SAVi Sustainable Asset Valuation

A Sustainable Asset Valuation Assessment of the Mass Rapid Transit System in Pampanga, Philippines

METHODOLOGICAL NOTE FOR THE NATIONAL ECONOMIC AND DEVELOPMENT AUTHORITY

IISD International Institute for Sustainable Development

OECD

SIPA Sustainable Infrastructure Programme in Asia

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

IKI International Climate Initiative

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International Institute for Sustainable Development

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1.0 Overview

IISD carried out a sustainable asset valuation (SAVi) assessment of the recently proposed mass rapid transit (MRT) system in Pampanga, Philippines. The MRT system is expected to improve access to transportation across the region by connecting the main cities and municipalities, as well as create jobs and reduce congestion, CO_2 emissions, and exposure to air pollution. The public transport project will consist of four bus rapid transit (BRT) lines and one light rail transit (LRT) line.

We use the SAVi methodology to develop an integrated assessment aimed at raising awareness of the impact of sustainable infrastructure by demonstrating a wide range of economic, social, and environmental impacts that the MRT will have on the region of Pampanga.

This document serves as a methodological background note for engagement with the National Economic and Development Authority (NEDA). It provides definitions of sustainable transport, indicators to consider, the modelling approach proposed, and the resulting analysis.

1.1. Introduction

DEFINITION OF SUSTAINABLE TRANSPORT

Sustainable transport can be defined through three pillars: efficiency, equity, and environment (Transformative Urban Mobility Initiative, 2018). In this formulation, "efficiency" refers to the improvement of sustainable technologies and services, "equity" refers to supporting the mobility of users, and "environment" refers to reducing the negative impacts of mobility. One of the most comprehensive definitions is proposed by the High-Level Advisory Group on Sustainable Transport for the United Nations (2016, p. 10):

> Sustainable transport is the provision of services and infrastructure for the mobility of people and goods—advancing economic and social development to benefit today's and future generations—in a manner that is safe, affordable, accessible, efficient, and resilient while minimizing carbon and other emissions and environmental impacts.

INDICATORS

To assess the sustainability of transport projects, indicators from the three dimensions of sustainability are crucial. The United Nations Economic Commission for Europe (UNECE) (2020) offers a list of indicators for this purpose, as shown in Table 1. Several of these indicators have been used to design the SAVi assessment for sustainable transport, in which indicators are divided into the following categories: economic, poverty and social, environmental, and risk to sustainability (Bassi et al., 2017). It is worth noting that the list of indicators can be expanded or reduced depending on the requirements of the project.

Table 1. Environmental and socio-economic indicators suggested by UNECE to evaluate the sustainability of transport projects

	Theme	Indicator
Environmental indicators	Global climate change	• Greenhouse gas emissions from transport
	Air pollution	• Acidifying gases from transport • Volatile organic compounds from transport
	Consumption of natural resources	• Consumption of mineral and oil products from transport • Land coverage • Need for additional new construction
Social indicators	Health	• Exposure to particulate matter from transport in the living environment • Exposure to nitrogen dioxide from transport in the living environment • Exposure to traffic noise • Traffic deaths • Traffic injuries
	Equity	• Justice of distribution of economic benefits • Justice of exposure to particulate matter • Justice of exposure to nitrogen dioxide • Justice of exposure to noise • Segregation
	Opportunities	• Housing standards • Vitality of city centre • Vitality of surrounding region • Productivity gain from land use
	Accessibility and traffic	• Total time spent in traffic • Level of service of public transport and slow modes • Accessibility to city centre • Accessibility to services • Accessibility to open spaces
Economic indicators	Total net benefit from transport	• Transport investment cost • Transport user benefits • Transport operator benefits • Government benefits from transport • External accident costs • External emission costs • External greenhouse gas costs • External noise costs

Source: UNECE, 2020.

1.2. Scenarios

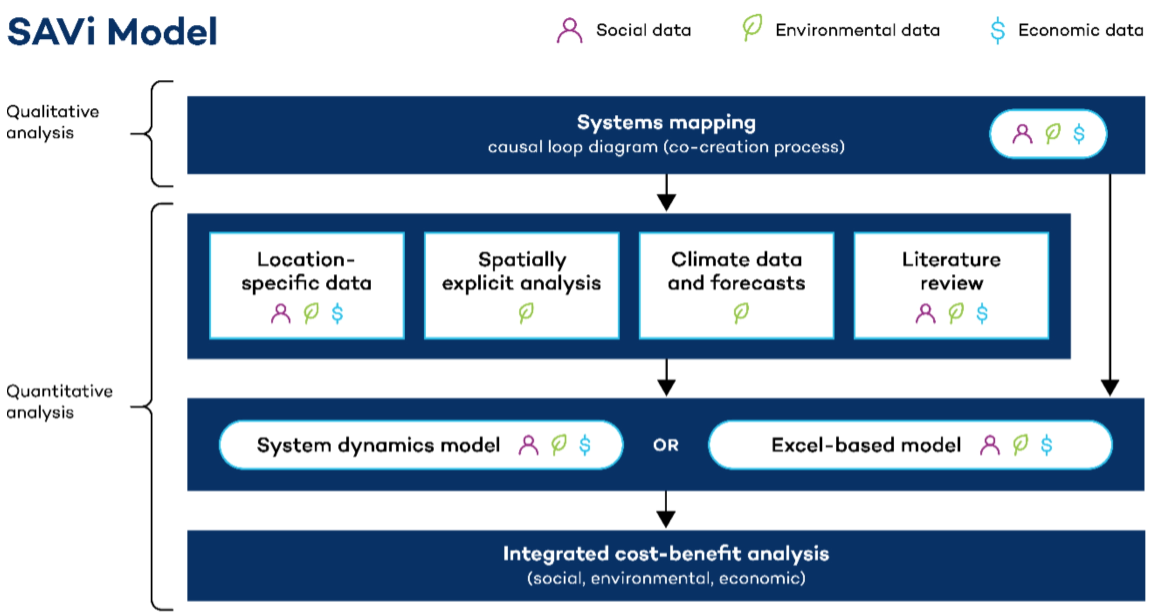
The following provides descriptions of the two scenarios assessed in the study. The first scenario entails "no action," that is, no MRT infrastructure is built, and existing road infrastructure is mostly used for transportation in the region. The second scenario considers the proposed MRT system and its multiple long-term benefits:

1. **No action:** No infrastructure is built, and regional economic benefits are left untapped.
2. **MRT:** This scenario proposes the introduction of four BRT lines and one LRT line as a more sustainable transport option. Sustainable transport infrastructure such as bus and rail systems have certain advantages, such as providing a safer, more accessible transport alternative, reducing congestion and traffic accidents, using cleaner energy (when electrified with renewable energy), and reducing negative environmental impacts.

1.3. Sustainable Asset Valuation

The SAVi methodology allows the assessment of infrastructure projects considering risks usually overlooked in traditional valuations, making it possible to identify the monetary value of the environmental and socio-economic co-benefits of avoided costs. SAVi is based on systems thinking (Bassi & Pallaske, n.d.) and combines a set of different modelling tools: system dynamics modelling, multi-criteria analysis, spatial models, and project finance modelling. SAVi also provides scenario analysis and compares how the financial performance of an infrastructure project changes in relation to climate change and other drivers over time. SAVi thus considers different types of indicators (environmental, social, and economic) with a high level of customization, with additional financial indicators, informing decision-makers on the costs, avoided costs, and benefits of their projects. The SAVi methodology is designed to provide evidence of the risks, benefits, and climate impacts of infrastructure projects (Bassi et al., 2021). SAVi has been applied to various infrastructure projects and across sectors in more than 20 countries around the world. A summarized version of the different steps of the SAVi model can be found in Figure 1.

Figure 1. Steps of the SAVi model

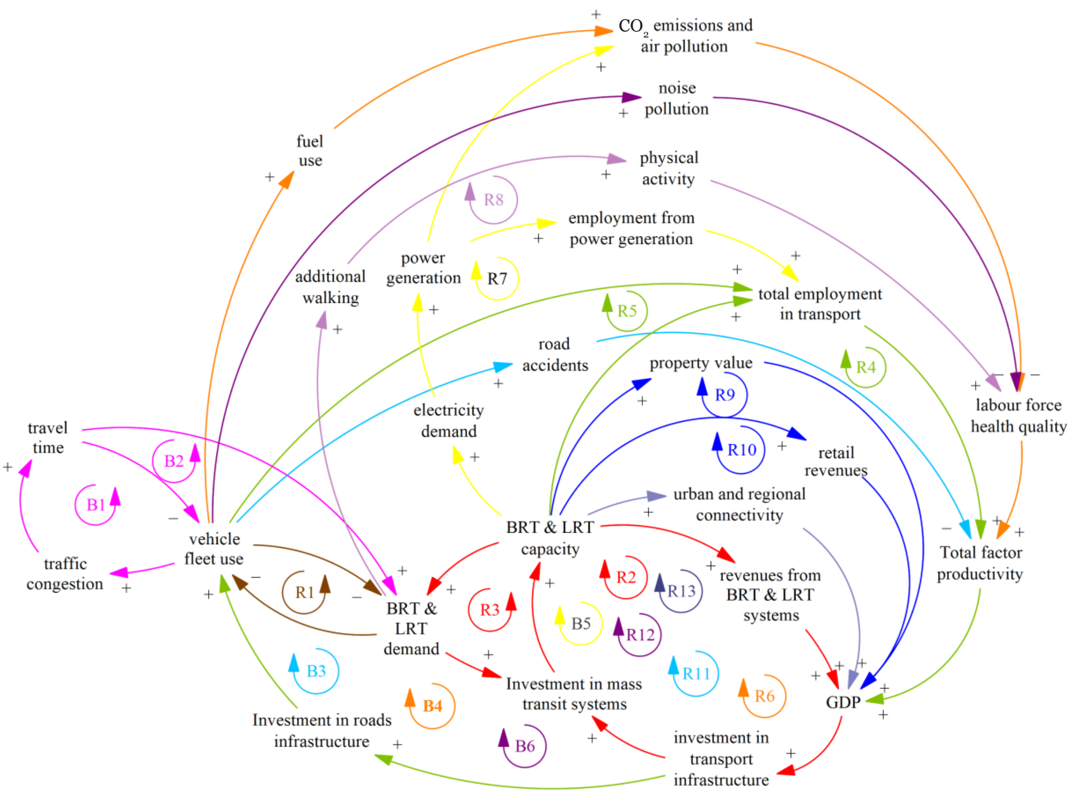


Source: IISD.

A first step in the SAVi assessment is to identify the impacts and underlying dynamics of a transport project, including driving forces and key indicators, summarizing them in causal loop diagrams (CLDs). CLDs show the interconnections of social, economic, and environmental components of the system, highlighting key dynamics and potential trade-offs emerging from the different scenarios considered in a SAVi assessment. The CLD is the starting point for the development of the mathematical stock-and-flow model that will simulate the business-as-usual and sustainable scenarios. The CLD was validated through engagement with NEDA.

Figure 2 shows the CLD that was developed for the MRT system in Pampanga. The impacts of MRT and its feedback mechanisms are represented in the CLD. The relationships are diverse and involve interconnected social, environmental, and economic variables.

Figure 2. CLD representing the dynamics of the MRT system in Pampanga



One of the main dynamics of the system is the shift from the private vehicle fleet use to mass transit systems and vice versa, which is represented by a reinforcing loop (R1) that is strengthened or weakened by the rest of the loops. As the province of Pampanga keeps developing and its population keeps growing, the need for transport infrastructure increases. Currently, road transport and individual transport modes have been leading the mobility solutions in Pampanga, resulting in traffic congestion, higher CO_2 emissions, noise pollution, accidents, etc. These outcomes impact private vehicle fleet, BRT and LRT demand in different ways by either reinforcing or limiting their use.

The feedback loops that can positively or negatively impact BRT and LRT investment and use are the revenues from the BRT and LRT systems operation (R2), BRT and LRT demand (R3), transport employment (R4 and R7), fuel use from the private vehicle fleet (R6), additional physical activity due to increased walking (R8), increase in property value around BRT and LRT stations (R9), increase in retail revenues around BRT and LRT stations (R10), reduction in road accidents (R11), decrease in noise pollution from private vehicles (R12), and increase in urban and regional connectivity (R13). In addition, there is a reinforcing loop that directly impacts investments in roads infrastructure through the employment generated from private vehicle fleet use (R5).

Two balancing loops can counteract the effects of the reinforcing loops in BRT and LRT systems use, specifically those representing the impact of travel time as a result of BRT and LRT use (B2) and the impact of CO_2 emissions from power generation (B5). In the case of private vehicle fleet use, several impacts offset its growth including the impact of traffic congestion (B1), accidents (B3), CO_2 emissions from fuel use (B4), and noise pollution (B6).

In general, the CLD exercise demonstrates that BRT and LRT systems can enhance positive social outcomes (employment, physical activity), mitigate negative environmental impacts (reducing fuel use and CO_2 emissions), and improve economic outcomes (GDP, property values, retail revenues).

A SAVi assessment provides an integrated cost-benefit analysis along with financial performance indicators that assist in comparing costs and benefits, including externalities, that are selected according to the characteristics of the infrastructure project and the objectives of the assessment.

Sustainable infrastructure investments must have environmental and social cohesion at their core, given the current challenges posed by climate change and population growth. The "what-if" simulations based on the SAVi methodology are designed to inform decision-makers while considering those challenges.

The what-if scenarios are run to understand the socio-economic benefits that can be realized when public spending (also from sustainable recovery packages) is targeted at sustainable infrastructure. To do so, simulations are based on authoritative data and scientific analysis, incorporating different methods and models.

The SAVi assessment can also include climate data to understand how different climate change scenarios will affect the costs and benefits of the project, as well as spatial data retrieved from spatial models (such as InVEST). SAVi models use integrated world-class data on climate from the Copernicus Climate Change Service, which provides a single entry point for continuously updated climate data and products on the past, present, and future (International Institute for Sustainable Development, n.d.).

2.0 Key Assumptions and Data Sources

Table 2. Assumptions and data sources used in the SAVi assessment of the MRT in Pampanga

Parameters for calculating added benefits and avoided costs

Added benefit or avoided cost	Indicator	Value	Data source
Capital investment costs	Total capital investment for all BRT and LRT lines	PHP 97,177 million *(author's calculation)*	NEDA, 2021
	Total additional investment for all BRT and LRT lines (2033–2046)	PHP 32,006 million *(author's calculation)*	NEDA, 2021
Operations and maintenance (O&M) costs	Total O&M costs for all BRT and LRT lines (2025–2050)	PHP 17,794 million *(author's calculation)*	NEDA, 2021
Revenues	Total revenues from all BRT and LRT lines (2025–2050)	PHP 49,926 million *(author's calculation)*	NEDA, 2021
Income creation from employment	Total number of BRT buses and total number of LRT trains across all lines	161 BRT buses across four lines, 90 LRT trains	NEDA, 2021
	Construction jobs per BRT bus	1.6	Kapetanakis et al., 2023a
	O&M jobs per BRT train	0.26	Kapetanakis et al., 2023a
	Construction jobs per LRT train	2.5	Kapetanakis et al., 2023a
	O&M jobs per LRT train	1	Kapetanakis et al., 2023a
	Average yearly salary of bus drivers	PHP 420,000	Talent, 2024
	Share of discretionary spending	22%	TransUnion, 2022
	Number of staff positions	105	NEDA, 2021

Parameters for calculating added benefits and avoided costs

Added benefit or avoided cost	Indicator	Value	Data source
Value of time saved	Total yearly value of time saved for all BRT and LRT lines (2025-2053)	PHP 86,962.87 Million *(author's calculation)*	NEDA, 2021
Property value	Average m^2 of apartments in Pampanga	212	Dot Property, 2024
	Average value per m^2	PHP 58,904	Dot Property, 2024
	Increase in property value	5%	Song & Knaap, 2003
Retail revenues	Average maximum passengers per hour per direction for all BRT and LRT lines (person per hour per direction)	18,062 *(author's calculation)*	NEDA, 2021
	Average daily minimum retail spending per year	INR 40.29	Kapetanakis et al., 2023b
	Increase in retail revenues	42.4%	Rabl & Nazelle, 2012
Air pollution	Total daily boarding/trips for all BRT and LRT lines (2023–2053)	700,784.75 *(author's calculation)*	NEDA, 2021
	Total length of trips for all BRT and LRT lines in km (2023-2053)	5,755,703 *(author's calculation)*	NEDA, 2021
	Emissions per litre (PM 2.5)	3,800 mg/litre	Naidja et al., 2017
	Economic health cost per PM 2.5 per kg	Low value: INR 1,371, high value: INR 10,523	CE Delft et al., 2011
	Population of Pampanga	2,198,110	NEDA, 2021
CO_2 emissions	Total yearly CO_2 emissions saved for all BRT and LRT lines (2025–2053)	PHP 5.08 million *(author's calculation)*	NEDA, 2021

Parameters for calculating added benefits and avoided costs

Added benefit or avoided cost	Indicator	Value	Data source
Accidents	Population of the Philippines	103,031,365	Worldometer, 2024
	Number of traffic accidents in the Philippines per year	200,362	Global Road Safety Facility, 2016
	Economic cost of injury and fatality per year	Injury: PHP 1.67 million, fatality: PHP 7.96 million	NEDA, 2021
	Share of accidents per severity	Injury: 80%, fatality: 20%	Government of Tamil Nadu (Transport) Department, 2019
Fuel use	Fuel consumption per vehicle-km—BRT and private vehicles	BRT: 0.07, private vehicles: 0.06	Goel et al., 2016
	Vehicle occupancy rate	3	Bassi et al., 2019
	Average vehicle-km travelled per trip	8	Bassi et al., 2019
	Fuel price in the Philippines	PHP 70.90 /litre	Global Petrol Prices, 2024
Vehicle operating costs	Total yearly vehicle operating costs saved for all BRT and LRT lines (2025–2053)	PHP 47,365.35 Million *(author's calculation)*	NEDA, 2021

Source: Authors.

References

Bassi, A., Casier, L., Pallaske, G., & Uzsoki, D. (2021). *Sustainable asset valuation (SAVi) of Paterson Park's building infrastructure: City of Johannesburg (South Africa)*. Copernicus Climate Change Service. https://www.iisd.org/system/files/2021-04/savi-paterson-park-johnannesburg-south-africa.pdf

Bassi, A., Casier, L., Uzsoki, D., & Pallaske, G. (2019). *Sustainable asset valuation (SAVi) of the bus rapid transit project in Senegal: A focus on transport infrastructure*. International Institute of Sustainable Development. https://www.iisd.org/publications/report/sustainable-asset-valuation-savi-bus-rapid-transit-project-senegal

Bassi, A., McDougal, K., & Uzsoki, D. (2017). *Sustainable asset valuation tool: Roads.* International Institute for Sustainable Development. https://www.iisd.org/system/files/publications/sustainable-asset-valuation-tool-roads.pdf

Bassi, A. & Pallaske, G. (n.d.). *Introduction to systems analysis and system dynamics*. International Institute for Sustainable Development. https://www.iisd.org/savi/wp-content/uploads/2020/03/savi-academy-systems-thinking-dynamics-final.pdf

CE Delft, INFRAS, & Fraunhofer ISI. (2011). *External costs of transport in Europe: Update study for 2008*. https://ce.nl/wp-content/uploads/2021/03/CE_Delft_4215_External_Costs_of_Transport_in_Europe_def_1343133550.pdf

Dot Property. (2024). *Houses for sale in Pampanga*. https://www.dotproperty.com.ph/properties-for-sale/pampanga

Global Petrol Prices. (2024). *Philippines gasoline prices*. https://www.globalpetrolprices.com/Philippines/gasoline_prices/

Global Road Safety Facility. (2016). *Philippines road safety country profile*. https://www.roadsafetyfacility.org/country/philippines

Goel, R., Mohan, D., Guttikunda, S. K., & Tiwari, G. (2016). Assessment of motor vehicle use characteristics in three Indian cities. *Transportation Research Part D. Transport and Environment*, *44*, 254–265.

Government of Tamil Nadu (Transport) Department. (2019). *Road accident analysis in Tamil Nadu*. https://docslib.org/doc/11588202/department-road-accident-analysis-in-tamil-nadu

High-Level Advisory Group on Sustainable Transport. (2016). *Mobilizing sustainable transport for development*. United Nations. https://sustainabledevelopment.un.org/content/documents/2375Mobilizing%20Sustainable%20Transport.pdf

International Institute for Sustainable Development. (n.d.). *C3S data*. https://www.iisd.org/savi/c3s-data/

Kapetanakis, M., Casier, L., Niño, N., & Bassi, A. (2023a). *A sustainable asset valuation of a bus rapid transit system in Bandung, Indonesia*. International Institute for Sustainable Development. https://www.iisd.org/publications/report/savi-brt-bandung-indonesia

Kapetanakis, M., Casier, L., Niño, N., & Bassi, A. (2023b). *A sustainable asset valuation in Coimbatore, India*. International Institute for Sustainable Development. https://www.iisd.org/publications/report/savi-non-motorized-transport-coimbatore-india

Naidja, L., Ali-Khodja, H., & Khardi, S., (2017). Particulate matter from road traffic in Africa. *Journal of Earth Sciences and Geotechnical Engineering, 2017, 7*(1), 389–304. https://hal.science/hal-01453344/document

National Economic and Development Authority. (2021). *Pampanga mass transit system, final report*.

Rabl, A. & Nazelle, A. D. (2012). Benefits of shift from car to active transport. *Transport Policy, 19*(1), 121–131.

Song, Y., & Knaap, G. (2003). New urbanism and housing values: A disaggregate assessment. *Journal of Urban Economics, 54*(2), 218–238.

Talent. (2024). *Bus driver average salary in Philippines*. https://ph.talent.com/salary?job=bus+driver

Transformative Urban Mobility Initiative. (2018). *Elements of sustainable mobility*.

TransUnion. (2022). *Philippines consumer pulse study*. https://www.transunion.ph/blog/q2-2022-consumer-pulse

United Nations Economic Commission for Europe. (2020). *A handbook on sustainable urban mobility and spatial planning*. https://unece.org/transport/publications/handbook-sustainable-urban-mobility-and-spatial-planning

Worldometer. (2024). *Philippines population*. https://www.worldometers.info/world-population/philippines-population/#google_vignette

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