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Perceptions towards sustainable transportation and recommendations: A survey case study in Jakarta, Indonesia

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***Abstract*.** The United Nations' Sustainable Development Goals (SDG) are holistic in encompassing every aspect, which contributes towards better quality of life. Indonesia is an emerging and middle-income economy. Hence, the goals of this study are first, to review and compare sustainable transportation initiatives in some Western countries, some Eastern countries, and in Indonesia; and second, to investigate respondents' perceptions towards these sustainable transportation development initiatives, within the wider context of transportation demand management. The comparative findings indicate that there is much similarity between developed countries and middle higher-income economies, though strategies are adapted to the respective countries' context, and needs. Survey findings on 201 respondents in Jakarta indicate that most of the sustainable transportation initiatives are relevant to and positively perceived by the respondents. Findings also highlight the importance of prioritizing public transportation, linking ecosystems to other ecosystems, and real-time smart information recommendation. We conclude that in view of the pandemic, there is a greater need to adapt to the respective country's current contexts to create new business models in services and products, as the business model and market co-evolve such as in Society 5.0. This would extend transportation management to travel management and link SDG 3 (health and well-being), SDG9 (industry, innovation, and infrastructure, SDG11 (smart cities and smart communities, SDG 13 (climate action), SDG17 (partnership for the goals), and enable further studies of design and diverse types of anthropologies. Only further research can determine the degree to which these case study findings can be generalized.

***Keywords*:** Sustainable Development Goals (SDG), travel demand management, agile co-evolving business-market model, survey, interlinked ecosystems, Indonesia

I. Introduction

Sustainable transportation is an effort to create a positive impact towards society, the environment, and the climate. The transportation referred to here often encompasses land, water, air transport, and correspondingly, the source of energy, and transportation infrastructure. The recent trends include integrating policies and strategies to ease and improve rural-urban mobility. Examples of factors relevant to short-term and long-term planning are road infrastructure, pricing mechanisms, vehicle access restrictions, government funding, and financial incentives [1].

With the development of inter-linked ecosystems, the United Nations Economic and Social Commission for Asia and the Pacific's [2] Transport Division in its Brundtland Report [3] suggests that development must be planned for long-term sustainability, based on three pillars: economic, social, and environmental.

Such interlinked ecosystems have been predicted by Porter [4] in his Diamond model, and many researchers are concerned with globalization and business model transformations. Similarly, Holloway and Sebastiao [5] suggest that contrary to common business models, which often match firm resources and capabilities to the current market conditions, we

should encourage business model innovation. Consequently, market hypotheses need to co-evolve, based on individual and collective interests. The alignment of such interests to experimental and iterative effectuation of strategic visions and new business models would encourage an agile yet enterprising market. With changes in markets and players, co-evolution will take on different epistemologies and anthropologies.

Correspondingly, Malaysia's transport policy 2019-2030 [6], has considered the following future trends:

- Trend 1: Increasingly aging population
- Trend 2: Rapid urbanization
- Trend 3: Technological advances (digitization and real-time information)
- Trend 4: E-commerce market expansion
- Trend 5: Increasing shift towards environmentally sustainable transport
- Trend 6: Shift towards bigger vessels, consolidation, and containerization
- Trend 7: Increasing passenger travel and impact of low-cost carriers
- Trend 8: Development and proliferation of new technology.

Corresponding policy development has aimed to:

- strengthen governance to create a conducive environment for the development of the transport sector;
- optimize, build and maintain the use of transport infrastructure, services, and networks to maximize/optimize efficiency;
- enhance safety, integration, connectivity, and accessibility for seamless interconnected travel;
- advance towards green transport ecosystem and
- expand and promote internationalization of transport services.

A. Objective

The United Nations' Sustainable Development Goals (SDGs) [7] include every aspect which contributes towards quality of life. For instance, for sustainable transportation, interlinked goals are affordable and clean energy (SDG7), climate action (SGD13), industry, innovation, and infrastructure (SDG9), smart cities and smart communities (SDG11) and partnership for the goals (SDG17).

Motivated by the Atlanta Beltline Project [8], United Nations' Sustainable Development Goals, and more recently, Kennedy-Cuomo's [9] observations that the lack of unified planning is the most crucial to the development of efficient urban transport, this exploratory study aimed to investigate policies and strategies of some Western and Eastern countries with regards to sustainable transportation and subsequently, to recommend policies and strategies to improve sustainable transportation initiatives in Indonesia.

Indonesia is chosen for this study as this study is extended from a capstone project and the fourth author (the capstone student) was in Indonesia for the data collection and analysis parts of the study. Furthermore, Indonesia is ranked 63rd in the Logistics Performance Index in 2016 (The World Bank, [10]) and Indonesia's policies are focusing on reforming regulations. As such, Indonesia still holds many opportunities for the development of sustainable transportation systems.

The efficiency and capacity of transport infrastructure are two of the biggest challenges in Indonesia. With roughly 1,700 ports and 230 airports, there is still poor connectivity, with land infrastructure. This results in expensive shipping of goods to other cities (UNCTAD, [11]). In addition, according to Leung [12], Indonesia has the highest energy demand for fuel with an average rate of about 4.5% per year. Insufficient infrastructure, and lack of connection to the market will consequently affect economic growth, living standards, and increase inequalities across the archipelago.

Policies and strategies from other countries would provide the best reference for improvement. Our objectives are to:

a) review websites of and literature on four European countries and three Asian countries' policies and strategies towards sustainable transportation to identify similarities and differences,
b) assess the feasibility of these strategies based on four project management knowledge areas and based on a sample group of Indonesian respondents' perceptions towards these strategies.

Correspondingly, our research questions are:

a) Are there similarities and differences among sustainable transportation policies and strategies reviewed?
b) Which policies and strategies are feasible based on a) and which project management knowledge areas do these policies and strategies fall into?
c) How do a sample group of respondents in Indonesia perceive the suggested strategies?
d) What are possible strategies to look into further?

II. Methodology

The research was carried out based on a literature survey, followed by a questionnaire survey. For the literature review, the countries compared were selected based on a Google search using the keywords *sustainable transportation*. They were compared in terms of research questions a) and b). These reviews subsequently formulated the questions for a survey. The survey aimed to determine respondents' perception towards the current implementation of sustainable transportation in Indonesia, as well as their perception towards possible implementation of sustainable transportation initiatives identified from the literature reviewed, hitherto not implemented yet.

Data on respondents' perceptions were collected via a survey with multiple-choice questions (Appendix A). All questions adopted the five-item Likert scale, except for question 8, on awareness, where a three-item Likert scale was adopted.

We focused on the following sustainable transportation categories: factors/concerns when traveling, usefulness, effectiveness, awareness of future initiatives, and agreement. Table 1 presents the categories, question numbers, and number of items in each category.

Table 1. Distribution of survey questions

Category	Question number(s)	Number of items
Factors	4	7
Awareness	7	11
Usefulness	8	11
Effectiveness	9	15
Agreement	9	14

This survey was distributed to a random sample online as the study was carried out during the conditional movement control order arising from the COVID-19 pandemic. The sample respondents were 201 residents in Jakarta.

A quantitative approach was chosen as it would enable data-driven analyses and recommendations in the future. We utilized descriptive/inferential statistics and correlation analysis to analyze the data. Correlation analysis was chosen to determine the strength of relationships between independent variables and dependent variables. Further analysis involved statistical significance and effect size.

Due to the small sample size of 201, the findings from this study cannot be generalized. We would need larger sample sizes across different demographics for any inference to be conclusive and recommendable in line with Glaser and Strauss's [13] grounded theory.

III. Related work

Sustainable transportation covers a broad area of research and involves diverse stakeholders. One of the key considerations is transportation demand management (TDM), better known by its value-add component, travel demand management. TDM aims to increase the number of occupancies per vehicle while providing diverse mobility options and without increasing cost to people or adding new roads [14, 15].

Sections A and B answer Objective 1, i.e., to investigate similarities and differences among four European countries and three Asian countries' policies and strategies towards sustainable transportation, respectively.

A. Sustainable transportation strategies in European countries

Table 2a presents the approach and policies and Table 2b lists the strategies in four European countries. Though each of these countries has a different approach, they adhere to the same framework, i.e., the EU standard framework. The framework [16, 17, 18] improves mobility and competitiveness.

Table 2a. Sustainable transportation approach and policies in four European countries

Country / Strategy	Germany	Scotland	Sweden	The Netherlands
Government approach towards sustainable transportation	Create a multi-modal transportation system and create least-cost planning e.g., road pricing and public transportation cost.	Develop a travel-wise program to inform the public (reviews/information) to choose to use a pedestrian or bicycle and whether/when to use transit effectively.	Develop health and safe transportation with public education e.g., a zero-safety plan (separation of vehicle class during traffic hours), in-vehicle protection.	Preserve the environment and protect nature to increase economic growth.
Government policies to sustainable transportation	Create an emission standard for vehicles and promote alternative fuels for vehicles.	Develop car clubs, which offer city residents part-time access to a car without the cost of full-time ownership.	Develop truck movement regulations in high traffic areas, reduce the emission of truck pollutants.	Develop a mixed-use policy to limit stand-alone malls and office buildings.

Table 2b. Sustainable transportation strategies in four European countries

Country / Strategy	Germany	Scotland	Sweden	The Netherlands
Integrated land-use and transportation development/management	Reduce trips. Focus on mixed land-use and density to increase regional development. Address the key transport corridors and transit lines and land by using policies and plans to improve and/restrict greenfield in existing centers.	Coordinate central city and sub-urban transportation and land development. Prioritize non-motorized transport and transit to increase the use of public transportation.	Coordinate land use and transportation re-establishment by creating/locating towns with pedestrian-friendly densities near transit transportation and maintaining town centers' cultural, and social significance.	Focus on mixed land use/development and contiguous access and development of transit transport services.
Needs-centric transportation systems	Develop transit-friendly travel with dedicated bus lanes, great transit connection to major destinations, e.g., airports, rail terminals, bicycle facilities.	Develop transit-friendly travel with dedicated bus lanes, great transit connection to major destinations, e.g., airports, rail terminals, bicycle facilities.	Develop customer-oriented transit: Survey to know customers' preferences to increase transit use and to provide better information to customers.	Develop door-to-door rather than mode-by-mode: all public transportation is connected to the bicycle and pedestrian lanes.
Transport infrastructure development and maintenance	Focus on operations and management, e.g., by upgrading road & highway facilities; connection to ports, railways, other transport networks, and constructing new roads.	Focus on building a motorway network, road bridge to create reliability in the time taken, reduce traffic at the country's most active roads to ensure efficient transfer of goods.	Focus on reconstructing transport facilities e.g., highways to reduce traffic congestion and improve rail and freight transport's effectiveness and efficiency.	Focus on constructing highways, railroads, road network to connect all ports and airports in major cities.
Non-motorized transportation	Provide non-motorized transport infrastructure e.g., pedestrian, bicycle paths, and transit access to achieve compact urban development and growth.	Support non-motorized transport infrastructure e.g., by mapping information routes, cycle training, and cycle loan scheme to encourage people to walk, cycle.	Provide non-motorized transport infrastructure e.g., pedestrian, bicycle paths, and transit access to achieve compact urban development and growth.	Provide non-motorized transport infrastructure e.g., pedestrian lanes, bike lanes, bike parking areas along the sidewalk.
Use of new technology	Develop new technologies e.g., Intelligent Transportation Systems (navigation and maps, toll systems); alternate fuels for vehicles.	Develop new technologies e.g., Intelligent Transportation Systems; automatic plate recognition.	Develop new technologies e.g., Intelligent Transportation Systems (e.g., parking space information); alternate fuels, hybrid, alt-fuel buses.	Develop Intelligent Transportation Systems.

B. Sustainable transportation strategies in Asian countries

Table 3a presents the approach and policies in five Asian countries and Table 3b, their corresponding strategies. These are obtained from the respective governments' and organization's websites. They are the Government of Japan [19, 20], Palliyani and Horng [21], United Nations [22], Kuala Lumpur (KL) Municipal Council [23], Shakti Sustainable Energy Foundation [24], Delhi Development Authority [25], Soegijoko and Horthy [26], and Leung [12].

Table 3a. Implementation of approach and policies in five Asian countries

Countries/ Strategy	Japan	Singapore	Malaysia	India	Indonesia
Government approach towards sustainable transportation	"Eco- commuting" (Foundation, 2020) approach to encourage a shift from private vehicle to public transport, bicycle, walk.	Pragmatic approach to preserving equity between generations within development.	Travel Demand Management approach to encourage people to shift from private vehicle, to public transportation.	Huge investment in public transportation to improve the quality of life in cities.	Promote public transportation services and revitalize intermodal transport system.
Government policies	Provide funding for innovation, and engagement with the private sector.	Focus on travel demand management by controlling growth of motorization, and road pricing.	Encourage the utilization of biofuel and reduce fuel subsidies, adjust car parking charges, and private vehicle tax.	Implement fuel efficiency as standard policy and promote electric vehicles. Taxation for vehicles.	Reform regulations including transparent law, simplify license procedures and fuel subsidies.

Table 3b. Implementation of strategies in five Asian countries

Countries/ Strategy	Japan	Singapore	Malaysia	India	Indonesia
Integrated land-use and transportation management	Develop a compact town connected to the entire region. Coordinate with urban planning to revitalize and rehabilitate.	Decentralize population by constructing residential blocks away from central business districts connected by transits.	Mixed urban and sub-urban choice of transportation and land development, prioritized vehicle movement.	Reduce traffic congestion via mix-use, dense regional development especially key transport corridors, transit lines.	Develop urban transportation by improving mobility for goods transfer and land use.
Needs-centric transportation systems	Create minimal environmental effect - optimize logistics, improve convenience, increase bus travel.	Create convenience by ensuring transits are connected to walkways via the park and ride scheme.	Transit-friendly policies dedicated to rapid transit systems connecting to major destinations.	Road pricing and rapid transit-friendly.	Integrated public transportation system connected to major destination and recreation areas.
Non-motorized transportation	"Machinori" (Foundation, 2020) program - walkable town development with bike rental/sharing system from any port.	Cycling track connected to every public transport and pedestrian lane.	Pedestrian lanes and bicycle transport system.	Bicycle sharing system connected to public transportation.	Traditional non-motorized transportation e.g., becak, andong, while bicycle track, greenways are under development.
Use of new technology	Develop high-speed train, electric vehicles, Intelligent Transportation Systems (Vehicle Information system, communication/real-time traffic information, integrated traffic control systems).	Develop green vehicles e.g., electric vehicles, petrol-electric hybrid, and bio-fuel. Implement Intelligent Transportation Systems (ITS) e.g., real-time traffic information, operation control center.	Produce biofuel from palm oil, Intelligent Transportation Systems, and development of electric vehicles.	Develop electric car and biofuel, implement an Intelligent Transportation System to ensure efficient traffic flow.	Support new technologies, e.g., MRT and develop biofuel energy.

Section C answers Objective 2, i.e., which policies and strategies are feasible and which project management knowledge areas do these policies and strategies fall into?

C. Comparisons, suggestions, and project management knowledge area foci

Table 4 compares the similarities and differences between other countries and Indonesia's policies and strategies. We assess the feasibility of adopting/adapting these policies and strategies based on Project Management Knowledge Areas [27].

Table 4. Project Management knowledge areas and feasibility of adopting/adapting

Knowledge Areas	Implementation in other countries	Implementation in Indonesia (Tjahjati, 2020)	Feasibility of implementation in Indonesia

Project Integration Management	○ Integrated various transportation, and infrastructure modes along with transit-oriented development. ○ Implemented transit-friendly policies dedicated to rapid transit systems, which connect major destinations, e.g., BRT, MRT, LRT.	○ Indonesian cities mostly rely on the para-transit transportations (angkot, Metromini bus, bajaj). ○ Indonesia implemented strategies to develop urban transport focused on improving the interaction between mobility (public transport and transfer goods) and land use.	○ increase interconnection among various core places and remote areas to accommodate high demand and ensure efficiency ○ create a Metropolitan Transport Authority (MTA) to facilitate decision-making among various local administrative bodies in integration planning and synchronization of public transport modes (Farda & Lubis, 2018) [28]
Project Scope Management	○ Japan created a walkable town development and a "Machinori" program providing a rental bike and sharing cycle system.	○ Indonesia focuses on developing the footbridges, sidewalks, and crosswalks to ensure road users' safety.	○ develop bicycle tracks and parking, pedestrian lanes and crosswalks, to complement key elements of sustainable transportation systems. ○ traffic restrictions to regulate the movement of personally-owned vehicles.
Project Cost Management	○ ITS in European countries enabled real-time traffic information in smart navigation-map, bus departure and arrival information, smart parking, e-toll.	○ ITS in Indonesia: - GPS on taxi and bus. - Toll card transaction machine. - Navigation and map.	○ consider allocating investment in the improvement of ITS systems such as real-time traffic information to enable road users to know which route is best at any time.
Project Quality Management	○ European countries implemented the EU standard framework such as: - Emissions standards for CO2 in all transport modes - Production of biofuels - Standards guidelines for refueling infrastructure ○ Development of infrastructure	○ develop transport infrastructure e.g. toll, road bridge, new airport and ports, roadways to increase economic activities to connect all inter-island transportation. ○ reforming regulations including legal transparency in law, simplification of licensing procedures, fuel subsidies	○ the Indonesian government needs to reform their programs and regulations to attract more private sector investments. ○ Adapting regulations and frameworks e.g.,: - Emission Standard policy - Electric car vehicle regulation - Higher private vehicle tax - Transport Demand Management

In Section IV, we discuss findings from the survey on respondents' perceptions towards the suggested sustainable transportation initiatives in Section III (macro-micro policies and strategies in Western countries and Eastern countries). This section answers Objective 3.

IV. Findings and discussions

We first present results based on descriptive statistics and then inferential statistics and subsequently, the discussion.

A. Demographics

1) Respondents' gender

There were 201 respondents; 89 (44.3%) were female and 112 (55.7%) male. The ratio is close to the population ratio.

2) Respondents' age

The respondents were of six age categories: under 18, 18 – 24, 25 -34, 35-54 and 55 – 64. The majority of respondents were in the age group of 18 - 24 (55.7%) and 25 – 34 (23.9%). Percentage of respondents in the under 18, 35 – 44, 45 – 54 and 55 – 64 age groups were 0.8%, 9.5%, 8% and 2.5% respectively. The distribution of respondents leans towards the younger generation. The breakdown is presented in Table 5a.

Table 5a. Breakdown of age distribution

	Age group						Total
	<18	18-24	25-34	35-44	45-54	55-64	
N	5	112	48	19	16	1	201

3) Respondents' occupation

A majority of respondents were working adults (46.8%) and students (44.3%). Another 7% of respondents were unemployed and 2% others. The breakdown is in Table 5b.

Table 5b. Breakdown of occupation distribution

	Gender				Total
	Working	Student	Unemployed	Others	
N	94	95	8	4	201

B. Analysis (descriptive statistics)

1) Satisfaction towards current public transportation

The key dependent variable in our research (Survey question #3) "What do you think about our current public transportation?" The frequency distribution for this variable is as follows and reflects a Gaussian distribution:

Very Dissatisfied	24	11.9%
Dissatisfied	72	35.8%
Neutral	44	21.9%
Satisfied	50	24.9%
Very Satisfied	11	5.5%

2) Factors for not using public transportation

Next, we predicted this variable as the dependent variable in a regression where the independent variables were the factors listed for choosing not to use public transportation. Seven factors were considered with regards to whether to use public transportation. These were distance, time taken, length of the journey, weather, the lack of route information, and choice of transportation modes (bus, taxi, ojek, angkot, etc.)

This is supported by Figure 1 and Table 6, which indicate that distance, time taken, safety, weather, and length of journey are the most important factors. However, the differences in mean and standard deviation, are not substantial.

As such, we investigate deeper into the type of preferred transportation. We used a simultaneous regression algorithm. Only one factor was statistically significant: length of journey, with a beta of -.255 and a sig *t* of .014. The R squared was .109.

Due to the low R squared statistic, a correlation analysis was further carried out. Subsequent correlation analysis (Table 12) indicates a moderate correlation between i) length of journey and time taken, and ii) length of journey and safety. This implies a possible tradeoff among the three factors,

possibly, of equal weight, based on correlational strength of 0.642 and 0.559 respectively. This also implies persuasion and incentives may encourage acceptance and more extensive use of sustainable transportation.

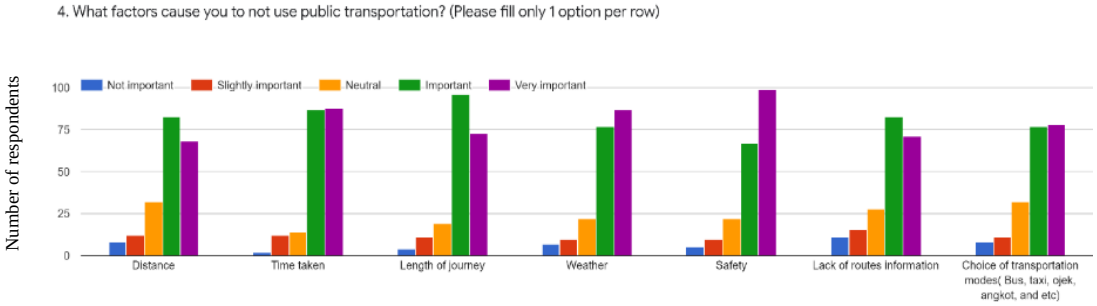


Figure 1. Factors for not using public transportation

Table 6. Mean value and standard deviation for factors affecting the avoidance of public transportation

Factors	Mean	Mean Rank	Standard deviation
Time taken	4.21	1	0.89
Safety	4.20	2	0.99
Weather	4.11	3	1.02
Length of journey	4.10	4	0.91
Choice of transportation	4.00	5	1.06
Distance	3.95	6	1.03
Lack of routes information	3.90	7	1.13

3) Transportation that respondents use for respective destinations

The transportation that respondents use were train, bus, motortcycle, car, taxi/grab, and walking. Figure 2 illustrates that most respondents drive to go shopping (99 respondents), for other activities (99 respondents), and to work (93 respondents). Another half of the respondents, however, utilize different types of transporation. The bus and car are the two most popular types of transportation. Since the percentage of preferences for this survey is almost equal, we investigate further about their opinion on the current transportation system.

4) Respondents' satisfaction about current transportation

The respondents' opinion about the current transportation were assessed based on a Likert scale of 1 to 5 where 1 is very dissatisfied, 2 less satisfied, 3 moderately satisfied, 4 satisfied, 5 very satisfied. Figure 3 shows that a total of 47.7% were very dissatisfied and less satisfied, 21.9% moderately satisfied and a total of 30.4% were satisfied and very satisfied. This may be due to Indonesia being a developing country and many initiatives being recently introduced. The mean value is 2.76 with a standard deviation of 1.12.

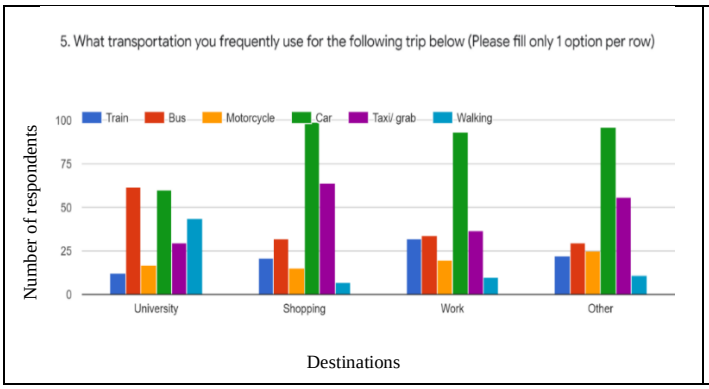


Figure 2. Types of transportation and destinations

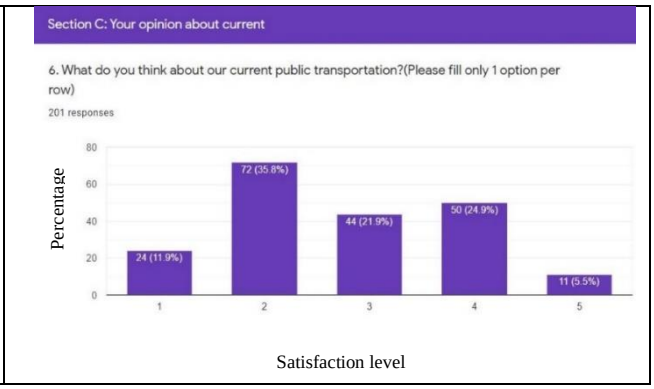


Figure 3. Respondents' satisfaction towards the current transportation system

5) Respondents' awareness of government's sustainable transportation initiatives

Hence, it makes sense to investigate respondents' awareness of transportation developments in Indonesia. This was assessed according to three levels of awareness: not aware, partially aware, fully aware. Figure 4 presents the 11 transportation developments in Indonesia along with respondents' level of awareness.

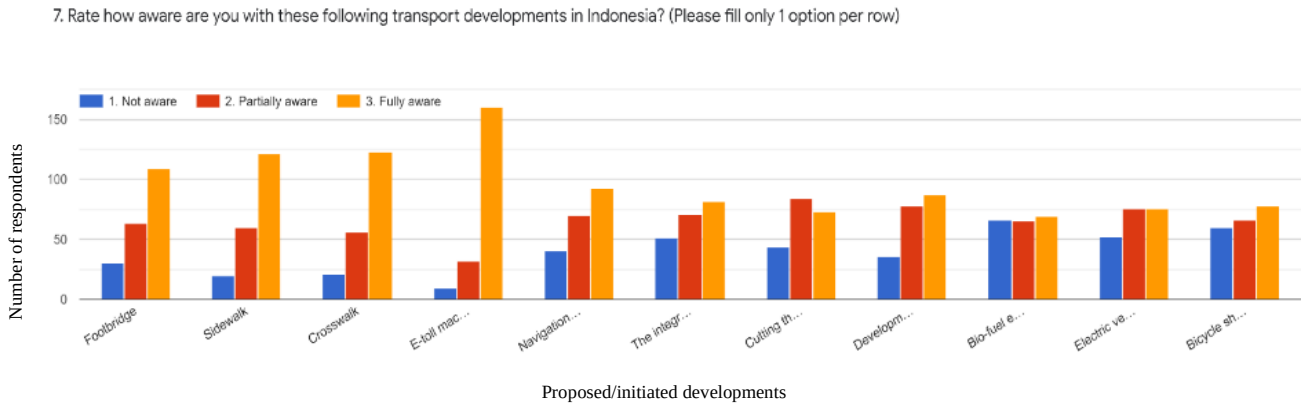


Figure 4. Respondents' awareness towards transportation developments in Indonesia

A majority of the respondents were aware of four developments: E-toll machine, crosswalk, sidewalk, and footbridge (Table 7). All respondents were partially aware (above 50%) of other developments. This indicates that the communication between the government and the public is positive. The higher percentage for e-toll may be due to the higher percentage of respondents who are working.

Table 7. Respondents' awareness towards transportation developments in Indonesia

Initiatives	Mean	Mean rank	Standard deviation
E-toll machine	2.74	1	0.54
Crosswalk	2.51	2	0.69
Sidewalk	2.50	3	0.68
Footbridge	2.39	4	0.74
Navigation on taxi and bus	2.25	5	0.77
Development of new toll	2.24	6	0.75
Cutting the fuel subsidies	2.15	7	0.74
The integration of transit system	2.13	8	0.80
Electric vehicles	2.12	9	0.78
Bicycle sharing system	2.07	10	0.83
Biofuel energy development	2.00	11	0.83

6) Usefulness of transportation initiatives

The usefulness of the current public transportation was assessed based on five levels: 1 not useful at all, 2 less useful, 3 average, 4 useful, 5 very useful. Figures 5a, 5b present the respondents' opinion towards the usefulness of the 11 current sustainable transportation initiatives in Indonesia.

From Figure 5a), a majority of the respondents think that Indonesia's sustainable public transportation development is useful. Among these, 97 respondents regarded sidewalk as useful, followed by 92 for e-toll, followed by 90 for crosswalk, and 76 for footbridge.

For those who take public transportation, Figure 5b shows that 88 respondents think the developments on navigation on taxi and bus are useful. For those who drive, the development of new tolls (86 respondents) is most welcomed, followed by the integration of transit system (Transjakarta, MRT station) (83), and cutting the fuel subsidies (73).

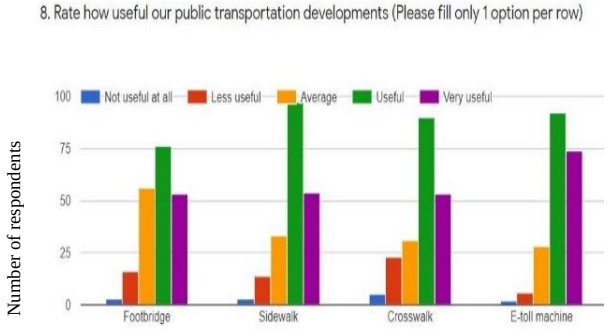


Figure 5a. Perceived usefulness towards sustainable transportation system

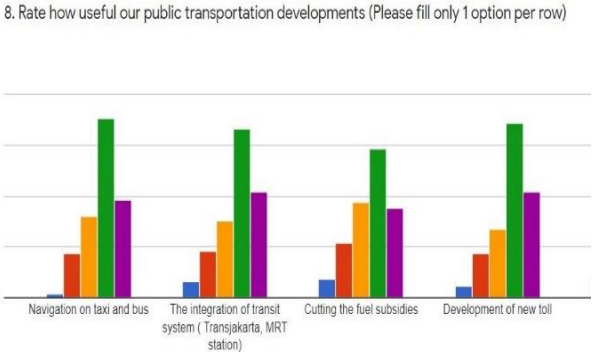


Figure 5b. Perceived usefulness towards sustainable transportation system

Table 8 presents the mean value and standard deviation for perceived usefulness towards sustainable transportation systems.

Table 8. Mean value and standard deviation for perceived usefulness towards sustainable transportation system

Initiatives	Mean	Mean rank	Standard deviation
Sidewalk	4.26	1	0.92
Footbridge	4.22	2	0.97
Crosswalk	4.20	3	1.03
E-toll machine	4.12	4	0.84
Navigation on taxi, bus	3.77	5	0.98
Development of new toll	3.77	5	1.06
Integration of transit system	3.71	7	1.10
Cutting the fuel subsidies	3.58	8	1.12
Bicycle sharing system	3.57	9	1.09
Electric vehicle	3.56	10	1.14
Bio-fuel energy development	3.54	11	1.1

7) Perceived effectiveness towards the sustainable initiatives

The initiatives investigated were divided into 15 developments, i.e., car sharing systems, cycle lanes, more bus routes, more bicycle parking, cheaper fare, pedestrian lane, high parking fees, more bus services, the frequency of bus and rail services, cut the fuel subsidies cost, accessibility to major destination, collaboration with different transport and services, best route information, real-time information (bus departure), and production in biofuel energy. These were assessed on a Likert scale of 1 to 5 with 1 being not effective, 2 slightly effective, 3 neutral, 4 effective, 5 very effective.

The overall mean values and standard deviation for perceived effectiveness towards these initiatives are presented in Table 9. The numbers in brackets indicate the number of those who rated 5. Real-time information, best route information, and accessibility to major destinations are the top three factors rated in perceived effectiveness.

This implies that the introduction of artificial intelligence towards accuracy and optimality into the transportation system would be highly desirable, consistent with Kennedy-Cuomo's suggestions for Intelligent Transportation Information Systems (ITIS), where networks of data are collected, and experts, as well as algorithms, can quickly evaluate traffic patterns, in order to optimize and alleviate traffic congestion and enhance road safety. Findings also indicate that the perceived effectiveness of more bus services depends on the number of routes and reduction of fares.

Table 9. Mean value and standard deviation for perceived effectiveness towards sustainable initiatives

Initiatives	Mean	Mean rank	Std dev.
Real-time information (85)	4.15	1	0.91
Best route information (98)	4.06	2	0.96
Accessibility to major destination (86)	4.05	3	0.98
More bus routes (96)	4.02	4	0.99
Cheaper fare (79)	4.01	5	1.04
Collaboration with different transport services (87)	4.01	5	0.98
Pedestrian lane (84)	3.98	7	0.97
More bus services (81)	3.96	8	0.95
The frequency of bus and rail services (94)	3.94	9	0.98
Production in bio-fuel energy (86)	3.89	10	1.00
Cycle lane (80)	3.85	11	1.03
More bicycle parking (76)	3.82	12	1.08
Cut the fuel subsidies (90)	3.71	13	1.03
Car sharing system (63)	3.71	13	1.17
High parking fees (69)	3.43	15	1.23

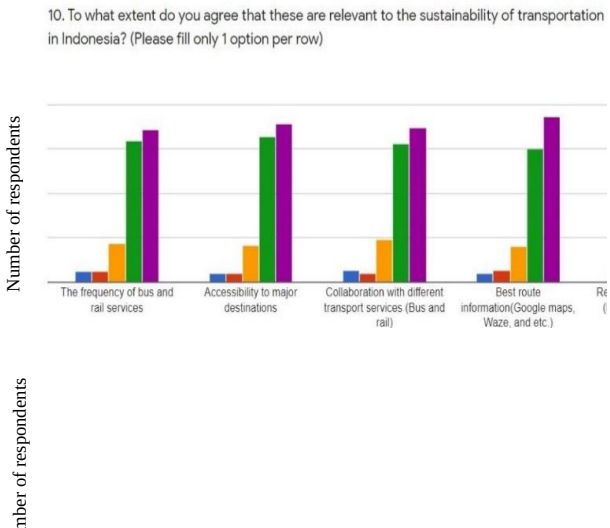
8) Agree or disagree with the sustainability initiatives

Respondents were asked to indicate to what extent they agree or disagree with the above-mentioned 15 initiatives. They were given a choice of strongly disagree, disagree, neutral, agree, or strongly agree. The top three factors are similar. However, the frequency of bus and rail services, and collaboration with different transport are ranked higher on average than more bus routes and more bus services in Table 10. This implies that respondents would prefer to optimize and extend initiatives, that would meet less resistance, with better and faster return on investments.

Table 10. Mean value and standard deviation for degree of agreement towards the sustainable initiatives

Initiatives	Mean	Mean rank	Std. dev.
Best route information (93)	4.20	1	0.97
Real-time information (87)	4.19	2	0.96
Accessibility to major destination (89)	4.19	2	0.94
The frequency of bus and rail services (86)	4.17	4	0.95
Collaboration with different transport services (87)	4.14	5	1.00
More bus routes (95)	4.11	6	0.93
More bus services (84)	4.10	7	0.98
Cheaper fare (81)	4.05	8	1.04
Pedestrian lane (88)	4.05	8	1.02
Cycle lane (92)	4.00	10	0.95
Production in bio-fuel energy (78)	3.99	11	1.02
More bicycle parking (83)	3.93	12	0.99
Car sharing system (72)	3.88	13	1.14
High parking fees (61)	3.67	14	1.18

Figure 6 presents the breakdown for the key positively agreed initiatives.



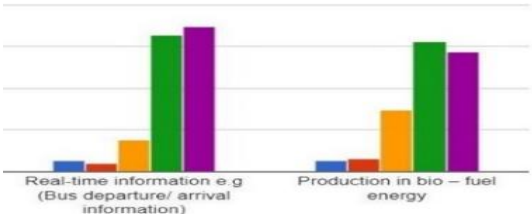


Figure 6. Degree of agreement or disagreement towards sustainable initiatives

To confirm the above findings we analyze the correlation strength using Pearson correlation. The findings are presented in the next subsection.

C. Correlation analysis

Pearson correlation is most fittingly used to analyze the relationship between two variables which are interval scaled [29]. Moreover, correlation coefficients disclose the magnitude and the course of relationships which are articulated as a *p*-value [30]. This study utilizes Pearson Correlation to test if a significant correlation exists among factors. According to the 'Guilford Rule of Thumb', [31] the strength of the correlation is based on Table 11.

Table 11. Rule of Thumb of Correlation (adapted from [31]

Criteria	Interpretation
0.00 – 0.10	Negligible
0.10 - 0.39	Weak
0.40 – 0.69	Moderate
0.70 – 0.89	Strong
0.90 – 1.00	Very Strong

The correlation analyses are presented in Table 12 below. We discuss only those with moderate and above correlation strength. We find that there are actually three main concerns: awareness of crosswalk-sidewalk-footbridge, which contributes greatly to whether respondents will take the train service (in blue), factors, which affect choice of transport (in green), and awareness of the interconnection between the bus/train and pedestrian walkways (the sidewalk), and navigation in the bus, which would provide real-time information (in purple).

Findings indicate that though there is an almost equal distribution of working people and students, most of the respondents are concerned with public transportation. As such, awareness of crosswalk-sidewalk-footbridge rank the highest in terms of Pearson correlation, at 0.786 and 0.747 respectively. The new toll is good news due to distance (0.689), time taken-length of journey (0.642) and weather (0.624). This is followed by the lack of route information and safety at 0.622. These footbridges and sidewalks (0.406, 0.394 respectively) are expected to be short in distance. Bolger [32] suggests that the maximum walking distance should be 250 m.

Table 12. Summary of correlation analyses

Factors	P- correlation	Rank
Awareness of crosswalk - Awareness of sidewalk	0.786	1
Awareness of sidewalk - Awareness of crosswalk	0.786	1
Awareness of footbridge - Awareness of sidewalk	0.747	3
Awareness development of new toll – Distance	0.689	4
Time taken - length of journey	0.642	5
Length of journey - time taken	0.642	5
Weather - time taken	0.624	7
Lack of route information - Safety	0.622	8
Distance - time taken	0.603	9
Choice of transportation - time taken	0.596	10
Time taken – Choice of transportation	0.596	10
Safety – Choice of transportation	0.571	12
Safety - length of journey	0.559	13
Awareness navigation on bus - Awareness integration of transit system	0.523	14
Awareness of sidewalk - Awareness of E-toll machine	0.515	15
Awareness of e-toll machine - Awareness of Sidewalk	0.515	15
Length of journey – Choice of transportation	0.509	17
Distance -Choice of transportation	0.499	18
Weather – Choice of transportation	0.476	19
Awareness of footbridge - Awareness of e-toll machine	0.451	20

The choice of transportation is determined by time taken at 0.596, safety at 0.571, and in turn, safety in influenced by length of journey at 0.559. Distance and weather are not as important as the navigation in the bus-integration with transit systems and sidewalk (0.523, 0.515) respectively, presumably because the respondents accept the trade-off in the length of journey (0.509).

Another interesting aspect is that although awareness of navigation in the bus and awareness of cut fuel subsidies are realistic concerns for most adult frequent travelers (due to environmental and cost concerns), the correlation strength is 0.442. This hints at the distribution of data which leans towards the younger generation as indicated in the demographics analysis.

Hence, initiatives to encourage sustainable transportation development should prioritize the interconnection between the non-vehicle and vehicle ecosystems, with higher priority to the non-vehicle ecosystem adapted to first suit the lifestyles of the respondents, such as short walking distances (due to hot humid weather), time, choice (navigation in the bus and integrated transit system), and safety. The other factors are weak in correlation strength.

The wish list derived from Tables 9, 10, and the corresponding correlation strength (Table 12) are indicated in Table 13. These findings suggest that priority may lean towards awareness of crosswalk-sidewalk-footbridge, followed by choice of transportation and integration-related concerns.

Thus far, we have identified the significant correlations and the three categories of factors. The focus on correlations is due to our interest in correlation as the root in association rule mining. There are other techniques in association rule mining, such as by Lim and Lee [32]. We next look at the statistical significance of demographic factors.

Table 13. Respondents' top wish list based on perceived effectiveness in achieving sustainable goals and key correlations

Initiatives	Mean
Real-time information (85)	4.15
Best route information (98)	4.06
Accessibility to major destination (86)	4.05
More bus routes (96)	4.02
Cheaper fare (79)	4.01
Collaboration with different transport services (87)	4.01
Pedestrian lane (84)	3.98
More bus services (81)	3.96
The frequency of bus and rail services (94)	3.94

Initiatives	Mean
Best route information (93)	4.20
Real-time information (87)	4.19
Accessibility to major destination (89)	4.19
The frequency of bus and rail services (86)	4.17
Collaboration with different transport services (87)	4.14
More bus routes (95)	4.11
More bus services (84)	4.10
Cheaper fare (81)	4.05
Pedestrian lane (88)	4.05
Cycle lane (92)	4.00

Factors	Pearson correlation
Choice of transportation - time taken	0.596
Time taken – Choice of transportation	0.596
Safety – Choice of transportation	0.571
Safety - length of journey	0.559
Awareness navigation on bus - Awareness integration of transit system	0.523
Awareness of sidewalk - Awareness of e-toll	0.515
Awareness of e-toll - Awareness of sidewalk	0.515

D. Statistical significance

1) Single-factor ANOVA with six different age groups across five categories

This subsection covers whether there are significant differences in terms of age groups, with regards to perception towards sustainable transportation. We calculated the average score of each category and used one-way ANOVA for each of the five sustainable transportation categories.

Table 15 displays the result. It turns out that there is no significant mean difference between age groups across all five sustainable transportation categories in Table 1. Findings support that of the correlation analysis.

Table 15. Single-factor ANOVA with six different age groups across five categories

Category	Source of variation	SS	df	MS	F	*p*-value
Factors	Between groups	4.818	5	0.963	1.649	0.149
	Within groups	113.960	195	0.584		
	Total	118.778	200			
Usefulness	Between groups	2.380	5	0.476	0.895	0.486
	Within groups	103.759	195	0.532		
	Total	106.139	200			
Effectiveness	Between groups	1.784	5	0.357	0.591	0.707
	Within groups	117.676	195	0.603		
	Total	119.460	200			
Awareness	Between groups	1.636	5	0.327	1.395	0.228
	Within groups	45.739	195	0.235		
	Total	47.375	200			
Agreement	Between groups	1.278	5	0.256	0.386	0.858
	Within groups	128.943	195	0.661		
	Total	130.221	200			

*significant at $\alpha = 0.05$

2) Single-factor ANOVA with four different occupation across five categories

This subsection covers whether there is a significant difference between the occupation groups with regards to sustainable transportation. We calculated the average score of each category, then conducted one-way ANOVA for each of five sustainable transportation categories. Table 16 displays the result.

There is no significant mean difference between occupation groups across all five categories, except for one factor, i.e., not using public transportation. Since the *p*-value corresponding to the F-statistic of one-way ANOVA is lower than 0.05 for the effectiveness category, it suggests that one or more factors are significantly different. However, after performing several post-hoc tests, including the Tukey HSD, and Scheffe and Bonferroni and Holm multiple comparison tests [33], we find no significant mean difference for occupation.

Table 16. Single-factor ANOVA with four different occupations across five categories

Category	Source of variation	SS	df	MS	F	*p*-value
Factors	Between groups	5.625	3	1.875	3.264	0.022*
	Within groups	113.153	197	0.574		
	Total	118.778	200			
Usefulness	Between groups	2.147	3	1.049	2.006	0.114
	Within groups	102.992	197	0.523		
	Total	106.139	200			
Effectiveness	Between groups	3.032	3	1.011	1.710	0.166
	Within groups	116.429	197	0.591		
	Total	119. 640	200			
Awareness	Between groups	0.164	3	0.054	0.228	0.877
	Within groups	47.211	197	0.240		
	Total	47.375	200			
Agreement	Between groups	0.686	3	0.229	0.348	0.791
	Within groups	129.626	197	0.658		
	Total	130.221	200			

*significant at $\alpha = 0.05$

3) Correlation and effect size

This subsection covers the correlation between each of the five sustainable transportation categories among all participants. We calculated the average score for each category. We observe that the correlation values between two distinct components across all five categories are positive. All correlation values are very significant ($p < 0.01$).

However, some of the correlations exhibit a stronger effect size than the others. The largest effect size ($r = 0.7753$) occurs between the category "Effectiveness towards sustainable transportation" and the category "Agreement to the relevancy

of sustainable transportation". Two correlations exhibit small effect sizes. The smallest effect size (r = 0.2509) occurs between the category "Factors for causing not using public transportation" and the category "Usefulness of public transportation developments". The second smallest effect size occurs between the same former but different latter categories, i.e., "Awareness towards sustainable transportation developments".

The other effect sizes are medium in effect size. Table 17 shows the findings.

Table 17. Correlation and effect size

	Factors	Awareness	Usefulness	Effectiveness	Agreement
Factors	1	0.2687	0.2509	0.4671	0.3929
Awareness		1	0.3638	0.3469	0.3940
Usefulness			1	0.5102	0.4454
Effectiveness				1	0.7353
Agreement					1

From the perception analyses above, we hope that the findings would better inform governments with regards to urban planning especially in terms of prioritizing budgets, due to financial barriers during and post-pandemic. Further readiness surveys would also need to be carried out, in order to develop more needs-based development, as different demographics would have different needs and environments.

Since findings from inferential statistics strongly support that of descriptive analyses, in the next section, we present some suggestions.

V. Comparison

Transport demand management is a concept to encourage people to shift from the use of a private vehicle to public transportation. The purpose of transport demand management is to create a variety of transportation options. The results indicate positive perceptions towards sustainable development initiatives. However, facilities will only be replaced due to wear and tear and based on the availability of funding/budget. Hence, in the next subsection, we compare our findings with that of other countries to assess the findings comparatively and to determine priorities.

A. Factors influencing demand for park and ride

The shift from transportation to travel demand strategy is highlighted by park-and-ride as a travel demand strategy. It is suggested by Ying and Xiang [14] and then by Rosli, Syed Adnan, Ismail and Hamsa [15]. Ying and Xiang [14] find that there are several factors influencing demand, i.e., *waiting time, transfer time, walking distance, and cost* of the transit line.

Based on their findings, 85% of the travelers are satisfied with 5 minutes of transfer time, and a 500-meter transfer distance. This guideline is useful in planning park-and-ride facilities, and public transportation systems.

In [15]'s review, they find that Atkins [16] and the DETR park and ride acceptance in Brighton, Cambridge, Coventry, Norwich, Plymouth, Reading, Shrewsbury, and York depends on *cost, convenience, reliability, frequency, difficulty in parking, and travel time.* They also find that among these factors, *cost and travel time are the most likely to influence more.*

Lam, Nicholas, and Lo's [35] findings on Eastern countries confirm that *cost and time savings* are the most important influences. Some developed and higher middle-income countries also plan in such a way that tourist attractions are easily accessible or near to the train stations. This helps not only in terms of sustainability, but also in terms of tourism.

Furthermore, multiple transit options with price comparisons, are positively accepted by users, across countries. Hence, there is much promise and room for expansion for intelligent interconnected ecosystems.

B. Modesplit and safety

These findings are also consistent with that of prior literature as reviewed above and Bachok, Ponrahono, Osman, Jaafar, Ibrahim, and Mohamed's [36] investigation into sustainable transport indicators in the Klang Valley, Malaysia. They find that for possible indicators, the highest mean value is for "Mode split: a portion of travel made by walking, cycling, rideshare, public transit, and telework," (i.e., diverse options), while the lowest mean value is for "Excise duty on road transport fuel (petrol, diesel per 1000 liters)."

Many developed countries have linked and connected their walkways with public transportation such as bus rapid transit (BRT) stations and many major destinations such as hospital, mall, theme park, to encourage people to drive less, reduce the traffic congestions, reduce the carbon emission, and promote public health. An example of walkway development is Sunway city's Eco Walk (Sunway Sustainability Report [37]. More outstanding global examples are in the Sustainable Development Solutions Network report [38].

Safety is found to be of equally high importance in both Jakarta and the Klang Valley. Hence, more awareness, such as the provision of real-time information and factors presented in Table 13 need to be considered.

VI. Suggestions

The following may add value:

a) In line with Information Science's Information Communications architectural design and development, most evident in enterprise resource planning, customer relationship management systems and supply chains, such as highlighted by [39], there is a need to rethink the interconnected and nested ecosystems between services, infrastructure and job creation around travel, work, living experiences, and economic generation; intertwining design anthropology with travel anthropology. An example is to link climate action (SDG13) to health and well-being (SDG3), smart cities and smart communities (SDG11), and interconnect with dynamic supply chains (partnership for the goals SDG17). For instance, mobile health and fitness apps, e.g., Fitbit and Strava, recommend new walking paths based on GPS locations, as well as real-time connection with other friends in the same vicinity, and leader boards, besides monitoring and display of health data. Recommendations of community-based and related businesses, such as by Foursquare can easily mushroom.
b) With the Internet of Things (IoT), analytics on human–computer interaction derived from the ways people generate, use, and find information holds much promise. Tyagi and Abraham's [40] survey on IoT problems and challenges, has identified several problems, and opportunities. We group them into input, processing, and output. With regards to input, in view of the multiple sources of data, data characteristics (such as volume, velocity, heterogeneity), indicate the need to develop new approaches, not only

for automatic /non-automatic data collection, data quality, standardization, and interoperability, but also integration and aggregation. In terms of processing, context-awareness needs to consider new techniques to automatically assign IoT input/device identity, develop easily reprogrammable networks for more efficient and effective scalability and interoperability and Quality of Service, unsupervised/ supervised/semi-supervised analytics and GIS-based visualizations. The outcome may be emergent or planned. The input, processing, output categorization reflects the agile, component-based, and adaptable flow across designs.

c) External influences such as human factors (privacy, security, and trust), pose further challenges to the development/sustenance of opportunities for innovation diffusion. Techniques such as convolution neural networks (CNN), within distributed agile ecosystems are expected to not only optimize information flows, but also social networks.

d) [41] suggest specifically focusing three weeks of Scrum to reengineering components/modules of high complexity. To evaluate complexity, they have used the Chidamber and Kemerer metrics. The consequent scope, time, cost savings for the login, IDE and user detail components in their case study are between 43%-75%. Greater emphasis on discussions among stakeholders would thus provide much avenue for technological, and policy reengineering.

VII. Conclusion

We have aimed to identify sustainable transportation initiatives in some Western and Eastern countries, and carried out a survey to investigate the perception of a sample group of respondents in Jakarta, Indonesia, towards sustainable transportation initiatives. Findings indicated that most of the respondents are aware and positive towards these initiatives. We have also identified that real-time information and safety are the most important factors in line with Kennedy-Cuomo (2018) and the Asian Development Bank. We conclude that the most important for sustainability in Smart Cities are (happy) and adaptable, extensive, and scalable smart communities (SDG3, 11), job creation, and partnerships (SDG17).

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