IMPACTS OF LARGE TRUCK RESTRICTIONS IN A DEVELOPING COUNTRY*

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1. Introduction

As traffic congestion continues to worsen in most cities throughout the world, increasing attention has been directed towards policies designed to improve the operational efficiency of urban streets. Large-scale infrastructure projects such as road construction and freight terminal development present considerable difficulties in financial, technical and social aspects. Also, application of information systems (IT), especially for freight transport, is still in the early stages of development and may present several technical barriers. Thus, the most viable strategy for developing countries would be to improve the operational efficiency of the freight transport system through transport demand management (TDM). Restricting large trucks in cities has been one of the most popular measures in developing countries due to road capacity limitations.

This paper evaluates the impacts of large truck restrictions in an urban area of a developing country, particularly Metro Manila in the Philippines. Changes that have taken place to the freight transport system due to large truck restrictions are first clarified with the help of past truck survey data. The effectiveness of the existing truck restriction scheme is then assessed by comparing traffic impacts and pollutant emissions for five different truck restriction schemes.

2. Freight Transport in Metro Manila

Large truck restriction, or the truck ban as popularly been called, was introduced in Metro Manila by the then Metropolitan Manila Authority (MMA) on 21 August 1978 as a measure to alleviate the worsening conditions of road traffic congestion. The ban applies to trucks with gross weights of more than 4.5 tons and prohibits truck movements along eleven specific routes, mostly primary arterial roads. There are presently two types of truck ban. One is the all-day truck ban, which prohibits trucks from using the circumferential road EDSA, the most heavily used thoroughfare, from 6AM to 9 PM during weekdays. The other is the peak hour truck ban, which prohibits trucks from using 10 major thoroughfares from 6-9 AM and 5-9 PM except Saturdays, Sundays and holidays (Figure 1).

As part of the transport master plan for Metro Manila, the Metro Manila Urban Transportation Integration Study (MMUTIS)[1)] conducted a truck survey in October 1996 to determine truck and cargo movements in the city. Freight vehicles entering and leaving the metropolis were surveyed at selected cordon line stations (Figure 1). Two types of surveys were conducted: truck volume counts and truck driver roadside interviews including origin-destination (OD) survey.

(1) Truck traffic characteristics

Truck traffic characteristics at the surveyed cordon stations are shown in Table 1. The overall share of truck traffic relative to the total vehicle traffic at cordon stations is around 10.2 percent. Light trucks form the majority of truck traffic with 19.3 percent for cargo jeepneys and vans and 26.7 percent for light cargo trucks. This may imply the popular use of light trucks as a way to avoid restrictions of the truck ban. Also, the average loading weight for all commodities per vehicle is only 2.0 tons per vehicle. The seemingly low average weight of commodities per vehicle may be due to: 1) small trucks with lower loading capacities are widely used for freight transport and delivery, and/or 2) majority of the vehicles are running empty.

(2) Shift to small trucks

Trucking companies have apparently shifted to using small trucks not covered by the ban. In fact, Metro Manila has been experiencing high annual growth increases of 14 percent in the registration of small freight vehicles in the last decade[1)]. Therefore, it may be that the effect of the truck ban has been to worsen congestion during peak hours due to the increased volume of small freight vehicles. Furthermore, a survey of the trucking fleet used by 29 medium sized freight forwarders and 12 large-sized freight shipping companies reveals that around one-third (32 to 36.6 percent) of the total truck fleet used for distribution belongs to small trucks. Thus, the effect of truck restrictions is to distort the size distribution of the fleet towards small trucks.

(3) Truck loading factors

In general, majority of the vehicles entering Metro Manila are running empty with a 56.1 percent overall share, while those leaving Metro Manila is only 35.4 percent. Inbound large trucks account for higher percentages of running empty, particularly 2-axle trucks with 39.4 percent, 3-axle trucks with 62.4 percent and trailer trucks with 79.4 percent. Thus, the empty return trip is not efficiently utilized.

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* Keywords: large truck restrictions, freight transport, traffic assignment, developing country

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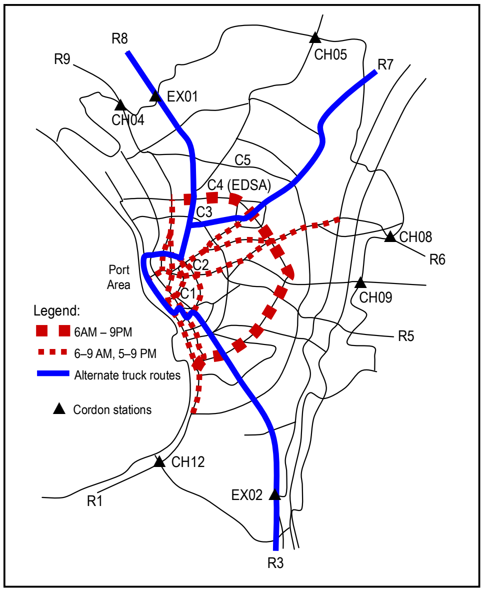

Table 1: Truck traffic characteristics

		North Cordon	East Cordon	South Cordon	Cordon Total
Truck Traffic Volume	16hr vol (000 veh.)	11.2	7.5	12.5	31.2
	% to 16hr volume	10.5	9.3	10.3	10.2
Truck Type (% to total volume)	Jeepney/van	11.0	47.4	9.8	19.3
	Light cargo	18.5	25.9	34.4	26.7
	2-axle truck	37.6	10.9	22.7	25.2
	3-axle truck	16.1	4.3	13.1	12.0
	Dump truck	7.8	6.6	6.3	6.9
	Trailer/Container	4.6	1.3	7.6	5.0
	Other large truck	4.4	3.6	6.0	4.9
Com-modity Type (weight/ veh)	Agricultural	2.4	2.4	3.7	2.9
	Manufacturing	2.0	1.8	3.2	2.2
	Forest/Mining	2.6	2.7	3.2	2.8
	Construction	2.1	1.6	1.5	1.8
	Ave ton/veh	2.2	1.7	2.1	2.0

Figure 1: Truck ban and location of survey stations

(4) Temporal distribution of traffic

To clarify the effect of the truck ban on traffic volumes, it is necessary to examine the temporal distribution of traffic at the cordon stations. Figure 2 presents the hourly distribution of traffic for all cordon stations. The left chart shows vehicle volumes in each time period, while the right chart shows the percentages of these volumes to the 16-hour traffic volume. The figures confirm that the effect of the truck ban on truck traffic volume is significant. There is minimum truck movements observed during the AM and PM truck ban periods as clearly shown in the right chart.

3. Assignment of Trucks to the Road Network

A program developed under Visual Basic is utilised to perform shortest path assignment for the truck movements in Metro Manila. Bitzios and Ferreira[2)] revealed in their study in Brisbane that the shortest route is the most important factor affecting route choice of drivers. The program uses Dijkstra's algorithm to calculate for the shortest path. Studies suggest that when the goal is to obtain a one-to-one shortest path or one-to-some shortest paths, the Dijkstra algorithm offers some advantages because it can be terminated as soon as the shortest path distance to the destination node is obtained[3,4)].

(1) Input data and alternative truck restriction schemes

The major inputs in the program are: 1) road network characteristics and 2) truck OD classified by truck type and time period. In the preparation of the road network, small local streets are not included as trucks do not use them. A list of street links that are affected by the truck ban in different time periods is also prepared. These links as well as changes in the road network due to alternative truck restriction schemes are integrated in the final road networks. OD tables are prepared from the actual truck driver roadside interview survey data

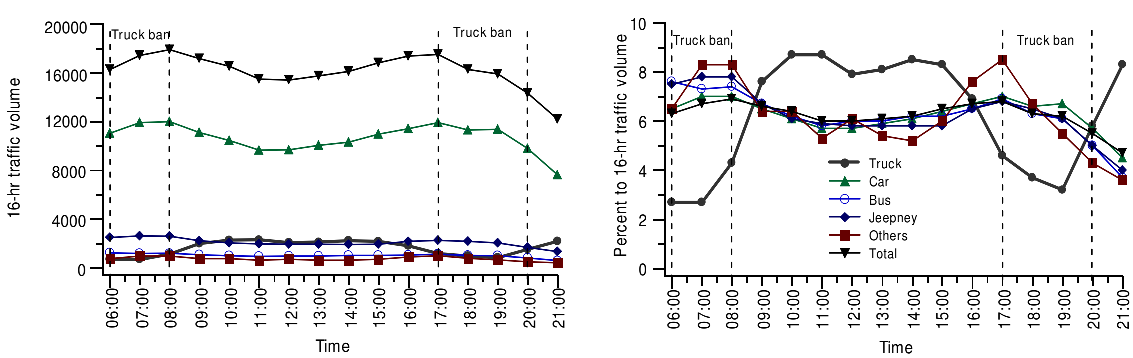

Figure 2: Temporal distribution of traffic at cordon stations

after applying the necessary expansion factors. Three time periods are included for traffic analysis: AM peak (6-9 AM), daytime off-peak (9 AM-5 PM) and PM peak (5-9 PM).

Five truck restriction schemes are examined to determine the probable effects of the truck restrictions in terms of vehicle-kilometers and vehicle hours. These are: 1) existing truck ban (base condition), 2) without truck ban, 3) peak-hour only truck ban, 4) all day truck ban at EDSA only, and 5) all day truck ban at EDSA and major roads.

(2) Results

A summary of the results of the assignment process for the five cases is given in Table 2. As expected, the "no truck ban" scheme has the least total vehicle kilometers and vehicle-hours among the five cases. Since trucks are allowed in all the major arterial roads, meaning both circumferential and radial roads, they do not have to use circuitous routes to get to their final destinations. The second best scheme is the "all-day truck ban at EDSA only". Large trucks optimise transport operation by taking advantage of the radial roads where they are allowed to pass all day. The "peak-hour only truck ban" scheme ranks third. As the truck ban is not in effect in EDSA during off-peak hours, large trucks are able to utilise the circumferential road. EDSA thus functions as the main distributor of traffic to the radial roads. The "existing truck ban" scheme only ranks fourth. The present scheme shows that large trucks widely use the available alternate routes to transport freight during the morning and afternoon peak-hour ban. Finally, the scheme with the highest vehicle-kilometers and vehicle-hours is the "all-day truck ban at EDSA and major roads". Since the truck ban is extended to cover all major roads, except those identified as alternate truck routes, large trucks are compelled to utilise these alternate routes at all times resulting in longer travel distances and travel times.

4. Environmental Assessment

Environmental assessment is performed by aggregating the results of the assignment process which identifies volume, type, and average speed of vehicles in each link. Pollutant emissions are assumed to be dependent on travel distance, travel speed, and emission factors for each vehicle type. Given a table of emission factors empirically estimated by the MMUTIS study team for each vehicle type, each pollutant emission can be estimated as the product of travel distance and the emission factor at the average speed.

Figure 3 shows the amount of pollutant emission for each scheme according to truck type. Carbon monoxide has the highest amount of emission ranging from 9 tons per day, followed by NOx with about 4 tons per day. Very minimal amounts of emission are observed for SOx and SPM. The most remarkable result is that small trucks cause the majority of the amount of carbon monoxide emissions while large trucks cause

Table 2: Traffic impacts of alternative truck restriction schemes

Truck restriction scheme		AM Peak (6-9 HR)	Off-Peak (9-17 HR)	PM Peak (17-21 HR)	Total (6-21 HR)
Existing truck ban	VKM	27166	520250	74949	622365
	VHR	580	10478	1519	12577
No truck ban	VKM	21861	512507	66338	600706
	VHR	480	10215	1324	12019
Peak-hour only truck ban	VKM	27166	512507	74949	614622
	VHR	580	10215	1519	12314
All-day truck ban at EDSA only	VKM	22193	520250	67105	609548
	VHR	484	10478	1348	12310
All-day truck ban at EDSA & major roads	VKM	27166	591311	74949	693426
	VHR	580	11918	1519	14017

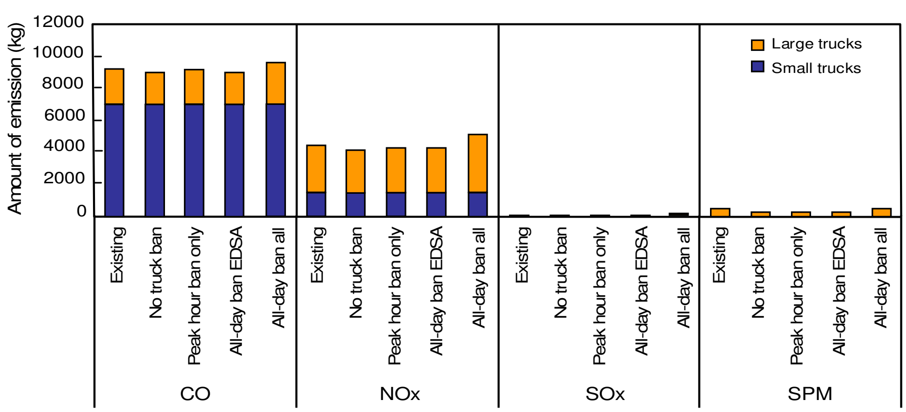

Figure 3: Amount of pollutant emission for each scheme

Table 3: Comparison of alternative truck restriction schemes to the existing truck ban

Truck restriction scheme	Distance (km)	%	Time (hrs)	%	CO (kg)	%	NOx (kg)	%	SOx (kg)	%	SPM (kg)	%
Existing truck ban	622365	-	12577	-	9186	-	4489	-	50	-	387	-
No truck ban	600706	-3.5	12019	-4.4	9046	-1.5	4289	-4.5	48	-4.4	370	-4.5
Peak hour truck ban only at EDSA and major routes	614622	-1.2	12314	-2.1	9136	-0.5	4417	-1.6	49	-1.6	381	-1.6
All-day truck ban at EDSA only	609548	-2.1	12310	-2.1	9103	-0.9	4371	-2.6	49	-2.6	377	-2.6
All-day truck ban at EDSA and major roads	693426	11.4	14017	11.4	9648	5.0	5144	14.6	57	14.1	444	14.6

the majority of nitrogen oxides emissions. The results suggest that any switch to gasoline powered small trucks due to the truck restriction will cause a small effect in SOx and SPM, a moderate decrease in NOx emissions but a large increase in CO emissions. A decrease in NOx emissions from large trucks, especially heavy diesel, may be beneficial since they account for a large percentage of the total NOx vehicle emissions.

5. Performance of Alternative Truck Restriction Schemes

The changes in performance are calculated by comparing alternative truck restriction schemes with the existing scheme. Table 3 summarizes the traffic and environmental impacts of the different schemes.

When compared with the existing truck ban scheme, the alternative with the highest reduction is the “no truck ban” scheme. The total travel distance is reduced by 3.5 percent, total travel time by 4.4 percent, CO by 1.5 percent, and NOx, SOx, and SPM by 4 to 5 percent. Shorter and direct routes as provided by the major radial and circumferential roads resulted in less total travel distances and travel times, which subsequently reduced pollutant emissions. The “all day truck ban at EDSA only” scheme follows next with a reduction of 2.1 percent for both total travel distance and travel time, 0.9 percent for CO and around 2.6 percent for NOx, SOx, and SPM. This is more feasible than the “no truck ban” scheme since a fairly significant reduction in the amount of emissions can be obtained by merely restricting along EDSA during the day and lifting the ban at the major routes during peak-hours. The “peak hour truck ban only at EDSA and major roads” scheme resulted in reductions of 1.2 percent for total distance and 2.1 percent for total travel time. Minimal reductions are obtained for CO with 0.5 percent and about 1.6 percent for the other pollutant emissions. This result only indicates that this option offers very little reduction when compared with the existing truck ban. Finally, the scheme with the worst performance is the “all-day truck ban at EDSA and major roads” scheme. The large increases in travel distances, travel time and pollutant emissions are due to the diversion of trucks and the use of circuitous alternate routes.

6. Conclusion

This paper explained the impacts of large truck restrictions on the freight transport system of Metro Manila. Aggregated results of the truck surveys indicated that: 1) traffic volume of ban-exempt smaller cargo vehicles increased, which is due to the utilisation of smaller trucks in place of larger trucks that are banned from using the major roads, and 2) temporal traffic distribution trends confirmed that the effect of the truck ban on truck traffic volume is significant. Minimal truck movements are observed during the peak-hour truck ban periods while peak volumes of trucks are observed during the middle hours of the off-peak period.

General findings indicate that additional restrictions significantly increase total vehicle-kilometers, total vehicle-hours and total pollutant emissions. These may translate into increased transport costs as total distance and total travel time are directly proportional to costs. These increases may add to the cost of goods to producers and eventually to consumers. These negative effects must be balanced against many economic and social benefits of truck restrictions.

Additional analysis is needed to estimate the benefits of reduced congestion brought about by the truck restrictions, such as its impact on passenger trips and the environment. However, the vague and poorly understood role of latent demand in canceling out any traffic congestion reductions brought about by the truck restrictions must always be considered.

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