SUSTAINABILITY INDEX ASSESSMENT OF URBAN TRANSPORT SERVICES IN DEVELOPING CITIES

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ABSTRACT

The growth and concentration of motor vehicles in developing cities has led to increased demand for urban mobility. Renewed commitments of Asian cities are required in order to achieve the SDG target on urban mobility as well as to enhance overall sustainability of urban transport systems and services. Cities and countries need to track the progress in improving urban mobility. With a view to support evidence based decision, the paper introduces the Sustainable Urban Transport Index (SUTI) of urban transport services, to help summarize, track and compare the state of urban mobility in Asian cities, as model for developing cities in the world. It also presents the results of pilot application of SUTI in four Asian cities: Greater Jakarta; Kathmandu; Hanoi; and Colombo. The four pilot cities were able to collect data, analyzed and assess the state of urban mobility in their city using SUTI. The assessment result supported policy makers to identify policy gaps, prioritize additional measures and investment strategies required to improve urban transport systems and services in each city. The visual output display in spider diagram was useful to comprehend state of all 10 key indicators in a glace. The pilot study demonstrated the usefulness of SUTI tool and the pilot cities were already using the results of SUTI analysis. In Kathmandu additional efforts are required to improve pedestrian infrastructure and facilities, Colombo needed to improve quality and reliability of public transport system, while Hanoi and Greater Jakarta need to put additional efforts to increase mode share of public transport system.

Keyword: urban transport; sustainability; index; asian cities.

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INTRODUCTION

Asia has witnessed rapid population growth and urbanization. In 2016, 48.7% of the region's 4.3 billion population lived in urban areas. According to recent projections, more than half of the region's population will be urban residents by 2018 (UNESCAP, UNDP and ADB, 2017), and by 2050 the total regional urban population will reach 3.2 billion (UNESCAP, 2016a). The fleet of motor vehicles is also growing steadily in the region's cities. The growth and concentration of motor vehicles in urban areas has led to increased demand for urban mobility. This rapid growth and increased urbanization will continue to stress urban transport systems and infrastructure leading to congestion, accidents and more consumption of fossil fuels, and correspondingly will raise greenhouse gas (GHG) emissions. Quality of life issues such as loss of productivity and health will also suffer as a follow-on impact.

Provision of sustainable urban transport is becoming a major issue due rapid urban development worldwide, including the Asia-Pacific region. The adoption of the 2030 Agenda for Sustainable Development with the 17 Sustainable Development Goals provides a new impetus to address global development challenges in the world including for transport in urban areas. Further, Sustainable Development Goals (SDG) target 11.2 focuses on improving accessibility for all with emphasis on public transport. Other recent and emerging global and regional commitments such as the Habitat III summit and its outcome the New Urban Agenda and the Ministerial Declaration on Sustainable Transport Connectivity in Asia and the Pacific further emphasize the urgent need to tackle urban transport challenges.

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In order to improve urban mobility, achieve the SDG target 11.2 as well as to enhance overall sustainability of urban transport systems and services renewed commitments from Asian countries and cities would be required.

Objective of Paper

In absence of comprehensive standard frameworks and tools to measure state of urban transport systems in Asian context, UNESCAP has developed the Sustainable Urban Transport Index (SUTI) with 10 key urban transport indicators (UNESCAP, 2016b). SUTI is based on ten key urban transport indicators representing transport system, environmental, social and economic dimension of sustainability. The result of assessment can support city policy makers to make evidence based policies and measures to improve urban mobility

In this context, this paper briefly presents current state of urban transport systems and services in Asia, introduces SUTI and presents the results of its pilot application in four Asian cities and draws some conclusions and policy implications.

Following this introduction, section 2 outlines current state of urban public transport system in Asia. Section 3 presents methodology as sustainable urban transport index, and section 4 state the assessment of urban transport systems in Jakarta and Greater Jakarta, outlining SUTI, data collection approach and results. Finally, section 5 includes conclusions and discussions and policy implications for enhancing sustainability of urban mobility in developing cities.

Urbanization and Motorization

Rapid urbanization has transformed cities in the Asia-Pacific region into production and economic centres, and has contributed to economic and social well-being. Cities account for about 80 % of the region's economic output (UNESCAP, ADB and UNDP, 2017).

The Asia-Pacific region has witnessed rapid motorization. Most countries showed growth in motorization rate (vehicles/1,000 inhabitants) from 2014 to 2015. The motorization rate in highly motorized countries, such as Australia, Japan, New Zealand and the Republic of Korea increased from 402-796 in 2014 to 417-819 in 2015, and the rate in less motorized countries, such as India, Pakistan, the Philippines and Viet Nam increased from 20-36 in 2014 to 22-38 in 2015.

This rising vehicle ownership led to traffic congestion which caused many negative externalities in urban areas, such as economic losses, increase in energy consumptions and air pollutions. In 2016, Asian cities, experienced severe traffic congestions ranging from 30 to 50 per cent (increase in overall travel times when compared to a free flow situation), with Bangkok (61 per cent), Jakarta (58 per cent) and Chongqing (52 per cent) had the worst traffic jams.[1]

In addition to the growing number of private vehicles, other characteristic of cities in South Asia and South-East Asia is that powered-two wheelers constitute a major share of vehicle population. For example, India, Indonesia, Thailand and Viet Nam have very high numbers of motorcycles. Due to growing numbers of private vehicles and lack of reliable public transport systems, regional cities and member States are finding it difficult to attract more commuters to the public transport as well keep its mode share.

Road fatalities among vulnerable road users that include motorcyclists, cyclists and pedestrians and urban road safety are a cause of concern in the region. The road traffic deaths among vulnerable road users account for 55 per cent of total road traffic fatalities.

Cities account for more than two-thirds of energy use and GHG emissions. Time losses and transport costs from road congestion imposes an economic cost of 2 to 5 per cent of gross domestic product in the region every year. Another important problem facing Asian cities is the prospect of an ageing population, which in turn adds challenges to urban and transport planning and demands for more urban space, barrier-free public transport and pedestrian facilities. New concepts of planning and designing livable cities are emerging that encourage sustainable and active mobility and accessibility, and which provide more vibrant public spaces.

The increasing trend of urban growth as a result of rural-urban migration in the search for economic opportunities, together with the accompanying motor vehicle fleet growth in cities, is posing challenges to urban planning and provision of urban mobility. The demand for urban public transport is increasing; urban roads are becoming more congested, leading to slower vehicle speeds as well as increased fossil fuel consumption and vehicle emissions.

State of urban mobility

Popular forms of urban public transport modes prevalent in the region's cities include buses, Bus Rapid Transit (BRT), elevated rail, Light Rail Transit (LRT), Mass Rapid Transit (MRT), paratransit, urban railways, taxis, and trams. Boats and ferries are also common modes of transport along inland waterways.

BRT is a popular form of public transport systems in the world, and it continues to be a favored system of mass transit in Asia, for their relative ease and low-cost of installation. Currently, 43 Asian cities operate 1,593 kilometres of BRT carrying about 9.3 million passengers per day. Tehran BRT has the highest capacity of 2 million passengers per day, while the Jakarta BRT system is the longest in the world with 207 kilometres.

The region also has many rail-based public transport systems, such as LRT and MRT. Cities such as Beijing, Guangzhou, Moscow, Tokyo, Seoul and Shanghai have more than 300 kilometres of rail-based urban transport networks. New constructions of rail-based urban mass transit systems are progressing in many Chinese and Indian cities, selected Iranian cities (Ahvaz, Karai, Kermanshah and Qom), as well as in Bangkok, Dhaka, Hanoi, Ho Chi Minh, Jakarta, and Lahore.

Figure 1 presents the total length of mass transit systems (rail-based and BRT) per million head of population in major cities. Seoul and Singapore have the greatest length per population, while Bangkok, Delhi, Manila and Mumbai still need to expand the coverage of their mass public transport systems

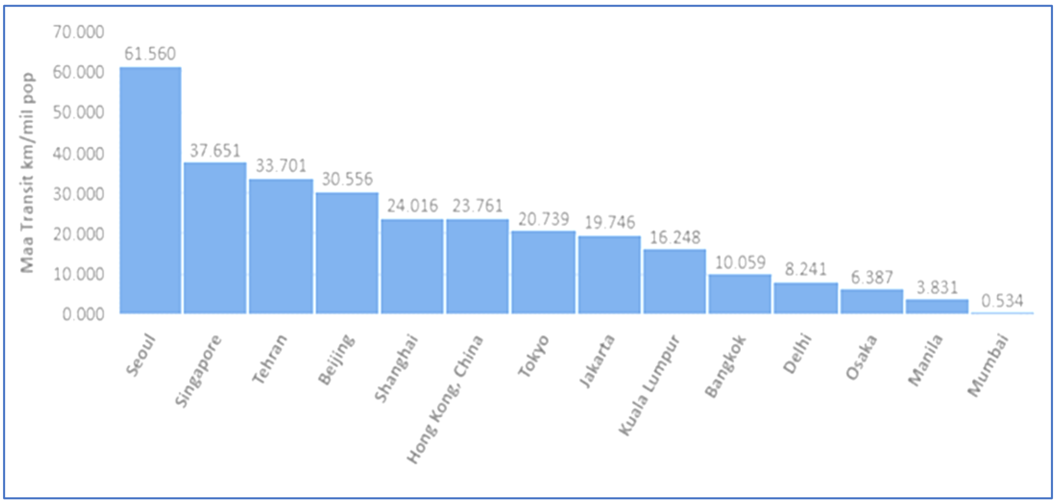

Figure 1. Mass transit system in selected cities *(Source: De Gruyter and others.)*

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In general, the quality of urban public transport is gauged by public perception, ridership and modal share. The mode share of public transport is high in some Asian cities like Manila (59 per cent), Colombo (53 per cent), Hong Kong, China (52 per cent), Mumbai (45 per cent), and Singapore (44 per cent). While Kathmandu (28 per cent) and Jakarta (27 per cent) have moderate public transport mode share, other major cities such as Ho Chi Minh (2 per cent), Hanoi (7 per cent), Kuala Lumpur (7 per cent) and Tehran (13 per cent) have a lower public transport mode share.

Inner city paratransit systems are often found in this region that provide flexible and affordable public transport services. Paratransit comes in various forms, including vans, mini-vans, tempos, electric-three wheelers, motorcycle taxis, minibuses and customized public pick-ups (e.g. Ankots in Indonesia, Tempos in Nepal, Songtao in Thailand and Jeepneys in Philippines).

Non-motorized transport, such as walking and cycling, is also gaining popularity in this region. Member States and city authorities are developing infrastructure for non-motorized transport and promoting car-free days as part of their comprehensive mobility plan. Bicycling has been growing and various forms of public bicycle sharing schemes are emerging in China, Japan, India, the Philippines, the Republic of Korea, Singapore and Thailand.

Another common problem in Asian cities is street parking and encroachment of footpaths by local vendors. Even though these activities are commonly restricted by traffic and local laws, however lack of strict enforcement reduces the capacity of roads and footpaths and induces congestion for movement vehicles and pedestrians.

In order to reduce dependency on private transport modes, policies to increase the share of public transport modes and discourage use of private vehicles can be employed. Popular push policies include parking restrictions and pricing, congestion charging, area licensing schemes, electronic road pricing, car sharing, designation of car-free areas and car-free days, and designation of high-occupancy lanes. Pull policies include improvement of the quality and extent of public transportation services. Hong Kong, China as well as Japan, the Republic of Korea and Singapore have developed well-functioning integrated urban transportation systems that are based on attractive public transport and restricted use of private vehicles. As a result of a vehicle quota system being implemented in Singapore, total vehicle population decreased from 974,170 in 2013 to 965,430 in 2016 (LTA, 2016).

Many of the region's megacities have attracted much attention from national Governments and city authorities as well as development partners in addressing urban mobility problems. Cities such as Hong Kong, China as well as Seoul, Shanghai, Singapore and Tokyo have already developed urban public transportation systems while Bangkok, Delhi, Dhaka, and Mumbai are at various stages in the development of urban public transportation systems. Emerging secondary and medium-sized cities offer opportunities to plan and develop integrated sustainable urban public transport systems as land and space to plan such systems can easily be acquired. Many large Asian cities are located on, or close to coastal areas and are vulnerable to the impacts of climate change (ADB, 2011). These cities also pose additional challenges to develop resilient urban transport systems.
In order to enhance the energy efficiency of transport sector in the region, regulations that support the usage of hybrid and electric passenger vehicles are also gaining popularity. Recent examples include the popular electric rickshaws (a new form of paratransit) in Nepal, and a fleet of electric buses operating in the central core of Hanoi and Ho Chi Minh city. The energy white paper of the Government of Nepal envisages policies to promote use of electric vehicles, development of charging stations and infrastructure. It aims to increase the import share of electric vehicles to 50 per cent in 5 years (by 2023) and the Energy Minister is currently using an electric vehicle.[2].

There is much agreement and consensus in urban transport experts and policy makers on how to plan, develop and operate urban transport systems and services including the use of emerging technologies. Planning and design guidelines (UN-HABITAT, 2013), technical standards, case studies and sourcebooks (ITDP, SUTP, ELTIS, 2017) that focus on a particular aspect of urban transport and mobility are readily available. Countries and cities of the region could focus attention on utilizing these resources for actual application and implementation. A broad coalition of development partners to support regional cities in implementing sustainable urban transport master plans would be a step in the right direction. An example of this approach is the Transformative Urban Mobility Initiative of the German Federal Ministry for Economic Cooperation and Development (BMZ), the objective of which is to enable leaders to plan and implement sustainable mobility concepts (TUMI, 2017). A project on Transforming Urban Transport: The Role of Political Leadership aims to advance knowledge about where political leadership has successfully implemented ground-breaking transportation policies in major cities (TUT-POL, 2017).

Some of the policies being taken by member States and cities are improving quality and extent of mass urban public transport systems, integration of various urban transport modes, prioritizing non-motorized transport, construction of intermodal transfer stations, using integrated ticketing and smart card systems, and restriction on the use of private vehicles.

Urban transportation is a need and demand for every user. The mobility of transportation users is a must for every day's activities. Every transportation trip is always accompanied by the use of both private and public vehicles. A good trip is planned starting from departure to the destination. Every trip is taken with good planning so that the transportation used will be more comfortable and safer (Karimah.H, Akbardin.J, 2019); (Daagustani.M, Murtejo.T, 2020); (Syaiful.S, Wahid.N, 2020); (Syaiful.S, Hariyadi.S, 2019).

RESEARCH METHODS

The methodology of the research is presented in figure 2 consisting of sequence block by block of activity.

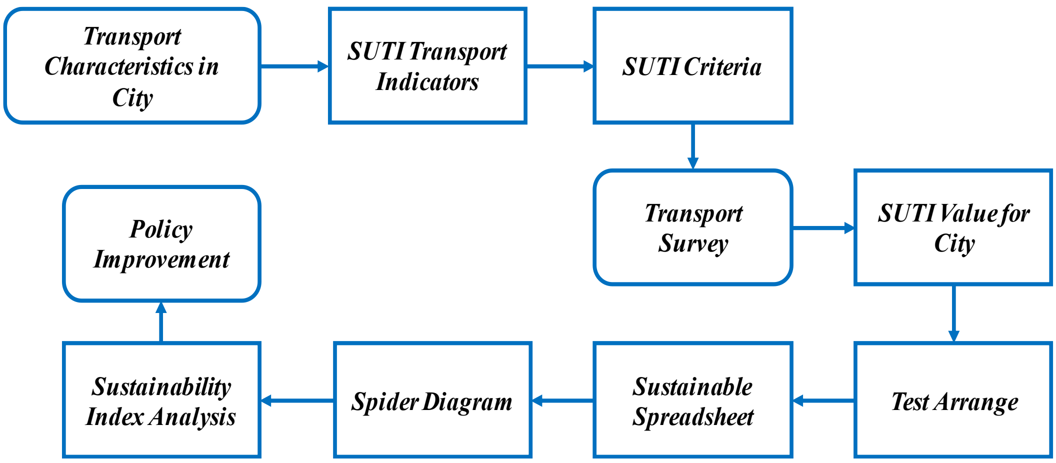

Figure 2. Methodology

SUTI calculation is based on the ten indicators that are shown in table 1.

Table 1. SUTI indicators

1	Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes
2	Modal share of active and public transport in commuting

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3	Convenient access to public transport service
4	Public transport quality and reliability
5	Traffic fatalities per 100.000 inhabitants
6	Affordability – travel costs as share of income
7	Operational costs of the public transport system
8	Investment in public transportation systems
9	Air quality (pm10)
10	Greenhouse gas emissions from transport

Indicator 1: Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes
This indicator must be produced by undertaking a manual document review of the City's most recent transport plan, and score it with a set of criteria defined for this indicator. This review involves designating an expert or a small expert team to read and score the plan according to the criteria.

Indicator 2: Modal share of active and public transport in commuting
This 'modal share' indicator is of interest in many cities, but definitions vary and data can be a problem. In case no data exist or existing ones are outdated (e.g. 10 years old or more) the city will need to derive new data on transport volumes (trips) per mode. This may involve conducting some form of a travel survey, or using other methods.

Indicator 3: Convenient access to public transport service
This indicator requires the combination of data for the density and frequency of the public transport (PT) service network, and data for the number of citizens living in 500 m buffer zones of main nodes in the network. There are different methods to estimate these data as described but it may require some effort to derive data both for PT frequency and population inside the buffer zones.

Indicator 4: Public transport quality and reliability
This indicator is based on measuring the satisfaction of Public Transport users with the quality and reliability of public transport service. Any existing survey results may need to be updated, adjusted or re-interpreted to match the format defined in this guidance. If no survey exists a basic one has to be prepared and conducted within a short time. This involves some practical survey work.

Indicator 5: Traffic fatalities per 100.000 inhabitants
Traffic fatality numbers can usually be found in official statistics, hospital or police records.
Indicator 6: Affordability – travel costs as part of income
The indicator needs data on costs for a monthly pass or similar to the PT network as well as statistical data on income for segments of the population.

Indicator 7: Operational costs of the public transport system
It will likely be necessary for some cities to consult public PT authority or company or individual operators to request the data.
Indicator 8: Investment in public transportation systems
The indicator uses data from public accounts of investments and spending.

Indicator 9: Air quality (pm10)
The indicator use is population weighted air quality monitoring data reported to national agency or WHO. May need conversion from PM2.5 data if PM10 not available. Should require limited effort.

Indicator 10: Greenhouse gas emissions from transport
If an account or estimate of the emissions of CO2 from transport in the city is not available, a figure has to be calculated using emission factors and data for traffic volumes (vehicle kilometers) for all emitting modes, or indirectly from gasoline and diesel sales.

This is the key part of the data sheet, where the city will enter data for the ten indicators, following the guidelines presented in section 3 of this report, and drawing on data entered in sub-sheets 1-10. In Sub-sheet B the city only enters one value for each SUTI indicator, ten values in total. If the city has indicator data available for more years or areas, these can be included in the relevant sub-sheet 1-10. The main table of the DATA ENTRY sub-sheet looks as follows:

Table 2. SUTI indicator Data Entry Sheet

No.	Indicators	Natural Units	*Weights*	Range MIN	Range MAX
1	Extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes	0 - 16 scale	*0.1*	0	16
2	Modal share of active and public transport in commuting	% of trips/mode	*0.1*	10	90
3	Convenient access to public transport service	% of population	*0.1*	20	100
4	Public transport quality and reliability	% satisfied	*0.1*	30	95
5	Traffic fatalities per 100.000 inhabitants	No. of fatalities	*0.1*	0	35
6	Affordability – travel costs as part of income	% of income	*0.1*	35	3.5
7	Operational costs of the public transport system	Cost recovery ratio	*0.1*	22	175
8	Investment in public transportation systems	% of total investment	*0.1*	0	50
9	Air quality (PM10)	µg/m3	*0.1*	150	10
10	Greenhouse gas emissions from transport	Tons/ Capita/year	*0.1*	2.75	0
			1.0		

When data for all ten indicators are collected and entered into the **Sheet B DATA ENTRY** in the appropriate fields, the SUTI is complete and the results can be reviewed.
Two different calculated results can be observed.

Data Sheet B shows the aggregate value for SUTI for the city. This is the geometric mean aggregate score across all 10 indicators, a value between 0 (worst case) and 100 (best case).

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The main use of the SUTI number is for comparison. Either in comparison with other cities or comparison over time, for following or previous years for the same city. Therefore, at this pilot phase, the SUTI number can tell state of urban transport in a city compared to other pilot cities. A high score is generally positive.
The other result is a spider diagram calculated in **Sheet C DIAGRAM.** The spider diagram illustrates the performance of each indicator for the city, compared with min and max performance in the literature. This diagram is produced automatically in the data sheet when the data in entered. An example using data for a more or less fictive city X is shown.

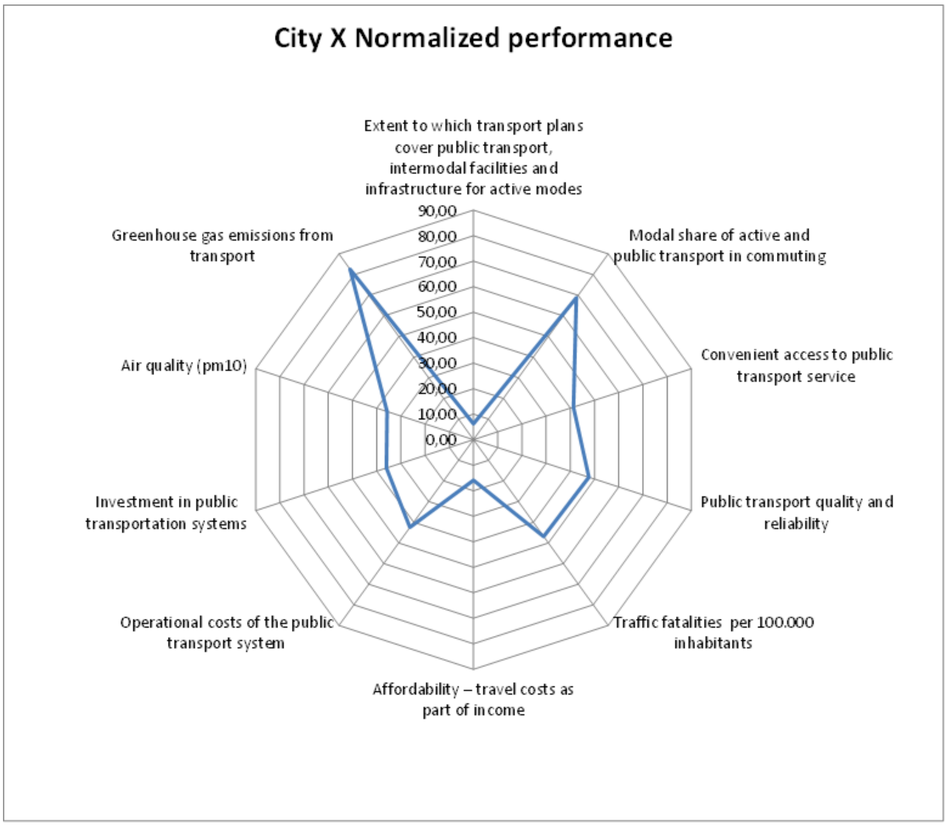

Figure 3. Normalized Performance

RESULTS AND DISCUSSION

Results

The pilot applications of the index were undertaken and completed in four cities in 2017: Colombo; Greater Jakarta; Hanoi; and Kathmandu. Table 2 shows basic characteristics of four pilot cities.

Table 3. Basic characteristics of the four pilot cities

	Greater Jakarta	Hanoi	Kathmandu	Colombo
Area	Greater Jakarta	Hanoi city	Kathmandu Valley	Western Region
Size	6,767 km2	3,325 km2	722 km2	3,684 km2
Population	30.1 mill.	7.7 mill.	2.8 mill.	5.8 mill
Average density	4,448 inh./km2	2,306 inh./km2	3,878 inh./km2	1,774 inh./km2

For sustainability assessment of public transport systems and services in four selected cities, the methodology outlined in the Assessment of Urban Transport Systems (UNESCAP, 2016b and Gudmundsson and Regmi, 2017) is used. The methodology is much inspired by the sustainable urban transport evaluation being used in the Republic of Korea (KOTI, 2015) and sustainable mobility (WBCSD, 2016). It involved collection of urban transport data for ten key indicators, discussion with city officials for validation of data and evaluation of urban transport master plans and analyze the data for each cities using SUTI excel sheet.

Analysis
SUTI analysis covers the Greater Jakarta area (JABODETABEK). This includes six cities and three regencies, Jakarta, Bogor, Depok, Tangerang, Bekasi, Tangerang Selatan, Bekasi regency, Tangerang regency and Bogor Regency. The population is more than 30 million.

According to the report, Jakarta has struggled with traffic and transportation problems in the last 20 years. The share of private vehicles has increased significantly, while the shares of public transport tends to decrease. In the 2000 the use of public transport was 58% while it significantly decreased in 2010 to 28%. The city experiences significant congestion due to motorization.

Data were collected for all 10 SUTI indicators and the results are shown in figure 3. Jakarta aggregate SUTI value is 52.5. Greater Jakarta scores highest in indicator 8 'Investments in public transport systems'. The city also scores fairly well in Indicator 5 'Traffic fatalities', indicator 1 on 'Transport plans' and indicator 10 'Greenhouse gas emissions'. Indicators 2 'mode share of public transport", 3 'accessibility' and 4 'quality and reliability' have low score. The lowest score is in indicator 7 'Operational costs of the public transport system'.

Greater Jakarta performed well compared to other pilot cities. Greater Jakarta has been investing for two mass transit systems and have developed an integrated urban transport plan. The road safety indicator showed good road safety situation. Based on the analysis, the Greater Jakarta city authorities have identified that additional efforts are required to: (i) extend public transport accessibility which is currently at 49 per cent, (ii) increase mode share of public transport which is currently at 27 per cent, (iii) improve quality and reliability of public transport services and (iv) improve air quality including strategies to reduce pollutant particles PM10, which stood at 82 ug/m3 annual mean value and exceeded the WHO guidelines (20 ug/m3) and has been ranked one of the highest in the region[3].

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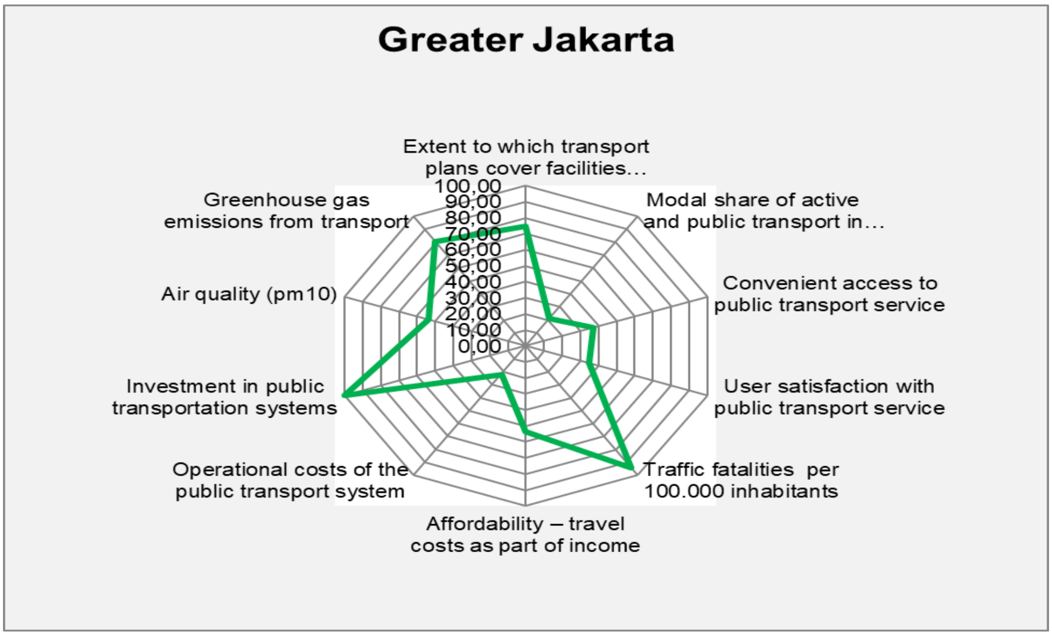

Figure 4. SUTI spider diagram for Greater Jakarta

CONCLUSION

The Sustainable Urban Transport Index (SUTI) as a tool to track and analyze the urban mobility has been assessed for developing Asia's cities. The data collected in Greater Jakarta, Kathmandu, Hanoi and Colombo analyzed by 10 key indicators and presented using spider diagram can identify the policy gaps, from there each city can prioritize additional measures required to improve the urban transport system in the future. The analysis of SUTI can help summarize urban transport problem and solution, as in Greater Jakarta, should put additional effort to improve modal share of public transport system.

RECOMMENDATION

The new SUTI model as a tool for growing cities in Indonesia need to track in improving urban mobility, while limited budget during pandemic covid-19. More than 50 cities including metropolitan, large cities and medium size cities is in urgent to prioritized their investment in the short- medium range. A tool for measuring the urban transport index is in accordance with the Medium Term Development Program, so the modified SUTI can be one of the solutions to be recommended.

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