



## Dual Formal and Informal Transport Modes towards Quasi-Seamless Transit in a Developing City

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### History:

Received: 25 July 2018

Accepted: 30 August 2018

Available Online: 30 September 2018

### Keywords:

Informal transport, formal transport, duality, continuum, quasi-seamless transit.

### DOI:

10.11113/ijbes.v5.n3.307

### ABSTRACT

Dual formal and informal transport modes have been complementing one another in Bandung City for more than four decades now. The issue appears due to inability of formal transport to provide adequate services to the citizens. However, this accompaniment has brought Bandung City to a quasi-seamless transportation process as both transport modes play their roles as a continuum. Amid insufficient public transportation system in Bandung City, the informal transport modes have properly paired their formal transport counterparts. This study was conducted in Bandung City, Indonesia, by profiling the transportation users, observing the characteristics of both formal and informal transports, and acquiring the relevant secondary information at city and national levels. The study found that within the issue of appropriateness of few modes of informal transport such as becaks and ojeks, they have shown their contribution to the state of quasi-seamless transit process in the city as well as their impacts to reduce the CO<sub>2</sub> emission in comparison to formal fossil fuel-based transportation.

## 1. Introduction

Formality and informality in many sectors are frequently seen as a dichotomy (Rothenberg et al, 2016; Schindler, 2014; Günther & Launov, 2012). This view has created a clear boundary between the two and resulting in discontinuity of the policies to handle this duality. This dichotomous view is in fact true to some extents if it is examined along several dimensions of formal sector vis-à-vis informal sector as illustrated in Table 1. Different outlook sees that formal sector and informal sector are rather a continuum than a dichotomous entity (Verreynne et al., 2016; Nadin & Williams, 2012). This view argues that in the formality there is certain degree of informality. In similar manner, the informality to some extents contains

formality. It is therefore an in-between area present which links informality and formality. This opinion also argues that an informal sector can be transformed to formal sector by certain mechanism. The transformation of informal sector to formal sector is also not a binary process rather a gradual process that passes through grey area between the two sectors. Another argument on this continuum is that informality appears due to incapability of formal sector to provide its full service (La Porta & Shleifer, 2014). A visible example on this case is that jobs in urban informal sector are created because formal sector unable to create formal jobs. Although informal sector is predominantly available in developing countries, it is, however, not necessarily that informal sector is a domain of cities in

**Table 1** Informal and Formal Sectors Dichotomy

Dimension	Formal Sector	Informal Sector
Economic Standing	Middle and Upper Class	Lower Class, Poor
Political Influence	Strong, Empowered	Weak
Legitimacy	Legal, Regulated	Illegal, Unregulated
Society and Culture	Modern	Traditional
Internal Organization	Orderly, Vertically Integrated	Less Structured, Horizontally Integrated
Assets and Capitalization	Intensive	Minimal
Financing and Credit Access	Commercial Banks	Family and Loan Sharks
Technology	High Tech	Low tech
Skill Levels	Knowledge-Based, Cognitive	Labor-Based, Adaptive
Legal Status	Registered	Unregistered

Source: Cervero (2000), Lubell (1991), Portes et al. eds (1989), Sarosa (1993).

developing countries (Cervero, 2000; La Porta & Shleifer, 2014; Sinclair, 2017).

Although informal sector is not domain of cities in developing country as argued by Cervero (2000), but undeniably, cities in developing countries are predominant harbor of informal sector for one strong reason, which is the characteristics of informal sector is perfectly compatible with the conditions of developing countries (Günther & Launov, 2012; Pugh, 2013). A city in developing country is therefore the focus of discussion on formality and informality particularly in transportation sector.

In the transportation sector, formality and informality are also present. Formal transportation mode, to a great extent, is more preferable by city authorities over informal transport because of its regularity. Although the complementary roles of informal transport cannot be totally ignored (Kumar et al., 2016). Informal transport services are also notable for their role as “gap fillers”. They exist in large part to fill the service that voids left unfilled by formal public transport operators (Cervero, 2000). Poor transportation infrastructure, particularly road facilities, lack capabilities of city authorities to develop a strategic plan for better formal transportation which can lead to traffic congestion and air pollution, are generally occur in formal transport mode. This situation stimulates informal transport to take a role as gap filler. In line with this, formal transport services cannot also satisfy increasing demand for travel (Enoch, 2016). This situation, and by considering the essential role of informal transport, is therefore essential in a sense that government must support the informal and formal public transport by providing well-articulated policies to improve the performance of operations and services (Aworemi et al., 2008).

Articulation of informal and formal policies to improve the performance of transportation services towards an acceptable level is necessary (Walters, 2013). The high level of transportation performance will also affect urban environment condition, such as better-off urban air quality (Yusop & Permana, 2016). The policies are targeted to address transportation sector with urbanization and land use as its backward linkage and environment as forward linkages. Although the nexus of urbanization, land use, transport and environment is not linear, but by considering only the strongest connection among the elements of nexus, the nexus is safely regarded as linear (Permana et al., 2015). The linearity of transport modes either informal or formal transport is maintained. In view of this circumstance, Bandung City has been selected as study area providing the complexity of the dynamic interplay between informal and formal transports in this city which leads to present condition of urban environment.

## 2. Study Area

Bandung City, the study area, is approximately located on 1070 East and 6055' South at the altitude about 650 above mean sea level. The present area of the City is 16,767 hectares and is geographically located in the center of West Java Province (refer to Figure 1). Urban expansion of Bandung City has been undergoing in an inconceivable pace during the period of 1970-1980. In many Indonesian big cities including Bandung, the annual population growth during this period accounted for 2.4 to 3.0 percent (Simmons, 2000). With this growth, Bandung suffered from the pressures on land, infrastructure and services. In this period, the residential area has been expanded by about nine percent. This expansion was predominantly underway in the Southern periphery, since this area is relatively flat compared to the others. Amid the threats from annual

flooding, however, the expansion to this area and to the eastern part were still the best, due to availability and readability of the land for expansion. The urban expansion in this period accounted for forty-five percent with respect to total city area. The expansion has significantly created motorized transport dependent citizens, and further affects transport energy consumption and environment issues in this city.

A significant expansion of the urban area, which was marked by considerable residential development, occurred during the period of 1990-2000. Total urban area has expanded by about sixty-three percent during this period. In the same period, the residential area has also expanded by about 145 percent. At the end of 2000, the length of urban roads was only about 932 km (CDPA, 2003) and the number of cars was 451,957 units. It showed that the length of road per unit vehicle was only 2.0 meter, and it also indicated that traffic congestion becomes a usual incidence for the citizens of Bandung. The economic losses due to traffic congestion (in terms of energy and environmental losses) in Bandung were about US\$ 700,000 per day (Tamin, 2004). This showed the importance of urban expansion which generates traffic congestion and eventually leads to degradation of air quality.

The problems inefficient and inadequate public transportation and growing number of private vehicles, degradation of air quality and other urban environmental problems in Bandung City have been important issues for quite long time. However, local authorities are still struggling with fundamental issues on public transport and illegal para-transit, and paying less attention to solving overall problems of urban transportation in the city. As a result, problems created by urban transportation system are now leading towards point of no return and therefore its level of irreversibility is high.

Urban transportation system in Bandung City is generally denoted by significant contribution of private transport over public transport, discomfort public transport despite extensive routes, and concentrated destination for work travel. Although legally banned to operate on main roads in the city, the operation of informal transport such as becak (non-motorized three-wheelers), ojek (motorbike taxis), and horse-pulled wagon are still visible. The interplay of formal and informal transport connotes current urban transportation system in Bandung City. In terms of public transport, Table 2 shows the characteristics of formal and informal public transports in Bandung City.

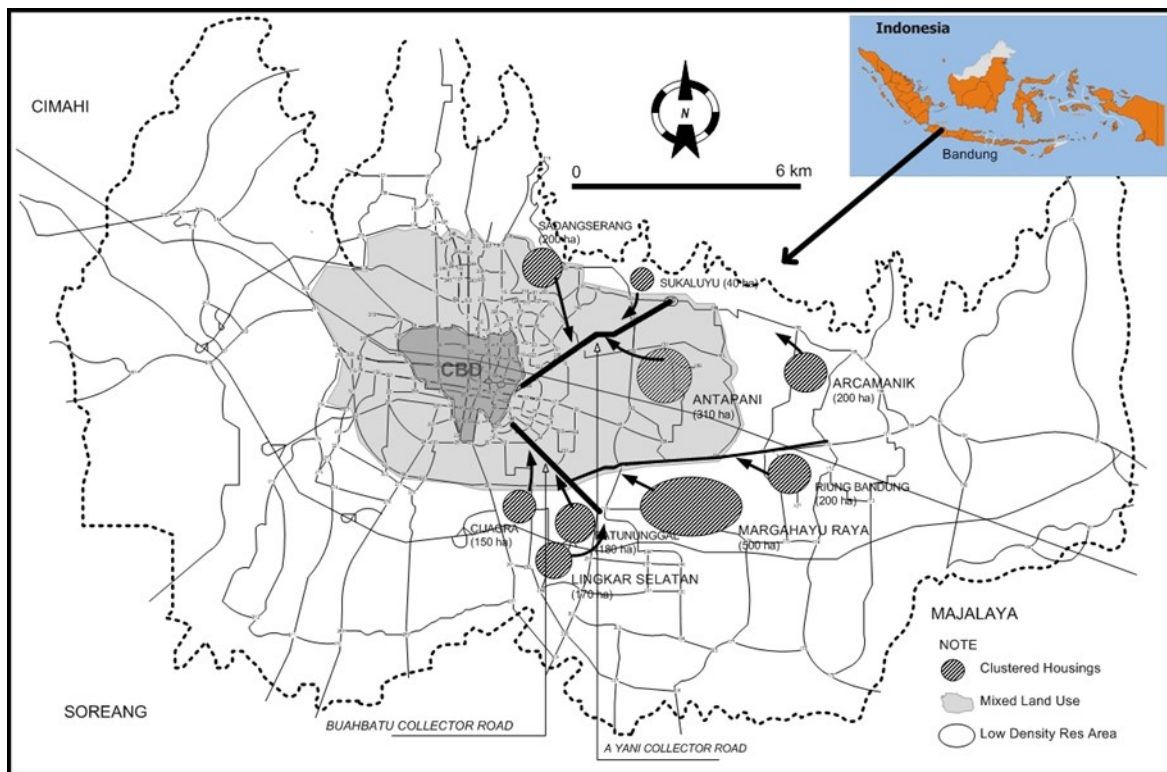


Figure 1: Bandung City, the Study Area

*Table 2 Formal and Informal Public Transports in Bandung City*

Aspect	Formal Public Transport	Informal Public Transport
Service Delivery	Designated, fixed and personalized routes	Personalized routes, adaptive
Schedule	Semi-fixed, passenger-driven	Flexible, passenger-driven
Reliability of service	Inconsistent to reliable depending on type	Inconsistent to semi-reliable
Vehicle Capacity	4-seat to 40-seat passengers	2-seat passengers
Vehicle Type	Motorized	Non-motorized and motorized
Ownership	Public and Private	Private, individual
Market Perspective	Monopolist (public), Entrepreneurial (private)	Entrepreneurial, individual
Labor	Semi-skilled	Semi- to non-skilled labor
Organization	Bureaucracy, route associations	Individual, social associations
User's social status	Low to medium income	Low to medium income
Fare structure	Fixed, standardized	Variable, non-standardized

Source: Format is adapted from Cervero (2000)

Formal and informal public transports are both needed in an urban transportation system. The informal transport modes generally operate in the street where the operation of formal transport modes is unavailable. These two transport modes can actually complement each other to form a smooth quasi transit system for the comfort of travelers if only city authorities have a willingness to facilitate it. Formal and informal transport modes, as discussed in preceding section, should be accommodated in articulated policies, so they can synergize to constitute better urban transportation system.

### 3. Present Formal Transport Modes in Bandung City

Formal transport mode is seemingly the backbone of transportation sector in Bandung City, for a reason that presently, informal transport mode is not officially recognized by city's legal system. Present city regulation is yet preventing this transport mode to operate. Despite this legal issue, formal transport particularly *becak*, is still presently operating underground amid frequent 'clearing operation' to avert *becaks* operating in city. From social viewpoint, *becaks*' drivers have the right to earn money in the city. But from legal viewpoint, city authority argues that, according to city's bylaw, *becaks* are indecent transport mode and therefore should not be allowed to operate. In this social-legal dilemma, legal aspect takes precedence over social aspect, although do not 100 percent applies. Unlike organization of formal transport, unclear organization of informal transport has also been used by city authorities to legitimize their action in restraining *becaks* in Bandung City.

#### 3.1 Organization

Formal transport modes in Bandung City consist of public inter-city and intra-city buses, inter-city trains, taxis, *angkots*, private cars, and private motorcycles. Inter-city public buses are owned mostly by private companies. The only inter-city and intra-city public buses owned by government is *Damri*. The private companies formed a sole organization so called *Organda* (Organization of public land transport entrepreneurs). This is a legal organization run by themselves in which all members are entrepreneurs (not companies) of the public land transport.

Intra-city public bus in Bandung City, in different manner, is exclusively and monopolistically run by *Damri*, a state-owned company. Due to this ownership, *Damri* is not a member of *Organda*. Similarly, inter-city trains are operated monopolistically by PTKA, a state-owned company, for the whole country. There are two types of ownership for taxis in Bandung City. First, taxi is owned by individual but among the owners, they form an association under same taxi name. Second, taxi is owned by company. There are presently nine taxi names/companies operating in Bandung City. *Angkots* are owned by individuals but the owners form an association so called *Angkot* (City Transportation). The name of *angkot* is then becoming popular name public vans in this city.

Inter-city bus, taxi and *angkot* are members of *Organda*. *Organda* is organization for the entrepreneurs of public transportation. Uniquely, the drivers of this public transportation are member of labor union of *Organda*. Between *Organda* and Labor Union of *Organda* is sometime confronting each other due to different interests. This case

particularly occurs in taxi Company. The owners of taxi (members of *Organda*) intend to hike the fare, but taxi drivers (members of Labor Union of *Organda*) against this decision, because from the driver's side, the increase of fare means significant reduction of customers and therefore less income. This happens because the fees must be submitted by the taxi drivers to the owners were based on fix daily rate, for example, IDR 500,000.00 (USD 40) per day.

The fare of all public transport modes is determined by the government based on *Organda*'s proposal and other factors. Fare differentiation for different public transportation system reflects comfort and convenience of the transport modes. Fare is also an important determining factor of the market. It usually follows that individual income defines the choice of transport modes.

### 3.2 Market

There is certainly market segregation of urban transport users, particularly in public transport users. By using interval income of USD 150, the result of recent survey in the study area shows that private vehicles are mostly (72 percent) used only by middle to upper income earners, which is those whom their income more than USD 450/month. The users of private motorcycles are those with income more than USD 300/month (91 percent). Majority (more than 50 percent) of the users of formal public transport, meanwhile, is clustered as follows as reflected in the survey results:

- Taxi (including Grabs and Uber); 65 percent of the users earned income of more than USD 300/month
- Air-conditioned public bus; 87 percent of the users earned income of more than USD 150/month
- Non-air conditioned public bus; the users are coming from all strata of income;
- *Angkot*; the users are coming from all strata of income;
- Intercity air-conditioned bus; 67 percent of the users earned income of more than USD 150/month
- Intercity non- air conditioned bus; the users are coming from all strata of income;
- Intercity air-conditioned train; 71 percent of the users earned income of more then USD 300/month
- Intercity non-air conditioned train; the users are coming from all strata of income.

From the above facts, *angkot* and non-air conditioned public bus are the most frequently used public transportation in the city. This fact urges the authority to

appropriately attend to these types of public transport modes, particularly in supply side. *Angkots*, in fact, is out of the authority's hand to control since they belong to individual owners, although control is still possible to some extent. For public bus, the city authority can still have control on the supply side of the services, since the DAMRI bus is owned by the government.

### 3.3 The Supply Side: Operations and Operators

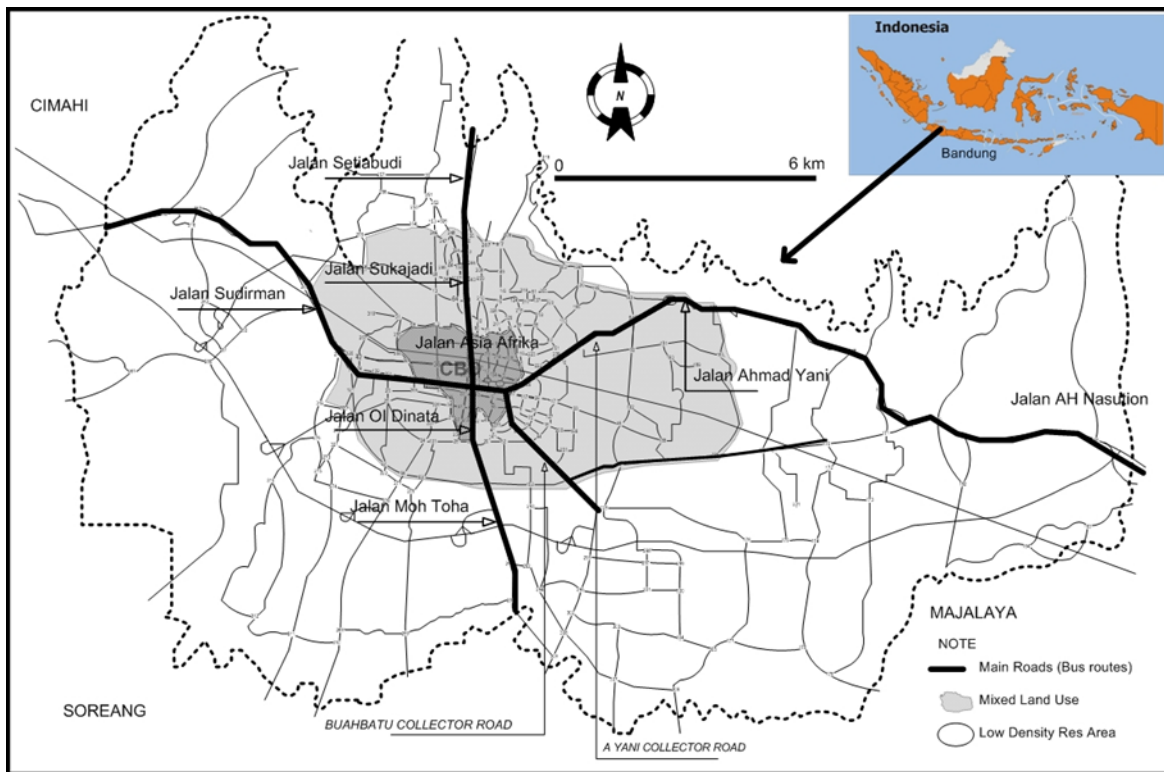
Public bus with crowded passengers at public bus (non air conditioned bus) is common scenery in public transport in Bandung. This does occur not only during peak rush hour but also during 'normal' hours. Ageing fleets of non-air conditioned DAMRI buses are also significant issue of public bus transport mode in the city. In different way, the supply of *angkot* is abundant and over capacity, because suppliers are actually individuals. In some cases, these individuals formed an informal organization to get better bargaining position against *Organda* or city government as regulator.

There are presently 193 public buses (with about 5,700-seat capacity) and 8,811 *angkots* daily operating in city (about 65,000 seats). This capacity is equivalent to about 1.4 million passenger-kilometer traveled. This seems sufficient to accommodate the need of transport in city, however, present quality of services discourage people to use these two public transports. The regulators, operators, and operation systems need to be improved.

### 3.4 Working Environment

There are two persons that serve the passengers in a public bus, 1 driver and 1 conductor. The driver and conductor usually wear uniform provided by the company. For *angkots*, there is only driver to serve the passenger and no uniform for *angkot's* driver. The dress code for public transport is not regulated by city authority rather internal regulation. The service time of public bus is 6:00am to 21:00pm. There are normally two shifts of working hours. Driver and conductor of public bus therefore work for 7.5 hours per day on rotational basis meaning morning shift for today and evening shift for next day.

In different way, *angkot's* drivers have no regular working time. They can work whatever and whenever they like as long as their daily mandatory deposits are fulfilled. The amount of deposits is negotiable (between *angkot's* owner and driver) depending on *angkot's* age. However, the daily deposits are presently between USD 15 (for older *angkot*)



**Figure 2** Main Roads – Public Bus Routes

to USD 25 (for newer *angkot*). *Angkot* drivers earn money from the remaining money they earn deductible from gasoline expense. Drivers of public transport are the most exposed persons to air pollution along with traffic police. However, there is no report on this matter available.

### 3.5 Operating Characteristics

Public buses routes are generally on main axes roads of city as shown in Figure 2, while *angkot's* routes are on secondary roads. It has fewer routes (15 routes with total length of 311.1 km) in comparison to *angkot's* (35 routes with 542.7 km).

As shown in Figure 2, city public buses serve a route obviously on main and important roads in east-west direction e.g. Jalan AH Nasution – Jalan Ahmad Yani – Jalan Asia Afrika – Jalan Sudirman, and south-north direction e.g. Jalan Setiabudi – Jalan Sukajadi – Jalan Gardujati – Jalan Oto Iskandar Dinata. In the same time, smaller vans (*Angkot*) serve other secondary roads. Almost whole city parts are served by *Angkots* and this has created a quasi transit system where bus' routes and *angkot's* routes are connected at many points. There are actually numerous potential advantages from the integration of informal and

formal transport towards better services of these two transport modes to the users.

### 3.6 Gender User's Profile

As discussed in paragraph 3.1.2., the users of public buses and *angkots* are generally low to middle income earners. In terms of gender, sampling survey on *angkot* and public bus users shows that almost similar percentage of women and men exist. Women counted for 48.2 percent while men about 51.8 percent including both air conditioned and non-air conditioned buses. However, for air conditioned public bus, women outnumbered men users, which is 53.0 percent for women against 47.0 men. No gender survey on taxi's passengers was carried out.

The presence of formal transport, with current quality of service, has contributed to the movement of citizens within the city to accomplish their travel purposes. However, travel purposes of the citizens cannot be served completely without the presence of informal transport. It is because formal transports serve only certain routes and may not cover all areas of the city. The presence of informal transports is therefore necessary.

## 4. Present Informal Transport Modes

The informality in this study is singularly attributed to 'recognition by the authority' or legal status of the transport modes. With this definition, there are two major types of informal transports in Bandung City, namely *becaks* (three-wheeled non-motorized transport modes) and *ojeks* (motorcycles taxi). Horse-pulled carts are not discussed further for the reason that this kind of informal transport are now gradually vanishing. Amid legal warning from the authority upon the illegal operation of *becaks*, the numbers of *becaks*, which are presently operating in many city alleys, are considerably large. Interview with 20 *becak* drivers shows that presently about 3000 to 4000 *becaks* exist and actively operating in city. There is no hard proof in this particular case. The legal or illegal controversy of *becaks* as one of transport modes in the city is actually rooted from the unavailability of decent jobs offered in the city for unskilled workers. Creating more job opportunities and improving skill of the workforces are possible response to this issue. The authority meanwhile does not do something to cope with this issue. Repressive action has been the easiest option chosen by the authority to deal with *becaks* problem in city.

For longer distance and hilly areas, where *becaks* cannot operate, *ojeks* (motorcycle taxi) are normally operated. There is no data on the number of *ojeks* which presently operate in city, however, according estimate by some *ojeks* drivers, about 2000-2500 *ojeks* are presently exist. Similar with *becaks*, *ojeks* operate in alleys. The *ojeks* seems more fortunate in comparison to *becaks*, because city authority neither recognizes nor prohibits the operation of *ojeks* within the city.

Those above two informal transport modes are focus of discussion of this study. The discussion consists of organization, market, working environment and other aspects which are necessary to understand.

### 4.1 Organization

Since informal transport modes are illegal in nature, there is no formal legal organization which binds the owners and the drivers of informal transports. Informal association within the owners or the drivers are formed for one reason, they have same destiny. They consider themselves as outsider because of their feeling of exclusion in the mainstream. In fact, their voices have never been heard by the authority, except during mayor's election. With frequent clearing operation undertaken by special police

force under city government, they consider the force as their natural enemy. With this kind of feeling, it is socially difficult to embrace them into urban development mainstream. Their wishes are actually very simple, recognition by the authority and opportunity from the authority. This needs to be included in the policy on urban poverty. With their nature of informality and images of poverty stigmatized to them, their market is different from formal transport modes.

### 4.2 Market

Formal transports users are to include middle upper income earners as well. Informal transport users are mostly low income earners, and to some extent middle income earners. This market's segmentation may cause in a difficulty for informal transport users and drivers to improve their socio-economic condition. For information, all *becaks* drivers are urban poor and more than 90 percent of *ojeks* drivers are also categorized as urban poor. With such condition, working environment is also poor.

### 4.3 Working Environment

Informal transport drivers have no certain working hours. They sometimes work on round-the-clock basis. They will stop their work whenever two things achieved; tired or they think they earn 'enough' money for the day. 'Enough' for them is totally different with others, although it is difficult to define 'enough'. On average, their daily income for driving *becaks* is not that proper. It is only about IDR 50,000 to 100,000 (USD 4 to 7) per day with 5-10 operating hours and 15 to 25 kilometer traveled per day. This can only be achieved at relatively flat geographical areas. Almost similar story on poverty exists in *ojeks* operation. Interview with 20 *ojeks* drivers showed that their daily income were IDR 75,000 to 150,000 (USD 5 to 10), with travel distance about 25 to 50 kilometer per day. It looks above poverty line, however, if their income is divided with their household's size (mostly above 5), result shows that they are in an extreme poverty condition. World Bank's criterion on poverty is USD 1 per day per person. Low income, bad working environment and uncertain operating areas are the most significant issues of informal transport modes.

### 4.4 Operating Characteristics

Informal transport modes operations are generally characterized by the followings conditions as shown in Table 3.



**Table 3** Operating Characteristics of Informal Transport Modes

Aspect	<i>Becaks</i>	<i>Ojeks</i>
Operation Area	At junctions and within residential areas	At junctions and within residential areas
Topography	Flat only	Flat and hilly lands
Working hours	24 hours	24 hours
Basic Fare	Negotiable, for 1 km distance is about IDR 15,000 (USD 1.0)	Negotiable, for 1 km distance is about IDR 10,000 (USD 0.8)
Farthest distance	About 5 km	None
Max no of passengers	2 adults	1 adults and 1 child
Power	Human	Engine
Safety	Uncertain	Uncertain
Legal basis	Illegal	Not recognized by the authority

Operating characteristics of informal transports can be further formalized if city authority wishes to formally recognize them and included them into formal and legal city regulation. However, with current mindset of the authorities, it seems difficult that informal transport particularly *becaks* to be included in formal transport. Present mindset of the authorities considers *becaks* as indecent transport mode and therefore indecent jobs for the drivers. This is main factor that hampers the recognition of informal transport as a mode of urban transportation system and the operators as well. Simultaneously, city government is not capable to provide job opportunities amid high unemployment rate in Bandung City.

#### 4.5 Operator Profiles

Informal transports are owned by people with low to middle income level, but the drivers are mainly the poor. *Becaks*, for example, are owned by individuals. In most cases, *becaks* drivers are also the owners. About 80 percent of the samples show that *becaks* drivers are also the owners. In same way, about 90 percent of *ojeks* drivers are the owners. If the majority of *becaks* drivers have education at primary school level, the *ojeks* drivers have higher education level. Most of them have high school education background. *Becaks* drivers admit that their jobs are indecent jobs. This is the only choice they have, because they have no other skill to look for jobs that are more appropriate. Similarly, *ojeks* drivers are not intended choice. They choose this job because of easy to enter and no skill is required, as long as they can legally ride the motorcycles.

#### 4.6 Gender User's Profile

Users of informal transports are generally low to middle income earners. In terms of gender, sampling survey on

*becaks* are majority women. It accounted for 78.5 percent while men about 21.5 percent. For *ojeks* users, men outnumbered women users, which is 64.0 percent for women against 36.0 men. Regarding user's satisfaction, with two choices satisfy and dissatisfy, about 53 percent of the *becaks* users express their satisfaction with the services because *becaks* are able to provide door-to-door service. However, only 48 percent of samples of *ojeks* users are satisfied with the services of *ojeks*.

### 5. Environmental Impacts Created by Formal-Informal Transportation System

The most visible environmental impact of generated by transport is obviously air pollution. Monitoring undertaken by West Java and Bandung City Environmental Protection Agency shows the tendency of degrading air quality in the city over time. The major contributor of air pollution is transportation sector. Monitoring of air quality data to understand the extent of contribution of transportation sector to air pollution were carried out by means of mobile air quality monitoring laboratory (MAQML) at ten monitoring points. Because of its mobile nature, the MAQML could be operated anywhere. The data were acquired by employing MAQML. The measurement was undertaken by parking the MAQML at the road-side, and then MAQML observed the air quality. At the same time, traffic volumes were simultaneously analyzed.

The ambient air quality was monitored in hourly basis during 8:00 to 16:00 hours for seven consecutive days. There were eight-hour interval data samples, with minimum, maximum, and average parameters. Eight air pollutants viz. SO, CO, O<sub>3</sub>, HC, Non CH<sub>4</sub>, CH<sub>4</sub>, SPM and SO<sub>x</sub> were monitored. Fifteen points of the air quality monitoring stations across the city were actually available, however considering the incompleteness of data records,



**Table 4** Air Quality at Selected Points in Bandung

Selected Monitoring Points	Year of Monitoring	Traffic Vol (PCU)	Air Pollutants (ppm)					
			SO <sub>2</sub>	CO	NO <sub>x</sub>	O <sub>3</sub>	HC	PM (mg/m <sup>3</sup> )
Leuwipanjang	2003	6,835	0.042	3.000	0.080	0.045	1.940	151.61
	2002	1,974	0.040	2.067	0.043	0.031	1.409	126.40
Cicaheum	2003	6,471	0.050	3.601	0.102	0.030	1.970	115.20
	2002	2,730	0.048	2.890	0.096	0.031	1.730	133.60
Elang Raya, Cibereum	2003	3,430	0.046	1.703	0.059	0.053	1.302	128.80
	2002	1,266	0.034	1.960	0.047	0.053	1.240	98.67
Margahayu Raya	2003	610	0.023	1.400	0.043	0.038	1.130	96.77
	2002	258	0.027	1.059	0.006	0.054	1.078	60.53
Sarijadi KPAD	2003	2,460	0.033	1.178	0.054	0.039	1.020	85.45
	2002	665	0.024	2.278	0.022	0.056	0.700	102.30
Buah Batu	2003	4,891	0.043	4.290	0.128	0.037	2.310	153.79
Cibiru	2003	4,310	0.033	2.400	0.063	0.031	1.370	102.40
	2002	1,431	0.043	1.618	0.059	0.032	0.796	120.80
Ujung Berung, Rumah Sakit	2003	1,733	0.030	2.054	0.052	0.030	1.353	69.60
	2002	575	0.032	0.261	0.012	0.031	0.173	45.26
Ahmad Yani, PERSIB	2003	4,936	0.052	3.650	0.072	0.037	1.880	108.00

only ten points were considered (Table 4). Establishment of the correlation is undertaken by employing ordinary least square non-linear regression. A study conducted by Zhonghan et al. (2002) has attempted to rationally correlate traffic and emission intensity. This study resulted in a following rational correlation.

$$E_p = \sum_{i=1}^n L \times N_i \times F_{pi}$$

Where  $E_p$  is emission intensity of a line segment (gram/hour/km),  $L$  is length of road researched (km),  $N_i$  is traffic flow, number of vehicles of type  $i$  passing through the road segment (vehicles/km),  $i$  is vehicle type (1 to  $n$ ) and  $F_{pi}$  is emission factor of vehicle type  $i$  (g/km). The dissimilarity between Zonghan's and this study is that Zonghan considers the source of emission at a line domain while this study observes a point domain to assess the quantity of emission.

Contribution of informal transports to air pollution is much less than formal transport or even positive in terms of air quality improvement. For *ojeks*, with engine capacity of the motorcycles used for *ojeks* operation is 100-125 cm<sup>3</sup>. Understanding engine capacity is to comprehend the emission factor in order to be able to calculate the emission discharged by *ojeks*. With this size of petrol engine, the emission factor is found to be 0.0729 kg of CO<sub>2</sub> per kilometer traveled. For petrol private car up to 1.5 liter engine size, the emission factor is 0.1831 kg per kilometer traveled (<http://www.defra.gov.uk>).

With above emission factor for CO<sub>2</sub>, the contribution of *becaks* or *ojeks* in the reduction of CO<sub>2</sub>, if both are substituted by private vehicles, are shown in Table 1. Presently there is a potential reduction of emission of CO<sub>2</sub>, means improvement of air quality, within Bandung City, of more than 5,000 kg of CO<sub>2</sub> if *ojeks* substitute motorcycles for travel purpose of the citizens within their residential

**Table 5** Contribution of Informal Transport in CO<sub>2</sub> reduction

Non-motorized transport modes	Total Daily travel for whole city (km)	Kg of CO <sub>2</sub> , as substitute of motorcycle travel (e=0.0729kg/km)	Kg of CO <sub>2</sub> , as substitute of private cars of 1.5 liter engine size (e=0.1831kg/km)
<i>Becaks</i>	70,000	5,103	12,817
<i>Ojeks</i>	84,375	0	9,298
TOTAL potential reduction		5,103	22,115

**Table 6: Distribution of thermal sensation and comfort votes**

Thermal sensation	Cold (-3)	Cool (-2)	Slightly cool (-1)	Neutral (0)	Slightly warm (+1)	Warm (+2)	Hot (+3)
SM1	0	0.7%	4.2%	36.8%	37.5%	15.3%	5.6%
			<b>78.5%</b>				
SM2	0	0	4.8%	38.6%	45.5%	10.3%	0.7%
			<b>88.9%</b>				

Comfort	Very uncomfortable	Uncomfortable	Just uncomfortable	Just comfortable	Comfortable	Very comfortable
SM1	2.8%	10.4%	21.5%	56.3%	8.3%	0.7%
	<b>34.7%</b>		<b>65.3%</b>			
SM2	1.4%	11.7%	37.2%	45.5%	4.1%	0
	<b>50.3%</b>		<b>49.6%</b>			

areas. If becaks and ojekes will be able to substitute private cars, this number is higher of more than 22,000 kg of CO2 per day. This is a significant amount of contribution.

Table above counts only CO2 emission, together with other GHG emission, the contribution of informal non-motorized transport is quite significant. If the operating area of this non-motorized transport mode is expanded, the contribution will be even larger. The issue is now, how to settle the controversy. It is definitely difficult to solve since numerous social factors involve. Some thoughts on compromising the controversy are useful to consider. These thoughts include:

Allow non-motorized transport modes e.g. becaks or bicycles taxi to operate legally within the residential areas in city

Design non-motorized transport modes in such a way that is able to nullify the image of indecent job

**Table 7: Distribution of acceptability votes**

	Clearly unacceptable	Just unacceptable	Just acceptable	Clearly acceptable
SM1	2.1%	16.7%	73.6%	7.6%
	<b>18.8%</b>		<b>81.2%</b>	
SM2	2.8%	23.4%	73.1%	0.7%
	<b>26.2%</b>		<b>73.8%</b>	

**Table 8: Distribution of temperature preference**

	No change	warmer	cooler
SM1	22.2%	1.4%	76.4%
SM2	18.6%	1.4%	80.0%

**Table 9: Distribution of air movement preference**

	No change	Less air movement	More air movement
SM1	30.6%	1.4%	68.1%
SM2	24.8%	4.1%	71.0%

Control the number of this transport modes by creating comparable alternative job for unskilled workers  
 Provide adequate facilities for this transport mode such as terminal at a connecting point with motorized transport modes.

Urban air quality degradation clearly goes hand-in-hand with the increase of number of vehicle on roads. Coping strategies to deal with this issue may include emission control, promotion of non-motorized transport, encouraging the use of public transportation instead of private transportation, discouraging unnecessary travel, or other strategies which generate co-benefits among the measures. These strategies should preferably be

accommodated in environmental management measures of the city.

## 6. Present Environmental Management Measures

The forms of environmental management measures are generally command and control, economic instruments and suasive measures. Similar situation can also be applied for environment issue generated by transportation sector. Present instruments pertaining to environment and transport are summarized in Table 6.

### 6.1 Legal Settings for Formal Transport

Transportation system in Indonesia including Bandung is mainly based on Law on Traffic and Overland Transportation, LTOT (22/2009). There is no specific regulation at city level regarding traffic management and transportation in Bandung. In the absence of city regulation, the national law (LTOT) is the main regulation to be guided in Bandung. This law is uniformly valid all over the country. The objective of this law is to achieve the traffic and land transportation system that is characterized by safe, secure, fast, free-flow, order, regulated, comfort

*Table 6 Summary of Present Policy Instruments (Law and Regulation) pertaining to Transportation and Environment*

Level of Directives	Name of the Policy Instruments			Major Gaps Identified in the Nexus
	Land Use	Transportation	Environment	
National	Law on Spatial Plan and Management (26/2007) - LSPM	Law on Traffic and Overland Transports (22/2009) –	Law on Environmental Management (32/2009) - LEM	Law on Traffic and Overland Transports, and Law on Environmental Management are loosely connected to Law on Spatial Plan, as a result, partial and uncoordinated activities of the nexus exist.
	Government Regulation on National Spatial Plan (26/2008) - RNSP		Min of Environment (MoE) Decree on Ambient Level of Motorized Vehicle Emission (20/2017)	Law on Spatial Plan and Management enacts more on guidance on “land allocation” and lack of guidance toward sustainable development.
			MoE Decree on Emission Standard of Stationary Sources	LTOT provides insufficient guidance on transportation, and transportation management is not well addressed. The environmentally sound transport is not addressed.
			MoE Decree on Blue Sky Implementation in the Priority Areas	LEM and all its derivative regulations are adequate to address air pollution problems, but more coercive rather than inductive nature.
City			MoE Decree on Air Pollution Standard Index	Blue Sky Policy is half-hearted policy, it requires strong enforcement to implement.
			Guidelines on Air Pollution Control of Mobile and Stationary Sources	
	City Regulation on General Plan on Spatial Management of the City of Bandung (18/2011)	Not available in Bandung City. But nation-wide LTOT is applied.	Not available in Bandung City. But some derivatives of the nation-wide regulations are applied.	General Plan provides too generic guidance and does not address the sustainable interconnection of the land use-transportation-environment nexus.
	City Regulation on Detailed Spatial Plan of the City of Bandung			Detailed Spatial Plan provides “house-keeping” kind of land use guidelines, and no significant direction toward sustainable city.
				No specific guidance on the traffic management in the city toward better urban environment. City transportation system is not sufficiently addressed.
				Control on pollution particularly urban air pollution is not well addressed.

and efficient. A transportation system that is able to integrate all transport modes and support the growth and distribution of development is the main objective of this law. The law, however, provides weak connection to spatial and environmental sectors or other sectors associated with this instrument. Since environment is the most influenced sector, therefore, minimizing impacts of transportation on the environment must actually be addressed here, however messages on how to minimize the impacts is inadequately envisioned by the instrument. This gap needs to be abridged, and it must be reflected in the proposed instruments.

There must be sets of guidance and guidelines to achieve the objectives, particularly those associated with land traffic management. Traffic management should actually improve the traffic flow, reduce emissions per vehicle kilometer traveled as well as enhance urban mobility. In principle, it consists of supply and demand traffic management. In the supply side, traffic management is intended to increase speeds of existing traffic volume that follows existing traffic volume without modifying it, while demand side desires on the improvement of speed by reducing traffic volume. These all detail guidelines are required to avail in Bandung. In fact, Law on Traffic and Overland Transportation provides no sufficient guidance on that. The law does not adequately guide efficient traffic toward less congestion in urban area, rather discussing and regulating traffic signaling and rule-breaking punishment. The law also does not address the environmental traffic that is expected to link this law with environment law. This issue is raised since the initiators of the law are Indonesian National Police Department and Ministry of Transportation, although interdepartmental and inter-sectoral discussion were undertaken, but still the key messages of the instruments were heavily affected by the initiators.

Present policy instruments pertaining to environment actually provide sufficient guidance toward better air quality. However, implementation of the instrument is insufficient, since law enforcement is the weakest points among the process. With insufficient law enforcement the environmental degradation is steadily decreasing over time, this is among other reflected in the degradation of urban air quality. In addition, some instruments do not clearly guide toward the objectives of improving urban air quality and environmental condition in general.

Presently, the highest level of direction on environment is Law on Environmental Management (23/1997). The

objectives of this law are to achieve sustainable development by considering the need of current and future generation, and to undertake environmental management which is balance, concordance and suitable in the achievement of sustainable development.

This law generally addresses issues on traffic associated environment, while addressing the needs of further regulation for specific purposes. To complement the law, some complementary regulations have been promulgated. These regulations are mainly in the form of Minister of Environment Decree. Ambient level of car emission, emission standards, blue sky policy, air pollution standard index and guidelines on the control of air pollution were also addressed adequately.

The weakness point of these instruments is on the implementation process. Due to weak implementation at city level, a lot of Indonesian cities are alarming in urban air quality. Example of the weakness is the implementation of Blue Sky Policy. This policy was a half-hearted-like policy, since the implementation was only in the form of appealing and encouraging people. Yet the implementation of this policy was in voluntarily basis. Another example was emission test. The test was undertaken intermittently without clear plan to continue this good practice. The emission test was also compulsory for public transport, but numerous polluting bus and other public transport vehicles were still operated on road.

Policy instruments on urban air quality concern are seems adequate with respect to the extent of guidance. Sources of air pollution are sufficiently addressed. However, the instrument does not cover all sectors those have strong connection with urban air quality. The messages on urban planning and transportation are not addressed at all. The messages are heavily concentrated on natural and anthropogenic relationships, because this is a significant issue in Indonesia. Emission control is addressed but more focused on end-of-pipe strategy rather than root-cause problem solving. This is again because of the initiators of the instruments was Ministry of Environment without adequate consultation with other sectors such as urban planning and transportation departments. This inadequate connection must be appropriately solved, and it must be reflected in the proposed comprehensive strategy in order to improve urban air quality.

As the conclusion on this policy analysis, it can be said that traffic related environment policies are abundant (and sometimes redundant) and relatively completed in

comparison with land use and transport related policies. However, implementation is the weakest point. This leads to the environmental degradation, including the degradation of urban air quality in the most Indonesian cities.

It seems from Table 6 that present instruments pertaining to transportation and environment are mainly on command and control aspect. In fact, this is true since there are no economic instruments or suasive measures in place. Economic instruments at city level have never been employed so far in Bandung City for urban and environmental management. Some suasive measures are occasionally employed for particular purpose, but these measures are not permanently institutionalized. The presence of gaps in the policies or instruments of formal transport have probably contributed to present conditions of transportation and environment. This should be

appropriately addressed in by future legal instruments, and mainstreamed in the present legal systems.

## 6.2 Legal Setting for Informal Transport

Present legal systems of transportation and environment for Bandung City including its implementation systems leave considerable holes and gaps which created present condition of transportation and environment in Bandung City. The terms of 'formality' shall actually give the impression that formal transport is well equipped with adequate policies and instruments. The fact is in contradiction with what 'out to be'. It can therefore be imagined that the informality of informal transport is inadequately facilitated with appropriate policies or instruments. The informal transport like *becaks*, for example, even receives systematic harassment from the city authority through regular law enforcement which forbids

Table 7 Possible Plans and Policy Instruments at Urgent Stage

Level of Directive	Components	Nature of the Policy Instruments/Plans	Objectives	Targeted EMM	
City	Air Pollution	Emission control attached to car licensing	To improve urban air quality by enforcing vehicle to comply with the emission standard	Command and control (CC) for formal transport	
	Transportation Management	MLRT Public Transport		To discourage people to use private car	CC for formal transport
		<i>Kancil</i> small wheeled transport		Provide low emission small public transport	CC for formal transport
		<i>Becaks</i> , tricycle transport		To reduce air pollution within residential area	CC for informal transport
		<i>Ojeks</i> , two-wheel transport		To reduce air pollution within residential area	CC for informal transport
		Park and ride system		Support MLRT and reduce number of vehicles operating within the city	CC for formal transport
	Land Use and Urban Planning	<i>Rukan</i> development		To obtain proximity between housing and jobs	CC for Urban development – formality
		<i>Ruko</i> development		To obtain proximity between housing and jobs (for commercial people)	CC for Urban development – formality
		<i>Masyarakat Jalan Kaki, Majaka</i>		To create pedestrian people by providing pedestrian friendly environment	Suasive Measure (SM) for community development - informality
	Public Awareness	Education for <i>becaks</i> and <i>ojeks</i> drivers  Awareness on transportation, environment and energy use		To create communities with high awareness particularly on transport, energy and environment	Suasive Measure for community development at large

*becaks* to operate within city, or they have to face severe penalty.

This condition is possible due to the presence of City Regulation No. 3/2005 which states:

*“Dalam rangka mengatur kelancaran arus lalu lintas, Pemerintah Daerah dapat menetapkan jalan satu arah, jalan bebas becak, jalan bebas sado/delman, jalur bebas parkir dan kawasan tertib lalu lintas pada jalan-jalan tertentu yang rawan kemacetan”*

Literally meaning, that for the purpose of smooth traffic flow, Government of Bandung City has the right to declare one-way traffic, *becaks* free zone, horse-pulled cart free zone, parking free zone, and zone of regulated and ordered traffic at certain streets where traffic congestion frequently occurs. The statement seems not too furious for *becaks*, however in the implementation, all streets in Bandung City are declared as *becaks* free zone. *Becaks* will not allow operating, failure to follow this rule, will face penalty such as capturing *becaks* without having opportunities to defend before the court.

The recognition of two-wheelers *ojeks* is unclear, whether this informal transport mode is recognized by city authority or not. No clear policy on this kind of informal transport, however, daily treatment from the authority on this two-wheeler motorized *ojeks* shows ambivalence. On one hand, city authority does not formally recognize this transport mode, it means at any time *ojeks* may face clearing operation from city streets. On the other hand, city authority closes its eyes on the operation of *ojeks*. This long time ambivalence has led to growing number of motorized two-wheel *ojeks*.

Informal transport such as *becaks*, *ojeks*, and horse-pulled wagons have not been accommodated appropriately by the city. City Regulation No 3/2005 is still effective as a ground to clear every eyesore in city. Illegal street vendors are the most suffering side of city's stakeholders in comparison to informal transport sector. They need to be accommodated appropriately since they are also stakeholders of city, however it seems that city accommodates only stakeholder which has strong economic power. This gap, if not carefully handled, will be a latent pressure to city in the whole which in turn will hamper the achievement of sustainable urban development.

Various gaps identified in present formal-informal transportation require attention from city authorities to

improve transportation and environment situation in Bandung City. The gaps should ideally be bridged by accommodating formal and informal transportation system. However, this issue will not be properly considered by the authorities without convincing them on the advantages of informal transport, if they are properly managed. One significant advantage of the informal transport that the authorities must know is environmental benefit contributed by informal transport. Analysis on informal transport, particularly non-motorized transport like *becaks*, shows that presently *becaks* contribute to the reduction of 5,000-12,000 kg of CO<sub>2</sub> per day, considering their numbers and operating areas. The contribution is equal to the reduction of 1.8 to 6 million kg of CO<sub>2</sub>. This is only contribution of CO<sub>2</sub>; other pollutants such as SO<sub>x</sub>, NO<sub>x</sub>, hydrocarbon, CO are not yet calculated. This figure should be understood by the authorities and by other city stakeholders prior to design environmental management measures toward better urban environment.

## **7. Implications on Environmental Management Measures**

Discussion on urban transportation system cannot avoid its backward and forward linkages. Land use as one of direct backward linkages and environment as one of the forward linkages. This field has been sufficiently researched (Banister et al, 1995; Breheny, 1995; Anderson et al 1996; Kenworthy and Hu, 2002; Hickman and Banister, 2007). A comprehensive EMM should therefore addresses these backward linkage e.g. land use and forward linkage e.g. energy and environment, and also covers three possible conventional measures e.g. command and control, economic, and suasive measures. The EMM can be policies or instruments depending on the suitability for particular purpose at particular place. With such backward and forward linkages, the identification of possible policies will attempt to explore all possibilities related to land use, transportation and its associations for the purpose of improvement of urban air quality in the city of Bandung.

### **7.1 Possible Urgent Environmental Management Measures**

In general, it is recommended that city specific policy instruments and plans produced by “city specific scenario” are recommended to carry out in the first phase, since this scenario is the most viable within few years to come. It can also include plans or policy instruments those recommended by “comprehensive and progressive scenario” under short-term time frame.

The recommended plans and policy instruments is presented in Table 7. However, by considering present technical and financial capability of the Government of Bandung City, the only presently doable plans are recommended to implement at the very beginning of the development phase. Implementation of the policies are particularly prioritized to those which having higher degree of implementability as well as having more synergized co-benefits. The more co-benefits are expected to have multiplier impacts for the improvement of the urban environment of Bandung City.

This recommended policy instruments or plans are intended for immediate actions, although the time-frame of the implementation is medium (1-2 year) or long-terms (2-5 years). A comprehensive management measures, although difficult to achieve, are also proposed. Do nothing or business as usual scenario is not considered, since nowadays city authorities should do something for the improvement of urban environment the city.

The recognition of informal transport with modifications are also proposed to achieve win-win solution, in which *becaks* would be recognized as one transport mode in city and the drivers would not regarded as indecent jobs. In the

**Table 8 Recommended Comprehensive and Progressive Plans and Policy Interventions (second stage)**

Level of Directive	Components	Nature of the Policy Instruments/Plans	Objectives	Targeted EMM	
National	Air Pollution	Standard of Compliance of Vehicle Emission	To reduce emissions from mobile sources	CC for formal and informal transport	
		Economic incentives and disincentives e.g. fuel tax	To reduce the need of motorized travel	Economic Instrument (EI) for formal transport	
City	Air Pollution	The Use of low emission fuels (CNG, LPG)	To reduce the emission from mobile sources	CC for formal transport	
		Temporary command and control on the implementation of the existing regulation	To achieve smooth transition	CC for formal and informal transport	
		Transportation (TDM)	Application of Area Licensing Fee	To discourage traffic at certain areas	CC for formal transport
	Transportation (TDM)	Application of Vehicle Quota System	To control the number of private vehicles ownership	CC for formal private transport	
		Transportation (TSM)	Guidelines on Appropriate Traffic Management	To achieve better traffic mechanism	CC for formal and informal transports
	Provision of traffic infrastructures		EI for formal and informal transports		
	Transportation (TSM)	Guidelines on appropriate parking system	To encourage the use of public transport	CC for formal and informal transports	
		Provision of appropriate mass rapid transportation system		EI for formal transport	
	Land Use and Urban Planning	Redevelopment and Revitalization of the CBD	Promotion of Mixed-Use development and high density residential	To achieve efficient and harmonious urban development characterized less pollution and energy-efficient transport	CC for formal urban development - formality
			Redevelopment of Bandung Sub-center and urban containment		
Promotion of the neighborhood type development					
Development Incentives and Disincentives		EI for urban development - formality			
Command and Control		CC for formal urban development			



long term, *becaks* can be gradually replaced by modern non-polluting small urban transport mode in the future such as electric Tata Nano cars cheaply produced by India.

## 7.2 Comprehensive long-term Environmental Management Measures

Implementation of the recommended policy instruments or plans cannot be undertaken at once. By keeping and maintaining the momentum of simultaneous and continuous actions toward the improvement of urban air quality in Bandung City, the subsequent phase can be planned. Similar consideration with the first phase is undertaken. The short-term and long-term plan should be pursued in a continuous basis to ensure that these two terms of proposal are well articulated.

For that purpose, following the first stage, in the next stage, comprehensive and progressive policy instruments or plans are recommended. The implementation is undertaken according to given time-frame. The interventions which are addressed by the conclusion must be reflected in the recommendation. With this consideration, in the second phase, the recommended plans or policy instruments as resulted by the comprehensive and progressive scenario are presented in Table 8.

All possible interventions are proposed, but by using the degree of implementability, preliminary economic analysis and the creation of possible co-benefits, the proposed interventions are screened. Those policies are, in principle, doable and implementable to certain degree with respect to current condition, in the sense that political will of the government and citizen awareness are now enshrining. The policies or instruments for formal and informal transports including its backward and forward linkages are expected to create a synergy towards better urban environmental conditions of Bandung City on the way to livable city and sustainable city.

## 8. Conclusions

Informal transport if it is managed appropriately may complement formal transport in providing more comfort urban transportation system in Bandung City. Formal transport which in Bandung's case is predominated by non-motorized transport such as *becaks* and also motorized transport two-wheel *ojeks*, are able to contribute to the betterment of urban environment, since these two modes, particularly *becaks*, do not emit or less pollutants. The

problem now in Bandung City is recognition of these two informal transport modes. So far, city authority does not recognize these two informal transport modes.

Environmental management measures which can be manifested or implemented in various forms such as plans, policies or instruments should accommodate these two formal and informal transport modes towards better urban environment. Although transportation is key policy arena for EMM in this study, but proposed EMM should also address land use as backward linkage of transport, as well as energy and environment as forward linkage in order to be able to provide comprehensive EMM to achieve better urban environment towards livable city. Some forty to fifty years ago, Bandung City was famously attributed as Parijs van Java (Paris in Java) and Flower City, but now Bandung is notoriously as congested city. This situation cannot be tolerated. This study is expected to contribute to the improvement of urban environment in Bandung City.

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