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Assessment of Public Transport Supply in Motorcycle Dependent Cities

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Abstract: In many cities of Asian countries, urban transport system is held by motorcycle. For example, motorcycle accounted for more than 65 percent of the total modal share in Hanoi and Hochiminh City (Vietnam). One of the critical reasons is that the public transport system has provided a substandard quality and limited capacity. A lack of awareness for the perceived quality and the missing of planned and systematic performance evaluation system for public transport are main causes of the poor service quality and the rapid growth of individual motorized traffic in these cities. Thus, it is important to get a clear picture of the causes of inadequacy of the public transport service. This research is aim to assess the public transport supply quality in Hanoi, a typical Motorcycle Dependent City. The results show that the bus network is urgently to extend and service punctuality have to be improved.

Keywords: Public transport, Quality, Network

1. INTRODUCTION

In Asian countries, the term “motorcycle dependent cities - MDCs” has been used to indicate a city with low income, high-density land use and motorcycles’ domination in traffic flow.

Hung (2006) gave a definition of a motorcycle dependent city (MDC) by establishing three groups of criteria: (i) vehicle ownership, (ii) availability of alternatives to individual motorised vehicles, and (iii) motorcycle use. Based on this definition, some cities, such as Hanoi and HCMC, are categorized into the group of highly motorcycle dependent cities.

In motorcycle dependent cities, motorcycle ownership is higher than 500 motorcycles per 1000 inhabitants. Motorcycles play a dominant role in the urban transport system where public transport quality is poor, cars and taxis are expensive and bicycles are very slow.

The lack of roads and parking facilities, fast urbanization and high rate of motorcycle in traffic flow in MDCs are the cause of the serious transport problems such as traffic accident, traffic congestion, and air pollution, which are much more serious than those in other cities. In this context, public transport is expected as the key measure to deal with the transport consequences.

However, so far in MDCs, public transport services have provided a substandard quality and limited capacity. A lack of awareness for the delivered quality and the missing quality management system are main causes of the poor quality of public transport services and the rapid growth of individual motorized traffic in these cities. Several MDCs like Hanoi and Hochiminh City (Vietnam), despite service improvements and continuously increased subsidies, bus shares increased modestly from 3% to 10% during 15 years (Parikesit and Susantono, 2013; Tuan, 2012). While there is a lot of emphasis on new and expensive infrastructure development to meet the supply gap in public transport, softer and often low-cost interventions like improving service quality are totally neglected. There is no mechanism that exits to assess if the available pubic modes are fulfilling their expected roles and meet various the standards regarding accessibility, convenience, reliability, safety,

comfort and so on. In most cases, there are no standards (Chhavi Dhingra, 2011). Experiences from developed countries show that to compete against private transport, public transport must continuously improve its quality and enhance the service it offers to regain passengers (Morichi and Acharya, 2013). This means that public transport service must safeguard commuters' interest by standards. From transport authority perspective the quality standard is a guideline for securing the provision of public transport services.

Understanding public transport service is an essential issue for improving it. Both transport operators and authorities need to understand which quality attributes are under the threshold to have some appropriate actions.

2. LITERATURE REVIEW

The ability to improve public transport performance is closely tied on the ability to measure it. So far, many performance measures have been developed and used in variety of way, reflecting differing viewpoints and responding to differing public transport problems (Bhat et al., 2006; Isaac K, 1993).

When dealing with public transport service quality, EN 13816:2002 developed a set of quality criteria which were organized into eight categories: the first two categories, availability and accessibility, mentioned the public transport provision in more general terms, while the next five present the service quality in detail, the last category describes the environmental impact on the community at large (EN 13816:2002). Recently, quality criteria from EN 13816:2002 have been widely applied in almost public transport systems.

Eboli and Mazzulla (2011) investigates that the aspects mainly characterizing public transport service, especially bus service, are service availability, service reliability, comfort, cleanliness, safety and security, information, customer care and environmental impacts.

According to Vuchic (2005), there are several areas of concern of public transport to customers, namely availability, accessibility, information, travel time and reliability, comfort and convenience of service, safety and security, and environmental impact. This author proposes an enough comprehensive classification of performance criteria: transport quantity or volume; system and network performance; transport work and productivity; system efficiency criteria; consumption rates and utilization criteria.

In accordance with eight quality categories in EN 13816:2002, the TRB (2003) proposes 31 criteria and more than 400 performance indicators. TRB (2003) also considers the needs of data collection, potential strengths and weaknesses for particular applications. At the earlier efforts, the TRB (1999) suggests a range of simple disaggregate performance measures which can be used for measuring the ability of a public transport agency to offer services that meet customer expectations. These performance measures are quantitative measures expressed as a numerical value, which provides no information by itself about how "good" or "bad" a specific result is, and for this reason it must be compared with a fixed standard or past performance.

Although someone may not be so happy with quality standards defined by EN 13816:2002, but almost people totally agreed that these quality criteria are suitable not only for a developed countries, like European countries, but they can be properly applied in any country, including developing countries. Therefore, these criteria are firstly invited for further works in establishing quality standards for public transport in MDCs. These criteria can refer to the transport operator, and transport authority's perception. Transport operator point-of-view reflects performance of public transport in normal operating conditions. Meanwhile, transport authority's point-of-view measure public transport quality in both aspects: (i) the level of quality that is achieved in normal operation conditions, and (ii) public

transport's role in meeting broad community objectives. In order to measuring and ensuring continuous improvement of public transport quality, performance indicators are an essential tool for transport operator and on focusing their strategic objectives.

In conclusion, assessment of public transport quality from supplier's viewpoint includes a number of performance indicators as indicated in Table 1.

Table 1. List of quality criteria and performance indicators from supplier's viewpoint

Cat.	Criteria	Performance Indicator*
Availability	Network coverage	▪Percent of population served in the buffer area of a stop ▪Percent of area served by public transport
	Network density	▪Ratio of route length to road square
	Route overlap	▪Ratio of total route length to network length
	Service directness	▪Ratio of bus route length to shortest road path
	Stop spacing	▪Number of bus stops per kilometre ▪Average distance between stops
	Frequency/headway	▪Number of vehicles per hour ▪Time interval between vehicles
	Span of service	▪Operating hours per day
Accessi-bility	Walking distance	▪Average walking distance
	Vehicle accessibility	▪Percent of vehicles that are wheelchair accessible ▪Percent of fleet composed of low-floor buses
Information	Information availability	▪Response time for providing requested information ▪Stations/stops name visible from vehicles
	Real-time data	▪Response time for providing requested information
	Announcement	▪Presence, audibility, frequency of announcement
Time	Percent of punctual trips	▪Percent of scheduled bus trips operated on each bus service ▪Percent of bus breakdown rate on all bus services
	Travel time	▪Transfer time ▪Waiting time
	Travel speed	▪Commercial speed of the vehicle
Customer care	Customer complaint	▪Complaint rate
	Response time	▪Answer time for customer inquires
	Driver behaviour	▪Driver courtesy, friendliness ▪Driving skill
	Customer satisfaction	▪Perception of customers on service provided
Comfort	Comfort on board	▪Mean vehicle age ▪Passenger load ▪Temperature ▪Passenger environment
	Comfort at stations	▪Percent of bus stops with shelters and benches

Cat.	Criteria	Performance Indicator*
	Cleanliness	▪Items (floor, seats, doors, windows, etc.) are clearly identified by the trained staff
Safety	Safety	▪Accident rate ▪Fatal/injury/property-damage-only accidents per passenger-kilometre ▪Fatal/injury/property-damage-only accidents per vehicle-kilometre
	Security from crimes	▪Passenger security (light, presence of staffs, absent of vandalism
Environmental impact	Air pollution	▪Air pollutant emissions
	Noise pollution	▪Noise pollutant emissions
	Energy consumption	▪Fuel consumption per vehicle-kilometre

3. METHODOLOGY

This paper aims to assess the public transport quality which is needed to ensure the quality of public transport provision and create a fully customer oriented public transport network in MDCs. In order to gain its objective, the basic approach of this study involved a comprehensive analysis of public transport service which is conducted through field survey and statistic figures which were referred from prevailing publications, official statistics, and from related agencies' documents.

The sample of this study is narrowed down to Hanoi Capital, Vietnam, which is seriously facing with quality deterioration and low public transport share. Hanoi is also known to be one of the most motorcycle dominated cities in the world. Currently, motorcycle accounted for more than 65 percent of the total modal share and this significantly influences traveler's behavior because citizens do not much motivation of shifting to travelling by bus instead of motorcycle.

15 quality criteria were selected to ranking which were network coverage, route directness, network density, route length and stop spacing, frequency, span of service, information, travel time, punctuality, excess waiting time, passenger load, passenger environment, passenger care, safety, and environmental impact. These attributes are popularly used in almost all public transport surveys.

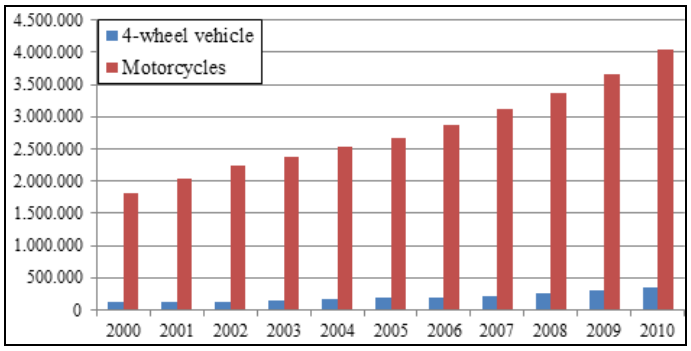
4. CASE STUDY AREA

Located in the North center of Vietnam, Hanoi is one of the most populated cities in Asia after Jakarta (Indonesia) and Hochiminh City (Vietnam). Covering an area of more than 3.300km^2 and with a population of nearly seven million, Hanoi is facing a large number of travel demands. Road users are composed of 80-90% motorcycles and 6-10% cars. Approximately 95% of road vehicles are private vehicles and only 2% are public bus transport (TRAHUD, 2009).

The number of private motorized vehicles has rapidly increased over ten years, from 2 million in 2000 to 4.4 million in 2010. In this period, the annual average growth rate of private motorized vehicle was 8.3% for motorcycles and 11.6% for automobile. Currently, Hanoi is dealing with high traffic congestion and other negative effects related to high private vehicle use.

It is often assumed that the extremely high rate of population and the relatively lower level of economic development make public transport the most suitable mode. However, the case of Hanoi shows that the relationship between income levels (indicated by Gross

Domestic Product per Capita) and use of public transport is not as simple as might have been expected. Hanoi had lower level of public transport use than might be expected given their incomes (Fig. 2). Meanwhile, other low-income cities such as Bangkok and Shanghai had public transport usage levels that were surprisingly high.



Source: Hanoi Traffic Police Bureau

Fig. 1. Number of vehicles in Hanoi.

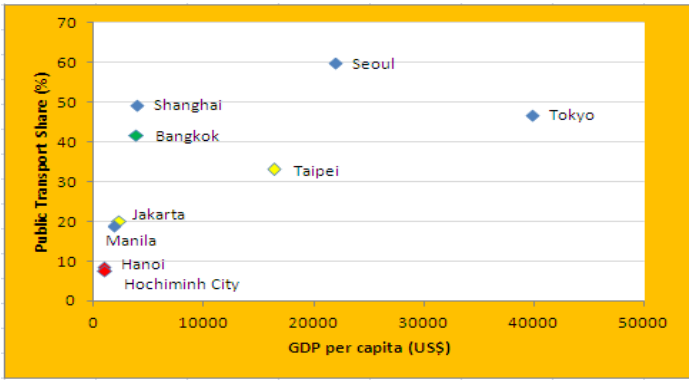


Fig. 2. Public transport modal split versus GDP per capita

Nowadays, the public transport system consists of only a bus system with 71 routes and 1.200 bus vehicle, which serves more than one million trips every day (TRANCONCEN, 2011). This public bus system seems to be over capacity. Over the past ten years, the city government has invested a large amount of money in the vehicle fleet and to improve service quality, with the aim to attract new users. Unfortunately, the market share of public transport system has not been changed in recent years when it has satisfied only 10% of travel demand.

5. RESULTS

5.1 Availability

On this category, seven criteria are selected for collecting data. The following will show the detailed analysis.

- **Network coverage**

Public transport is not quite good in the aspect of network coverage. It is estimated that 82.3% of population in centre area of Hanoi live within 500 metres (a walkable distance) of a bus route. However, the population in centre area is accounted for only 29.6% of the overall population in the cities. It means that public transport service is poorly accessible in the suburban area.

Table 2. Spatial coverage from bus stop in Hanoi

Distance from the bus stop (m)	Area served (%)		Population served (%)	
	All-inclusive Hanoi area	Urban core	All-inclusive Hanoi area	Urban core
0 – 500 m	9.82	58.5	-	82.3
500 – 1000 m	10.68	21.4	-	10.5
1000 – 1500 m	9.09	11.0	-	4.1
1500 – 2000 m	6.11	5.7	-	1.0

In the urban core area, it is found that only 58.5% of the areas are covered by the public transport system. The service coverage percentages considerably fall down in the case of all-inclusive areas of Hanoi administrative boundaries because the rural area of Hanoi almost lacks of public transport service. Even with a maximum threshold of 1.000m distance, these figures only go up to 20.5% for the all-inclusive area coverage.

- **Route Directness**

Route directness indicates the difference between the lengths of the trip covered by public transport and the shortest path by other transport mode.

Directness helps in saving time and cost. When route directness is improved, more services can be provided with the same number of vehicles, operating hours and vehicle kilometres. In other words, more frequent services, offering faster journeys can be provided for the same cost.

According to Ampt et al. (1990), Mistretta et al. (2009), directness ratios from 1.1 to 1.3 are acceptable for most bus routes, although higher ratios may be acceptable for shuttles and community buses. The average directness ratio for Hanoi bus route is calculated equivalently 1.07, it can be considered as good value. However, in fact, many bus routes are forced to be an indirect route from origin point to destination point, but they are almost direct routes due to the poor street layout. Many roads in Hanoi are so indirect and incomprehensible. Therefore bus journeys are so slow that most people with self-riding option will avoid the bus.

- **Network Density and Route Overlapping**

Network density represents the distribution of bus routes across zones passed by public transport route. It reveals the degree of consistency between residents and public bus routes. Contrary to network density, the route overlapping describes repetition of bus routes at a particular road segment. At a particular location, a higher route overlap implies a greater opportunity for direct trips, and a great chance to travel to numerous destinations. In the negative aspect, a high route overlap may probable increase the traffic congestion.

Table 3 illustrates the public transport network density and route overlapping in Hanoi. The high network density is observed in the city centre (i.e. 10 urban districts), this coefficient is reduced 11 times (0.35 km/km2) when considering all-inclusive areas of Hanoi. This number indicates a serious imbalance in the bus network between the urban and suburban areas.

The total length of bus network is 442 km, while the total length of bus routes in Hanoi is 1,407 km. Hence the corresponding route overlapping coefficient is equivalent to 3.18. This coefficient is relative compared to a maximum threshold of 5. However, the roads segments in the area of city centre have a relatively higher route overlap. This implies that in Hanoi, except in main city hubs, there is a considerable less opportunity for direct trip to

numerous destinations by public transport. According to Guihaire and Hao (2008), when direct trips are insufficient, the demand may be considered unsatisfied.

Table 3. Network density and route overlapping in Hanoi

Criteria	Unit	Urban area	All-inclusive area
Total length of network	km	234	442
Total length of route	km	1,188	1,407
Network density	km/km^2	4.07	0.35
Route overlapping ratio	m	5.05	3.18

- **Route Length and Stop Spacing**

The route length defines the travelled distance by bus service to link end-terminals. According to Ceder (2007), the route length should be kept within 40 to 100 minutes for one-way journey, which is about 12 to 30 km, at the average operating speed of 20 km/h. Based on this standard, the bus routes in Hanoi are acceptable. The average bus route length in Hanoi is 19.8 km.

Table 4. Route length and stop spacing in Hanoi

Criteria	Unit	Urban area	All-inclusive area
Total length of route	km	1,188	1,407
Average route length	km	19.8	20.1
Stop spacing	m	430	500

The location and spacing of bus stops are core elements of public transport, since these are points at which passengers can access services. The average bus stop spacing along the route indirectly explains whether the bus stops are redundant or insufficient. Redundant bus stops would increase the total travel time, especially in situations where buses are forced to stop at each bus stop, such as the case of bus service in Hanoi. However, an insufficient bus stop would result in poor service coverage (Schöbel, 2006). The survey result shows that the average bus stop spacing in Hanoi is 500m, which is reasonable compared to the identified threshold. A shorter distance is acknowledged in the city centre with the spacing of 430 m. In the suburban, the longer average distance of 578 m is acceptable.

- **Frequency**

Observed frequency reflects the amount of service provided. It further determines service hours which in turn impacts the convenience of public transport from customer's point-of-view. In addition, it can constrain the types of trips made by public transport.

Table 5. Descriptive analysis of service frequency in Hanoi

Frequency	Number of bus route	Percentage
< 3 vehicle/h	5	7.04%
3-6 vehicle/h	31	43.66%
> 6 vehicle/h	35	49.29%
Average frequency = 6 vehicle/h		

As illustrated in Table 5, service frequency in Hanoi bus is very high. Average headway is 10 minutes. Data of Hanoi shows that 77.46% of bus routes have a high frequency. Most of these routes concentrate in the urban core, and there is only 7.04% of bus routes have frequency fewer than 3 vehicles/h. These routes operate in the suburban area.

- **Span of service**

In Hanoi, bus service operates more than 17 hours, from 5:00 a.m to 10:30 p.m. It is slightly lower than the acceptable number of hours of well-operated system as suggested by Vuchic (2005).

5.2. Information

With the change from "public transport users by necessity" to "customers by choice", passenger information has become much more elaborate, sophisticated, and user-friendly.

Unfortunately, public transport system in MDCs still remains the obsolete practice of giving minimal information. Both public transport authority and operators do not pay enough attention to this aspect of their service. As a result, information gradually deteriorates to the minimal items needed for regular users only. For example, in Hanoi and HCMC, at bus stops with signs only, information on services is usually the route numbers of buses and shortened schedule of the routes. At stops with shelters, extra information is often added such as maps of bus routes, network maps, etc. Also, the shelters can be used for advertising and information dissemination. Table 5 describes the current situation of passenger information in MDCs.

Table 5 Information provision in public transport in MDCs

Location of information		Hanoi bus
Pre-trip information		
i.	Internet	
	Line number, frequency, fare	☒
	Time of desired trip	Missing
	Closest origin stop	Missing
	Closest departure	Missing
	Transfer location	Missing
ii.	Telephone	
	Line number, frequency, fare	☒
	Time of desired trip	Missing
	Closest origin stop	Missing
	Closest departure	Missing
	Transfer location	Missing
On-board information		
i.	Exterior	
	Line number	☒
	Terminal name	☒
	Agency logo, name, information telephone, website address	☒
ii.	Interior	
	Schematic map of the line	☒
	Announcement of next stop (voice or dynamic signal)	☒
Information in facilities		

Location of information		Hanoi bus
i.	Stop	
	Line number, terminal name, headway	☒
	Schedule	☒
	On-line electronic display of the arrival of the next vehicle	Missing
ii.	Transfer	
	Line number, terminal name, headway	☒
	On-line electronic display of the arrival of the next vehicle	Testing
	Schedules of all lines	☒
iii.	Train station	
	Full information about lines	Missing
	Schedules	
	Fare payment procedures	Missing
	Large-scale map of surroundings	Missing
	Real-time information about train arrivals	Missing

There are some means for users to acquire the information of bus transport. Users can call a sales office to ask for season ticket, company of bus operation, etc. They can obtain information from some websites by public transport operators or the other agencies. However, what they can acquire is only the network (routes), time zone of operation or time gap of each operation etc. Information on where a bus stop is and how long it will take from one bus stop to another bus stop is only available on the buses. In addition, since the exact arrival time of each stop is not determined, users need to wait for the bus that no one knows the precise arrival time.

5.3. Time

There are three criteria used for evaluating time: travel time/speed, punctuality, and excessive waiting time.

- **Travel Time**

An extended travel time may reflect an inadequate bus supply or poor scheduling and routing (Armstrong-Wright et al., 1987). Considering only the bus element of the journey, the travel time will depend on the travel speed or commercial speed of the buses. In Hanoi, the travel speeds for buses average 15 to 20 kilometres per hour (kph) for urban areas but drop to 9.5 kph for a short busy section of the CBD, 20-30 kph for suburban services. According to Armstrong-Wright et al., (1987), these speeds are relatively acceptable.

Different travel speeds can be expected in the peak and off-peak periods. In Hanoi, travel speeds have been recorded at 12 kph during the peak period and 25 kph in the off-peak (TRAHUD, 2009). Once again, the actual results will be dependent more on traffic and road conditions than on the efficiency of the bus service.

According to David (2012), bus frequency may affect the operating speed as well as travel time in a mixed traffic. Normally, a high bus frequency includes low operating speed. However, it was found that there is no significant relationship between the buses frequency and the operating speed of buses in Hanoi. Apart of buses frequency, the average operating speed of buses in Hanoi depends on the prevailing road and traffic conditions, since the buses operate in a mixed traffic.

- **Punctuality**

Punctuality is the most concern from passenger' point-of-view, a public transport vehicle is considered "on time" if it departs a location within a certain number of minutes after and/or before the scheduled time. From a passenger point-of-view, an early departure means a wait of one headway for the next vehicle. The window of time considered to be on time varies considerable from one agency to another (TRB, 2003). TRB (1995) reported most agencies were in the range of 1 minute early to 5 minute late, but TRB (1999) recommends using a value of from 0 minute early to 5 minutes late. Meanwhile, agencies in Germany were in the range of 0 minutes early to 3 minutes late, and agencies in Japan use a value of 0 minutes early to 2 minutes late. However, the one used in this study is 1 minute early to 5 minutes late.

Distribution of bus delay in Hanoi based on arrival time is plotted in Fig. 3. The buses arriving earlier than schedule are presented with a negative number and those arriving later with a positive number. The green bars represent those arriving on time, which correspond to 48.3% of all arrivals. Late arrivals correspond to 11% and a significant number of buses arrive earlier than schedule (40.7%). The average delay is 4.1 minutes and standard deviation is 5.9 minutes. This situation indicates that the service is very unreliable.

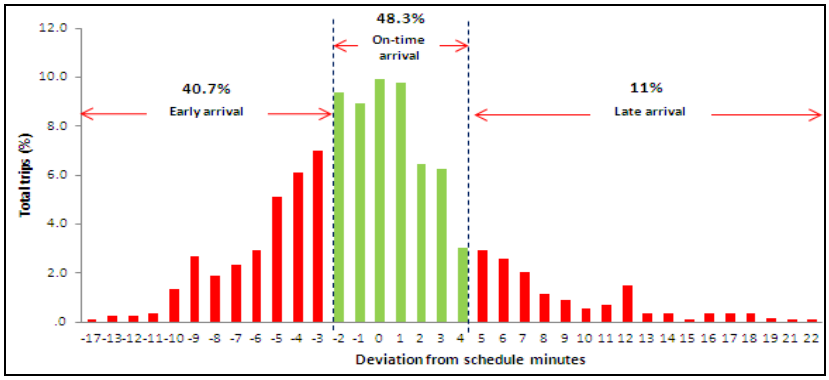


Fig. 3. Deviation from schedule headway in Hanoi (number of samples N = 484)

- **Excess Waiting Time**

Excess waiting time implies the additional waiting time at the stop due to bus delay. Fig. 4 illustrates the excessive waiting time for the passengers for selected eleven routes. This graph clearly indicates the effect of driving ahead of the schedule on increasing passenger waiting time. The average excessive waiting time for a passenger is 2.1 minutes.

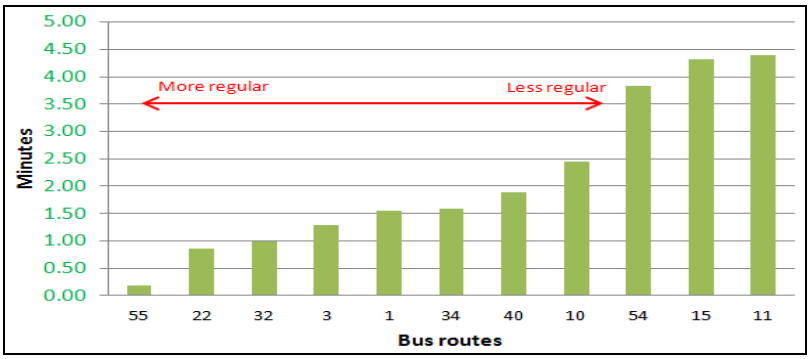


Fig.4. Excess Waiting Time for passengers in Hanoi (N = 484 observations)

5.4. Comfort

Passenger load and passenger environment are used to consider the issue of comfort in MDCs.

- **Passenger Load**

This criterion estimates the vehicle load during their daily operation and it is expressed as the number of on-board passengers divided by the capacity of the vehicles. Fig. shows that during peak-hours vehicles carry over capacity and also during off peak hours the demand falls to the extent that the buses operate quarter full. According to TRANSERCO (2010), the maximum capacity of a bus is 80 passengers, but the number of passenger is 1.2 – 1.5 times higher than bus capacity in peak hour. Therefore, the passengers certainly feel crowded and uncomfortable.

Fig. 5 and Fig. 6 calculates the load factor for the 44 routes. The load factor curve below indicates that during the peak hours in some routes the vehicles carry more than one and a half of their capacity. In most routes, they carry more than their capacity.

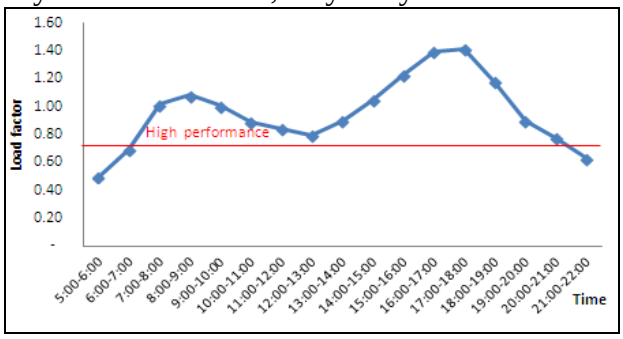


Fig. 5. Average load factors by time (N = 44 routes)

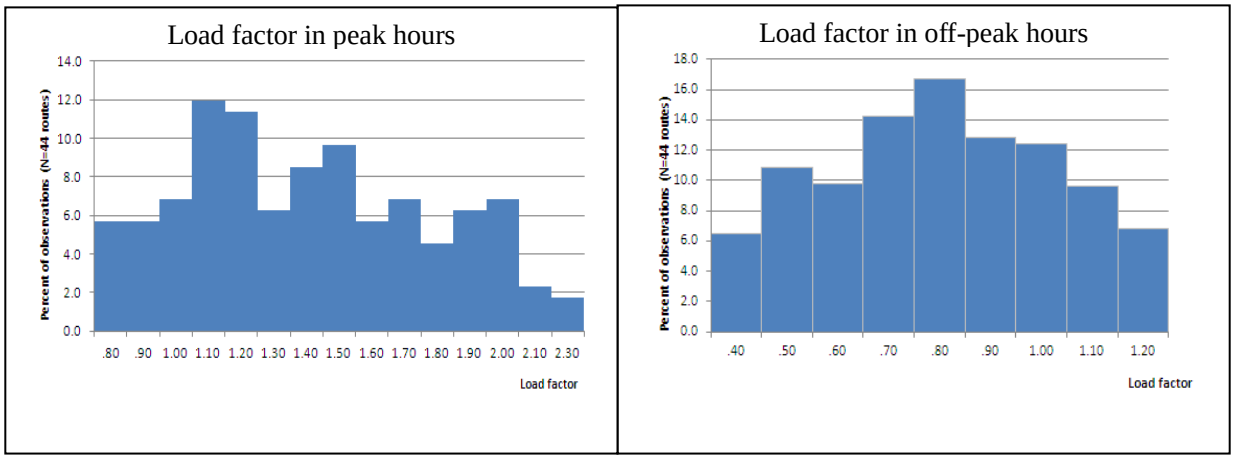


Fig. 6. Distributes of load factor (N = 44 routes)

- **Passenger Environment**

Passenger environment relates to the physical and mentally conditions that make customer more comfortable while riding a bus. Factors evaluated for passenger environment include: 1) cleanliness and appearance (e.g., vehicle interior cleanliness, exterior dirt conditions), (2) customer information (e.g., readable and correct signage, correct and legible bus map, etc.,), (3) equipment (e.g., air-conditioner, wheelchair lift), and (4) operators (e.g., uniform of drivers and conductors).

In general, public transport users in MDCs do not satisfy with physical conditions in buses as well as at stops. Survey results in Hanoi show that staying in a congested bus makes

people not only physically exhausted, but also unsecured due to increase of pickpocket.

According to the TRAHUD (2009), the physical conditions inside and outside Hanoi buses were not good in aspect of cleanliness. It was common to observe the insanitary situation at floors and seating as well as the outside of buses. Information was ineffective for passengers, for example the texts were unreadable, and maps were also missing. In aspect of equipment, almost buses installed air-condition system but they lacked of window curtains to maximize maximise air-conditioners' effectiveness. It is often observe that bus users would even use their umbrellas to shield themselves from the very hot sunlight coming in.

5.5. Customer care

Behaviour of bus drivers and conductors is really a big problem in operating public transport in MDCs. Driving skills of drivers, and behaviour of both drivers and conductors are not regarded to be at good quality. Drivers do not only stop and start suddenly but they also do not stop properly when embarking and disembarking passengers. It was often observed that the passengers have to jump in and out of the bus. But this problem may not be solely due to driving skills. Since the bus operator gave priority to schedule, driving behaviour was usually affected since drivers were always in a rush to prevent the delay in schedule. Also, conductors do not have full appreciation of customer service. It is common to find them either chatting with each other or sleeping on passenger seats. Though it seems that the staff training on driving and customer service is provided by each bus operator, the actual situation and the level of staff's skills and understanding are unreliable.

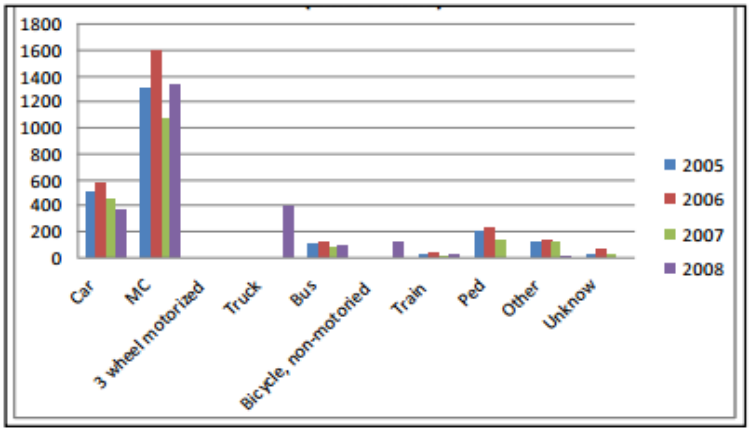
Since the bus does not stop properly, passengers are trying to jump into the bus.

While passengers stand, a staff is occupying a seat.

Fig.7. Driving and staff services

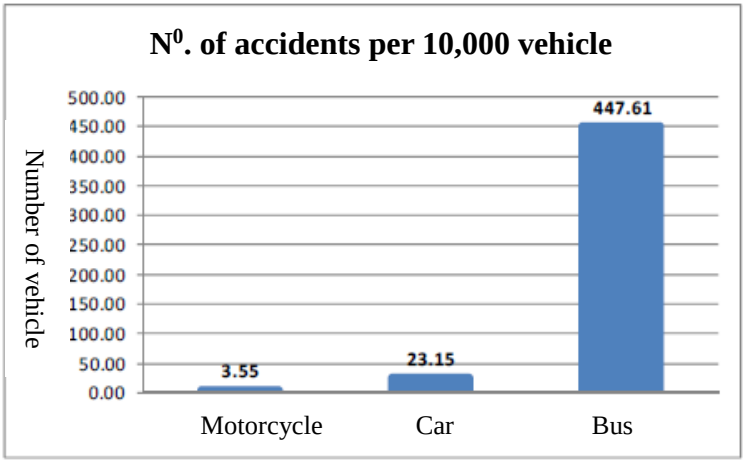
5.6. Safety

The number of bus-related accidents seems to be not an interest topic from authorities. Therefore, it is difficult to obtain complete statistics of bus accidents in all MDCs. However, it is evident that the transport system is clearly not as safe as it should be. Fig 8 shows the traffic accidents by bus in four years, from 2005 to 2008, in Hanoi. The bus which related to traffic accident is significantly lower than other type of vehicles in amount but if we use the indicator of number of accidents per 10,000 vehicles, the number of 448 is considered as the accidents per 10,000 buses, while car-related and motorcycle-related accidents are only 23.15 and 3.55, respectively.



Source: Hanoi Traffic Police Bureau (2009)

Fig.8. Traffic accidents by bus in all modes in Hanoi



Source: Truong (2012)

Fig.9 Number of Accidents per 10,000 vehicles

5.7. Environmental Impact

It is rather difficult to have data of noise or air emission caused by public transport. The statistical data of vehicle standards can provide some suggestion:

Hanoi has more than 1,000 operating vehicles but only 30% of buses meet Euro II emission standards. The remaining 70% only meet Euro 0 and Euro I.

6. CONCLUSIONS AND DISCUSSIONS

The main findings of this study are the description of problems of public transport supply in Hanoi.

Almost all identified performance indicators for selected criteria, except the frequency, have a relatively low performance compared to the common thresholds. In fact, the existing public transport network covers 58.5% of the urban core and 82.3% of population in urban core, based on a buffer of 500 metres from a particular bus stop. However, about 64% of inhabitants living in suburban are not served by public transport. The network density is considerable low in the suburban. The average bus stop spacing in Hanoi is 500 metres, which is acceptable compared to the identified thresholds. The route overlapping coefficient is equivalent to 3.18, which is somewhat low compared on a maximum threshold of 5. A better

access to public transport service is only observed nearby the centre core, considering that the high network density and high route overlap are observed in these areas. This implies that in Hanoi, except in centre core, there is less opportunity for direct trip to numerous destinations by public transport.

The average service span is 16 hours, which is slightly low, and is likely to constrain the number of trips that can be made by public transport. The headway is less than 10 minutes in most bus routes, and even less than 3 minutes in a number of bus routes. On other hand, the high frequency of buses does not cope with the demand; rather it contributes to the traffic congestion considering that buses operate in mixed traffic.

Service punctuality is one big issue. Late arrivals correspond to 11% and a significant number of buses arrive earlier than schedule (40.7%). The average delay is 4.1 minutes and standard deviation is 5.9 minutes. This situation indicates that the service is very unreliable.

The analysis results provide the evidences for improve the public transport service. One of the suggested improvements is to extend the coverage of public transport system. Along this, we identified suitable roads for public transport network expansion. To address the insufficiency of public transport service, we suggested the provision of larger buses in peak-hours. We have also identified priority bus lines that should be allocated larger buses and ensure punctuality.

On other hand, the level of performance depends on the threshold used. Since there is no specific standard for bus service performance assessment in Hanoi, we should identify performance indicators which are generally applicable in MDCs. The implementation of quality standards in reality needs sufficient protection of regulations, enforcement services and good awareness of transport authorities and operators. Improvements of regulations and enforcement services always presented as the fundamental requirements for quality management in public transport in MDCs.

However, even public transport quality is improved, it meets difficulty to compete to motorcycle. Motorcycle has become more dominant than public transport because it is usually available when required, takes the user from door to door and can reach dispersed destination. In this case, government plays an important role in implementing the enforcements to reduce the motorcycle use, such as reducing the supply of parking or raising its price. The other case is applying congestion taxes.

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