

PAPER • OPEN ACCESS

## A governance of climate change mitigation in transport sector and selected co-benefits in Indonesia: the case of Bandung City

To cite this article: H Gunawan *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **306** 012015

View the [article online](#) for updates and enhancements.

# A governance of climate change mitigation in transport sector and selected co-benefits in Indonesia: the case of Bandung City

H Gunawan<sup>1,2</sup> \*, H Bressers<sup>1</sup>, E. N Megantara<sup>2</sup>, T B A Kurnani<sup>2</sup>, T Hoppe<sup>3</sup>, N Mohlakoana<sup>1</sup>, Parikesit<sup>2</sup>

<sup>1</sup>Department of Governance and Technology of Sustainability (CSTM), Faculty of Behavioural, Management, and Social Science, University of Twente, 7522 NB Enschede, The Netherlands;

<sup>2</sup>Graduate School of Environmental Science, Padjadjaran University, Jawa Barat 45363, Indonesia;

<sup>3</sup>Policy, Organisation, Law and Gaming (POLG), Department of Multi-Actor Systems (MAS), Faculty of Technology, Policy and Management (TPM), Delft University of Technology, Jaffalaan 5, 2628 BX Delft, The Netherlands;

\*Email : h.gunawan@utwente.nl; Tel:+62-816610066

## Abstract

Climate change mitigation policy has a strong influence on policy processes in worldwide. Indonesia as a developing country has committed to reducing greenhouse gas (GHG) emissions by 29 percent by the year 2030. This calls into question the extent of how the cities or local governments can cope with the challenges of the current transport sector climate change mitigation in Bandung City. This paper aims to assess the governance context of climate policies in Bandung City and support further co-benefits. The preliminary stage of study shows that the policies in reducing GHG emissions are not in accordance with what was written by the government. The provincial and local government was aware that the stipulation delivered by the central government regarding mitigation on climate change stated in the regulation both in provincial and local level. Based on the actor's characteristic, the policies that encourage to reduce GHG emissions drive as a multi-actor interaction process namely The Paratransit, Trans Metro Bandung (TMB) and Vehicle Emissions Test. The research design involved an empirical case study on governance and policy relevant to climate change efforts to lower GHG in Bandung City, Indonesia. The analytical framework used for this analysis is the Governance Assessment Tool and the co-benefits approach. Data collection involved semi-structured interviews, a review of policy documents, and secondary quantitative data. The results reveal that the governance qualities create a context that there still are some limits, although several improvements have shown the positive trend at the local level. This is due to the qualities of the extent aspect as a low to moderate, the flexibility as a restrictive, and the coherence and intensity as moderate. The assessment of the criteria of co-benefits is more relevant to the public transport. The TMB has met all of the criteria of co-benefits. Thus, this TMB program has the highest impact to attain the co-benefits. The paratransit has the positive value of the criteria for lowering GHG emissions, energy and environmental sustainability, and development goals. The vehicle emission test met the criteria of sustainability and technical feasibility.

**Keywords:** climate change mitigation, co-benefits, greenhouse gas (GHG), governance



## 1. Introduction

Global climate change, environmental degradation, poverty, lack of availability of water and food due to population density pressures are the factors that magnify disasters that should be avoided, mitigated and thoroughly managed, particularly in developing countries [1]–[3]. Most of the climate models predict Greenhouse Gases<sup>1</sup> emissions (GHGs) to rise twofold from pre-industrial with an average temperature increase between 2 and 5°C by the year 2030 and 2060 respectively [4]. Based on a WWF report in Indonesia (2007) which included results from a study by Hulme and Sheard (1999) there has been a marked change an increase in the annual basis average temperature since 1900 by 0,3°C and a decrease in annual rainfall by 2-3 percent during the last century [5]. Some of the evidence based on climate change parameters in Bandung City from temperature data collected (1960 - 2010) shows a consistent increase with rising trends [6] and other various conditions exist in most part of Indonesia. Energy consumption generally correlates with gross domestic product (GDP) and development. To a large extent, this is due to activities in urban areas [7]. Considering the impact and risks resulting from climate change, efforts are needed to reduce and manage climate change: mitigation and adaptation [8], [9]. Nevertheless, with the continuous growth of GHG emissions - when the mitigation effort is not implemented - the risk and impact of climate change impacts occurring will be more severe. The climate change mitigation scheme (IPCC) has a slight effect on climate conditions in the next decade, but the successful mitigation effort might be able to avoid major climate change from happening in the future [10].

Although the Republic of Indonesia (RoI) has ratified several international conventions related to climate change<sup>2</sup>, it has no formal obligation to reducing GHG emissions. Nonetheless, in 2009 Indonesia committed itself to voluntarily reducing greenhouse gas emissions by 26 % by 2020 and 29% by 2030 from the level of Business as usual (BAU) by itself and 41 % when also considering international assistance mechanisms. In 2010, the Government of Indonesia (GoI) launched the Indonesia Climate Change Sectoral Roadmap (ICCSR) 2010-2030, which set national objectives, sectoral targets<sup>3</sup>, and priority measures related to adaptation and mitigation of climate change for different economic sectors. ICCSR content has also been integrated into development planning and reinforced by Presidential Decree No. 61 Year 2011 on National Action Plan for Mitigation Greenhouse Gasses (RAN-GRK).

The transport sector, in particular, is difficult to reduce CO<sub>2</sub> emission because many primary economic activities rely on this sector. The transport sector contributes to 26% of global CO<sub>2</sub> emissions and is one of the few industrial sectors where emissions are still growing [11]. Nonetheless targeting this sector for mitigation actions also has other negative effects such as social and economic costs. In climate change mitigation terminology, transport is a sector with a huge potential to be included in the Nationally Appropriate Mitigation Actions (NAMAs). NAMAs is a new instrument regarding international climate policy that aims to tackle issues of GHG in developing countries which contribute to sustainable development. NAMAs has to require Measurement, Reporting and Verification (MRV) [12], [13]. Although climate change is a global problem, mitigation efforts are highly dependent on the actions taken at the local level, for example, by using or combining various options to improve

<sup>1</sup> Kyoto protocol the group of greenhouse gasses as Carbon dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous Oxide (N<sub>2</sub>O), Hydro Fluorocarbon (HFCs), Per fluorocarbons (PFCs) and Sulphur Hexafluoride (SF<sub>6</sub>) (IPCC, 2001)

<sup>2</sup> Law no. 6 year 2004 about Climate Change and Law no. 17 year 2004 about Kyoto Protocol

<sup>3</sup> agriculture; forestry and peat land; energy and transportation; industry; waste management; other supporting activities

air quality and at the same time lowering GHG emissions in the urban transport sector in certain areas of cities [14], [15].

Another problem that requires attention in urban areas is air pollution. Every year, the number of vehicles in Bandung City has increased 10-15 percent as compared to the increasing road construction (0.45% per year from 2000-2014). It has ultimately led to lessening supply rather than demand and triggering congestion of vehicles in Bandung City [16], [17]. This issue is exacerbated by the lack of green open space areas ( $\pm 8\%$  of the total Bandung City area, which is less than prescriptions mentioning 30%) [6].

Governance aspects play an important role in stimulating the new innovation and supporting the existing climate change mitigation programs with the adoption of co-benefits strategies. The innovations systems such as incentives, networks, flexibility resources mechanism, and culture have potentially improved the policy instruments. In this perspective, this paper aims to analyze the governance of climate change mitigation programs in the transport sector aim and contribute to selected co-benefits. The main research question is: ***What are the qualities of the governance context and actor characteristics could have an impact on the effectiveness of the policies as established in lowering of GHG emission and how these policies be further improved to contribute to selected co-benefits goals?*** This paper is structured as follows: in Section 2, the theoretical frameworks of the Governance Assessment Tool (GAT) and the co-benefits approach are presented. In Section 3, the research design and methodology are presented. In Section 4, the results of the case study analysis are presented. In Section 5, the results of the analysis are discussed. And finally, in Section 6, the conclusions are presented.

## **2. Research Design and Methodology**

A case study design was used to analyze the governance of climate change mitigation in Indonesia. Bandung, the third largest urban city, was selected as a single case study to illustrate how the GAT can be applied to the implementation of climate change mitigation. This study assesses the transport sector and air pollution control as policy instruments in Bandung City in terms of how those policies aim contribute to climate change mitigation.

### *2.1 Case selection*

As a highly urbanized city, Bandung has grown substantially in terms of population size (the 2012 this was 2.6 million) with recent indicators of strong economic growth 9% (2013) and 8.98% in the years 2008-2012 (largest contribution in trade, hotels and restaurants) as compared to the national average of 5.8% [18]. This trend goes hand in hand with increased growth numbers of vehicle used as well as waste generation, lack of available land space, and water resources. The confluence of these factors creates complex problems in terms of environmental management. Furthermore, selecting Bandung as a location of study is considered appropriate because it is considered as a very vulnerable city to climate change (second after Jakarta in the country) [19]. In addition, due to the geographical conditions of Bandung City in the Bandung basin, problems related to air pollution and climate variability as a result of the "Urban Heat Island" phenomenon are expected to become more intense [20].

### *2.2 Data Collection*

Data collection involved both primary and secondary data sources. The relevant stakeholders who are part of the governance setting both directly or indirectly affect the policy implementation. The previous

study already identified the actors that dealing with the programs [21]. A semi-structured questionnaire was prepared for the interviews.

### 2.3 Data Analysis

The interviews were based on the semi-structure questions that already prepared previously, but there was a chance the interviews open-ended. The respondents were free to respond as widely as possible to the questions asked. Most of the data (compiled as field notes & recorded) was analyzed manually by highlighting responses in each section of interest to build the narrative. The section of analyzed also categorized and grouped according to the GAT questions. To avoid personal bias, the main researcher (first author) did not conduct the analysis alone, but also received feedback from other research (supervisors) on the preliminary results of the analysis. This so-called GAT (Governance Assessment Tool) has been used in several water governance fields to assess the supportiveness of the water governance regime for the realization of certain policies and measures [22], [23]. More recently also uses on other fields have occurred, like energy efficient buildings in India [24]. The four quality criteria are:

- a. Extent: are all relevant aspects taken into account?
- b. Coherence: are all aspects reinforcing rather than contradicting each other?
- c. Flexibility: are multiple roads to the goals, depending on opportunities and threats as they arise, allowed and supported?
- d. Intensity: the degree to which the regime elements urge changes in the status quo or in current developments

The full GAT consists of a matrix in which specific questions define the precise meaning of each cell:

**Table 1.** Main evaluative questions of governance assessment tool<sup>a</sup>

Governance dimension	Quality of the governance regime			
	Extent	Coherence	Flexibility	Intensity
<b>Levels and scales</b>	How many levels are involved and dealing with an issue? Are there any important gaps or missing levels?	Do these levels work together and do they trust each other between levels? To what degree is the mutual dependence among levels recognized?	Is it possible to move up and down levels (up scaling and downscaling) given the issue at stake?	Is there a strong impact from a certain level towards behavioral change or management reform?
<b>Actors and networks</b>	Are all relevant stakeholders involved? Are there any stakeholders not involved or even excluded?	What is the strength of interactions between stakeholders? In what ways are these interactions institutionalized in stable structures? Do the stakeholders have experience in working together? Do they trust and respect each other?	Is it possible that new actors are included or even that the lead shifts from one actor to another when there are pragmatic reasons for this? Do the actors share in 'social capital' allowing them to support each other's tasks?	Is there a strong pressure from an actor or actor coalition towards behavioral change or management reform?
<b>Problem perspectives and goal ambitions</b>	To what extent are the various problem perspectives taken care of?	To what extent do the various perspectives and goals support each other, or are they in competition or conflict?	Are there opportunities to re-assess goals?	How different are the goal ambitions from the status quo or business as usual?

<b>Strategies and instruments</b>	What types of instruments are included in the policy strategy? Are there any excluded types? Are monitoring and enforcement instruments included?	To what extent is the incentive system based on synergy? Are trade-offs in cost benefits and distributional effects considered? Are there any overlaps or conflicts of incentives created by the included policy instruments?	Are there opportunities to combine or make use of different types of instruments? Is there a choice?	What is the implied behavioral deviation from current practice and how strongly do the instruments require and enforce this?
<b>Responsibilities and resources</b>	Are all responsibilities clearly assigned and facilitated with resources?	To what extent do the assigned responsibilities create competence struggles or cooperation within or across institutions? Are they considered legitimate by the main stakeholders?	To what extent is it possible to pool the assigned responsibilities and resources as long as accountability and transparency are not compromised?	Is the amount of allocated resources sufficient to implement the measures needed for the intended change?

<sup>a</sup>Source: [25]

The questions above used as guidelines to address the quality of the governance. However, sometimes it is hard to measure and quantify all of them. To some degree, it is unavoidable that the scores are based on “informed judgements”. Therefore, the scores for each cell most often just divided in three: supportive, neutral or restrictive.

### 3. Results

#### 3.1 GAT of the Bandung Case Study

To solve the climate change issue, the Indonesian government has promoted a national action plan for reducing greenhouse gas emission (RAN-GRK). This RAN-GRK was aimed at increasing information access and guidelines for a regional action plan. At the local level and regional level, this RAN-GRK is translated into the regional action plan (RAD-GRK). However, in Bandung City, this RAD is only a strategic plan for dealing with climate policies particularly by the Local Environmental Management Agency (EMA). This section will unfold the general GAT applied to the implementing actors (government) in Bandung City and at the regional levels (as an extension of the central government) and other stakeholders. The policy instruments that evaluates the quality of governance already research in the previous study (Emission measurements, Trans Metro Bandung, and Paratransit “angkot”)

There are three levels involved in the governance of climate change mitigation in Indonesia. The central government (the first level) is engaged in the planning process and the creating of the strategic projects in Indonesia. The provincial government (the second level) is concerned with the action plan developed in their level through implementing the guidance distributed by the central government. Urban city policy (third level) in Indonesia related to climate change is guided by the Directorate of Urban and Rural (under the Ministry of National Development Planning/National Development Planning Agency - Bappenas). The monitoring of RAN-GRK is in the arrangement of tasks of the Coordinating Ministry of Economic Affairs.

At the local level (see table 2), there are seven programs that intended to reduce GHG emission. Four programs were categorized as involving infrastructure and facilities (bus provision, bus stops, traffic facilities, and terminals) and three as activities (vehicle emission test, validity test, and reduce congestion). From the multi-level governance point of view, all levels have made some legal basis for respecting climate change mitigation. At the central government, all actions planned in energy and transport sector are still segregated among the few governmental sectors but are stated together in the RAN-GRK. The linkages and relationships of the RAN-GRK with the RAD-GRK, are as follows: (1)

RAD-GRK is part of RAN-GRK; yet the regional governments contribute according to their abilities and authorities, (2) RAD-GRK has to comply with RAN-GRK as far as their potential makes this possible and in line with to the priorities of each province and they can include different activities that are not yet regulated by the Presidential regulation no. 61/2011.

**Table 2.** Overlay Mitigation Actions Based on Legal Basis of Multi-level governance in Transport Sector as Part of Energy and Transport (Bandung City)<sup>a</sup>

	Central Government	West Java Province	Bandung City
<b>Action plan</b>	<ol style="list-style-type: none"> <li>1. Vehicle test (include private cars and motorcycle) (2010-2020)</li> <li>2. Application of emission standard for passenger new cars (2010-2020)</li> <li>3. Development of modern system logistic (2010-2020)</li> <li>4. Development of car labeling (2010-2020)</li> <li>5. Speed Limitation on highways (2010-2014)</li> <li>6. Vehicle tax based on CO<sub>2</sub> emission (2010-2014)</li> <li>7. Tree plantation in urban area (2010-2014)</li> </ol>	<ol style="list-style-type: none"> <li>1. 15% of Biofuels in 2025 for gasoline and diesel fuel</li> </ol> Category of activities*): <ol style="list-style-type: none"> <li>a. Intelligent transport</li> <li>b. Traffic control</li> <li>c. Parking management</li> <li>d. Bus rapid transit system</li> <li>e. Public transport fleet upgrade</li> <li>f. CFD</li> <li>g. Eco-driving</li> </ol>	<ol style="list-style-type: none"> <li>1. Vehicle emission test(2013-2018 → 5-25%)</li> <li>2. Development of transportation infrastructure / bus stop (2013-2018 → 54-80 unit)</li> <li>3. Development of terminal facilities (2013-2018 → 2-10 unit)</li> <li>4. Rehabilitation and maintenance of traffic facilities (from 2013-2018 increased from 50-80%)</li> <li>5. Vehicle validity test (2013-2018 → 95 -97.5%)</li> <li>6. Development of TMB corridor (2013-2018 → 2 -4 corridor)</li> <li>7. Congestion parse (2013-2018 → 23-25km/hour)</li> </ol>
<b>Legal Basis</b>	Presidential Decree no. 61/2011	Governor Decree No. 56/2012 *) based on regional action plan guidelines	Bandung City Regulation No. 3/2014
<b>Responsibilities</b>	1,2,3,4,5 → Ministry of Transportation 6 → Ministry of Finance 7 → Ministry of Public works	1 → Department of Energy and Mineral Resources (West Java) a-g: Transportation Department	1 → Bandung Environmental management agency 2 – 6: Bandung Transport Department
<b>Target Achievement</b>	0.038 Giga Ton CO <sub>2</sub> e	1.1 million-ton CO <sub>2</sub> e	CO <sub>2</sub> → 2127.06 Gg CH <sub>4</sub> → 7.44 Gg N <sub>2</sub> O → 0.07 Gg
<b>Co-benefits perceived</b>	<ol style="list-style-type: none"> <li>1. Better air quality</li> <li>2. Increase fuel economic</li> <li>3. Reducing the cost</li> <li>4. Safety improvement</li> <li>5. Enhanced water recharge</li> <li>6. Increase time travel</li> </ol>	<ol style="list-style-type: none"> <li>1. Better air quality</li> <li>2. Increase fuel economic</li> <li>3. Reducing the cost</li> <li>4. Increase time travel</li> <li>5. Safety improvement</li> </ol>	<ol style="list-style-type: none"> <li>1. Better air quality</li> <li>2. Increase fuel economic</li> <li>3. Reducing the cost</li> <li>4. Increase time travel</li> <li>5. Safety improvement</li> </ol>

<sup>a</sup>Source: Collected data and interview analysis

In the year 2016, the Ministry of Environmental protection and Forestry launched the National Registry System (SRN-PPI) about climate change action. The objectives of SRN-PPI were: organizing the action, informing the climate change action, delivering the data and information to the citizen, and avoiding the double counting. This system has implemented the principle of “clarity, transparency, and understanding” (CTU). However, prior to 2018 the mitigation actions especially regarding the transport sector were not recorded in the directory system. In another sense, the mitigation programs were not rooted at the local level. The efforts were made by the central government, translated from their own resources and cognitions. The local level has to reformulate the programs to make them feasible, based on their creativity and leaning on its limited resources.

3.2. Summary of findings

From the three consecutive programs, two programs (Emission measurement and TMB) have involved multiple levels and scales. Only paratransit as the public transport that is managed at the local level. To conclude, the results of the qualities of governance regimes from all of the programs have the contribution to the environment, social justice, and economic activities. However, the quantities of those programs to lowering the GHG emissions still have to research further.

Emission measurements are not only to test the emission of private and public vehicles as stated in the programs (see Table 3a). The aim of this measurement is also to encourage the vehicles users to improve vehicle performance complying with the standard set by the rule. Energy efficiency on road transport has already been acknowledged that it benefits not only for transport efficiency and air quality but also for climate consideration [16], [26]. In general, the emission test is perceived as the business as a common program that enacted by the central government. The result of the analysis of the problem definition and goal statement aspect and also from the strategies and instruments stated as low to moderate. The programs should be incorporate the local problems into the climate change mitigation as the global problems.

In the case of TMB as the public transport that exists in Bandung City, as explained previously, it's owned by the local government. The corridor service has intersected with those of other modes such as paratransit and DAMRI. In the environmental context, the use of this BRT could benefit more to reduce the GHG emission because the vehicles have energy efficiency that is standardized by the government. Taking the passenger load more than the paratransit has an impact on the lowering of GHG emission. However, in terms of governance context, TMB has to improve their level of services. From the five elements of governance (see Table 3b), the three elements as (1) the actors and networks, (2) problem definitions and goals, and (3) strategies and instruments have lower quality. Lots of actors involved in public transport services make the competition between the transport modes more difficult. There is a need for the implementing actors to reassess the goals and on how to improve the strategies for increasing the level of services. Extended service time, dependable services (continuous), and separated lanes should become priorities by the actors.

It is necessary to explain the quality of paratransit governance is a restrictive program that is contrary to the Trans Metro Bandung. The paratransit has the low qualities of governance context (see Table 3c). The help from the provincial and state level is needed to maintain that the paratransit has the opportunity to play a role in reducing GHG emissions especially on conducting the eco-driving, conversion to the gas fuel and maintaining the paratransit in optimally. The strategy to separate the niche from the TMB or DAMRI should be a solution to the sustainability of this mode of transportation. The expanded growth of online business transport (Grab and GO-JEK) needs to be anticipated by improving the level of services while waiting for the new rule (law) that regulates fair competition for the public transport sector.

**Table 3.** Qualities of governance from emission measurement

(a) Emission measurement context

Emission measurement	Qualities of governance regimes			
	Extent	Coherence	Flexibility	Intensity
<b>Level &amp; scales</b>	Moderate (All levels deal with this issue)	Moderate (Only two levels work together; some of the funding is from central levels and trusted to the provincial levels)	Low (It is hard to do downscaling or up-scaling)	Moderate (The central government has the power to stop the funding)

Emission measurement	Qualities of governance regimes			
	Extent	Coherence	Flexibility	Intensity
<b>Actors &amp; networks</b>	Moderate (Almost all relevant actors engage in activities including association workshop, government in all levels)	Moderate (They have the standard procedure and it is already established)	Low (It is hard to do downscaling or up-scaling)	Moderate (There is no strong urge from Ministry or West up-scaling Java EMA to push the Local Transport Department or Local EMA to conduct the measurement)
<b>Problem perspectives and goal ambitions</b>	Low (The various problems that <i>have</i> to be addressed in local level increases due to additional programs from the central government)	Moderate (All levels do not conflict with each other in terms of the monitoring)	Low (It is hard to do downscaling or up-scaling)	Low (Different perspective of goals from each level)
<b>Strategies and instruments</b>	Moderate (Not all strategies are implemented, measurement is only estimated based on traffic counting and air pollution; other strategies that need further collaboration are still disregarded)	Moderate (They have the standard procedure and it is already established)	Low (It is possible to combine the emission measurement, this however there still a problem with the cross-sectoral issue)	Low (Central government has the power to change the system and to facilitate measurement)
<b>Responsibilities and resources</b>	Moderate (Not all responsibilities are clearly assigned and measurement is only related to local problems / co-benefits)	Moderate (Local government struggle with the emission inventory for primary data)	Low (inflexibility to pool resources)	Low (There has allocated resources from other actors)

(b) Trans Metro Bandung context

Trans Metro Bandung	Qualities of governance regimes			
	Extent	Coherence	Flexibility	Intensity
<b>Level &amp; scales</b>	Moderate (Only central government and local level are involved)	Low (Mutual dependence is indicated by bus provision from the central government; provincial level did not interfere)	Low (It is not possible to give the flexibility for local level to provide their facilities)	Moderate (Central government has the power to halt the resources)
<b>Actors &amp; Networks</b>	Low (Only the central government and the local level are involved, other actors (paratransit driver and users) are rarely engage), other institution such as Public works rarely involved by transport department	Low (Interaction strength is low; the operation is sometimes halted)	Low (It is not possible to give the flexibility for local level to provide their facilities)	Moderate (Local government has the power to halt. In some occasion, it is halted by paratransit)
<b>Problem perspectives</b>	Low (local level with the small resources has to deal with competitions between	Low (There are	Low (It is possible to re-assess goal, however	Moderate (Transport department has

Trans Metro Bandung	Qualities of governance regimes			
	Extent	Coherence	Flexibility	Intensity
<b>and goal ambitions</b>	various problems that occurs in the field)	public transport mode. There is also another competition between transport department with another department such as Public works, Spatial plan)	concerning the sector perspective, it is hard to be carried out)	different goals regarding climate change mitigation, however encourage the TMB development)
<b>Strategies and instruments</b>	Low (Policy strategy to convert the paratransit into bus; there are still no progress in building separate lane for TMB and corridors development)	Low (Local level will buy the paratransit that has already expired in 10 years; still conflict with paratransit owner regarding route intersection)	Moderate (There are opportunities to combine different type of instruments such as school bus, NMT programs)	Low (The strategies still do not fully follow the rule of Bus Rapid Transit; Almost the same with DAMRI)
<b>Responsibilities and resources</b>	Low (The source of resources is mostly from local level; the central government only support the initial part of the program)	Moderate (To reduce the conflict with other public transport, join the cooperation within other public transport)	Moderate (The co-investment program exists in TMB)	Low (The imbalance in resources has to used optimally)

(c) Paratransit context.

Paratransit	Qualities of governance regimes			
	Extent	Coherence	Flexibility	Intensity
<b>Level &amp; scales</b>	Low (Only local levels are involved)	Low (Only local levels are involved)	Low (Not flexible; based on administrative level)	Low (only the local government has to do with their programs)
<b>Actors &amp; networks</b>	Low (Only the local government and association are involved)	Moderate (On some occasion, the paratransit protested the TMB operation)	Low (Not flexible; based on administrative level)	Low (Local government worked based on their program)
<b>Problem perspectives and goal ambitions</b>	Low (Only the local government has to deal with association, drivers, users; In the later issues, the provincial level have more influence to settle this issue (online application)	Low (Contradictive with TMB goals)	Low (re-assessment goals are based on resources availability from the local government)	Low (Local government has the aim to diminish the use of the paratransit)
<b>Strategies and instruments</b>	Low (Local level makes some excluded to paratransit; the strategy has also to consider energy efficiency)	Low (The incentive for private owner vehicles (LCGC programs) neglected)	Low (Not flexible; some programs are based on central government authorities to)	Low (age restriction and validity test for vehicles are not)

Paratransit	Qualities of governance regimes			
	Extent	Coherence	Flexibility	Intensity
<b>Responsibilities and resources</b>	of the vehicles and livelihood strategy of the drivers)	the paratransit driver as the weak actors)	encourage the use of private vehicles)	effectively implemented)
	Low (Lack of resources to manage the paratransit)	Low (There is interdependency between the actors but it needs improvement)	Low (Flexibility to pool resources; however, with the precaution principles)	Low (The allocated resources are not sufficient to implement the monitoring of prerequisite as stipulated)

3.3. Evaluation of the climate co-benefits program implementation

The quality of governance of the public transport (TMB and Paratransit) was in the low to moderate condition. This implies that from the quality of governance perspective, these programs suffered from lack of resources, lack of support, and lack of actors involved. However, from the co-benefit’s aspect, both public transport (TMB and Paratransit) have met the criteria of co-benefits.

**Table 4.** Comparison of the programs<sup>a</sup>

Policy instruments:	Emission measurement	Trans Metro Bandung (BRT)	Paratransit (angkot)
<b>Policy objectives:</b>	Target: Testing the public transport and private vehicles Purpose: check the exhaust gas content as per the specified standard, check the fuel burning conditions of the vehicle, reduce the air pollution	Target: Bandung residents or suburban residents Purpose: as a mass rapid transportation connecting the feeder to urban fringe, reduce the use of private vehicles	Target: mostly Bandung residents Purpose: as a feeder connecting the residence with other transports mode, reduce the use of private vehicles
<b>Actors:</b>	Implementer: Transport Department, Environmental Protection Agency, Asbekindo Target: paratransit owners, TMB operator	Implementer: Transport Department, TMB operator Target: Bandung residents and resident across the border	Implementer: Paratransit Drivers, Paratransit Owners, Cooperatives Target: Bandung residents
<b>Existing condition:</b>	<ul style="list-style-type: none"> <li>The test applies to public transport in idle condition</li> <li>The regulatory to test all vehicles (including private transport) as the prerequisite of vehicle license is not yet enforced.</li> <li>It is estimated that 1,000 cars/years already checked the emission and maintenance. There are 54 unit of emission test workshop in Bandung</li> </ul>	<ul style="list-style-type: none"> <li>Inaugurated since 2008, only three corridors exist (13 corridor as a planned)</li> <li>The shelters condition is not well-maintained, damaged, and most of it is not used (18 shelter averages for every corridor exist)</li> <li>36 buses with 664 passengers/day. It is estimated only 60% of passengers use TMB</li> </ul>	<ul style="list-style-type: none"> <li>As many as 5.521-unit paratransit in Bandung City, it is estimated only as much as 30 percent operates includes the illegal paratransit.</li> <li>In the year 2017, many shelters have been built</li> </ul>
<b>Action Taken</b>	six months / one year	Every day (05.00 – 20.00), the current condition (06.00 – 18.00)	Every day (05.00 – 20.00), at certain route such as terminal route or market (24 hours)
<b>Inventory emission</b>	4 Gas emission analyzers (after services has increase the CO <sub>2</sub> percentage).	IPCC 2006 mobile resources	IPCC 2006 mobile resources

<sup>a</sup>Source: Collected data and interview analysis

### 3.4. The assessment of policy instruments

There are many kinds of research in measuring the criteria and rank the programs [27]–[30]. This research adopts the basic rating scale. This checklist of criteria evaluates the quality of elements, including a scoring system [31], [32]. However, the rating uses the judgment based on the perception of the meanings of the terms and based on the case study previously conducted. There are six criteria chose to address the co-benefits of policy instruments. The summary of the criteria specified can be seen in Table 5 below.

**Table 5.** Assessment of policy instruments that aim to contribute to mitigation climate change and selected co-benefits<sup>a</sup>

Criteria	Description	Vehicle emission Test	TMB	Paratransit	
<b>Mitigation Potential</b>	GHGs reduction	Net lower GHG emission (tones of CO <sub>2</sub> )	0	+	+
<b>Sustainability</b>	<ul style="list-style-type: none"> <li>• Efficiency of resource use &amp; Energy security</li> <li>• Air</li> </ul>	<ul style="list-style-type: none"> <li>• Increased energy security due to reduction from fossil fuel demand</li> <li>• The program has the strategy to lower air pollution to the environment</li> </ul>	++	+	++
<b>Development goals</b>	Improving outcomes for the poorest	Improve access for public transport, reduce cost of transport (public)	0	+	++
<b>Political Feasibility</b>	Predict the probable outcome of a proposed solution	Examining the actors, events and environment involved in all stages of policy (political support)	0	+	-
<b>Social Feasibility</b>	Probability that the cases would have to be accepted	<ul style="list-style-type: none"> <li>• Examining group of people that are directly affected (safety)</li> <li>• Reduce congestion, reduces fatalities, injuries</li> </ul>	0	+	0
<b>Technical Feasibility</b>	Evaluating project management and coordinator	<ul style="list-style-type: none"> <li>• Evaluating system performance, data availability and quality</li> <li>• customer support</li> <li>• security</li> </ul>	+	++	0

<sup>a</sup>Notes: a “+” if it has a positive impact, a “0” if it’s neutral and “-” if it has a negative impact. The input of the qualitative scores based on the author judgement using the reference from the qualitative and quantitative approach Source: Collected data and interview analysis, Table is adapted from [33], [34]

### 3.5. Mitigation potential

The net lowering of GHG emissions from vehicle emission tests comes from the fuel efficiency in maintenance the engine [35]. In Bandung City, every year approximately 1,000 vehicles tune-up and take an emission test. The emission test and tune-up will reduce the CO (23%) and HC (50%), however, it will increase CO<sub>2</sub> (106%) (based on Asbekindo data). The researcher suggests that driving techniques (eco-driving) can influence fuel efficiency by as much as 30 percent [36]–[39]. In Bandung City, the car (i.e. privately-owned cars) has a 23% mode share, whereas the share of the minibus (i.e., publicly-

owned) is only 4-5%. The highest percentage of mode share comes from the motorcycle (privately-owned), which is around 65-70% [40]. The Trans Metro Bandung (TMB) ridership until now only exists in three corridors in Bandung City. This BRT ridership is equal to 1,200 ridership/day (60%) and equal to 10.8 million ridership/year predicted in 2019 [41]. The cumulative length of TMB constructed would be 20 km. This TMB is different from other forms of BRT such as Jakarta or Palembang because separate road lane does not yet exist.

The paratransit is still using gasoline as its main fuel, and only a small amount of paratransit use gas. The paratransit trajectory is 39 service areas that cover length various from 8 km to 24 km. The load factor of paratransit is 36.6%, and this public transport mode only has a share of 23% from all of the transport mode services. The capacity of ridership/year is between 1.53 -1.87 million ridership; however, the real ridership only shares one a third of this capacity because of low service performance. The use of public transport will also lead to the use of active transport. As part of active transport, non-motorized transport (NMT) can be used to improve the mobility with its flexibility and affordability. For instance, bicycles have a significant role in the Netherlands. NMT plays a crucial role in mobility of people not only in the cities, but also in rural areas. In Asia regions such as China, Indonesia and Philippines, the NMT has promoted as the strategy to reduce the use of private vehicle use [42]–[44]. Research shows the benefits of the shift from car use to active transport use (i.e., bicycles), especially regarding health benefits and reduction in air pollution [45]–[47]. The paratransit function as the feeder of the TMB and walking or cycling as part of the activities when using public transport has encouraged the Bandung City government to evolve the paratransit so that it can carry bicycles. Cycling policy as part of the thematic day (every Friday) arranged in handbill form simply sets for the internal local government employee. Positively, the local government action was followed by the provincial government and established free areas of motorized vehicles, such as in Gedung Sate (the official building for the West Java Province) and Balaikota. However, this policy valid since October 2013 and only works for a moment (after 2015 the parking area can be use by vehicles).

### *3.6. Sustainability*

In the transport sector development, the vehicle fuel consumption has become the criteria to develop. The sustainable energy is part of the indicator of energy security. There are four aspects of energy security i.e. availability, affordability, accessibility, acceptability, and sustainability. The sustainable energy as the criteria to choose the co-benefits assessment has linked to the availability of the energy supply and the sustainability. All programs have the primary goal to reduce the energy use and maintain energy sustainability. For the vehicle emission test and inspection program, this goal will help the vehicle to improve engine performance by reducing inefficient combustion [48]. The use of public transport such as paratransit and Trans Metro Bandung (TMB) will reduce the use of private transport and finally could reduce the energy use. This will also reduce the congestion that occasionally happens in Bandung City. The vehicle emission test that commonly analyses the carbon monoxide (CO), hydrocarbon (HC) and carbon dioxide (CO<sub>2</sub>) from the vehicle exhaust will lead to the efficiency of car engine. It will reduce the inefficient combustion in the car engine and calibrate the engine [49]. However, the fuel demand will continue to increase in most countries, unless additional intervention could reduce the fuel demand and shift to more fuel-efficient or low emission vehicles [35].

To date, the TMB still use the diesel fuel for their vehicle. The development of fuel injection system technology has helped the vehicle become more efficient in fuel consumption. The TMB will consume energy for 74.03 TJ/year. The total GHG emissions per year for this TMB is equal to 53,413

ton/year. However, the TMB emits 4.95 kg GHG emission/ridership/year. The paratransit will consume energy for about 309.74 TJ/year. The GHG emissions for this paratransit equal to 21,987 tons/year. However, the paratransit emits 11.76 kg GHG emission/ridership/year. Since the year 2000, the paratransit has started using a fuel injection burning system instead of combustion system using a carburetor. It is unclear regarding procurement arrangement of vehicle specification to use as public transport in Bandung, so this is left to each paratransit cooperation.

On the contrary, the TMB that is owned by the government has the rule to apply in each region especially concerning the fuel efficiency of vehicles. Vehicle emission test has a large influence on improving energy efficiency if afterward efforts are made to improve combustion. However, the improvement of the vehicles for the paratransit, especially engine combustion, are handed over each paratransit owner. To date, the Trans Metro Bandung program still has great influence in reducing the energy use than the paratransit program. However, in the future, if the vehicle emission test including vehicle maintenance are applied in Bandung City, this effort will help to reduce the energy use greater than other programs.

### *3.7. Development goals*

The programs have the obligation to serve the community in transportation services. There are two aspects of the programs to improve the outcomes for the poorest in the public transport services i.e.: (1) reduce cost of transportation; (2) improve access of the programs. The first aspect related to the ability of the consumer to pay for their travel modes. From the data collection, the TMB mode of transport is the cheapest transport mode. To illustrate, for every corridor (20 km) the passenger only spent for Rp.5.000 (equal to 36 cents US). For the same distance, the passenger will travel two or three routes with the paratransit mode. The price is varies depending on distance. The vehicle emission test has the indirect relation to improve outcomes for the poorest. As from the previous information, this test has the ability to make the public transportation improve their fuel efficiency. In terms of the access to public transport, only paratransit has the higher service coverage (works as a feeder). The paratransit route is generally located on a connecting road (collector) to a provincial or national road. The TMB route is located on the provincial or national roads. However, there is no connection between improving access for the poorest with the vehicle emission test. The vehicle emission test generally conducted for the people or institution who have the opportunity of using their transport mode.

### *3.8. Political, Social, and Technical feasibility*

All programs have the function to serve the Bandung citizen in using public transportation. The previous research already analysed the actors, events, and environment involved in all stages of policy instruments. The result of previous research shows that the political feasibility more relevant to the Trans Metro Bandung (TMB) and emission test, thus the paratransit program is often neglected by the influence of local levels. To be socially accepted, all programs have to meet the standard stipulated by the government and evaluation from the people (target users), especially for the safety and performance. However, another aspect to consider is how these programs have the ability to reduce congestion, reduces fatalities, and injuries, the respondents aware that the public need to maintain this paratransit as part of their travel mode. Due to a low quality of governance of this paratransit and unhealthy competition from the various modes of transports (app-based transportation, motorcycle, and buses) causing this vehicle in the worst condition. On the contrary, all aspects of the quality of governance show positive collaboration on the TMB program. The local government was in the position to maintain

and develop this mode of transport. The vehicle emission test that has the contribute to the climate change mitigation and improving environmental quality are less prioritized by the community.

Technical feasibility as a criterion for co-benefits represented by evaluating the performance system, data availability and quality, customer support, and security. The TMB and Paratransit as informed were in low performance, particularly the paratransit has the worst technical feasibility due to the low quality of maintenance and inspection aspect. The vehicle emission test that establishes and still to use as a reference in the driving feasibility also has few drawbacks such as lack of awareness of urban transport to conduct the vehicle tune-up and not including the test for the requirement to make of vehicle registration certificate (STNK).

#### **4. Conclusion**

The results of governance assessment conclude that the problem perspectives and goals were mostly faced by all of the cases. Different perspectives of the actors often complicate the development of the running programs. For instance, the progress of public transport will sustain and improve continuously if the goals and perspectives of the actors are in the same corridor. To understand and acknowledge other actor's problems will help to solve the problems and eliminate resistance from other parties. Until now, the problem arises from the rapid development of online transportation which cannot be anticipated by all stakeholders. The similar condition occurs in the emission measurement program which is to acknowledge the goals beyond the present condition could solve not only local problems but also the global problem. The governance is seen as "beyond the government" and a context for decision making and implementation [50]. The GAT supports us in looking at the element of governance that has to be strengthened in achieving better outcomes.

The practical lessons derived from this analysis shows the complex situation of managing the structural context as the core qualities of governance. There is no panacea for tackling the problems that exist in all cases. "Practitioners and scholars who fall into panacea traps falsely assume that all problems of resource governance can be represented by a small set of simple models, because they falsely perceive that the preferences and perceptions of most resource users are the same" [51]. Empowering the local level as a way of democratization and better public governance such as decentralization should not be viewed as a panacea. Sometimes it will reinforce the power and influence of the elites at the local level [52]. It also stated that "sustainability as the fundamental value of the sustainable urban transport that seen as a panacea for environmental problems has lacked its insight on how and when to implement this concept" [23].

The co-benefits approach results are more relevant to the public transport. The TMB has the highest value because this program meets all of the criteria of co-benefits approach. The paratransit has the positive value on the criteria of mitigation climate change, energy and environmental sustainability, and development goals. The vehicle emission test has the lowest feasibility (the criteria of sustainability and technical feasibility).

#### **Acknowledgements**

The authors would like to express their sincere gratitude to the University of Twente (CSTM) and University Padjadjaran for offering advanced academic courses and training in research skills. The research was supported by the Ministry of Education and Cultural, through Beasiswa Unggulan and West Java EMA.

## 5. References

- [1] UNFCCC 2007 *Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries* United National Framework Convention on Climate Change (Bonn, Germany)
- [2] MoE 2007, *Indonesia country report: Climate Variability and Climate Change and their Implication* Jakarta: Ministry of Environment Republik of Indonesia
- [3] R. T. Watson, D. L. Albritton, T. Barker, I. a. Bashmakov, O. Canziani, R. Christ, and U. Cubasch 2001 *Climate Change 2001: Synthesis Report*
- [4] Stern 2006, *The Economic of Climate Change* [http://www.hm-treasury.gov.uk/stern\\_review\\_report.htm](http://www.hm-treasury.gov.uk/stern_review_report.htm)
- [5] M. Case, F. Ardiansyah, and E. Spector 2007 *Climate Change in Indonesia: Implications for Humans and Nature* WWF
- [6] BPLH 2013 *Status Lingkungan Hidup Daerah Kota Bandung* (Bandung City Environmental Status) Badan Pengelola Lingkungan Hidup Kota Bandung (Bandung)
- [7] J. T. Robert 2007 *A climate of injustice: global inequality, North-South Politics, and climate policy*. (Massachusetts Institute of Technology)
- [8] T. Barker 2007 *Climate Change* 446 (11) 12–17
- [9] H. Bulkeley, H. Schroeder, K. Janda, J. Zhao, A. Armstrong, S. Y. Chu, and S. Ghosh 2009 *Cities and Climate Change: The role of institutions, governance and urban planning in Cities and Climate Change: Responding to an Urgent Agenda*, Hemdon, VA, USA: World Bank, 125–159.
- [10] A. E. Dessler 2012, *Introduction to modern climate change*. (Cambridge University Press)
- [11] L. Chapman 2007 *Journal Transp. Geogr.*, 354–367
- [12] IGES 2011 *Mainstreaming Transport Co- benefits Approach. A Guide to Evaluating Transport Projects*
- [13] UNFCCC 2014 *Handbook on Measurement, Reporting and Verification*
- [14] F. Creutzig, R. Mühlhoff, and J. Römer 2012 *Decarbonizing urban transport in European cities: four cases show possibly high co-benefits* *Environ. Res. Lett.*, 7 (4) 044042
- [15] K. Hamilton and S. Akbar 2010 *Enviroment Strateg. Anal. Backgr. Pap.*, 1, 1–34
- [16] A. Y. Bigazzi 2011 *Traffic Congestion Mitigation as an Emissions Reduction Strategy* (Portland State University)
- [17] Z. Eldewisa and Driejana 2008 *Perbandingan Estimasi Beban Emisi CO dan CO<sub>2</sub> dengan Pendekatan Konsumsi Bahan Bakar Dan Kecepatan Kendaraan ( Studi Kasus : Bunderan Cibiru- Lembang )* the Comparison of CO and CO<sub>2</sub> Emission Load Estimation With Fuel Consumption and Vehicles Speed Approach (ITB Bandung)
- [18] BPS Kota Bandung 2013 (*Statistical Bureau*) [Online]. Available: <http://bandungkota.bps.go.id/subyek/penduduk-2013>. [Accessed: 21-Jan-2015]
- [19] DNPI 2010 *Peluang dan Kebijakan Emisi: Sektor Transportasi* Dewan Nasional Perubahan Iklim, Indonesia
- [20] Tursilowati 2004 *Pusat Pemanfaat. Sains Atmosfer dan Iklim LAPAN*, 1–8
- [21] H. Gunawan, H. Bressers, N. Mohlakoana, and T. Hoppe 2017 *Environments* 4 (4). 45, 1-17
- [22] C. Casiano and C. de Boer 2015 *Int. J. Water Gov.* 3 (4) 1–24
- [23] K. A. Owens 2008 Understanding how actors influence policy implementation: A comparative study of wetland restorations in New Jersey, Oregon, The Netherlands and Finland
- [24] M. Jain, T. Hoppe, and H. Bressers 2017 *Energies*, 10 (8)
- [25] H. Bressers and C. de Boer 2013 *Contextual interaction Theory for assessing water governance, policy and knowledge transfer in Water Governance, Policy and Knowledge Transfer* (Earthscan from Routledge) 36–54.
- [26] ADB 2006 *Energy Efficiency and Climate Change Considerations for On-road Transport in Asia* (Philippines)
- [27] M. M. Rahman, J. V. Paatero, R. Lahdelma, and M. A. Wahid 2016 *Appl. Energy*, 164, 237–244
- [28] CLG 2009 *Multicriteria Analysis: a manual* (Crown, London)
- [29] S. Scarpellini, A. Valero, E. Llera, and A. Aranda 2013 *Energy*, 57 160–168
- [30] K. Steele, Y. Carmel, J. Cross, and C. Wilcox 2009 *Risk Anal.*, 29 1–8

- [31] P. Dawson 2017 *Assess. Eval. High. Educ.*, 42 (3) 347–360
- [32] A. Munoz-Restrepo 2017 *Rev. Int. Investig. en Educ.*, vol. 9 (19) 115–132
- [33] N. K. Dubash, D. Raghunandan, G. Sant, A. Sreenivas, and A. Dubash, Navroz K; Raghunandan, D; Sant, Girish; Sreenivas 2013 *Econ. Polit. Wkly.*, vol. XLVIII, (22) 47–61
- [34] Ministry of the Environment Government of Japan 2009 *Manual for Quantitative Evaluation of the Co-Benefits Approach to Climate Change Projects*
- [35] OECD 2002 *Strategies to reduce greenhouse gas emissions from road transport: Analytical methods* France
- [36] C. Andrieu and G. Saint Pierre 2014 *Eur. J. Transp. Infrastruct. Res.*, vol. 14 (3) 201–213
- [37] J. C. Ferreira, J. De Almeida, and A. R. Da Silva 2015 *IEEE Trans. Intell. Transp. Syst.*, vol. 16 (5) 2653–2662
- [38] D. Arokiaraj and M. Banumathi 2014 *Res. J. Soc. Sci. Manag.*, vol. 03 (11) 223–230
- [39] A. Funazaki 2012 *Eco-driving – Introduction of the Japanese activities and a plan of demonstration in China* Japan
- [40] Bappeda 2013 *Review Masterplan Transportasi kota Bandung* (Bandung, Indonesia)
- [41] S. B. Nugroho and E. Zusman 2015 *J. East. Asia Soc. fo Transp. Stud.* 1–15
- [42] N. C. C. Tiglao 2007 *Integrating Environmentally Sustainable Transport and Metropolitan Development Under a Decentralized Framework* vol. 6
- [43] Y. Koizumi, N. Nishimiya, and M. Kaneko 2013 *J. East. Asia Soc. fo Transp. Stud.*, vol. 10 (1999) 81–99
- [44] T. B. Joewono and H. Kubota 2005 *East. Asia Soc. Transp. Stud.*, vol. 6, 262–277
- [45] A. De Nazelle, M. J. Nieuwenhuijsen, J. M. Anto, M. Brauer, D. Briggs, C. Braun-Fahrlander, N. Cavill, A. R. Cooper, H. Desqueyroux, S. Fruin, G. Hoek, L. I. Panis, N. Janssen, M. Jerrett, M. Joffe, Z. J. Andersen, E. van Kempen, S. Kingham, N. Kubesch, K. M. Leyden, J. D. Marshall, J. Matamala, G. Mellios, M. Mendez, H. Nassif, D. Ogilvie, R. Peire, K. Perez, A. Rabl, M. Ragettli, D. Rodriguez, D. Rojas, P. Ruiz, J. F. Sallis, J. Terwoert, J. F. Toussaint, J. Tuomisto, M. Zurbier, and E. Lebret 2011 *Environ. Int.*, vol. 37 (4) 766–777
- [46] A. Rabl and A. de Nazelle 2012 *Transp. Policy*, vol. 19 121–131
- [47] I. N. Sener and P. R. Reeder 2014 *Transp. Res. Part A Policy Pract.*, vol. 67 381–393
- [48] M. Moglia and L. Marquez 2002 *24th Conference of Australian Institutes of Transport Research*, 2002 (12) 1–14
- [49] M. Kuwahara, M. de Kievit, S. Shladover, W.-B. Zhang, and M. Barth 2013 *Guidelines for Assessing the Effects of ITS on CO<sub>2</sub> Emissions* - International Joint Report
- [50] H. Bressers and S. Kuks 2003 *What does ‘governance’ mean? From conception to elaboration* Hans Bress., Westport, Connecticut, 65–88.
- [51] E. Ostrom, M. Janssen, and J. M. Anderies 2007 *National Academy of Sciences* 104 (39) 15176–8.
- [52] United Nations 2007 *Public Governance Indicators : A Literature Review*