



Paper 84

Scenario Planning Development for Public Transportation
in Jakarta to Achieve Net Zero Emission

Muhammad Rizky Ramadhan, Yos Sunitiyoso, and Agung Wicaksono

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Abstract - Indonesia is one of the countries that participated in the Paris Agreement, the international pact concerned with reducing global warming growth by targeting to achieve Net Zero Emission (NZE) in 2060 or earlier. One of the sectors that can be implied to reduce the emissions produced in the transportation sector. This research aimed to identify the challenges and plausible scenarios for public transportation in Jakarta in the upcoming ten years to achieve net zero emissions. The method used in this study was qualitative by interviewing several stakeholders. The interview results were analyzed and written into a transformative scenario. The sequence of scenarios is implemented based on urgency to achieve the ideal situation according to the interconnection analysis of each factor with high impact and uncertainty. It results in five scenarios, namely 1) Gridlock and Pollution, 2) Stopping at Red Light, 3) Green Light to Go, 4) Getting There, and 5) Green and Connected. Therefore, it is expected that the public transportation providers cooperate with the Government, regulators, and firms related to their operation to achieve net zero emission in 2032.

Keywords - Scenario Planning; Public Transportation; Net Zero Emission.

I. INTRODUCTION

In this modern era, many technologies are often found to make human life more manageable. However, this convenience does not deny the negative side of global warming. Global warming is a form of ecosystem imbalance due to increasing the average temperature. If not controlled immediately, global warming can harm human life, such as sea-level rise, temperature increases beyond the limits of human adaptation, prolonged drought, etc.

To avoid this problem, various countries are making efforts to reduce the growth of global warming through the Paris Agreement. The Paris Agreement is a legally binding international treaty on climate change adopted by 196 Parties at COP 21 in Paris on December 12, 2015 and entered into force on November 4, 2016 [1]. The Paris Agreement aims to slow global warming by maintaining it below 2, preferably 1.5 degrees Celsius. There are three ways for countries involved in the Paris Agreement to support each other to achieve their goals: financial, technical, and capacity-building support.

One of the countries that participated in the Paris Agreement is Indonesia. In November 2021, Febrio Kacaribu, Head of the Fiscal Policy Agency (BKF) of the Ministry of Finance (Kemenkeu), explained to the press that in the 2021 NDC update document, through the long-term strategy - low carbon and climate resilience (LTS - LTCCR) Indonesia has also targeted to achieve Net Zero Emission (NZE) in 2060 or earlier [2]. Achieving this takes much participation by various parties, both public and private.

One sector that can provide an immense contribution is the transportation sector. People need transportation to move to various places to carry out activities. As the capital city of Indonesia, Jakarta is the country's representative. According to the TomTom Traffic Index in January 2021, cited from [3], Jakarta ranks 31st out of 416 cities of the World's Worst Cities for Traffic Jams in 2020. One of the causes of congestion, in general, is the high number of private vehicles. According to the research conducted by the Central Bureau of Statistics of Indonesia, the number of private vehicles such as private cars and motorcycles has been rising in significant numbers for the last couple of years. In percentage, private cars have increased 0.60% (2018 - 2019) and 9.94% (2019 - 2020) while motorcycle has increased 0.72% (2018 - 2019) and 96.97% (2019 - 2020). The details of its numbers are shown in the table below:

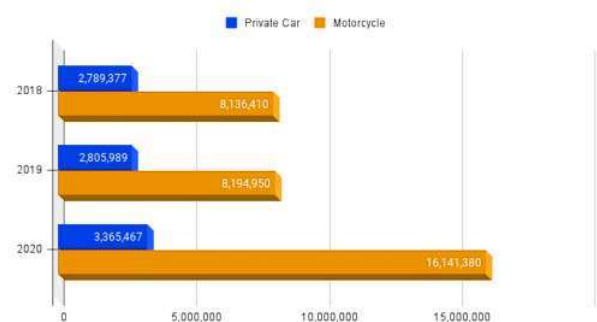


Fig. 1. Number of Motorized Vehicles by Vehicle Type (units) in DKI Jakarta Province 2018-2020. Source: [4]

Therefore, noting that the number of private vehicles arises so fast that it may cause gridlock and environmental pollution, the Government, with the help of public transportation operators in Jakarta, needs to be present

more deeply to attract people to shift from private vehicles to public transportation that friendly environment to achieve net zero emission.

This research aimed to identify the challenges and plausible scenarios for public transportation in Jakarta in the upcoming ten years to achieve net zero emissions. The research started with exploring the issue by conducting industry analysis throughout PESTEL and literature review. Furthermore, to have a deeper understanding of Jakarta's public transportation industry due to the realization of Net Zero Emission, this research also interviewed several experts from stakeholders that comprehensively understand public transportation and the implementation of net zero emissions in their respective firms.

The interview aims to capture the steps taken, the challenges, and the driving forces that have high impact and uncertainty, which may drive the implementation of net zero emissions in their respective firms. The interview results then used to be the primary material for scenario analysis to achieve net zero emission for public transportation in Jakarta.

II. METHODOLOGY

The research was conducted through qualitative methods. Meanwhile, the literature review is useful as basic reference material to determine the theory to be used in this study. In addition, the literature review is needed to help the author capture the industry's environment and interview to get the insight of every stakeholder involved in the industry so the author can have a broad understanding before developing the key focal issue.

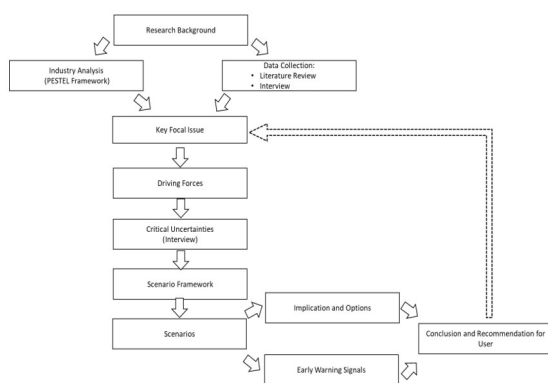


Fig. 2. Research methodology.

PESTEL model is a framework that categorizes and analyzes six important segments: Political, Economic, Socio-cultural, Technological, Ecological, and Legal, that might impinge upon a firm and create both opportunities and threats for the firm [5]. In this study, PESTEL is also used to be the basis of interview questions to dig deeper into how each factor in PESTEL influences the implementation of net zero emissions in public transportation according to the stakeholders involved.

The early shift to net zero emission must bring uncertainty to the public transportation industry. This study uses scenario planning to bring an ease for stakeholders involved in facing uncertain conditions. The term scenario has many meanings, ranging from movie scripts and loose projections to statistical combinations of uncertainties [6]. However, if examined in more depth, the existing combination of uncertainties can be used as the basis for a plan to tackle the impact of uncertainties in the future, which we can call scenario planning. Reference [7] show one of the definitions of scenario planning as an effective futuring tool that enables planners to examine what is likely and what is unlikely to happen, knowing well that unlikely elements in an organization are those that can determine its relative success.

Making scenario planning has many benefits that can help policymakers in Government or decision-makers in a company prepare things to help their firm stay afloat amidst the uncertainties. The benefit of scenario planning lies in its ability to anticipate the future, thereby improving the potential of an organization to better respond to future events [8]. It also empowers professional planners by making them aware of the different ways the future may unfold for their communities—regardless of their scale or resources [9]. Considering its impact, scenario planning is often used in various areas. For example, it is widely used in military planning, business planning, emergency preparedness, disaster planning, and other applications, including education, environmental policy, health, and the pharmaceutical industry [10].

In conducting scenario planning, there are several components that we must put concerns and stages to be passed so that our scenario planning can be right on target and valuable for the firm or stakeholders we helped. Reference [11] defined several scenario planning components and stages. When combined, all these elements can create a multidimensional future vision. The methodology is depicted in the figure below, along with the elements in the green box and their relationships.

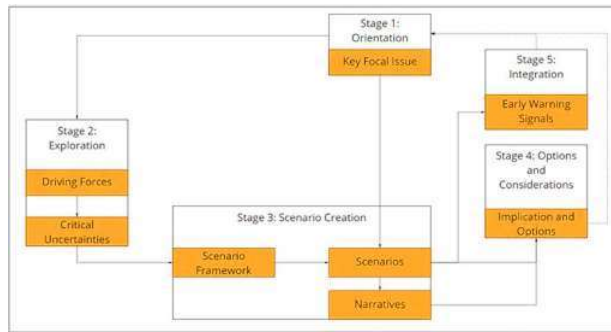


Fig. 3. Methodology and elements of scenario planning. Adapted from [11] as cited in [12]

In order to figure out stage 1 and stage 2, this study conducted interviews with eight experts from the stakeholders involved in the public transportation industry. These experts are business expansion – rail-line based company A (1), fleet evaluation & development – road-based company (2), external relations & corporate image care – rail-line based company B (3), president director – integrated payment company (4), VP transport & mobility – ride-hailing company (5), energy analyst – regulators (6), associate professor – ITB (7), and expert – state-owned enterprises energy (8). Due to the COVID – 19 pandemics, the interviews in this study were carried out in April – July 2022 via Zoom and phone calls. Therefore, the technique of determining respondents in this study was carried out purposively, namely, selecting sources assessed according to research needs and capabilities to provide the information researchers need.

III. RESULTS

In stage 1, based on the interview conducted with several stakeholders, the Authors find issues that may prolong NZE's realization of Public Transportation in Jakarta. Therefore, the key focal issue is "What steps need to be taken to achieve Net Zero-Emissions in the next ten years?". Besides that, the interview conducted with several stakeholders is codified and visualized. It aims to provide an overview of what steps have been taken by public transportation providers, their challenges, and the steps they need to take to improve the implementation of the Net Zero-Emission program. As a result, several steps have been taken by public transportation providers in Jakarta, which are: 1) Raise public awareness, 2) Electric vehicles (EVs) implementation, 3) Emission check services, 4) Integrated payment, 5) EVs battery ecosystem development, 6) Roadmap development, 7) Carbon offset incentives, 8) Renewable energy plan, and 9) Battery swap.

Nonetheless, in doing all of those steps above, public transportation providers may face different challenges,

depending on their offered services. From the in-depth interview activities conducted by the author, the respondents also gave information about the challenges they currently face in accelerating the net zero-emission program in their firm. All the challenges mentioned by the respondents are 1) Infrastructure readiness, 2) Economic readiness, 3) Technology scarcity, 4) Surplus electricity, 5) Law implementation, 6) Lack of regulation support, and 7) Lack of public awareness.

In addition, the authors also discussed the steps that needed to be improved to accelerate the implementation of the Net Zero-Emission program in the Public Transportation Industry in Jakarta. This effort is needed to capture their point of view and plans in the next couple of years so that in the making of scenario, the authors can have a broader view of the issue that may prolong and accelerate the implementation. There are some steps mentioned by respondents that need to be done by stakeholders involved are 1) Push and pull policy, 2) Scale up electric vehicles (EVs) implementation, 3) Renewable energy certificate, 4) Energy transition, and 5) Energy saving.

In stage 2, the authors are trying to identify the driving forces of the Net Zero-Emission program in Public Transportation in Jakarta. To capture it, the author questions how each factor that consists of political, economic, socio-cultural, technology, environmental, and legal or namely PESTEL, can affect the program and how it becomes the driving force with the highest impact and highest uncertainty. All the respondents' answers were then codified and visualized to summarize these issues, as shown in figure 4, for the highest impact:



Fig. 4. Driving forces with the highest impact on the realization of net zero-emission in public transport (Size of each box represents how often the respondents mention the factors)

In addition, the factors that become the driving forces with the highest uncertainty are shown in figure 5 below:



Fig. 5. Driving forces with the highest uncertainty on the realization of net zero-emission in public transport. (Size of each box represents how often the respondents mention the steps)

Based on the interview conducted, four factors have a high impact and high uncertainties mentioned by the respondents, as shown in the table below:

Table 1 - DETAILS OF DRIVING FORCES WITH HIGH IMPACT AND UNCERTAINTY

High Impact	High Uncertainty
Economic (Economic Readiness, Economies of Scale, and Lack of Economic Support)	Socio-culture (Public Awareness and Willingness)
Technological (Technological Development and Transfer knowledge)	Economic (Economies of Scale and Economic Growth)
Legal (Incentives Regulation, Policy Period, Law Enforcement)	Political (Political Willingness, Presidential Terms, and Political Resilience)
Political (Political Decision and Political Willingness)	Legal (Implementation Plan and Complex Bureaucracy)

Therefore, instead of choosing which top two factors have the highest impact and uncertainty, the author built a scenario based on all those factors. Considering that all factors have interconnection, the implementation will not run well if we take out one from the group.



Fig. 6 Interconnection between each factor.

In addition, noting that legal is an output of political action and willingness, the authors decided to group these two into one factor named regulation. The interconnection of each factor is visualized above and described below. The orders of category in the design are built based on what should be the priority according to the interview result and the author's assumption:

1. Interconnection of Regulation to:

- o Economics

Regulation will be a determining factor in helping public transportation providers to achieve net-zero emissions. When the Government later stipulates applicable regulations as a reference for the public transportation industry, especially Jakarta, to perform net-zero emissions, these regulations will have the power to bind public transportation providers to implement net-zero emissions, which will enforce them to prepare the Economic Readiness.

- o Technology

Other than enforcing the public transport provider to prepare their economic readiness to implement EVs and technology related to renewable energy that may be useful to achieve net zero-emission, the Government should give incentives to the firm/public transportation provider. It will make them attracted to shift into environmentally – friendly technology. Incentives are needed by considering the price of technology to implementing net zero-emission is kindly expensive. Therefore, incentives such as tax or else, hopefully, can ease the financial burden carried out by the public transport provider.

- o Socio-culture

In addition to encouraging the implementation of net-zero emissions through the economic factors of public transport providers and technology, the Government may also accelerate it by giving incentives to the public. It is all needed considering that the technology investment to support net zero-emission is expensive, so the public transport provider should raise the cost of the services to cover up the investment. The incentives to gain higher rates of users can be imposed through public service obligations so that the usage cost paid by the customer can be more affordable. In the situation where the Government didn't provide incentives to socio-culture factors, along with the usage cost of private vehicles such as two-wheelers being lower than using public transport, the failure possibility of public transportation is high. As a result, the investment that all stakeholders involved spend does not reach the maximum benefits.

2. Interconnection of Economic to:

- o Technology

In a condition where the Government has enforced the public transport provider to prepare their economic readiness and give incentives to those willing to shift to environmentally friendly technology throughout regulation, the economy and technology factors will have an interconnection. The interconnection happens in the form of research and development, where the public transport provider has economic readiness and help from the Government through incentives.

3. Interconnection of Technology to:

o Economic

When technology gets support from regulations in the form of incentives and public transport providers have economic readiness, research and development will be created. This research and development activity will result in the interconnection between technology and the economy, which is economies of scale, where the production of a technology increases and makes the technology become something familiar, leading to higher cost-saving for public transportation providers.

o Socio-culture

In a condition where technology is getting cheaper because it has reached the point of economies of scale, this will result in more public transportation providers able to provide technology such as EVs, charging stations, solar panels, and others. Furthermore, the more widespread technology is used, it will increase public awareness of net-zero emissions and related technology. In addition, support from the Government for socio-culture, such as incentives in the form of public service obligations that result in lower prices for public transportation services, can increase public willingness to use public transportation services so that investments made by public transportation providers achieve maximum benefits.

In stage 3, based on the interconnection analysis of each factor above, it can be concluded that regulation plays an important role. It relates to political actors' impact of applying regulations on other factors. However, to achieve net zero-emission in the public transportation industry, the Government must cooperate with the public transport providers involved so that the conditions created are not only environmentally friendly technology, but users of public transport also have a high level of public awareness and willingness so that it can provide maximum benefit.

In addition, the sequence of stages will be implemented based on urgency to achieve the ideal situation based on the interconnection analysis of each factor above, and the form of the scenario used in this study is the transformative scenario. The scenario framework in this study will consist of four different stages before the implementation of net zero-emission in the public transport industry in Jakarta

achieves the ideal condition that the author aims for, as can be seen in figure below:

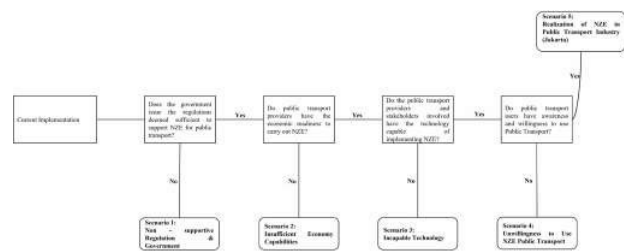


Fig. 7. Scenario Framework for Public Transportation in Jakarta to Achieve Net Zero Emission.

Each scenario in the framework will run for the next ten years, or 2032 by considering the results of interviews with several public transport providers targeting a total shift to environmentally friendly such as EVs and the application of renewable energy in the range of 2030 – 2035.

Each scenario above will be named and given headlines to represent its situation. In addition, the details of each scenario will then be described in narratives to capture how one scenario affects the other and the condition of the implementation of net zero emission in the public transportation industry in 2032.

Naming each scenario uses a vehicle's movement and its type. For example, ICE vehicles are illustrated with exhaust smoke, and EVs are represented with electric plugs. All these illustrations represent the complexity of shifting to environmentally friendly vehicles and the changing habits from using private cars to public transportation. Considering that the form of the scenario is a transformative study, the direction, the number of private and public vehicles, and their types (such as ICE and EVs) represent a transformation process from one scenario to another

Table 2 - SCENARIO TITLE AND HEADLINE

Scenario	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	Gridlock and Pollution	Stopping at Red Light	Green Light to Go	Getting There	Green and Connected
Headlines	"The number of vehicles and pollution is no longer on the tolerable level, we need to find the solution to it."	"We all know where we are, however, we must prepare before going there."	"A assumption of worthy destinations called net zero emission."	"We move at a decent pace, but we need to find a way to move faster to save the environment."	"We have it all in our hand, for a better environment and future for our sons and daughters."
Illustration					

Scenario 1, Gridlock and Pollution, defines the conditions and constraints faced by the Government and public transportation in Jakarta in overcoming pollution problems caused by congestion. One of the solutions is to shift to net zero emission programs in the future. However, the name and illustration are trying to represent the worst possibility of government participation in net zero emission without providing support and supportive regulation. For example, the transition of public transportation providers back to using ICE vehicles and the failure of public encouragement will likely cause gridlock and pollution to the precedent level before planning to shift to net zero emission.

As for scenario 2, the Stopping at Red Light means that all stakeholders stand in place without moving towards their goals. It may illustrate the conditions where public transportation providers know where they should go through the Government's national plan and regulatory support. However, they cannot move because the red light or, in this case, economic readiness constrain them from reaching their destination.

Scenario 3, the Green Light to Go, means the resumption of all stakeholders after the stop caused by the precedent scenario. It may illustrate the conditions in which the Government provides support, and public transportation providers have economic readiness to shift, which means they are moving one step at a time. But unfortunately, they do not have technological capabilities, so they must do research and development. In addition, the public transportation provider does not know what will happen next in the vehicles that start to move after the green light is on. Whether they will be available to move towards their goal or should stop their movement, in this case, the technological research and development because the green light has turned red.

Otherwise, in scenario 4, the Getting There is a condition where the Government is supportive, and public transportation providers have economic and technological capabilities, which may seem easy for them to shift to net zero emission. The shifting of public transportation providers to NZE is faster than the precedent scenario. Therefore, as seen in the illustration, the number of environmentally friendly vehicles is still low compared to environmentally friendly vehicles. In conclusion, the Government and public transportation providers should find a way to move faster by raising public awareness and willingness to use public transport. Otherwise, the impact of shifting may not reach its maximum advantages.

The ideal condition is scenario 5, Green and Connected. It illustrates the four main parts of implementing net zero emission: regulation, economic readiness, technological capabilities, and public awareness – willingness fulfilled which may help them shift to net zero emission as fast

as possible. As seen in the illustration, the numbers of ICE vehicles, either private or public transportation, are zero, while the numbers of environmentally friendly public transportation arising and taking a way to reach their destination without any constraint.

Stage 4 will describe how each scenario may cause implications involving the change in government regulation, economic readiness and technological capability of Public Transportation providers, and public habits.

o Implication on Regulation

Scenario 1 is mainly caused by the political action that hasn't been ready to set the target. Yet, the regulations do not match the public transportation providers' needs. Other than that, some other things, such as policy period, and presidential terms, also affect the implementation of net zero emission since it may be giving the public transportation providers some uncertain conditions they have to deal with. All these causes may happen by the complex bureaucracy and political willingness. Unsupportive regulation will likely burden public transportation and put them in an uncertain situation to implement NZE.

Scenario 2 is a condition where the regulators or political actors have set out the target and yet support the public transportation providers by providing a supportive regulation that matches their needs. The political actors are highly willing to support net zero-emission, as seen from the imposed regulation built by the interaction between the regulator and public transportation providers. A regulation can be made at no specific time. It may take a short period, or it may take longer. However, the lack of economic capabilities that the public transportation providers have may prolong the implementation of the regulation, which will likely extend the implementation of net zero emission in the long run.

Scenario 3 is a condition where the regulators or political actors have set the target and provided a supportive regulation that matches the public transportation needs. In addition, the public transportation providers have an economic readiness to implement the regulation and reach the target set. However, the technology needed to implement net zero emission in Jakarta hasn't been ready. Therefore, they must research and develop to massively expand the implementation. The research and development may take time. For example, the acceleration of EVs buses implemented by the road-based transportation providers from 30 to 100 bears a year to be implemented. In order to accelerate it, regulations such as incentives must be given to the firm that is likely to shift and do R&D for the technology may be imposed by the Government.

Scenario 4 is a condition where the regulators or political

actors have set out the target and provided a supportive regulation that matches the public transportation needs while supported with the economic readiness and technological capabilities owned by the public transportation providers. The regulation imposed may take part in building the economies of scale in the technical aspect, so the amount of investment that the public transportation needs to spend is likely decreased, followed by the massive expansion of its technology to serve the public. However, in scenario 4, the public awareness of net zero emission is still low, followed by their low willingness to use public transportation. In order to accelerate it, regulations such as incentives are given to public transportation providers in the form of public service obligations, so the price of using public transportation can get lower. The massive expansion in technology and low cost of using public transportation will likely raise public awareness and willingness toward net zero emission.

Scenario 5 is the ideal condition where the regulations match the needs of public transport, followed by the economic readiness owned by the public transportation with technological capabilities that reached the economies of scale by its massive expansion and high awareness and willingness of the public to use the public transportation. In this scenario, the regulation will likely adjust the needs of public transportation providers to implement net zero emissions while also giving incentives to keep the public willingness to use public transportation as high as possible. Regulation plays an important role since, without the support of regulators and political actors, it will be hard to implement net zero emission in public transportation, noting that each provider has different economic capabilities. Suppose the implementation is not reached together by all the public transportation providers in Jakarta; net zero emission will likely be implemented in those who are capable of economic factors, and the use of it will be low because the technology will still be expensive, affecting the public's awareness and willingness to use it.

o Implication on Economic Readiness and Technological Capabilities of Public Transportation Providers

The economic capabilities of public transportation providers and their technological capabilities are related. Public transportation providers will not be able to research and develop the technology if they have insufficient economic capabilities. Therefore, instead of making it into separated parts, the author decided to group it into one section. Scenario 1 is a situation where the regulation and government action are not supportive of the implementation of net zero emission as it can be seen that the national target hasn't been targeted yet. In that situation, the public transportation providers are

not obliged to accelerate the implementation of net zero emissions. Private and mass public transportation providers have different economic capabilities. It makes them shift to the environment by their motives and carry out the financial burden by themselves to fulfill the technological capabilities while they don't have any clue about the things that need to be achieved.

Scenario 2 is a situation where the Government has aware of the needs of public transportation providers and imposes some regulation that matches their requirements. In this scenario, public transportation providers must know the target set out by the Government, which is obliged to implement net zero emission in their firm. The obligation of the regulation makes the public transportation providers have to prepare their economic readiness. Yet because private and mass public transportation providers have different economic capabilities, it may prolong the implementation of the net zero emission target by the Government. The implication of Scenario 2 can be seen from the enforcement of regulation to public transportation providers to have economic capabilities by raising their budget through farebox revenue, non-farebox revenue, and public service obligation. The insufficient economic may prolong their capabilities to research and development the right technology for their services.

Scenario 3 is a situation where the Government is aware of the needs of public transportation providers and imposes some regulation that matches their requirements. In addition, it is supported by the economic capabilities of public transportation providers to implement the regulation prevailed. Otherwise, in this scenario, public transportation has not found the right technology to be massively invested in accelerating the implementation of net zero emission in their firm. The economic readiness of public transportation positively affects the procurement of the right technology they need. The implication of scenario 3 can be seen from the budget that public transportation providers spend on research and development to find the right technology to accelerate the net zero emission implementation in their firm. In the future, with the increasing number of technologies used, such as EVs and renewable energy sources for their operational activities, the price of the technology will be lower and reach the point of economies of scale.

Scenario 4 is the output of what happened in scenario 3. With the condition where the Government is aware and supportive of the net zero emission program in public transportation and supported by the economic and technological aspects that public transportation providers have, the procurement of related technologies is invested massively and achieved economies of scale. However, one of the issues in scenario 4 is that the public transportation users are not yet aware and willing to use

public transportation that shifted to environmentally friendly. The implication of this scenario can be seen in the collaboration of the Government and public transportation providers to raise public awareness and willingness. It can be done by doing public service obligation to provide lower service prices, noting that service costs of EVs and shift to environmentally friendly technology are more expensive than the ICE vehicles and the non-environmentally friendly. In addition, the rise of the technology availability related to accelerating the implementation of net zero emission will also raise awareness and willingness to use.

Scenario 5 is the ideal situation where the Government is supportive, and Public Transportation Providers have the economic and technological capabilities, which affect the rise of public awareness and willingness towards the importance of using public transport to achieve net zero emission. The implication of scenario 5 can be seen due to the adjustments made by Government and Public Transportation Users to maintain public awareness and willingness to use public transportation as high as possible by innovating the technology they use from time to time.

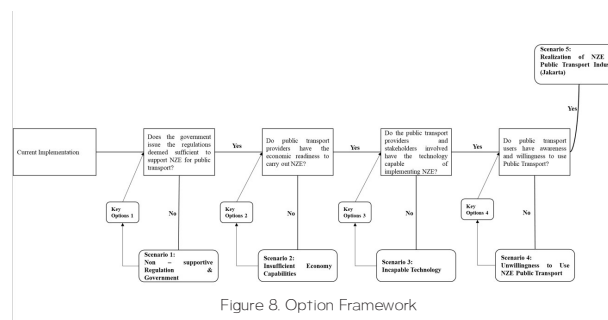
o Implications on Public Awareness and Willingness

The implications of scenarios 1-3 are very low because the procurement of related technology has not been carried out on a massive scale. For example, from interviews with several sources, the procurement of environmentally friendly transportation such as EVs on two-wheelers or ride-hailing and bus rapid transit has only been provided in the South Jakarta area with particular routes. In addition, the four-wheeler of ride-hailing is provided only with routes that start from Soekarno Hatta airport. Therefore, the limitation in implementing the kind of services mentioned before affects the public awareness of environmentally friendly technology in Jakarta is still relatively low.

Whereas in scenario 4, the stakeholders can already do environmentally friendly technologies such as EVs and the transition to renewable energy sources, considering they have the capabilities to shift massively to create scenario 5 where environmentally friendly technology can be known and felt by the wider community. In conclusion, the Government as a regulator has an essential role in encouraging shifting to net zero emissions by providing regulations that support and follow the needs of public transportation providers. Besides that, Public Transportation Providers have an important role in implementing the targets and regulations set by the Government with economic readiness to procure environmentally friendly technology. When these three things have been realized and run well, it will affect public awareness and willingness.

Noting that the transformative scenarios in this study are composed of several scenarios that need to be met

before reaching the ideal scenario, the stakeholders are divided into two: government and public transportation providers. Besides that, integrated payment providers also play an important role in supporting the scenario. While separated stakeholders into several groups, the key options are offered in each scenario to help them move from one scenario to another:



Key options 1 – 4 are needed to help the stakeholders transform from one scenario to another. In contrast, there is an additional key option to maintain the implementation of net zero emissions in the public transportation industry sustained in scenario 5. All these key options are the things that need to be done by stakeholders involved to keep on track to achieve and maintain the implementation of net zero emissions in scenario 5.

Stage 5 will describe the early warning signals that are needed to help all stakeholders execute the key options at the right time, which are mentioned in stage 4 above. However, the key options will work well if all stakeholders who play a role in each scenario have the desire and ability to transform from one scenario to another. Therefore, the early warning signals shown below will be conducted with a broader perspective noting that every scenario has different issues.

Table 3 - EARLY WARNING SIGNALS

Factor	Indicator	Early Warning Signals
Scenario 1: Gridlock and Pollution		
Presidency and Political Transition	Presidential and/or gubernatorial elections	Candidates who describe their program by ignoring environmental factors and the public transportation industry.
External Factors	International Pact	The implementation of government involvement in international pacts without preparing a roadmap to achieve the agreement's targets. Several public transport providers concerned about the international agreement are trying to implement it by creating their respective roadmaps.
Scenario 2: Stopping at Red Light		
Presidency and Political Transition	Presidential and/or gubernatorial elections	Candidates who explained their programs with concerns about environmental factors and the public transportation industry.
Regulation Factor	Supportive Regulation	The government and regulators invite public transportation providers to cooperate in creating regulations to support the acceleration of net zero emissions in public transportation providers.
	Regulation Enforcement	The government and regulators have set incentives for public transportation providers who wish to implement net zero emissions in their firms. The government and regulators have set penalties for public transportation providers who are reluctant to implement net zero emissions in their firms. The punishment has not yet been implemented.
External Factor	International Pact	The government's involvement in international pacts is supported by a roadmap to achieve the agreement's targets. Several public transport providers who have concerns about the international agreement are trying to implement it by using the government roadmap as a reference
Economic Condition	Economic Readiness	Several public transport providers with strong economic capacity are trying to implement it by bearing the financial risk alone. Some public transport providers who have weak economic capacity are trying to make plans to prepare their economic readiness.

IV. DISCUSSION

The success of the precedent scenario determines the success of moving from one scenario to another. It means that every factor such as regulation, economics, technology, and socio-culture has an equally important role and is interconnected. In addition, the level of cooperation and desire of all stakeholders involved is the most important thing in achieving net zero emissions in the public transportation industry in Jakarta. If each stakeholder decides to go their separate ways without coordinating, it will likely prolong the shifting or even fail them to achieve net zero emission.

Noting that net zero emissions are new for developing countries such as Indonesia, an effort is needed to introduce and expand them to accelerate the program. One of the efforts that can be made is procuring electric vehicles for the public sector fleets. Reference [14] stated procuring electric vehicles for the public-sector fleets demonstrates leadership and has the potential to stimulate the early electric vehicle market through mechanisms such as increased model availability from industry, increased public awareness of electric vehicles, increased development of charging infrastructure, and stimulation of related businesses and expertise. Other than that, it can also be supported by the zero-energy building. Zero-energy building level in terms of operation is defined as a condition where the total amount of operational energy used by the building is compensated mainly by renewable energy generation on a typically annual basis [15].

V. CONCLUSION

In dealing with new conditions with high uncertainty, scenario planning is one of the appropriate methods. Scenario planning helps all stakeholders to capture the issue and determine what will happen from decisions taken in the future. Four factors are used as the basis for the formation of the scenario: regulation, economic, technological, and socio-cultural. Then, the sequence of factors that will be implemented is based on urgency and interconnection between each factor to achieve the ideal situation of implementing net zero emissions in Jakarta.

Each scenario in this study has different implications and early warning signals. Otherwise, it can be concluded that the Government and regulators play an essential role in this case. Without support from the Government and regulators, public transportation providers will experience difficulties because they must bear the burden of the economy, technology, and socio-cultural changes by themselves. Therefore, cooperation between stakeholders in the public transportation industry plays a significant role in achieving ideal conditions for implementing net

Scenario 3: Green Light to Go		
Presidency and Political Transition	Presidential and/or gubernatorial elections	Candidates who explained their programs with concerns about environmental factors and the public transportation industry.
Regulation Factor	Supportive Regulation	The government and regulators invite public transportation providers to cooperate in creating regulations to support the acceleration of net zero emissions in public transportation providers.
	Regulation Enforcement	The government and regulators have set incentives for public transportation providers who wish to implement net zero emissions in their firms.
		The government and regulators have set penalties for public transportation providers who are reluctant to implement net zero emissions in their firms. The punishment has not yet been implemented.
External Factor	International Pact	The government's involvement in international pacts is supported by a roadmap to achieve the agreement's targets.
		Several public transport providers who have concerns about the international agreement are trying to implement it by using the government roadmap as a reference
Economic Condition	Economic Readiness	All public transportation providers have economic readiness that comes from the firm's financial capability and government support to implement and achieve the target set by the Government.
Technological Factor	Research and Development	Public Transportation providers started to conduct research and development related to environmentally friendly technology to accelerate the implementation of net zero emission in their firms.
Scenario 4: Getting There		
Presidency and Political Transition	Presidential and/or gubernatorial elections	Candidates who explained their programs with concerns about environmental factors and the public transportation industry.
Regulation Factor	Supportive Regulation	The government and regulators invite public transportation providers to cooperate in creating regulations to support the acceleration of net zero emissions in public transportation providers.
	Regulation Enforcement	The government and regulators have set incentives for public transportation providers who wish to implement net zero emissions in their firms.
		The government and regulators have set penalties for public transportation providers who are reluctant to implement net zero emissions in their firms. The punishment has not yet been implemented.
External Factor	International Pact	The government's involvement in international pacts is supported by a roadmap to achieve the agreement's targets.
		Several public transport providers who have concerns about the international agreement are trying to implement it by using the government roadmap as a reference
Economic Condition	Economic Readiness	All public transportation providers have economic readiness that comes from the firm's economic capability and government support to implement and achieve the target set by the Government.
Technological Factor	Research and Development	Public transportation providers have succeeded in finding suitable technology to accelerate the implementation of net zero emission in their firm
	Economies of Scale	The technology procurement cost becomes cheaper considering the widespread use of related technologies in the public transportation industry.
	Technological Procurement	Public transportation providers invest in related technology massively.
Socio-culture	Public awareness	Public awareness towards net zero emission and related technology already exists but is still relatively low.
	Public willingness	Public willingness to use public transportation already exists but is not yet at its maximum point Public willingness to contribute to the carbon offset on the use of ICE vehicles is still low
Scenario 5: Green and Connected		
Presidency and Political Transition	Presidential and/or gubernatorial elections	Candidates who explained their programs with concerns about environmental factors and the public transportation industry.
Regulation Factor	Supportive Regulation	The government and regulators invite public transportation providers to cooperate in creating regulations to support the acceleration of net zero emissions in public transportation providers.
	Regulation Enforcement	The government and regulators have set incentives for public transportation providers who wish to implement net zero emissions in their firms.
		The government and regulators have set penalties for public transportation providers who are reluctant to implement net zero emissions in their firms. The punishment has not yet been implemented.
External Factor	International Pact	The government's involvement in international pacts is supported by a roadmap to achieve the agreement's targets.
		Several public transport providers who have concerns about the international agreement are trying to implement it by using the government roadmap as a reference
Economic Condition	Economic Readiness	All public transportation providers have economic readiness that comes from the firm's financial capability and government support to implement and achieve the target set by the Government.
Technological Factor	Research and Development	Public transportation providers have succeeded in finding suitable technology to accelerate the implementation of net zero emission in their firm
	Economies of Scale	The technology procurement cost becomes cheaper considering the widespread use of related technologies in the public transportation industry.
	Technological Procurement	Public transportation providers invest in related technology massively.
Socio-culture	Public awareness	Public awareness of the net zero emission and related technology is already high
	Public willingness	Public willingness to use public transportation is already at its maximum point Public willingness to contribute to the carbon offset on high use of existing ICE vehicles (just in case the ICE vehicles are still in use, especially for the ride-hailing partners)

zero emissions in Jakarta.

In addition, the shifting to net-zero emission should happen in conjunction with public awareness and willingness to use environmentally-friendly public transportation. Decoupling the public mobility from emission will cause the effort to shift to net zero emission not to be achieved perfectly. Reference [16] stated by keeping car dependency intact, traffic volumes continue to increase, and it is therefore not surprising to see that emissions reductions from decoupling efforts, e.g., from vehicle electrification, have been ineffective in most countries. Behavioral changes of the public in using public transport is one of the critical keys, right after the government has provided the regulation with economic readiness and technological capabilities owned by the public transportation providers.

The managerial implications of this research are twofold. First, implementing net zero emissions may force the Government to provide regulations and incentives to bind and support the public transportation providers. It will encourage the public transportation providers to prepare their economic readiness, technological capabilities and raise public awareness also willingness to use public transportation, as seen in the interconnection analysis in figure 6 above. Second, the stakeholders involved in the public transportation businesses, or this case, the public transportation providers. The implementation of net zero emission will make them spend budget and do research and development for the technology related to net zero emission. Other than that, the public transportation providers need to cooperate with the Government to ensure that public transportation rates are stable and rising through the given incentives, along with maintaining its services and technologies.

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