KEY INDICATORS OF PUBLIC UTILITY VEHICLE TRANSPORT SYSTEM IN THE PHILIPPINES TOWARD SUSTAINABLE TRANSPORTATION DEVELOPMENT

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ABSTRACT: *Sustainable transportation is fundamental to development at a macroscale level and has an extensive impact on environmental equilibrium, social change and economic growth. This study identified and characterized public transportation indicators and synthesized an integrated top-priority framework into a standardized set of sustainable transportation development indicators. Using the list of main indicators extracted from various scientific papers, a four-step process is used to determine the indicator sub-categories: 1) Main Sustainable Transportation Development Indicator List, 2) Indicator Sub-category Data Collection, 3) Collection Strategy and Measurement Support for each indicator and 4) Analysis and Evaluation of Sustainable Transportation Development Level. This study established a comprehensive and standardized sustainable transportation development main indicator list, desirable for transportation development assessment across different communities and jurisdictions. It also identified indicator sub-categories in its framework to provide in-depth analysis and evaluation of existing sustainable transportation development, affecting the transportation sector in communities. It is recommended to explore further an organized set of other main indicators and indicator sub-categories that may be convenient and advantageous to specific communities or jurisdictions in assessing the level of sustainable transportation development, dependent on existing factors present in their transportation system.*

Keywords: Sustainable transportation development, sustainable development, transportation indicators, transportation system, transportation assessment

INTRODUCTION

The Philippines' most prevalent public transport system relies on the jeepneys, a cultural icon of innovation and a symbol of national pride of the repurposed military vehicle from the Americans during World War 2. These jeepneys are domestically fabricated and are backyard-manufactured using aged diesel engine models over 15 years old capable of accommodating 18-26 passengers in one full travel. The Public Utility Vehicle Modernization (PUVM) Program of the Philippines spearheaded by the Department of Transportation aims to transform the road and highway sector of the public transport system through the introduction of modern, safer, environment-friendly fueled public vehicles and imposed an age limit of transport vehicles allowed to operate and improved road transport policies and industry regulation and consolidation [1]. This national-level program also aims to uplift the quality of life, reduce economic losses due to time lost during travel and traffic, reduce greenhouse gas emissions and improve the economic state of the transport industry through high-level quality of transportation service.

The present trend in a car-dominated nation like the Philippines in addition to outdated and low-quality public road transport system constitutes to severe risks to our country's overall social, environmental and economic development. Loss of various opportunities, additional fuel consumption and health risks caused by air pollution from the aging transport system. The jeepney, topping the modal share of road transport mobility is due to its relative affordability and the lack of any better alternatives of public transport. It may not offer the point-to-point service to commuters, the jeepney still is the most favored public transport compared to taxis, buses and motorized/pedal-powered tricycles. A modernized public utility vehicle transportation system is a significant factor in attaining sustainable development goals but like any other city in the Philippines, it lacks the indicators that measure transportation developments like the speed of travel time to move goods and services and promptly reach the intended destinations, safety, comfort and satisfaction to commuters during travel time and to improve the quality of life of the people in the community. Movement through modern road transportation enables the social development sectors like health, education and public safety just to name a few [2]. Mobility and accessibility are important elements for the development of people in communities – rural and urban. An efficient road transportation system creates access to recreational facilities and other essential life-shaping social opportunities that enable people to improve their quality of living conditions and escape the hustle and bustle of commuting which happens on a day-to-day activity. The void in the framework for sustainable transportation indicators creates doubt in the measure of an effective and reliable sustainable transportation system. An indicator-based assessment method for sustainable transportation could harmonize the 3 dimensions of sustainable development into a unified framework and recoup the nullity of comprehensiveness in the existing policies to measure sustainable transportation development.

Various approaches to sustainable transportation development in the past created division and confusion among major stakeholders in understanding the concept of modern transportation system, needing a framework to address the gaps in the present practice and study. This paper aims to provide a framework that will dispense to industry practitioners with a readily accessible list of comprehensive sustainable transportation development indicators. An indicator-based approach creates a framework, at the same time meets two important elements; first, the development of indicators and their relationship to each other and the integration of the three dimensions of sustainable development as far as sustainable transportation development is concerned.

Objectives of the Study

The objectives of this study are as follows:

1. Identify and characterize the indicators of a sustainable public utility vehicle transport system and associate them with the perspectives of sustainable development (3 Pillars of Sustainable Development – Environmental, Social and Economic and the UN-Sustainable Development Goals).
2. Synthesize into an integrated framework and analyze the relationship of different sustainable transportation development indicators in several areas of priority in the transport system.
3. Gather transportation development indicators from various literature for inclusion in a standardized set of sustainable transportation development indicators.

The Shape of the Environment in a Modernized Public Utility Vehicle Transport System

It has been uncovered that modern transport development has a significant role in carbon dioxide emission reduction effect. A modern public transport sector changes energy consumption trends in the transportation industry using fuel efficiency and energy input optimization effect from modern engines used in the development [3]. Road transportation influences the quality of the environment, contributing to global warming at the same time. It was observed that monopolies in traditional road public transport systems are prevalent in developing countries [4]. The influence of the traditional PUV has been embedded within the culture of the Philippines, but the amount of fossil fuels consumed to run these old transportation means is increasing thus environment, climate and health concerns should in the frontline for preservation. Modern modes of transportation change like the MPUV's had gained popularity among commuters, and understanding the clamor of the end-users helped in transportation policy reform and change to improve the acceptance of the new transport facilities fitting to the community's needs [5]. This makes the acceptance of modernized public utility vehicle transport on the side of the transport operators and drivers hard since many are affected by the change. These operators opt to maintain and repair old PUV chassis and engines making our roads and commuters unsafe during transit.

Table 1: Economic Dimension Sustainable Transportation Development Indicators

Sustainable Development Dimension		Main Indicator on Sutainable Transportation Development		Description of Indicator	Unit of Measure/Assesment Tool	UN Sustainable Development Goal Connection	Reference Source
1	Environmental Dimension (END)	1.1 Energy Demand	END1	Limitation in the consumption of non-renewable energy sources like petroleum products	km/liter (fuel efficiency)	SDG 7, SDG 11, SDG 12, SDG 13, SDG 14, SDG 15	(Q. Jing et al., 2022), (P. González-Aliste *et al* ., 2023)
		1.2 Greenhouse Gases Emmission/Carbon Dioxide Emission	END2	Reduction in air pollution from the road transport system	Metric tons of carbon dioxide equivalent or MTCO2e	SDG 7, SDG 11, SDG 13, SDG 14, SDG 15	(P. Mariano, 2021), (M. Rith *et al* ., 2020), (S. Aminzadegan et al., 2022), (P. González-Aliste et al., 2023)
		1.3 Healthy Atmosphere and Improvement of Public Health	END3	Decreased exposure to harmful GHG's from the environment and Encourages good health and well being of the people	Metric tons of carbon dioxide equivalent or MTCO2e and air level (outdoor) of 400-1,000 ppm of CO2	SDG 3, SDG 11, SDG 13, SDG 14, SDG 15	(S. Aminzadegan *et al*., 2022), (P. González-Aliste *et al.*, 2023), (G.T.Tucho, 2022), (M. Rith et al., 2020)

Table 1 presents the indicators that affect sustainable transportation development for the Environmental Dimension of Sustainable Development (END). The following are the indicators; END1 - Energy Demand, END2 - Greenhouse Gases Emission/Carbon Dioxide Emission and END3 - Healthy Atmosphere and Improvement of Public Health with the description of each environmental dimension for sustainable transportation indicator, its unit of measure, UN Sustainable Development Goals association and reference source where the specific and general indicator was influenced.

Sustainable public transportation development and GHG emissions from the transport sector are correlated to each other. It is worthy of attention that energy consumption is reduced in effect to newer and much more modern transportation units, thus a reduction in air pollution is achieved and increased quality of health and well-being is prevalent in the community [3, 6]. Accessibility and mobility approaches are often left behind and untouched when developing technologies and innovations occur. Understanding cultural ideas and social traditions should be prime in modern living to enhance the quality of sustainable transportation development strategies [7]. Traffic jams are considered a major contributor to GHG emissions to the environment; a large amount of harmful gases are produced by idling PUVs on roads in addition to delayed movement of goods and people [8].

Social Development in a Modernized Public Utility Vehicle Transport Operation System

In the transportation sector in developing countries, social productivity gaps are wide compared to developed nations [9]. In developing economies like the Philippines, inconsistencies in the road transportation system may be important in policy recommendations concerning social development like safe movement of people and quality public transport vehicles that can make a quality of life for people in the community. Social productivity gaps can be seen when people hustle and bustle as they travel to their workplaces and arrive tired and drained resulting in low self-esteem compared to quality travel to work, school or leisure areas. Government interventions like the Service Contracting Program aim to attain sustainable transportation service by providing a modern monitoring system that helps optimize the MPUV transport service by using the Sakay technology system as a system manager – an application used to monitor

the location of MPUVs on the route, the volume of passengers in designated PUV loading and unloading areas and the level of traffic in the designated routes [10]. Embracing modern technology in transportation can make a difference in social development as far as the interests of transport operators and drivers are concerned.

It is important to create transport infrastructure and unite the government and private sector for the purpose of developing the road transport sector infrastructure within the private-public partnership projects [11].]ad transport infrastructure projects stimulate and cultivate social activities in communities by providing windows of opportunities like quality travel experience and sustainable mobility and accessibility demanding interventions from various sectors in the community [7]. When the community sees a quality road transport infrastructure project it creates a sense of social stability since transportation moves people and goods to different places and allows people from various places to travel, trade and do recreation activities just to name a few.

Table 2. Social Dimension Sustainable Transportation Development Indicators

Sustainable Development Dimension			Main Indicator on Sutainable Transportation Development		Description of Indicator	Unit of Measure/Assesment Tool	UN Sustainable Development Goal Connection	Reference Source
2	Social Dimension (SDD)	2.1	Accessibility to Commuters (How much effort to reach that specific point)	SDD1	Provides Access to key services around the city (school, office, business etc.)	Measure of Central Tendency using Likert Scale Analysis and SPSS Crohnbach's Alpha Equation in ANOVA Table	SDG 8, SDG 13	(M. Freudendal-Pedersen *et al.*, 2020), (D. Horcher and A. Tirachini, 2021), (R. Eltanal, 2019), (L. Wang *et.al.*, 2018)
		2.2	Mobility of Commuters (Moving from one place to another)	SDD2	Promotes moving around the city reducing the use of private vehicles.		SDG 3, SDG 8, SDG 11	(M. Freudendal-Pedersen *et al.*, 2020), (R. Eltanal, 2019), (L. Wang *et.al.*, 2018)
		2.3	Level of Satisfaction and Comfort of Travel of Commuters/ Drivers	SDD3	Offers a prime choice in transportation mode and operates efficiently the transport sector		SDG 3, SDG 8, SDG 10, SDG 17	(R. dela Torre *et al.*, 2021), (C. Karayalcin and M. Pintea, 2022), (G.T.Tucho, 2022)
		2.4	Safety in Travel (Unloading and Loading from the MPUV)	SDD4	Promotes safe and sound loading and unloading designated areas reducing risks of accidents caused by poor transportation support infrastructure.		SDG 3, SDG 8, SDG 11, SDG 17	(P. Mariano, 2021), (C. Karayalcin and M. Pintea, 2022), (G.T.Tucho, 2022)
		2.5	Policies and Regulatory Controls (No. of allowable years of service of MPUV)	SDD5	Enforcement of rules and regulations for the efficient operation of MPUV's		SDG 4SDG 8, SDG 16, SDG 17	(A. Verma *et al*., 2021), (G.T.Tucho, 2022), (M. Tacderas, 2021), (J. Pontawe *et al.*, 2021)

Table 2 presents the indicators that affect sustainable transportation development for the Social Dimension of Sustainable Development (SDD). The following are the indicators; SDD1 - Accessibility to Commuters – How much effort to reach a specific distance, SDD2 - Mobility of Commuters – Moving from one place to another, SDD3 - Level of Satisfaction and Comfort of Travel of Commuters/Drivers, SDD4 - Safety in Travel – Unloading/Loading from MPUV designated stops and SDD5 - Policies and Regulatory Controls – Number of allowable years of service of MPUV with the description of each social dimension for sustainable transportation indicator, its unit of measure and assessment tool, UN Sustainable Development Goals association and reference source where the specific and general indicator was influenced.

On the social side of transportation sustainability, accessibility and mobility are two key elements that make urban transportation efficient. While accessibility is the measure of reaching a certain location or being reached from different locations, mobility is the choice decided by stakeholders to reach a certain destination, thus it is important to have basic yet efficient transportation infrastructure, transportation policies and a synchronized transportation development program to link social development to a sustainable transportation system for all. The frequency of improvements in transportation infrastructures is reasonable when automated technology solutions are applied to offer choices to commuters to satisfy safety and comfort levels [12]. Strong desire and determination to succeed in the transportation sector through policies and regulatory control initiatives in lowering carbon emissions is increasing globally. Most state policies are still at the experimental stage level to measure success due to lack of regular monitoring, complex bureaucratic management and governance, in addition to irregular land zoning and planning making the urban transportation system development inefficient [13].

Economic Development and the Modernized Public Utility Vehicle Transport System

Commodity exchange in form of goods and services is an important factor in economic development. It encourages an increase in the production of goods and efficient services from the working force that drives the economy of a country [11]. A quality and modern transport system drives the progress of the economy when people reach their destinations on time and with dignity away from the hustle and bustle in commuting the traditional public utility vehicle transport in the city. It was observed that economic activities on all types of resources would be completely impossible to be carried out from one place to another without a road transport system. Trade is totally dependent too on the availability of a good transport sector [14].

The availability of quality modern public transport compared to the traditional PUV may vary from the cost of its fare that commuters may experience and the huge financial investments imposed on the cooperatives as operators to grab a franchise to operate a modernized public utility transport that traditional PUV operators could not afford the costs implied [12]. A concern being raised by commuters, like transport fare prices difference between conventional PUVs compared to MPUV greatly affects the mid and low-income earners using the latter [15]. These are some of the reasons why the traditional mode of transport is difficult to completely change with the modern PUV. The traditional PUV also can traverse interior communities that modern public transport cannot, an alternative mode of transport is always a good find in a country like the Philippines where mobility and walkability of the sidewalks are taken for granted [16]. Lack of monitoring, in addition to complex bureaucratic capacities and urban development acceptance of communities, irregular zoning plans and ordinances and in inefficient comprehensive land use plans are the hindrances to seeing the intended level of success in the modern public utility vehicle system operation [13]. Timely topics related to transportation infrastructure include cost, performance, quality and investment issues from the project level until the implementation and evaluation level [17]. A fully implemented Comprehensive land use plan by the local government unit, an affordable modern public transport and a

quality road travel of commuters can make cities safer and more livable.

Higher taxes imposed on private vehicles resulted in increased quality of life, lower GHG emissions, faster delivery of goods, decreased noise pollution and lessened fuel consumption. It also promoted the use of trains and buses, walking and bicycling in distances less than five kilometers [8]. Government institution support will provide reduced transport registration and maintenance cost through subsidies and low-interest loans for MPUV operators and cooperatives. A comprehensive program for affected operators and drivers of conventional PUV's should be implemented to attain sustainable transportation creating job opportunities to those greatly affected by the shift in the transport sector [5]. The Service Contracting Program as the system manager of the MPUV in the Philippines pays the drivers on a daily salary rate basis and not by the traditional boundary-commission-based system, the latter is where the driver only gets whatever is left paying the rent and gasoline to the operators, with this type or service program paired with modern PUV units, drivers and transport operators in form of cooperatives now enjoy a sustainable income benefiting all stakeholders [10].

Table 3. Economic Dimension Sustainable Transportation Development Indicators

Sustainable Development Dimension			Main Indicator on Sutainable Transportation Development		Description of Indicator	Unit of Measure/Assesment Tool	UN Sustainable Development Goal Connection	Reference Source
3	Economic Dimension (ECD)	3.1	Traffic Congestion/Decongestion	ECD1	Increased traffic decongestion and increased traffic flow efficiency	Measure of Central Tendency using Likert Scale Analysis and SPSS Crohnbach's Alpha Equation in ANOVA Table	SDG 8, SDG 11, SDG 17	(R. dela Torre *et al.*, 2021), (D.A. Macheret, 2021), (S. Chakrabarti and V. Mukherjee, 2022), (P. González-Aliste *et al.*, 2023), (G.T.Tucho, 2022)
		3.2	Economic Changes to Commuters (Reduced/Increased Transportation Budget)	ECD2	Reduced or Increased Commuter Transportation-Budget/Cost		SDG 1, SDG 8, SDG 10, SDG 11, SDG 17	(S. Aminzadegan *et al*., 2022)
		3.3	Economic Changes to MPUV Operators (Reduced/ Increased Income)	ECD3	Reduced or Increased MPUV Driver Income and take home pay		SDG 1, SDG 2, SDG 8, SDG 10, SDG 11, SDG 17	(M. Tacderas, 2021), (J. Pontawe *et al*., 2021)
		3.4	Fleet Monitoring (Repairs and Maintenance of MPUV)	ECD4	Reduced cost on repairs and maintenance of MPUV fleet		SDG 1, SDG 2, SDG, SDG 8, SDG 10, SDG 11, SDG 12	(M. Tacderas, 2021), (J. Pontawe *et al.*, 2021)
		3.5	Investment and Operation of MPUV	ECD5	Reasonable Rate of Investment Return in operating the MPUV		SDG 1, SDG4, SDG 9, SDG 12, SDG 17	(L. Wang *et.al.*, 2018), (J. Pontawe *et al*., 2021)
		3.6	Routes/Route Plan efficiency from the government	ECD6	Efficient Exisiting and Future Routes/Route Plan from enforcing government agencies		SDG4, SDG 8, SDG 11, SDG 17	(M. Tacderas, 2021), (J. Pontawe *et al.*, 2021)
		3.7	Government Subsidy	ECD7	Availability of Governement subsidies in form of loan grants to MPUV Cooperative to cope up with the massive change in the transportation sector		SDG 4, SDG 8, SDg 9, SDG 11, SDG 16, SDG 17	(M. Tacderas, 2021), (J. Pontawe *et al.*, 2021)

Table 3 presents the indicators that affect sustainable transportation development for the Economic Dimension of Sustainable Development (ECD). The following are the indicators; ECD1 - Traffic Congestion/Decongestion, ECD2 - Economic Changes to Commuters (Reduced/Increased Transportation Budget), ECD3 - Economic Changes to MPUV Operators (Reduced/Increased Income), ECD4 - Fleet Monitoring (Repairs and Maintenance of MPUV), ECD5 - Investment and Operation of MPUV, ECD6 - Routes/Route Plan efficiency from the government (Existing and Future Plans) and ECD7 - Government Subsidy (Loan grants to MPUV Cooperatives) with the description of each environmental dimension for sustainable transportation indicator, its unit of measure and assessment tool, UN Sustainable Development Goals association and reference source where the specific and general indicator was influenced.

Regional integration and globalization, e-commerce, accessibility and mobility needs have brought about the requirement for an effective and quality transportation system for goods and services having the primary goal of reducing monetary costs during the process. Transportation sustainability concepts and indicators are being carefully considered as primary components in the existing transportation system and being taken into account in policy making conception of policy makers and actors in the design, operation and evaluation of the sustainable modern transportation sector [2].

MATERIALS AND METHODOLOGY

The Principles in Selecting Sustainable Transportation Development Indicators

Indicators in the concept of sustainability are variables carefully chosen and defined to measure progression towards the objectives of the study. The use of the indicators reflects the conceptual nature of sustainable transportation development and communicates key issues and direction towards sustainable transport. Given the 3 Sustainable Development Dimensions; Environmental, Social and Economic and the indicators affecting sustainable transportation development, both structures are addressed in this part. Using various research works and scientific articles we extracted the indicators and identified the best description that would apply to each field. The methodology used in this article is composed of these four (4) well-defined steps [18]:

1. *Search Engine Criteria.* A comprehensive set of keywords were used to identify and assess various sustainable transportation development indicators. Published research articles relative to sustainable transportation systems were sourced from open journals, abstract and citation databases of peer-reviewed literature, including scientific conference proceedings and scientific journal publications.
2. *Data Collection.* To provide a comprehensive outlook on sustainable transportation system indicator assessment, clear key terms were instituted for the inclusion in the chosen indicators, this ensures the selection of the most important factors for this study.
3. *Filtering Gathered Data.* The process of filtering the best indicator associated with several literature is essential to the study. This will build a strong primary indicator foundation on sustainable transportation development and come up with an indicator sub-category construction that refines the factors found in the research.
4. *Analysis and Discussion of Results.* The most pedantic part in the methodology process in this study refining the literature and presenting the findings. It involves a descriptive analysis of each indicator and is followed by an in-depth assessment of the reviewed studies. The conduct of an in-depth evaluation of the reviewed studies focused on the identification of research gaps and future research directions, distinctive to a comprehensible understanding of a sustainable transportation development indicator methodology.

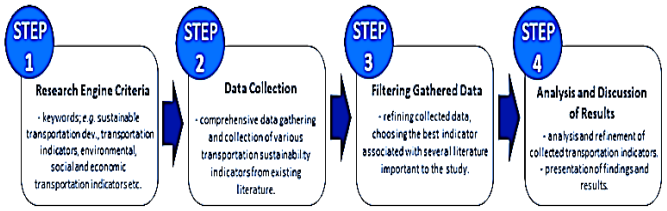

Figure 1. The research methodology flow for Sustainable Transportation Development Primary Indicator Category.

Figure 1 presents the research methodology flow used in this research. Focusing on refined and frequently used keywords in the research engine criteria for sustainable transportation development narrows the most important transportation indicators in the three (3) dimensions of sustainable development; environmental dimension (END), social dimension (SDD) and economic dimension (ECD) in addition to conducting a thorough identification, analysis and assessment of specific sustainable transportation development indicator sub-categories offering a comprehensive outlook on sustainable transportation development assessment action.

Target Respondents

A comprehensive list of data collection methods will be employed in this study. It aims to provide a comprehensive source for data collection strategies including the data collection process and discussing each type [19]. The researchers will select the most appropriate kind of data collection strategy according to the collected data group. This can be attained by examining the main indicator categories description with the corresponding indicator sub-category list.

This study will provide information about sustainable transportation development through the assessment and evaluation of various major transportation category indicators with their corresponding sub-category indicators. Various survey and data-gathering techniques will be employed for three (3) major respondent type in the transportation sector. The respondent's demographic factors are limited to age, gender, civil status, education, profession and income frequency of public transportation users that fall among the following;

R1 – Public Utility Vehicle Operators/Cooperatives - either single proprietorship franchisee, a cooperative franchisee or a corporation franchisee as PUV operator. An exclusive cooperative franchisee duly authorized by the state to operate the PUV Transport System.

R2 – Public Utility Drivers – PUV Drivers employed to operate public transportation units.

R3 – Public Transport Commuters - any person who travels some distance on a regular/irregular basis (can be both the driver and its passengers) carrying goods and services for work or leisure.

The total number of research respondents in the study will be determined using the Stratified Random Sampling Method. Using the entire population for a survey is exhaustive, expensive and time-consuming [20]. To obtain accurate data for assessment and analysis within the time frame of the study a portion of the population will be chosen, the Slovin's Formula in computing the sample size of stratified random sampling:

$$n = \frac{N}{1 + Ne^2}$$

where: N: Population Size (R1 + R2 + R3)
e: Margin of Error at 5%
n: Sample Size

The Respondents Sample Size Formula is derived from the following equation:

$$R = \frac{RPS}{N} \times n$$

where: R: Respondent (R1, R2 and R3)
RPS: Respondent Population Size
N: Population Size (R1 + R2 + R3)
n: Sample Size

The Sustainable Transportation Development Indicator Framework and the Key Structure of Sustainable Transportation Development Indicator Network

The analysis and assessment started by extracting all indicators found in various papers [21]. Selecting the main indicators that affect sustainable transportation development from Table 1, Table 2 and Table 3, extracted from various literature alone creates further in-depth inquiry about the separation of these indicators from each other. To abet in a more comprehensive assessment and analysis, the description of each main indicator is laid and additional indicator sub-categories are employed to streamline the main indicators into a more specific list of factors in transportation development. To avoid the repetition of sub-category indicators and create an integrated set of factors, each sub-indicator quality is deliberately grouped and addressed to determine specific criteria to match a particular main indicator found from the three (3) Sustainable Development dimensions.

The fundamental step in creating the sustainable transportation development indicators is to institute the relationship between the main indicators and determine the indicators sub-category list using the principles of sustainable transportation development and analysis of various references in existing articles. The existing references and literature helped connect indicators sub-categories to the main indicators: for example, 1.1.1 on END is the increased or decreased consumption of diesel or unleaded gasoline, creates 1.1 Energy Demand more measurable. Another example is, 2.1.1 on SDD is the satisfaction level of commuters to MPUV on designated pick-up and drop of points and 2.1.2 is the satisfaction level for loading and unloading points infrastructure, makes 2.1 Accessibility to Commuters (How much effort to reach that specific point?) quantifiable. While, 3.1.1 on ECD Reduced or Increased Traffic conditions from specific PUV traversed areas, build 3.1 Traffic Congestion/Decongestion conveys a realistic observation. The combination of these relationships and characteristics configures the sustainable transportation development framework, as shown in Figure 3.

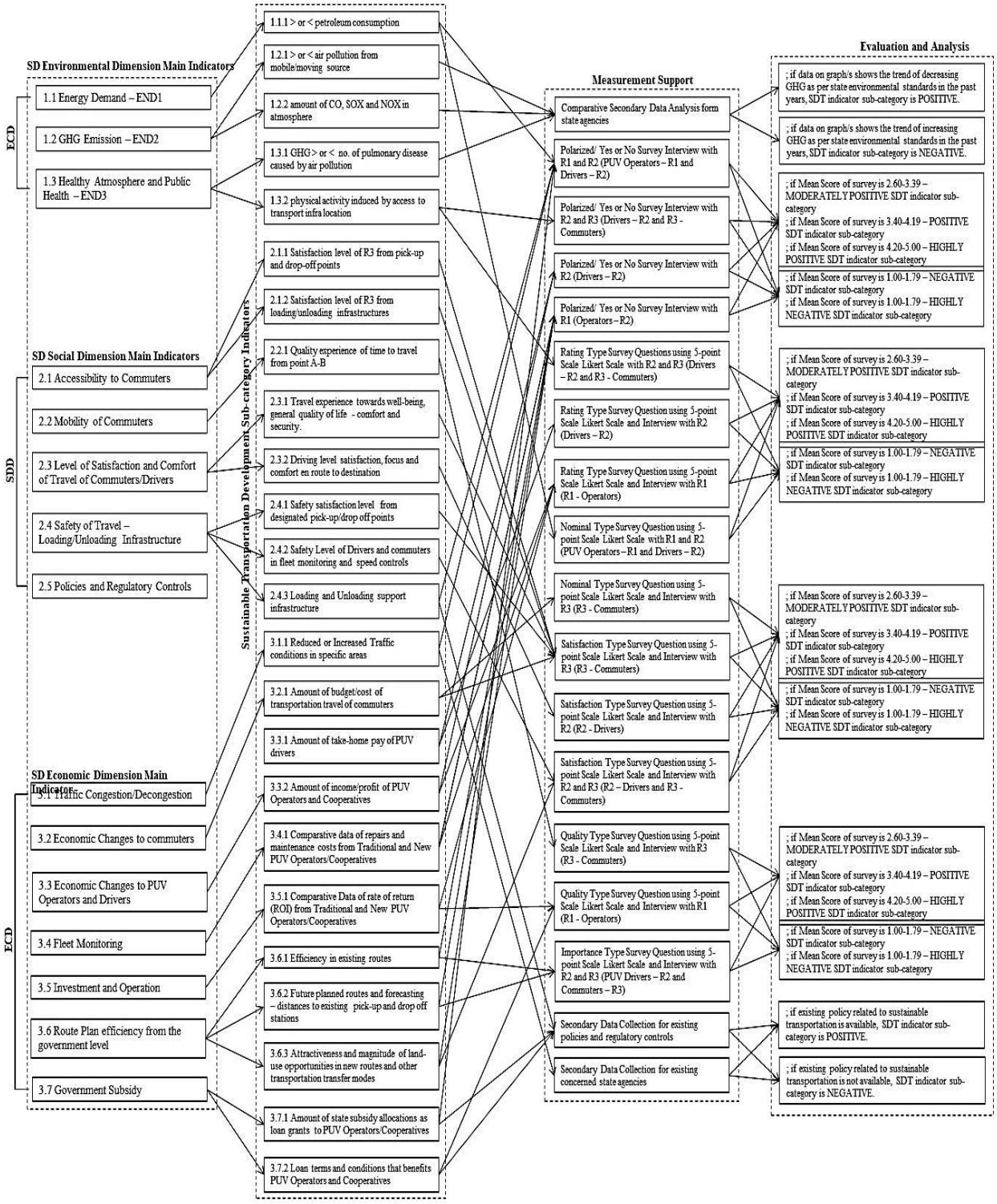

Figure 2. Sustainable Transportation Development Indicator's Structure and Framework

Measuring Support and Evaluation Techniques of the Indicators of Sustainable Transportation Development

This study will use three (3) techniques to measure and evaluate the indicators of sustainable transportation development: 1) Comparative Secondary Data Analysis, 2) Polarized Yes/No Survey and Interview 3) Various Types of 5-Point Likert Scale Survey and 4) Secondary Data Collection as to existing policies and state controls. First, is the use of the latest secondary data from state agencies as to greenhouse gas (GHG) emissions like CO (carbon monoxide), NOx (nitrogen oxide) and SOx (sulfur oxide) through transportation inventory emission records and create graphs to show the trend of pollutants. If data represented by graphs shows the trend of decreasing GHG in the

environment as per state environmental standards, we could justify that the indicator of this sustainable transportation development is POSITIVE. On the other hand, if transportation pollution-related data represented by graphs shows the trend of increasing GHG in the atmosphere, we could justify that the indicator of this sustainable transportation development is NEGATIVE.

Second, employ a Polarized Yes/No Survey and Interviews with various respondents of the study. The standardized words yes and no are responses to statements, commands, and actions and are answers to positive and negative polarized questions. A yes or no answer is considered an affirmative or negative clause similar to a full declarative sentence [22]. Having only two (2) possible answers, data collection on respondent feedback is one of the most effective ways to capture responses, maximize insights and easy analysis. In this study, a yes and no survey can easily be used to gather straightforward insights into questions like changes in the income of transport operators and drivers, increased or decreased gas use, comfort perception of commuters and satisfaction surveys in the new transport system

Third, is the application of Various Types of 5-Point Likert Scale Surveys like the Rating Scale Type, Nominal Type, Satisfaction Type, Quality Type and Importance Type that can measure latent variables that cannot be measured directly as physical variables [23]. The reliability of sustainable transportation indicators is assessed using scale-leveling [24]. This will feature precision to every question on the survey and interview intended for each indicator and sub-category indicators found in Table 5 and measure respondents' straightforward answers to survey questions. In Table 4, data is assessed using a numerical scale of 1-5 and the corresponding computed range and interval is shown with the verbal interpretation best suited to understand and describe sustainable transportation development level. The highest score on the scale is 5 which quadrates to "Highly Positive" and the lowest score is 1 which corresponds to "Highly Negative" as far as the status of the indicator is concerned.

Table 4. 5-Point Likert Scale Interpretation Reliability and Guide

5-Point Likert Scale Interpretation Guide		
Scale	**Range/Value**	**Verbal Interpretation** (for Sustainable Transportation Development)
1	1.00 - 1.79	Highly Negative
2	1.80 - 2.59	Negative
3	2.60 - 3.39	Moderately Positive
4	3.40 - 4.19	Positive
5	4.20 - 5.00	Highly Positive

The fourth technique is to gather data on existing policies, government regulations and other control measures related to sustainable transportation development policies. This will manifest that the government recognizes the key role of sustainable transportation in socioeconomic and environmental development in achieving inclusive sustainable development for nation-building. The availability of state laws indicates that the state's vision on the transport system management is geared towards an efficient, reliable, cost-effective, environmentally friendly and people-oriented national-level transport system that guarantees an improved quality of life for the people.

RESULTS AND DISCUSSION

The selection of main indicators and sub-indicators is the prime controlling benchmark in this sustainable transportation development guidelines. It directly refers to SDG 11, Target 11.2 "By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (UNESCAP, 2019). Hence, the transportation indicators shown in Table 5 exhibit and discuss the following: a) the description of the three (3) sustainable transportation development indicator categories; for the environmental dimension in Table 5 shows the Environmental Dimension - Sustainable Transportation Development Main Indicators and Description, Indicator Sub-categories, References and Measurement Support as END 1.1, 1.2 and 1.3, five (5) for social dimension in Table 6. Social Dimension - Sustainable Transportation Development Main Indicators and Description, Indicator Sub-categories, References and Measurement Support as SDD 2.1, 2.2, 2.3, 2.4 and 2.5, seven (7) for economic dimension in Table 7. Economic Dimension - Sustainable Transportation Development Main Indicators and Description, Indicator Sub-categories, References and Measurement Support as ECD 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 and 3.7, b) the sustainable transportation development indicator sub-categories of each major indicator c) reference and measurement support for each indicator sub-categories. The sustainable transportation development main indicator players initiated in this study suggest that including the indicator sub-categories can streamline the reliability of the assessment and evaluation process for transportation sustainability.

Assessment and Analysis of Environmental (END), Social (SDD) and Economic (ECD) Indicator Impacts to Sustainable Transportation System

The assessment and evaluation of the environmental dimension (END) in Figure 2 shows the sustainable transportation development indicator categories and sub-category END1-1.1.1 will employ the Polarized/Yes or No Survey and Interview with PUV Operators/Cooperatives – R1 and The use of Nominal Type Survey Question using 5-point Scale Likert Scale. END2-1.2.1 will take on Comparative secondary data analysis from government agencies and NGOs as to air pollution emission inventory represented by graphs and charts and data analysis from government agencies as to mobile air pollution-induced pulmonary diseases represented by graphs and charts. END3-1.3.1 will engage in a Polarized/Yes or No Survey and Interview with PUV Commuters (R3) and the Rating Type Survey Question using the 5-Point Scale Likert Scale.

Figure 2 shows the social dimension (SDD) of sustainable transportation development indicator categories and sub-categories SDD1-2.1.1 and 2.1.2, SDD2-2.2.1, SDD3-2.3.1 and 2.3.2, SDD4-2.4.1 and 2.4.2 will employ the Satisfaction Type Survey Question using the 5-Point Scale Likert Scale

and Interview with PUV commuters (R3) and PUV drivers (R2). SDD4-2.4.3 will take on the Polarized/Yes or No Survey and Interview with PUV and Traditional PUV Commuters (R3) and Satisfaction Type Survey Questions using the 5-Point Scale Likert Scale and Interview with PUV commuters (R3) and PUV drivers (R2). SDD5-2.5.1 will employ the Polarized/Yes or No Survey and Interview with PUV Operators/Cooperatives (R1) and secondary data collection of existing policies and regulatory controls.

The assessment and evaluation of the economic dimension (ECD) in Figure 2 exhibit the sustainable transportation development indicator categories and sub-category ECD1-3.1.1 will conduct a Polarized/Yes or No Survey and Interviews with PUV Operators/Cooperatives (R1), PUV Drivers (R2) and Commuters (R3) and secondary data collection of existing policies and regulatory controls. ECD2-3.2.1, ECD3-3.3.1 and 3.3.2, ECD4-3.4.1, ECD5-3.5.1, ECD6-3.6.1, 3.6.2 and 3.6.3 and ECD7-3.7.1 will conduct a Polarized/Yes or No Survey and Satisfaction Type Survey Questions using the 5-Point Scale Likert Scale and Interview with PUV Operators/Cooperatives (R1), PUV Drivers (R2) and Commuters (R3). ECD7-3.7.2 will conduct Satisfaction Type Survey Questions using the 5-Point Scale Likert Scale and secondary data collection of existing policies and regulatory controls regarding government subsidy.

To quantify environmental, social and economic sustainable transportation development indicators and sub-indicators support measures are recommended in Table 5. A combination of Comparative secondary data analysis, polarized surveys and interviews, different types of 5-point Likert Scale surveys, and secondary data collection on existing policies are selected as the best and most appropriate measurement support to measure respondents' responses.

Table 5. Environmental Dimension - Sustainable Transportation Development Main Indicators and Description, Indicator Sub-categories, References and Measurement Support

END		Indicators Affecting Sustainable Transportation Dev.		Description of Indicator		Indicator Sub-Category	Measurement Support
1. ENVIRONMENTAL DIMENSION	1.1	Energy Demand	END1	Limitation in the consumption of non-renewable energy sources like petroleum products	1.1.1	Increased or Decreased consumption of diesel or unleaded gasoline	a. Polarized/Yes or No Survey and Interview with MPUV Cooperatives/Operators and Drivers (R1 and R2). b. Nominal Type Survey Question using 5-Point Scale Likert Scale (R1 and R2).
	1.2	Greenhouse Gases Emmission/Carbon Dioxide Emission	END2	Reduction in air pollution from the road transport system	1.2.1	Reduced of Increased Air Pollution from Mobile/Moving Sources.	a. Comparative secondary data analysis from government agencies and NGO's as to air pollution emmission inventory is concerned represented by graphs and charts.
					1.2.2	Amount of Carbon Monixide (CO), Sulfur Dioxide (SOX) and Nitrogen Oxide (NOX) in the atmosphere	a. Comparative secondary data analysis from government agencies as to air pollution emmission inventory is concerned represented by graphs and charts.
	1.3	Healthy Atmosphere and Improvement of Public Health	END3	Decreased exposure to harmful GHG's from the environment and Encourages good health and well being of the people	1.3.1	Increased or Decreased number of patients related to pulmonary diseases caused by transportation air pollution	a. Comparative secondary data analysis from government agencies as to mobile air pollution induced pulmonary diseases represented by graphs and charts.
					1.3.2	Incorporating physical activity into daily living by walking to designated loading/unloading areas of MPUV.	a. Polarized/Yes or No Survey and Interview with Modern MPUV and Traditional PUV Commuters (R2 and R3). a. Rating Type Survey Question using 5-Point Scale Likert Scale.

Table 6. Social Dimension - Sustainable Transportation Development Main Indicators and Description, Indicator Sub-categories, References and Measurement Support

SDD		Indicators Affecting Sustainable Transportation Dev.		Description of Factor		Indicator Sub-Category	Measurement Support
2. SOCIAL DIMENSION	2.1	Accessibility to Commuters (How much effort to reach that specific point?)	SDD1	Provides Access to key services around the city (school, office, business etc.)	2.1.1	Satisfaction level of commuters to MPUV on designated pick-up and drop of points.	a. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV commuters.
					2.1.2	Satisfaction level for loading and unloading points infrastructure.	a. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV commuters.
	2.2	Mobility of Commuters (Moving from one place to another in a certain time)	SDD2	Promotes moving around the city at a given time and reducing the use of private vehicles .	2.2.1	Quality level of experience and amount of time used to travel from one area to a given destination.	a. Quality Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV commuters.
	2.3	Level of Satisfaction and Comfort of Travel of Commuters/Drivers	SDD3	Offers a prime choice in transportation mode and operates efficiently the transport sector	2.3.1	Satisfaction level of commuter's travel experience to their subjective well-being and general quality of life - comfort and safety.	a. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV commuters.
					2.3.2	Driving level satisfaction, focus and comfort while en route to a given destination - (provided that 1 assistant/conductor or an automated fare collection machine is provided).	a. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV drivers.
	2.4	Safety in Travel (Unloading and Loading from the MPUV)	SDD4	Promotes safe and sound loading and unloading designated areas reducing risks of accidents caused by poor transportation support infrastructure.	2.4.1	Safety Satisfaction level of commuters to MPUV on designated pick-up and drop of points.	a. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV commuters.
					2.4.2	Safety level of drivers and commuters as to visible monitoring (on board CCTV), PUV passenger side lighting and speed monioting.	a. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV drivers and commuters.
					2.4.3	Loading/Unloading support infrastructure for commuters and MPUV drivers.	a. Polarized/Yes or No Survey and Interview with MPUV Cooperatives/Operators and Drivers. a. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV drivers and commuters.
	2.5	Policies and Regulatory Controls (No. of allowable years of service of MPUV)	SDD5	Enforcement of rules and regulations for the efficient operation of MPUV's	2.5.1	Availability of exisiting rules and regulations for the MPUV operation and other future regulatory options.	a. Polarized/Yes or No Survey and Interview with MPUV Cooperatives/Operators and Drivers. b. Secondary data collection of exisiting policies and regulatory controls.

Table 7. Economic Dimension - Sustainable Transportation Development Main Indicators and Description, Indicator Sub-categories, References and Measurement Support

ECD		Indicators Affecting Sustainable Transportation Dev.		Description of Factor		Indicator Sub-Category	Measurement Support
3. ECONOMIC DIMENSION	3.1	Traffic Congestion/Deconges tion	ECD1	Increased traffic decongestion and increased traffic flow efficiency	3.1.1	Reduced or Increased Traffic conditions from specific PUV traversed areas.	a. Polarized/Yes or No Survey and Interview with MPUV Cooperatives/Operators and Drivers. b. Secondary data collection of exisiting concerned state agencies.
	3.2	Economic Changes to Commuters (Reduced/Increased Transportation Budget)	ECD2	Reduced or Increased Commuter Transportation-Budget/Cost	3.2.1	The amount of budget/cost of transportation travel on commuters.	a. Polarized/Yes or No Survey and Interview on MPUV and Traditional PUV commuters b. Nominal Type Survey Question using 5-Point Scale Likert Scale.
	3.3	Economic Changes to MPUV Operators and drivers (Reduced/Increased Income)	ECD3	Reduced or Increased MPUV Driver Income and take home pay	3.3.1	Comparative data on the amount of take-home pay of PUV and Traditional PUV drivers.	a. Polarized/Yes or No Survey and Interview on MPUVdrivers. b. Rating Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV drivers.
					3.3.2	Comparative data on the amount of income and profit of PUV and Traditional Operators/Cooperatives.	a. Polarized/Yes or No Survey and Interview on MPUV Operators b. Rating Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV Operators.
	3.4	Fleet Monitoring (Repairs and Maintenance of MPUV)	ECD4	Reduced cost on repairs and maintenance of MPUV fleet	3.4.1	Comparative data of repairs and maintenance costs from PUV and Traditional Operators/Cooperatives.	a. Polarized/Yes or No Survey and Interview on MPUV Operators b. Rating Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV Operators.
	3.5	Investment and Operation of MPUV	ECD5	Reasonable Rate of Investment Return in operating the MPUV	3.5.1	Comparative data of rate of return (ROI) from PUV and Traditional Operators/Cooperatives.	a. Polarized/Yes or No Survey and Interview on MPUV Operators b. Quality Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV Operators.
	3.6	Routes/Route Plan efficiency from the government	ECD6	Efficient Exisiting and Future Routes/Route Plan from enforcing government agencies	3.6.1	Efficiency in existing routes.	a. Polarized/Yes or No Survey and Interview on MPUV Operators b. Importance Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV drivers and commuters.
					3.6.2	Future PUV route analysis and forecasting - distance to existing stations.	a. Polarized/Yes or No Survey and Interview on MPUV Operators b. Importance Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV drivers and commuters.
					3.6.3	The combination of attractiveness and magnitude of land-use opportunites in new MPUV routes - transfer modes to other destinations.	a. Polarized/Yes or No Survey and Interview on MPUV Operators b. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV drivers and commuters.
	3.7	Government Subsidy	ECD7	Availability of Governement subsidies in form of loan grants to MPUV Cooperative to cope up with the massive change in the transportation sector	3.7.1	Amount of state subsidy allocation as loan grants to MPUV operators/cooperatives.	a. Polarized/Yes or No Survey and Interview with MPUV Cooperatives/Operators and Drivers. b. Secondary data collection of exisiting policies and regulatory controls as to government subsidy is concerned.
					3.7.2	Loan terms and conditions that are beneficial to MPUV operators/cooperatives.	a. Secondary data collection of exisiting policies and regulatory controls as to government subsidy is concerned. b. Satisfaction Type Survey Question using 5-Point Scale Likert Scale and Interview with PUV operators/cooperatives.

CONCLUSION

Sustainable transportation development is significant in reducing environmental and climate impact, increasing people's quality of life and well-being, and economic development accelerating progress, reducing inequality and reducing poverty. There is a need to enhance the quality of the transportation system to create a livable and sustainable community. This can only be attained by overcoming challenges in the transportation sector by identifying key indicators affecting the transportation system in communities. This study, having established standardized indicator sets is highly desirable for transportation development analysis across different communities and jurisdictions for the reason that the main indicators and indicator sub-categories are consistent in definitions and data collection methods, suitable for sustainable transportation development assessment, comparing impacts and trends to reflect the environmental, social and economic dimension of sustainable transportation development. This paper identified three (3) environmental dimension (END) main indicators of sustainable transportation development with five (5) indicator sub-categories, four (4) social dimension (SDD) main indicators of sustainable transportation development with eight (8) indicator sub-categories and seven (7) economic dimension (ECD) main indicators of sustainable transportation development with eleven (11) indicator sub-categories. The list of main indicators and indicator sub-categories in the framework will provide direction in the analysis and evaluation of sustainable transportation development systems and provide information on the status of the transportation system in specific cities and other locations.

To measure the degree of sustainability of the given manageable indicators this study suggested various types of rating scales and data collection strategies as measurement support to be used in assessing and evaluating sustainable transportation development conditions. This can only be achieved by the conduct of a comprehensive survey and interview session with the three (3) respondent types, R1, R2 and R3 identified in the study. Finally, the quantification of responses from surveys and interviews, in addition to gathering secondary data from various state agencies will be used to assess and evaluate the level of sustainable transportation development status of specific communities. Based on the results and findings of this paper, it is recommended to explore further an organized set of other main indicators and indicator sub-categories that may be favorable and advantageous to other communities or jurisdictions in assessing the level of sustainable transportation development depending on factors present in their transportation system that may influence the conduct of the evaluation of the indicator set used in the framework. We emphasize the important role of identifying a manageable number of sustainable transportation development indicators to facilitate the assessment of the status of the transportation system. Finally, this study spread awareness in the transportation sector and its contribution to the achievement of sustainable transportation development, which plays a pivotal role in the environmental, social and economic development of other sectors in society.

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