Water shortages 	<ul style="list-style-type: none"> - Ensure access to funding and improve market access - Build and strengthen institutional capacity to monitor SALT implementation - Establish clear national policy - Promote information and technical support - Promote awareness on SALT - Ensure water availability

Cover crop	
<ul style="list-style-type: none"> - Limited farmer access funding and market - Limited institutional capacity - Ineffective law enforcement - Limited knowledge and skills - Free grazing and farmer's mindset 	<ul style="list-style-type: none"> - Ensure access to funding and improve market access - Build and strengthen institutional capacity - Enforce existing law and strengthen coordination among relevant ministries - Promote technical supports - Promote customary law and farmer field school (FFS)

3 Conclusion

The BAEF was completed through an effective consultative process. The method followed the guidelines provided in the TNA Handbook on “overcoming barriers to the transfer and diffusion of climate technologies-second edition”. A wide range of individuals from the government, NGOs, development partners, the private sector, youth organisations, and other end users engaged in the process. A one-day consultation workshop was also held to evaluate the barriers and measures. Despite limited time and other involvement, participants were keen to share their insights and experiences relating to the technology and its processes.

The BAEF report has identified potential barriers and measures for the deployment and diffusion of mitigation technologies in the transportation, agriculture, land use, and forestry sectors. Based on the categorization, ranking, and decomposition of the barriers, a common pattern emerged. The long list of barriers was compiled under six sub-categories: economic, institutional, legal/regulatory, technical/capacity, resources/information, and social/cultural. Later, they were grouped into two different categories: financial and economic barriers and non-financial barriers. Essentially, barriers and measures were identified based on problem trees, feedback discussions, informal interviews, and relevant literature.

Financial resources and institutional capacity were identified as important barriers to the transfer of the eight technologies. It was then followed by a legal framework, data or information, and social. Hence, government institutions mentioned in this document, such as the Ministry of Transportation and Communication, the Ministry of Agriculture, Livestock, Fisheries, and Forestry, and other mandated ministries, must coordinate their efforts in order to ensure the efficient transfer and diffusion of these technologies.

Additionally, development partners and stakeholders need to work together as a team towards a common objective. Also, Timor-Leste urgently needs assistance with climate funding, capacity building, and technology development and/or transfer for each initiative to be effective. The implementation of these technologies will contribute to mitigating climate change at the national level.

The technology action plan (TAP) is the next phase. This is a concise plan for the adoption and deployment of priority technologies that will support Timor-Leste's social, environmental, and economic development and climate change mitigation.

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Annex I: Problem Trees

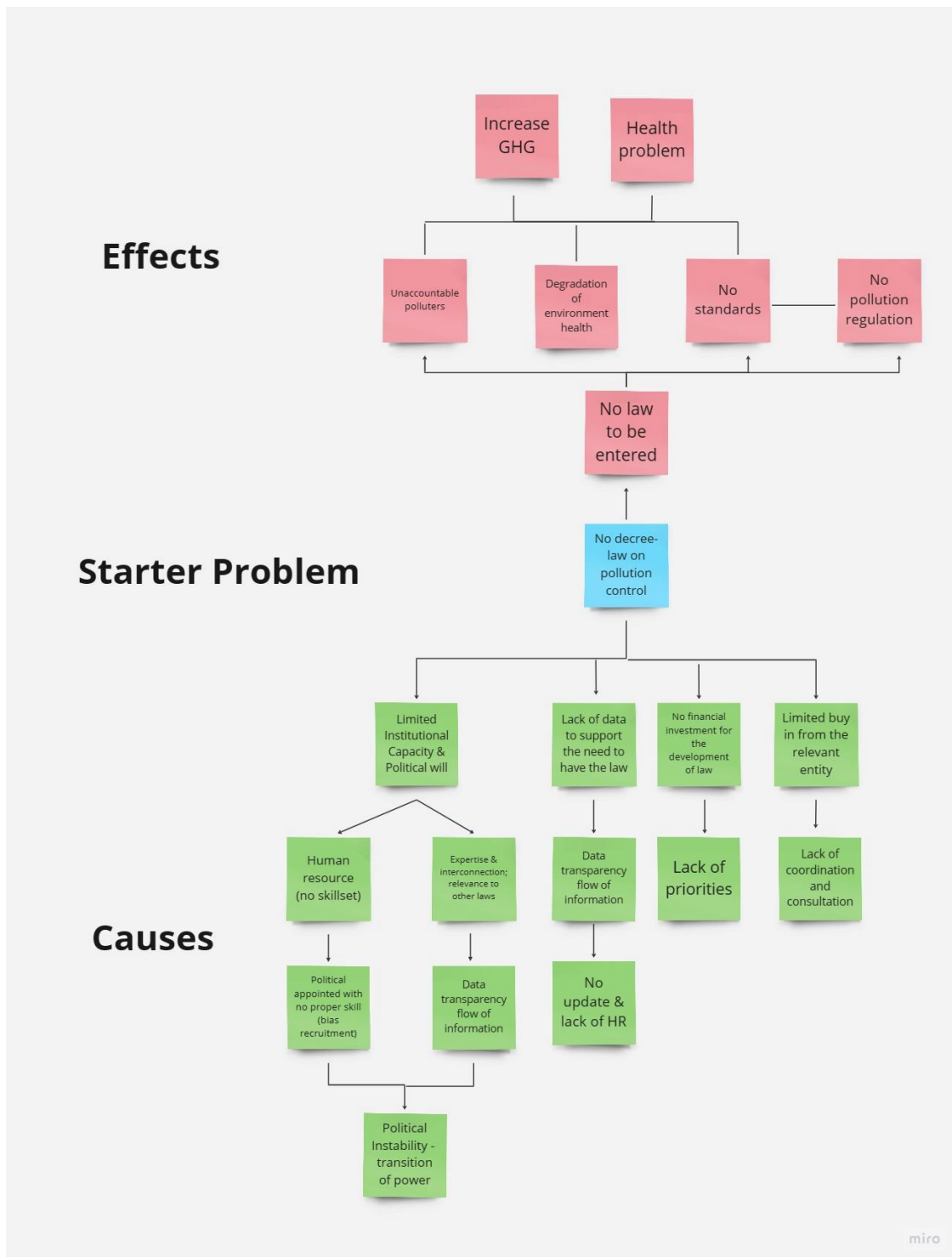
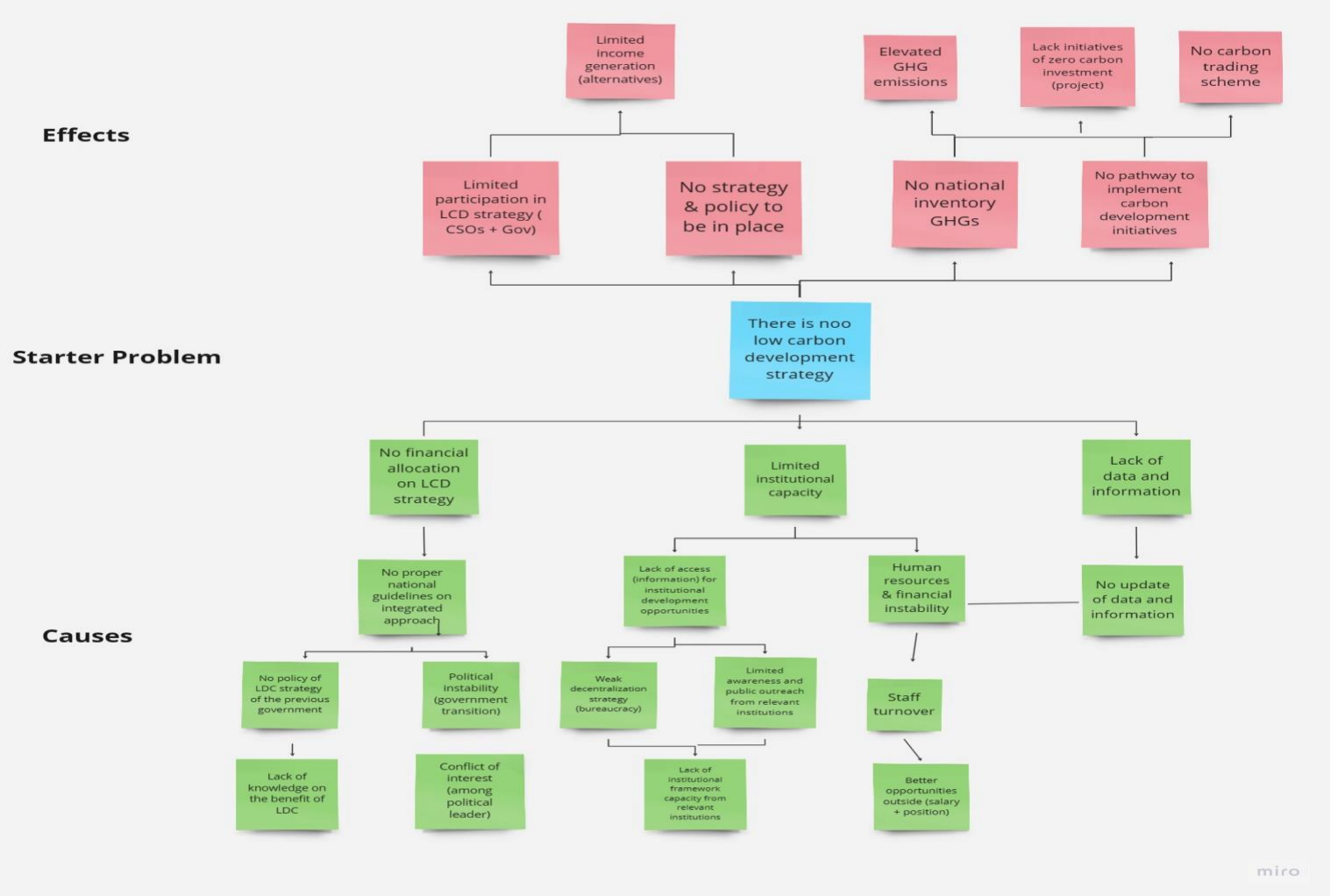


Figure 3: Problem tree of Pollution Control Decree-Law

Figure 4: Problem tree of Low Carbon Development Strategy



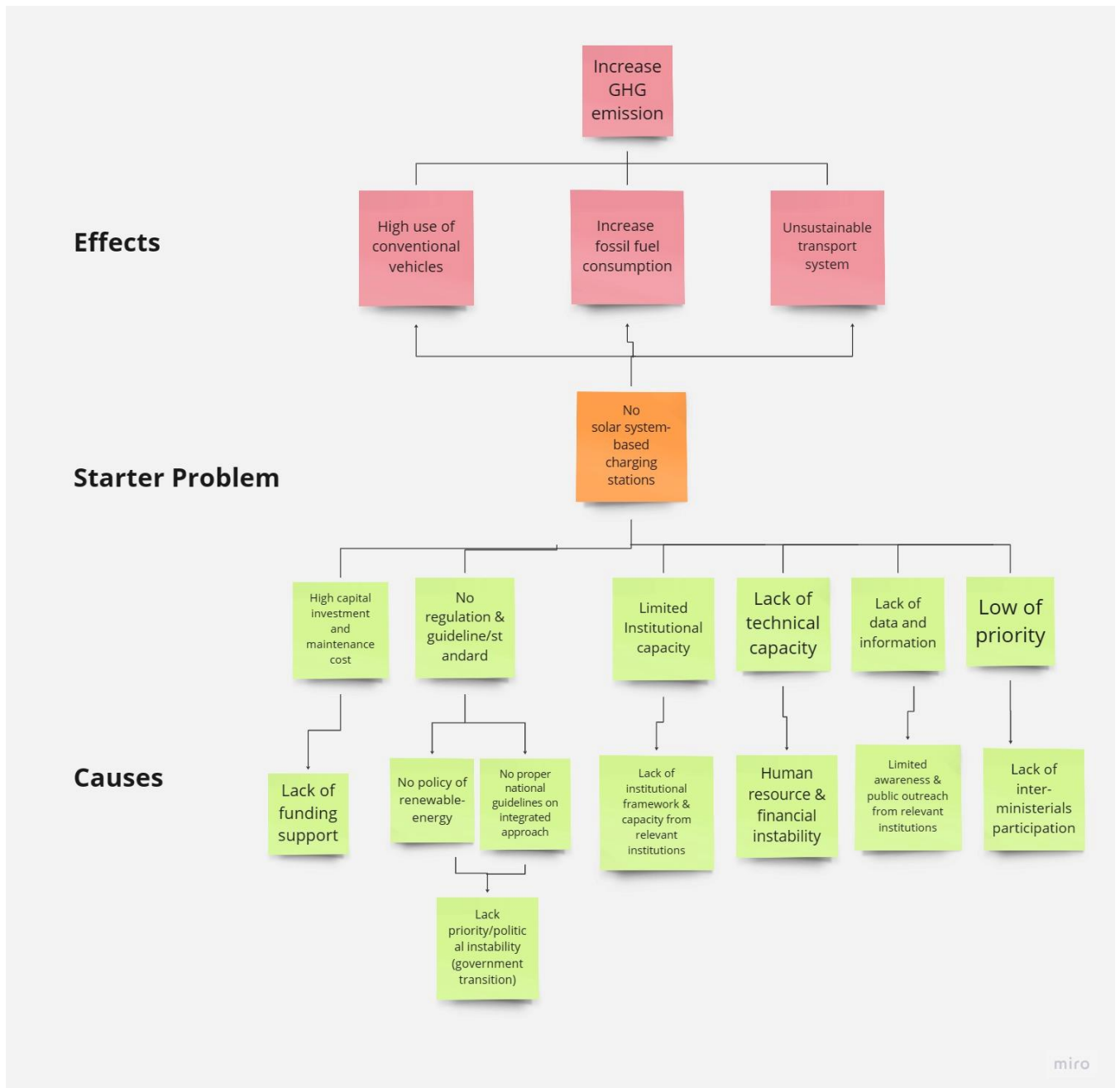


Figure 5: Problem tree of Research on Installing Solar system-based charging stations

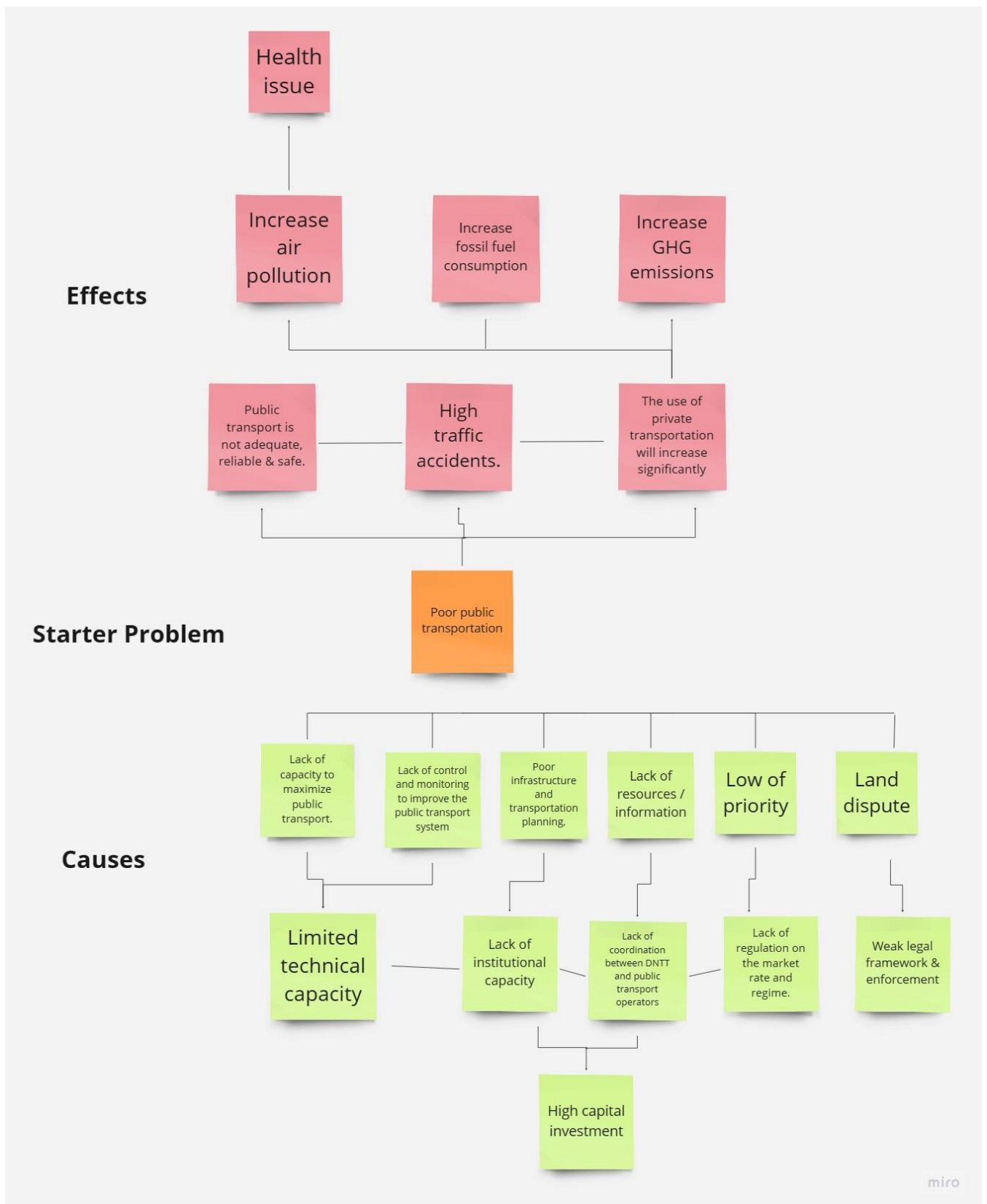


Figure 6: Problem tree of Public Transport Maximization

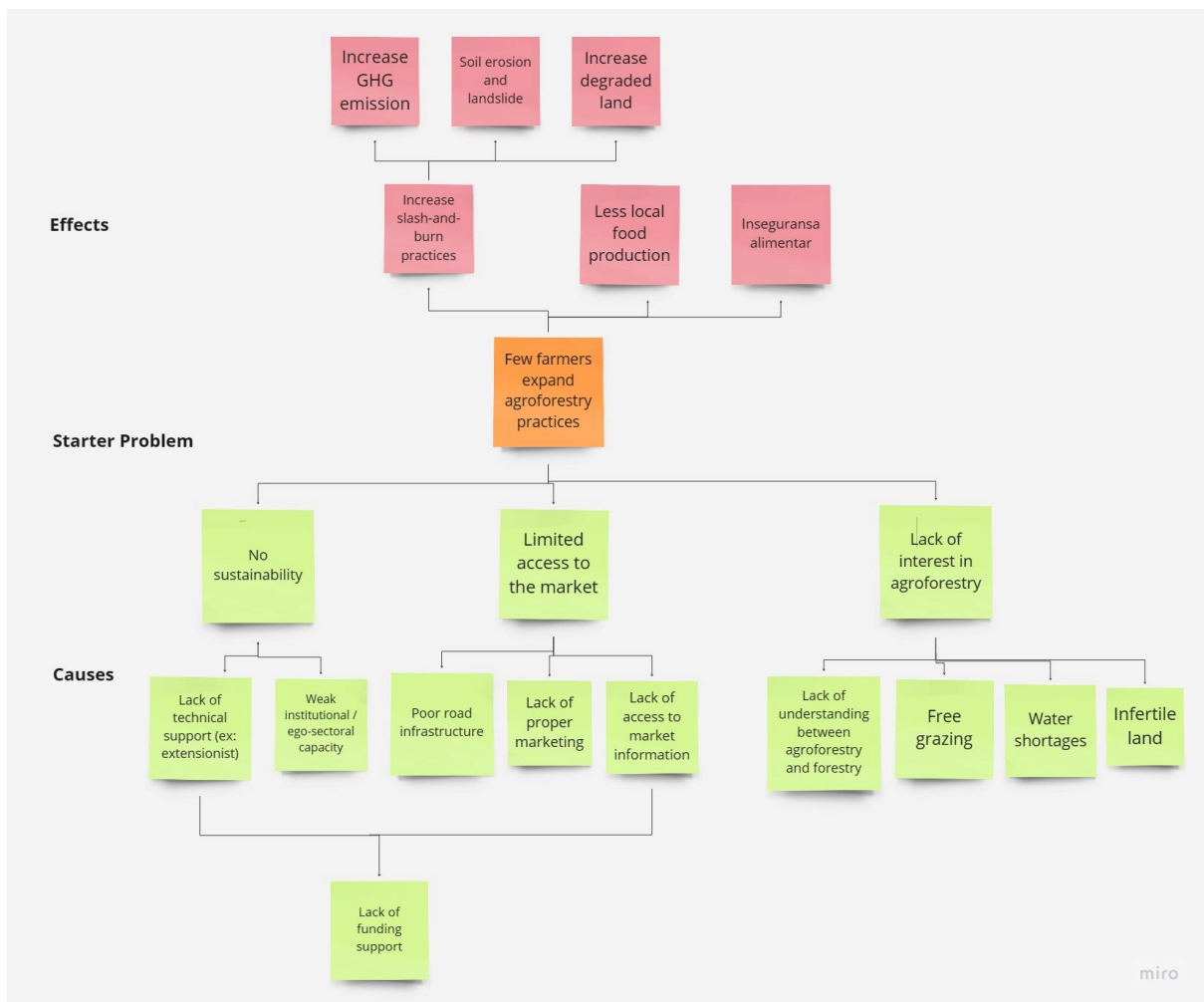


Figure 7: Problem tree of Agroforestry

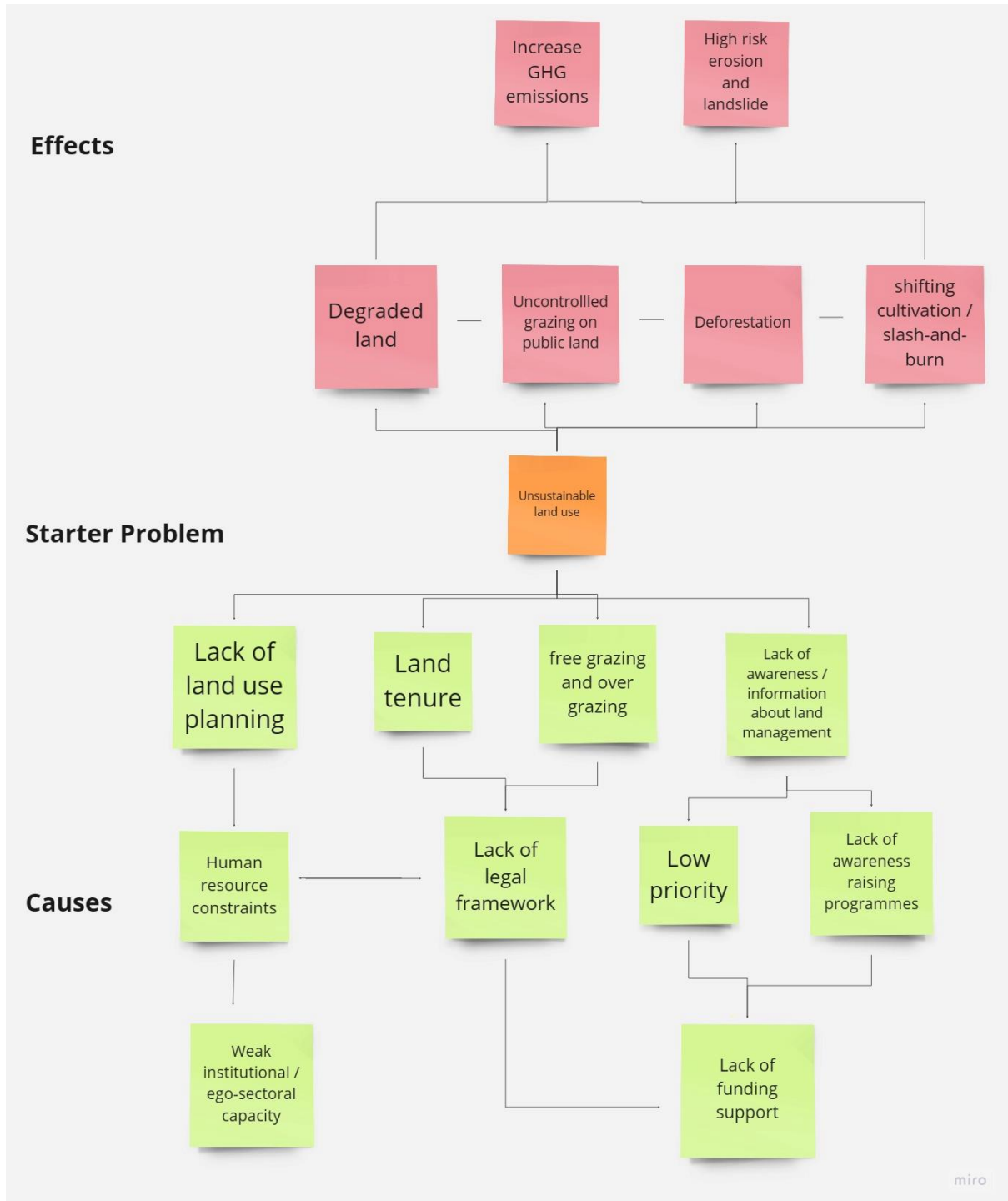


Figure 8: Problem tree of Participatory Land Use Planning

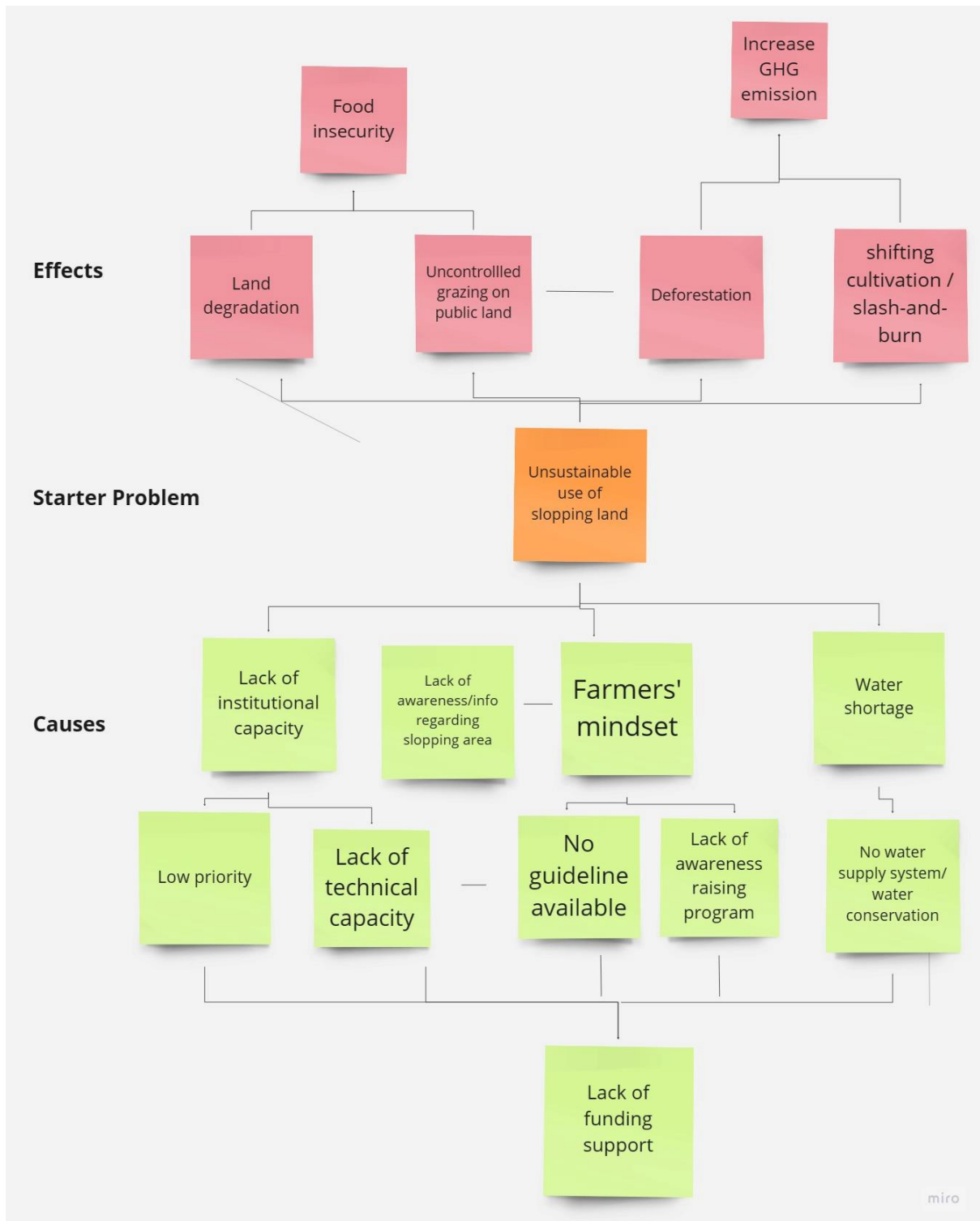


Figure 9: Problem tree of Sloping Agricultural Land Technology

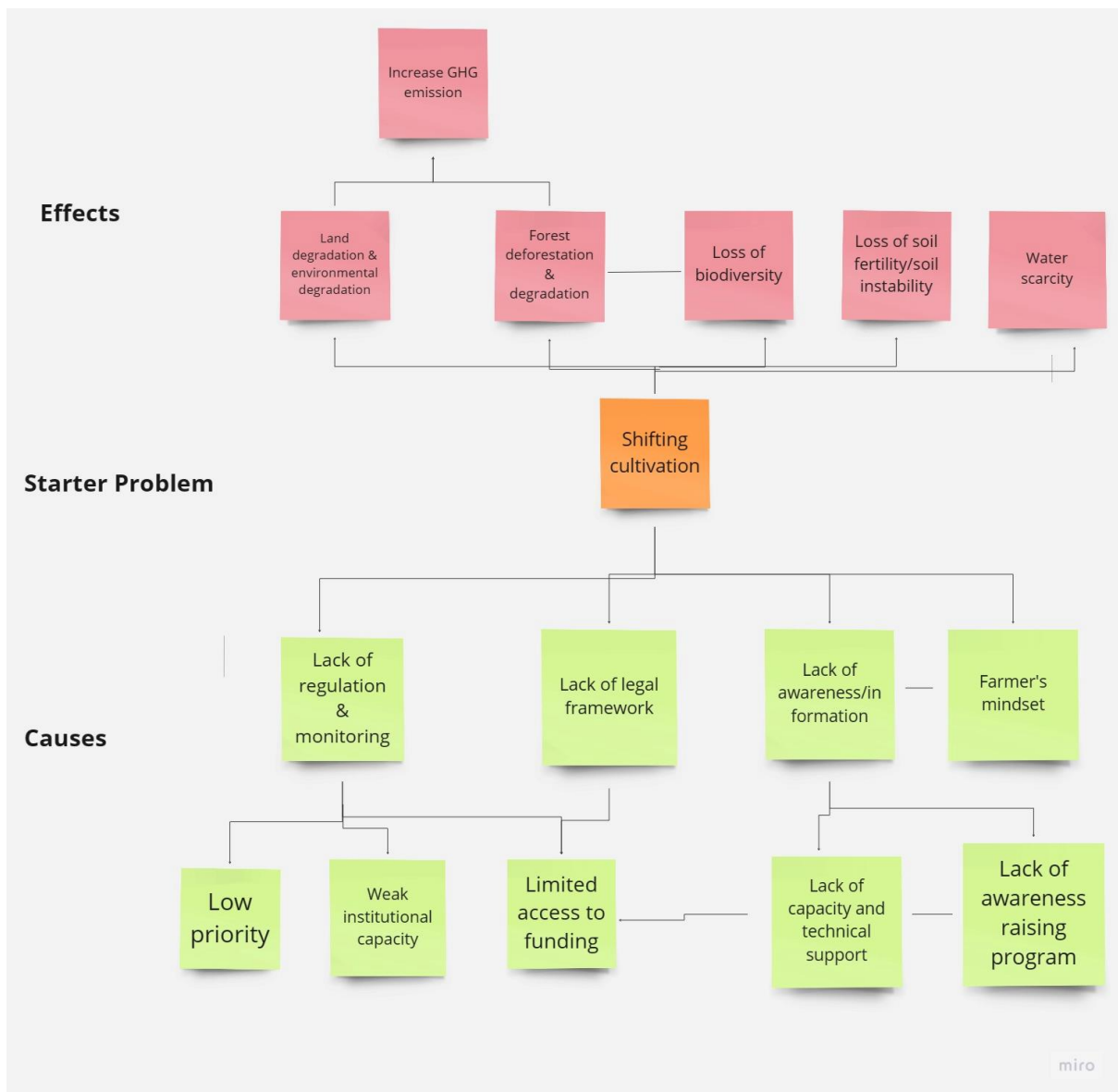


Figure 10: Problem tree of Cover Crop

Annex II: List of stakeholders

I. One-on-One Consultation Stakeholders

No.	Name	Institution	Position	Email Contact
1.	Mr. Rofino Soares Gusmão	National Directorate for Food Security and cooperation, Ministry of Agriculture and Fishery (MAF)	National Director	gerrandogusmao@gmail.com
2.	Mr. Agustinus Bruno Halle	DNTT	Vice Coordinator of the Public Transport Project Service Team	bruno_atta@yahoo.com
3.	Mr. Profirio Fernandes Xavier	DNTT/ADB	Technical Staff	konumalai@gmail.com
4.	Mr. Zacarias Bosco & Mr. Mercuides de Sousa	The National Authority for Electricity (ANE, IP)	Technical Staffs	zacarias.bosco@ane.tl / desousamercuides@gmail.com
5.	Mr. Mateus Maia	NGO Raebia	Deputy	xistomartins@raebia.org / ymartins@up.edu.ph
6.	Mr. Arlindo Silveiro	Environmental Planning and Management, National Directorate of Pollution Control	Chief Department	arlindosilveira642@gmail.com / silveiralindu@yahoo.co.id
7.	Mr. Ego Lemos	Permatil	Executive Director	ego.lemos72@gmail.com
8.	Mr. Alito Rosa	NGO KFF	Executive Director	
9.	Ms. Joana Gusmao	Ho Musan Ida/With One Seed	Coordinator Hub Enterprise Baguia & Finance Officer.	joana@withoneseed.org.au
10.	Ms. Leopoldina Joana	With One Seed/Rai Matak	Project Manager	leopoldinaj82@gmail.com

11.	Mr. Moises Guterres De Sar	Environmental Legal Office	Chief Department	
12.	Mr. Fernandino Xavier da Costa	MAF	Chief Department of Reforestation	
13.	Mr. Adelino	MAF	Staff	
14.	Mr. Zecky Carmo	TILOFE	Director	zeckyhironimos@gmail.com
15.	Mr. Robert W.	AI-COM	Director	rob@livethedream.tl
16.	Ms. Joaquina Barreto	AI-COM, Ministry of Agriculture and Fishery (MAF)	Staff	quina.barreto@gmail.com
17.	Mr. Carlos das Neves	Habelun Ai-parapa	Group Leader	
18.	Dulce Gusmão	EU		Dulce-Maria.e-silva-gusmao@eeas.europa.eu
19.	Expedito Belo	UNDP	Project Coordinator	expedito.belo@undp.org

II. Participants of Consultation Workshop

No.	Name	Institution	Type of Stakeholder
1.	Isaura Baptista Barros	Laudato Si Movement Timor-Leste (LSA-TL)	Youth group
2.	Albino da S. Barbosa	MAPPF	Government Institution
3.	Mercuides de Sousa	The National Authority for Electricity (ANE, IP)	Public Institution
4.	Zacarias Bosco	The National Authority for Electricity (ANE, IP)	Public Institution
5.	Liborio A. T. do Rosario	FCOTI	Foundation
6.	Jose R. O. Fernandes	MAPPF	Government Institution
7.	Armandina Clemencia	MPIE – DNOE	Government Institution
8.	Evaresto D. C	ADTL	Association
9.	Fernando Ronaldo da Costa	MPIE – DNOE	Government Institution
10.	Eligio Soares	TROBAS	NGO
11.	Antero Pinto Pereira	LCOY-TL	Youth Group
12.	Profirio Fernandes Xavier	DNTT (ADB technical Staff)	Government Institution
13.	Agustinus Bruno Halle	DNTT	Government Institution

14.	Marcia e Silva	FAO	UN Agency
15.	Apolonia Barreto	UNICEF	UN Agency
16.	Dulce Gusmão	Delegation of the European Union to Timor-Leste	International Organization
17.	Andre Neto da Silva	FCOTI	Foundation
18.	Martinho D. S da Costa	Laudato Si Movement Timor-Leste (LSA-TL)	Youth group
19.	Luis dos Santos Belo	DNAC	Government Institution
20.	Jose Barros	TOMAK - DFAT	Development Partner
21.	Claudino Nabais	FAO	UN Agency
22.	Graziela Xavier	Mercy Corps	INGO
23.	Justina Aurea Belo	NDCC	Government Institution
24.	Leonardo Rosa	NDCC	Government Institution
25.	Sofia Sagram	NDCC	Government Institution
26.	Mario Ximenes	NDCC	Government Institution
27.	Sebastiao da Costa	ANAS, IP	Public Institution
28.	Maria Resi	NDCC	Government Institution
29.	Suzana Cunha	Rai Matak – With One Seed	NGO
30.	Josafat de Araujo	CVTL	NGO
31.	Augusto Pinto	NDCC	Government Institution
32.	Zelia A. Maria	NDCC	Government Institution
33.	Vicente Ximenes	NDCC	Government Institution
34.	Roberto Amaral	NDCC	Government Institution
35.	Armando Barreto	NDCC	Government Institution
36.	Kassius Klei Ximenes	National Director Spatial Planning	Government Institution