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HISTORICAL BENEFIT AND CONTEMPORARY APPROACHES TO SUSTAINABLE (LOW CARBON) URBAN TRANSPORT IN JAPAN

by

Annika STYCZYNSKI*

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ECONOMIC RESEARCH CENTER
GRADUATE SCHOOL OF ECONOMICS
NAGOYA UNIVERSITY

* Visiting Fellow, Economic Research Center, Graduate School of Economics, Nagoya University, from October 17, 2011 to January 13, 2012.

HISTORICAL BENEFIT AND CONTEMPORARY APPROACHES TO SUSTAINABLE (LOW CARBON) URBAN TRANSPORT IN JAPAN

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Abstract

The Millennium Cities Database for Sustainable Transport ranks Tokyo as top performer in comparison to 84 cities in providing one of the comparatively most sustainable transport systems worldwide. This finding is examined on the basis of land-use and transport energy consumption in order to unlock the underlying success factors. As a result, three main reasons could be identified: (1) a strong regulatory and institutional framework, (2) integrated spatial planning strategies, and (3) investment decisions in an appropriate socio-economic environment.

In the second part of the paper, more contemporary approaches to sustainable urban transport and road transport related initiatives in particular are examined. For this purpose the "No Diesel-Vehicle Campaign" and the "Top-Runner Regulation" are analyzed. In addition, a first glance is thrown at the promotion of electric and plug-in-hybrid vehicles. In conclusion, the Top Runner Regulation could be more congruent with its initial goal, if stepwise weight-categorized fuel consumption standards would be replaced by a linear standard as applied in the European Union. How significant the loopholes created by the Japanese weight-categorized standards are in comparison to the EU regulation remains unclear. The European standard, however, is obviously more stringent. The "No Diesel-Vehicle Campaign", by contrast, has created positive results over the first two years of monitoring.

The third part discusses quality of life objections and argues that different from U.S. cases livability constrains in Tokyo are rather attributable to populousness than to urban transport infrastructure.

Keywords: land-use and transport energy, fuel consumption and vehicle emissions standards, EVs/PHVs, quality of life, Tokyo, Japan

1. Introduction: the problem in brief

Although metropolitan areas cover an almost negligible part of the earth's surface (2%), they consume between two thirds and three quarters of world energy demand and account for the bulk (more than 70%) of global greenhouse gas emissions (GHG). [BMBF 2010] Given the scale of city energy use and corresponding CO_2 emissions, world demographic change towards 9 billion people, and accelerating urbanization with more than half of the world's population dwelling urban areas, increasing attention is called from researchers, policy makers, local authorities, and practitioners.

A substantial and growing share of energy usage and related pollutants is generated within the transport sector. Petroleum being its major fuel, the transport sector's GHG emissions have increased at a faster rate than any other energy end use sector over the last decades. [EIA 2009 and 2010] Transport accounted for roughly one quarter of worldwide CO_2 production in 2003. Within the OECD, this share was as high as 29%. By contrast, transport sector emissions in Japan account for only 20%, which are almost entirely (90%) generated by automobiles. It follows that road transport is the major emission source and thus the major climate challenge within the transport sector.

Urban transport is a highly complex field of research that can be studied from a variety of perspectives. It covers not only energy use and the environment, but land use, technology, finance, health, safety, and the governance thereof, to mention only a few. To capture its complexity, the Toronto based Centre for Sustainable Transportation [2005] developed the most comprehensive and most widely used definition, according to which a sustainable transport system:

- Allows the basic access and development needs of individuals, companies, and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;

- Is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development;
- Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes while minimizing the impact on the use of land and the generation of noise.

While the center's definition describes a wide range of features and functions, it is still too complex to serve the purpose of this paper. Thus, I will focus my research on four recurrently arising and interlocking aspects in urban transport: energy, land-use, pollutants, and related health concerns.

Against this backdrop, the paper follows a threefold structure. In the first part, two objectives are pursued: first, to describe Tokyo's success in the Millennium Cities Database (MCD) according to which the mega city provides one of the comparatively most sustainable transport systems worldwide. (ch. 2.1) Second, to explain and contextualize Tokyo's MCD ranking in governance perspective. (ch. 2.2) In the second part, primarily the 2008 Tokyo Metropolitan Environmental Master Plan has been consulted to describe the status quo of urban mobility and to enlist measures to be taken for sustainable (low carbon) transport and mobility in Tokyo (ch. 3.1). As road transport is the major emission source, the second part focuses on two road transport related policy initiatives, the *No Diesel-Vehicle Campaign* (ch. 3.2) and the *Top-Runner Regulation* (ch. 3.3). Subsequent to that a first initiative in the promotion of electric and plug-in-hybrid vehicles is presented (ch. 3.4). The last part will discuss the polarity of Tokyo style mobility patterns vis-à-vis quality of life indicators and in particular objections against high-density living (ch. 4.1) and sums up what can be learned from Tokyo's transport system in the face of peak oil, climate change, and rapid urbanization in emerging economies (ch. 4.2).

2.1 The Millennium Cities Database for Sustainable Transport

Whether an urban transport system is truly sustainable requires a variety of hard data. The 1995 Millennium Cities Database for Sustainable Transport has collected such hard data through 26 variables by which to assess and compare the level of sustainability of urban transport systems. The data ranges from travel time by different modes, levels of energy use and emissions, the costs of transport, safety issues, comfort factors etc.[1]. As a result of the 1995 study, Tokyo and Osaka, Berlin and Munich are ranked within the "comparatively most sustainable transport" cluster, while Tokyo takes a top position second after Hong Kong.[2] Although Jeff Kenworthy and Felix Laube reveal variables according to which they have

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[1] Kenworthy [2008]

(1) Urban density (persons/ha)
(2) Proportion of jobs in CBD (%)
(3) Metropolitan gross domestic product per capita (USD)
(4) Average user cost of a car trip (% per capita GDP/trip)
(5) Average user cost of a public transport trip (% per capita GDP/trip)
(6) Length of freeway per person (m/person)
(7) Parking space per 1000 CBD jobs
(8) Total length of reserved public transport routes per 1000 persons (metros)
(9) Total length of reserved public transport routes per urban hectare (metros)
(10) Total private passenger vehicles per 1000 persons (cars-motorcycles)
(11) Total public transport seat kilometers of service per capita (seat km)
(12) Proportion of trips by non-motorized mode (%)
(13) Proportion of trips by motorized public modes (%)
(14) Total car+motorcycle+taxi passenger kilometers per person
(15) Total public transport boardings per capita
(16) Total passenger transport cost as percentage of metropolitan GDP (%)
(17) Total private+public passenger transport energy/person (MJ)
(18) Total CO_2 emissions per person from passenger transport (kg)
(19) Total emissions of CO_2, HC, NO_X and SO_2 per capita (kg)
(20) Total emissions of CO_2, HC, NO_X and SO_2 per urban hectare (kg)
(21) Total transport deaths per 100.00o people
(22) Total transport deaths per billion passenger kilometers on public transport (%)
(23) Proportion of total motorized passenger kilometers on public transport (%)
(24) Ratio of public versus private transport speeds
(25) Ratio of annual investment in public transport vs. private transport infrastructure
(26) Ratio of segregated public transport infrastructure versus freeways

[2] In the more current ˝Mobility in Cities Database˝ (MCD) from 2001 the number of cities under examination has decreased from 84 to 52 and shifted markedly towards European based metropolises. All Japanese examples and almost all U.S. American examples (except for Chicago) were left aside. The number of variables, by contrast, has increased from 26 to 120 indicators and the analysis of successful mobility policies has been added.

compared the cities, details for each city remain unpublished. To ensure nonetheless that the underlying characteristics of Tokyo's success can be unlocked and to keep this research in manageable limits, I will focus on land-use and transport related energy use for the first part of this paper.
There are traditionally three main factors that affect energy consumption in city transport. These factors are:

(1) Spatial pattern
(2) Income level
(3) The composition of the vehicle fleet

Kenworthy's pioneering research has shed light on the causal relationship between these three main factors and energy consumption within cities. Although his insights present common knowledge within the epistemic community today, I present them as a first empirical building block in guidance to my own research.

2.2 Transport system development in the Tokyo Metropolitan Region

To begin with, the literature on urban transport suggests that two main factors impede urban transport from performing sustainable.[3] Those are a fragmented institutional set up and a typically weak coordination mechanism among them. In a fragmented institutional setting different agencies are responsible for land use and transport planning. Whether they are situated at different levels of government or within one large government organization, the coordination of issues crucial to sustainable performance used to be missing. The hypothesis derived from this

[3] Cluster 1/Module 4: Integration of Land Use and Transport Planning; presentation prepared for the capacity building program Building Leaders in Urban Transport Planning (LUTP), Singapore 2012, p. 15.

observation is, that the Tokyo transport authority and land-use related institutions are better integrated and coordinated.[4]

2.2.1 Spatial pattern

The results of the MCD for Sustainable Transport show clearly that higher population density accounts for a more sustainable transport system, i.e. comparatively lower energy consumption and emissions. The literature on land-use and transport also suggests that compact versus sprawling urban areas, and mixed land-use versus segregated land-use patterns create favorable impact on energy consumption in cities.

There are three different definitions existing to the area of “Tokyo”. The first is defined by the 23 wards, which constitute Tokyo city (622km^2). The second definition describes the administrative region of Tokyo (approximately 13 million people on a territory of 2.187km^2) which is governed by the Tokyo Metropolitan Government (TMG). The Greater Tokyo Area or Tokyo Metropolitan Region (Shuto-ken) is defined as the area located 50-70 km from Tokyo station, comprising an area of approximately 13.500km^2 by stretching far into the prefectures of Saitama, Chiba, Kanagawa, and Ibaraki. According to UN data [2009] greater Tokyo comprises 36.7 million people in 2010, roughly one third of the entire Japanese population, and is thus, by far, the largest metropolitan area worldwide. The density varies largely from 2,403 people/km^2 in the greater Tokyo area to 14,389 people/km^2 within Tokyo City (23 wards) [TMG 2011]. Therewith, Tokyo ranks among the densest agglomerations worldwide. Transport infrastructure development and land-use are highly correlated when looking at urban density. A

[4] To test the hypothesis two salient aspects require in-depth research: first, the number of institutions/stakeholders involved in the decision making process; and second, how critical stakeholder issues such as the acquisition of land and related ownership rights within that process are solved. To answer those questions, however, a second research stay in Tokyo in January 2013 is planned.

World Bank Study on Urban Transport Development [2000] will shed more light on this aspect and contributes to elaborate on the institutional conditions under which land-use and public transport system[5] development in Tokyo have evolved.

2.2.2 Income level

The income level, as captured by the Metropolitan gross domestic product per capita, confirms the counter trend. Although all 5 clusters[6] of the MCD have a per capita GDP between $20.000 - 26.000, higher income tends to result in less sustainable transport. In the fiscal year 2008 the Tokyo Metropolitan GDP per capita was at $24.400 [TMG FY2008]. This, however, generates barely immediate explanatory value for why this would promote less energy intense transport. Rather, it can be argued that initial capital costs and circumstances that have led to investments into such a mass transport system, as well as a subsidy scheme involved, deserve more attention. I am thus inclined to question the relevance of the variable “income level” in relation to energy consumption in city transport.

Before looking into the “composition of the vehicle fleet”, I suggest to consider the overall modal split as this may reveal unexpected insight into the overarching research question. Only in a second step the composition of the vehicle fleet will be examined.

2.2.3 Modal split

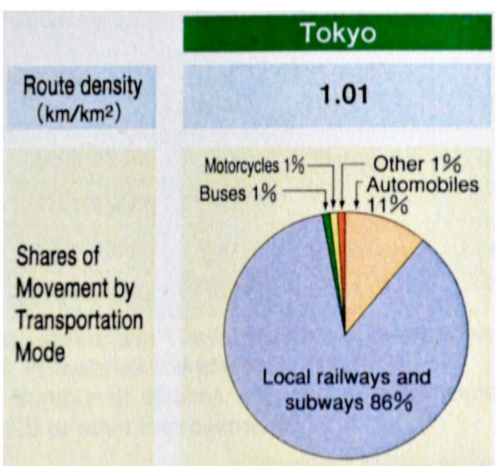
A statement on the causal relationship between modal split and the nature of the vehicle fleet in relation to transport energy can be approached by three of Kenworthy’s factors: first, the total private passenger vehicles per 1000 persons

[5] How about the road system?

[6] After the 84 cities were ranked on the various factors and a composite score for each city was created based on the twenty-six variables, the cities were subdivided into five groups/clusters, from “comparatively least sustainable” to “comparatively most sustainable transport”.

(cars + motorcycles); second, the total car + motorcycle + taxi passenger kilometers traveled per person (PKT); and third, the total of public transport boardings per capita. In the first two cases, cities within the comparatively most sustainable transport cluster show lowest values. In other words, urban transport systems with low rates of individual motorization are more sustainable than those with higher levels thereof. Data provided by the World Bank [2008] indicate a nation wide trend toward low levels of individual motorization. Within the 34 OECD member countries car ownership averaged at 429 passenger cars[7] (per 1,000 people) in 2008. Japan lies clearly below that figure with 319 vehicles countrywide and 238 passenger vehicles in the jurisdictional entity of Tokyo, which comprises 13 million inhabitants [MLIT 2010].[8] Complementary, high levels of public transport boarding satisfy the travel demand in a sustainable transport system. It follows that the modal split should be dominated by non-motorized and public transport in order to be low carbon.

Figure 1 Shares of Movement by Transportation Mode in Tokyo



Although no data on daily public transport boardings is available, the graph provided by the Tokyo Bureau of City Planning shows that transport in the Metropolitan Area is overwhelmingly dominated by rail-based modes.

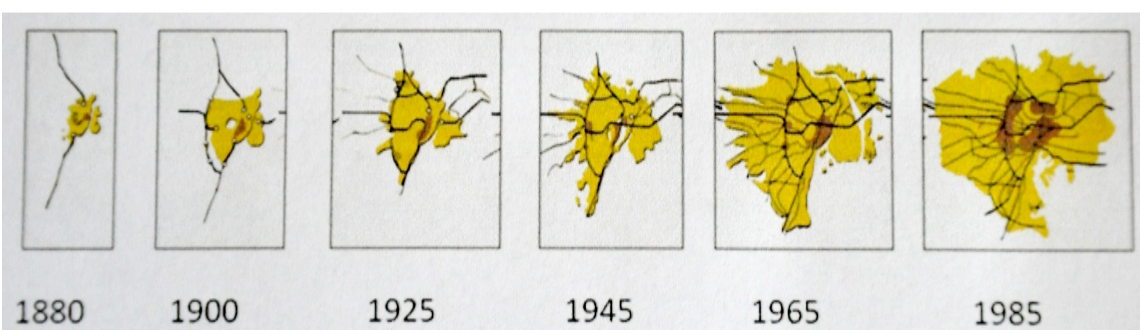
Source: TMG 2010

[7] Passenger cars refer to road motor vehicles, other than two-wheelers, intended for the carriage of passengers and designed to seat no more than nine people (including the driver).
[8] Only Hong Kong and Singapore have lower levels of passenger vehicles (below 100) due to strict vehicle restriction measures and road pricing.

2.2.3.1 The role of rail-based public transportation

Similar to Seoul and Shanghai, Tokyo disposes of a subway line of up to 350km, but in addition to the subway, the Tokyo Metropolitan Region has other railway systems connecting central Tokyo to suburban cities with total length of more than 2,000km. This is can be considered unique. With a total of 2,143 km in route length, the network is by far the world's largest. Moreover, Tokyo's approach in utilizing railways (including intercity and suburban rail lines and tramways in central Tokyo) to guide urban development has been consistently applied since the late 1920s. In the postwar period, the 1957 Government decision to construct five lines with a total route length of 108.6 km marks the continuation of an emphasis on rail-based public transportation. Under the Metropolitan Region Development Law of 1956 the Government of Japan embarked upon comprehensive development planning for Greater Tokyo. Long-term land-use policies were designed to control for the concentration of population, which was rapidly increasing in central Tokyo on the one hand, and to promote housing and employment further outside of the city, on the other. The employment concentration in central Tokyo, however, continued rapidly up until the mid-1960s, which led to a continued increase in commuter traffic from the different suburban centers to the central business district. Capacity expansion programs needed to be planned and implemented for suburban and intercity rail lines.

Figure 2 Evolution of Tokyo's railway oriented structure



Source: TMG 1994

2.2.3.2 Land-use planning

A remarkable aspect of land-use planning was initiated by rail-oriented new town development, which private railway companies were substantially involved in. They have adopted a historically decisive role in particularly building and operating suburban lines, but also in attracting more users. Through the purchase of great amounts of land along the planned railroad lines private railway companies have started to enter the real estate and distribution business, which in part laid the foundation for compact city planning to be realized. All this has been conducive to the creation of Tokyo's rail-oriented urban transport system as it is in use up until today. In turn, it explains for Tokyo's saturation and degree of maturity as compared to railway networks in other cities worldwide.

2.2.3.3 Demand and supply side rationales

On the demand side of the equation, the popularity of public transport has been spurred by a number of facts. As Paul Chorus has carved out quite neatly in his dissertation[9] railway operators are endowed with exclusive lifetime concessions, which constrain fierce competition. At the same time, strict fare regulations curb their commercial leeway. Since fares can be raised only when private railway operators prove to operate at a loss, business activities besides mere transportation have attracted much of the companies' interest.

Possibly not unique, but particularly noticeable, Japanese railway companies' core business strategies include many side-businesses such as retail and real estate, the running of hotels, golf courses and amusement parks. Because rail operators are interested in generating stable and increasing ridership the objective to meet and

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[9] Paul Chorus' dissertation on "Station area development in Tokyo and what Randstad can learn from it" is about to be published soon and detailed reference will be given subsequently.

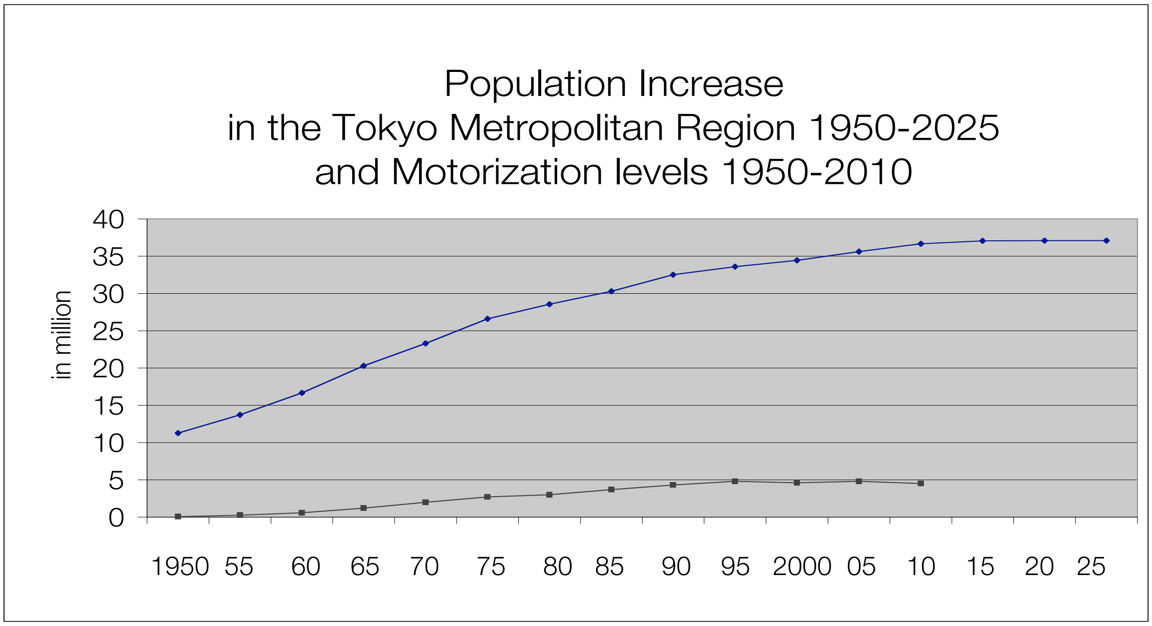
accommodate customer preferences is obvious. Thus, while rail operators are clearly driven by profit maximization, the customer can benefit in multiple ways.

In addition, the popularity of public transport usage has been greatly enhanced by commuting allowances. As most Japanese companies bear the full commuting costs of their employees, those do not have to worry about commuting expenses (except travel time) in deciding on the location of their residences. Employers in turn can fully deduct costs of commuting allowances (as high as 100,000 yen per month in the year 2000) from their corporate income taxes. Moreover, because of a payment system in place that allows for seamless transfer among the cooperatively operated railway system, passengers show no reluctance to use different lines. Last but not least, safety, punctuality, and time efficient transport promote the regular usage of public transportation.

2.2.3.4 The automobile – a true competitor?

A critical juncture occurred when between 1971 and 1980 the number of automobiles in Japan has doubled (to 37.33 million). Rail-based transportation, however, could assert its primacy. The literature gives two main reasons for why and how public transportation in Tokyo could prevail over the automobile: on the one hand, several factors constrain car ownership in the Tokyo Metropolitan Region. Those are strict parking space and related car ownership requirements. People, who intend to register a car must present evidence verifying the availability of an off-street parking space, which can be as expensive as approximately ¥50.000 or €500 a month. Moreover, the general narrowness of roads in Tokyo provides little space for on-street parking while random off-street parking in central Tokyo is disproportionately cost intense. All of these factors, in conjunction with high-quality rail services, and the strict control of illegal parking, have been conducive in discouraging the use of the automobile.

Figure 3 *Population growth and motorization*



Source: http://www.keishicho.metro.tokyo.jp/toukei/bunsyo/toukei22/pdf/kt22b001.pdf (accessed Jan. 6, 2012) and UN [2009]

On the other hand, conditions created by private railway companies as outlined earlier, contribute significantly to the success of public transportation. [Suzuki 2011:90; World Bank 2000]

2.2.3.5 The success factors of urban rail and land development

A World Bank Study on Urban Transport Development [2000:41f.] has compiled and systematized a number of factors adding to Tokyo-style urban rail development. In summary, there are three categories of success factors conducive to Tokyo's integrated urban rail and land development: (1) a strong regulatory and institutional framework, (2) integrated spatial planning strategies, and (3) investment decisions in an appropriate socio-economic environment. Each is fanned out below:

(1) The strong regulatory and institutional framework comprises:

- A comprehensive legal framework supporting integrated development.
- A licensing scheme to protect rail operators from excessive competition and to provide opportunities to feed the rail services through affiliate bus enterprises.
- A variety of financing options such as interest subsidies, soft loans, fiscal investment loans, and commercial loans.
- Tax-free commuting allowances encouraging the use of public transport.
- High level of coordination among individuals and institutions involved in railway development.
- Efficient administrative infrastructure to support the transfer of benefits.
- The availability of highly competent technical and financial teams.

(2) In the field of spatial planning strategies the Japanese approach encompasses:

- Integrated land use and transport planning process at the national and local level; well respected government policies on land use and transport development, which provide incentives to attract investment along the corridor.
- A land readjustment technique available to assist in efficient acquisition of rail rights-of-way.
- A strategic location of urban arterials to provide the space to construct an underground rail system.
- Railway construction to promote under-developed areas near the city center.
- A strategy to develop residential areas as well as other purpose areas (mixed-use) along rail corridors, so that high-density development creates passenger demand.
- A strategy to develop rail stations as inter-modal transport terminals and activity centers.

(3) The section on investment decisions in an appropriate socio-economic environment constitutes the following aspects:

- The railway network has been well developed before motor vehicles became widespread.

- Railways are providing a high level of service, which underlines the general consensus that railways are an essential mode of transport in an urban area.

- Private railway development profitable through land development along the corridor.

- Increased property values caused by rail construction enable value capture to finance part of the investments.

- Increased attractiveness of residential and commercial development along the railway corridor, which in turn, contributes to an increase in railway users.[10]

Although one important factor, the composition of the vehicle fleet, is still missing to the discussion, all the above mentioned explains for Tokyo being a top performer in terms of urban sustainable transport. It confirms the hypothesis that Tokyo's transport and land-use related institutions are and have been better integrated and coordinated. The continuation of rail-oriented development in the post-war period through private rail operators, flanked by governmental policies, and well received by customers speak a clear language. It suggests that high-density living was intended, mass oriented solutions required and the system gradually designed in such a way to accommodate 36 million people.[11] From a peak oil and climate change perspective, this obviously pays-off in many more regards than initially anticipated.

[10] To learn more about the how and why government and private rail companies interacted in a coordinated way towards compact city planning is the objective of further in depth research.

[11] Although Germany and Japan (+5,8%) have similar amounts of land at their disposal, approximately 56% more people inhabit the Japanese archipelago.

2.2.4 The composition of the vehicle fleet

The city vehicle fleet consists of a range of different vehicles such as passenger cars, rented cars, taxis, buses and trucks.[12] The actual composition both in terms of the number of vehicles and commensurate fuel efficiency standards is not sufficiently ascertainable.[13] Road transport, however, remains the major climate challenge within this particular sector. Hence, a contemporary approach to road transport related policy initiatives – the "Top-Runner Regulation" and the "No Diesel-Vehicle Campaign" – are analyzed with regard to their contribution to sustainable (low carbon) mobility.

3. Mediate and Immediate Contemporary Approaches to Sustainable Urban Transport in Japan

According to Sugiyama and Takeuchi [2008] the formulation of local climate change policies in Japan has started in the mid-1990s after the first Action Plan to Arrest Global Warming has been formulated by the Government of Japan in October 1990, and the Environment Agency (since 2001 the Ministry of the Environment) has published a Guideline with Measures to Prevent Global Warming (*National Guideline 93*) in 1993. In 1998, after the adoption of the Kyoto Protocol, several amendments to the *Energy Conservation Law* and the *Global Warming Law* were approved. One such amendment to the Energy Conservation Law was the Top-Runner Regulation, which is considered the most effective measure in Japan's national climate change policy [Sugiyama et. al. 2008:426]. I will come to discuss its effectiveness regarding sustainable transport in a later paragraph.

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[12] Motorcycles are not documented.
[13] The Automobile Inspection & Registration Information Association documents the number of vehicle ownership but diverges in its approach from the Tokyo Metropolitan Automobile Pollution Control Division (http://www.airia.or.jp/number/index.html)

The 1998 *Global Warming Law* is criticized for its lack of delegation. It neither authorizes the prefectural or local level to reduce its CO_2 emissions in relevant fields of action (e.g. energy policy, transport or housing) nor does it provide the financial means to do so. In response to a missing legal directive that would coordinate emissions reduction targets at the national level and actions to be taken, the Tokyo Metropolitan Government (TMG) has issued local ordinances, which claim competences over energy, traffic, and other GHG-related policy areas. [Sugiyama et al. 2008: 424, 434]. As the political and economic center of the nation that attracts particular international attention, Tokyo demands to evolve into an "environmentally-advanced" city – even a role model to the world – that offers appeal and vitality to its citizens and visitors. [cf. "The 10-year Plan"]

3.1 Current Trends in Sustainable Urban Road Transport in Tokyo

Both, the 2006 ”Tokyo's Big Change. The 10-year Plan”[14] and the 2008 Tokyo Metropolitan Environmental Master Plan[15] have articulated measures for the promotion of sustainable urban transport. Under the 10-year Plan, which, among other things, envisions the city's CO_2 emissions to be reduced by 25% on the levels of 2000 by 2020, two projects – the ”10-Year Project for Green Tokyo" and the "10-Year Project for a Carbon-Minus Tokyo" – are relevant to sustainable transportation. In a more full-fledged way, however, the Tokyo Metropolitan Environmental Master Plan addresses the realization of environmentally sustainable transportation.[16] Particularly fuel consumption regulations play a significant role in tackling CO_2 emissions today. They constitute, however, only one approach in retrofitting urban transport towards a low-carbon future. Besides the 'improve'

[14] In December 2006, the Tokyo Metropolitan Government formulated "Tokyo's Big Change: The 10-Year Plan", which presents Tokyo's vision of the city in the Olympic year of 2016, and the direction of Tokyo's policies that will be taken to achieve these goals.
http://www.metro.tokyo.jp/ENGLISH/PLAN/index.htm

[15] http://www.kankyo.metro.tokyo.jp/kouhou/english/master-plan/

[16] Measures with an asterisk (*) occur in all three documents.

strategy (promoting of the use of low-emission, fuel-efficient vehicles), also ‘avoid’ (reducing unnecessary travel demand) and ‘shift’ (shifting travel to lower-carbon modes) practices have been developed. All the below measures brought forward can be subsumed under one such category. All improve strategy measures will be marked by the large letter “I”, all avoid strategy measures by the letter “A”, and all shift strategy measures by the letter “S”.

The Environmental Master Plan covers:

1. <u>Change of travel behavior (shift from overdependence on vehicles)</u> (S+A)

- Promotion of public transportation usage
- Introduction of new public transportation system
- Promotion of bicycle usage
- Securing safe and comfortable mobile environment

2. <u>Controlling traffic volume and other issues</u>* (A)

- Control of running volume of commercial vehicles
- Control of vehicle traffic volume by economic instruments and regulatory instruments
- Utilization of parking space

3. <u>Shift and lead to environmental friendly vehicle usage</u> (S+I)

- Promotion of low emission and fuel efficient vehicle usage*
- Green procurement in vehicle usage
- Strengthening vehicle emission reduction program and other approaches
- Promotion of eco-driving*

4. <u>Enhancement of environmental performance of vehicle (development and diffusion of fuel-efficient vehicle)</u>* (I)

5. Measures for fuels* (I)

- Promotion of biomass fuel usage
- Development and diffusion of next-generation vehicle fuels

In conclusion, measures to promote the usage of low-emission, fuel-efficient vehicles seem to prevail the catalog of measures as the ”10-Year Project for Green Tokyo” and the ”10 Year Project for a Carbon Minus Tokyo” as well as the Environmental Master Plan quantitatively emphasize improve strategy measures. A simple explanation for this may lie in the Japanese automotive industry, which constitutes a significant producer and employer both domestically and internationally.[17]

Nakamura et al. [2011] have classified different typical measures being taken worldwide under the ‘improve’, ‘shift’, and ‘avoid’ categories to capture trends and effects. Traffic flow and traffic volume measures largely correspond with the shift category and entail a striking problem both in terms of driving convenience and pollutants released when driving speed at peak hours falls below 20km/h and increases emissions at the spot. Measures against congestion such as better bus services (Bus Rapid Transit) are thus advisable, also and in particular for Tokyo city.

In the year 2000 recorded fuel emissions in the transportation sector amounted to 18 million tons/year. Within the 20 years time span until 2020 the Transportation Department aspires a 40% reduction of greenhouse gas emissions within the sector, which equals a target of 10.8 million tons/year, including 8.8 million tons/year from automobiles. Nevertheless, according to the Tokyo Metropolitan Automobile Pollution Control Division it is technically and socio-economically

[17] Japanese auto manufacturers are Toyota, Nissan, Mitsubishi, Mitsubishi Fuso, Mazda, Isuzu, Honda, Hino, Suzuki, Daihatsu, Subaru, and UD Trucks.

impossible to reduce fuel consumption of automobiles alone or traffic volume alone to reach the 40% target.

The Tokyo Metropolitan Automobile Pollution Control Division thus pursues a dual approach by integrating fuel consumption and traffic volume measures applied to the entire on road vehicle portfolio except for motorized two-wheelers. Their measures and guidelines for emissions reduction encompass the following six points[18]:

1. Measures to reduce traffic volume of passenger cars

To reduce 9% of passenger car traffic volume, about 300.000 passengers must use alternative means of transportation instead of their own cars. In order to reduce fuel consumption by 500.000 tons, measures need to be implemented to spread hybrid and electric vehicles at a pace of 50.000 cars per year. The spread of new (fuel efficient) cars is limited however as the increase of newly registered cars in the Tokyo Metropolitan area is 5% or below. Moreover, one quarter of passenger car traffic volume comes from vehicles registered outside of Tokyo. Thus, obviously the above-mentioned 300.000 passengers could easily be found among the owners of vehicles registered outside of Tokyo. If it is feasible to shift their travel behavior, a big step forward would be taken.

2. Improvement of passenger car fuel efficiency

To improve passenger car fuel efficiency the Automobile Pollution Control Division talks about accelerating the implementation of the 2020 fuel consumption standard[19] in order to be able to sell fuel-efficient vehicles sooner than initially anticipated. To make this happen three decisive actions need to be taken: (1) corresponding proposals need to be made to the Japanese government, (2) public

[18] Notably, car-sharing initiatives are not included.

[19] As of August 2011 Japan's national standard will likely be increased to a fleet average of 20.3 kilometers per liter of fuel by 2020. Hybrids like Toyota's Prius would be covered by the guideline, while electric cars and plug-in hybrids would be excluded from the requirements.

opinion needs to be spurred on, and (3) an attractive automobile market needs to be created.

3. Improvement of taxi fuel efficiency

Taxis can substitute private cars. It is thus crucial to improve fuel efficiency of commercially used cars, which in turn can serve as showcase of new propulsion systems in a non-binding way. Well aware of the deteriorating effects of increasing loading rates onto fuel efficiency, the Automobile Pollution Control Division calls for high fuel efficiency vehicles that can offset the load detriment. The more so as taxis drive nine times more distance than private cars.

4. Purchase of next-generation buses

It requires political commitment to manufacture next-generation buses to transport the above-mentioned 300.000 passengers. To replace all commercial large-size buses by hybrid buses and to further reduce CO_2 emissions through bio fuel usage is regarded as solution to the challenge of congestion.

5. Use commercial vehicles in place of freight trucks

Freight transport is a particularly sensitive domain for the vitality of an economy. Thus, whereas reduction in traffic volume can be achieved only to a limited extent the improvement of fuel efficiency seems to be more promising.

6. Improvement of fuel efficiency of freight vehicles

Similar to taxis, freight vehicles are subject to the deteriorating effects on fuel efficiency, which requires the promotion of highly fuel-efficient propulsion systems.

Next to passenger transport, urban freight adopts an increasingly important role. The home shopping market, for example, has rapidly grown worldwide since

2003.[20] Japanese *takkyubins* (Yamato and Sagawa as the two leaders) are parcel transport companies specializing in home deliveries; these represent an original service and a specific feature of Japanese urban logistics. Urban freight represents roughly 10-15% of vehicle kilometers on city streets, which contributes significantly to road congestion. Freight needs dedicated urban spaces, such as loading and unloading areas, which add up to space limitations in Tokyo. Moreover, environmental concerns have led some cities into actually developing logistic facilities. Twenty-two freight facilities in Tokyo, and fourteen in other Japanese cities, have been implemented with the help of the national state in order to solve urban difficulties for truck companies. In terms of pollution control, the "No-Diesel-Vehicles Campaign" tackles particularly truck engine exhaust fumes in Japan.

3.2 The "No Diesel Vehicle Campaign"

As mentioned earlier, transport accounts for nearly 25% of global energy related CO_2 emissions. Additionally, transportation sources emit several other compounds that are believed to have an indirect effect on climate change, but are not considered greenhouse gases, except for ozone (O_3). These substances include nitrogen dioxide (NO_X), sulfates, carbon monoxide (CO) and aerosols (black carbon and soot).

The health risks involved in transportation both to the ecosystem and directly onto human beings are not negligible. According to the World Health Organization [2011] urban air pollution is estimated to cause around 1.3 million deaths worldwide every year. Corollary, the lower the levels of air pollution in a city, the lower the risk to develop respiratory and cardiovascular diseases. Since the exposure to air

[20] Cluster 5/Module 4: Urban Freight Package; presentation prepared for the capacity building program Building Leaders in Urban Transport Planning (LUTP), Singapore 2012, p. 8.

pollutants is largely beyond the control of individuals, actions taken by public authorities at the national, regional and even international level are required.

Still in the 1960s, air pollution in Japan was basically attributed to industrial processes. Only in 1973, five years after the Air Pollution Control Act, the Automobile Exhaust Gas Regulation was enacted. Another five years later in 1978, an environmental control standard for nitrogen oxides has been introduced – the Japanese version of the Muskie Act. Honda had developed a vehicle that complied with the original act, proposed by U.S. Senator Edmund Muskie, which forced reduction of CO, HC, and NO_X emissions by 90% for vehicles produced in 1975 and 1976 as compared to those produced in 1970/71. As U.S. car manufacturers have bailed out, the way was cleared for Japanese manufacturers to successfully enter the global market for automobiles.[21] [Suzuki 2011:80]

However, environmental quality standards with regard to nitrogen dioxide and suspended particulate matter (SPM) were not sufficiently met, which happened mainly because of steadily increasing automobile traffic and the fumes emitted by diesel-powered vehicles. In August 1999 the Tokyo Metropolitan Government started to discuss the “No Diesel Vehicle Campaign”. Four years later, in October 2003, ahead of the Japanese Government, TMG started to restrict diesel-powered vehicles in collaboration with the eight local governments in Kanto region. Since then, concentrations of suspended particulate matter have been significantly reduced and almost all related environmental quality standards could be met. According to the results of air-quality measurements in FY2006, environmental quality standards were met at all roadside air pollution monitoring stations for two years in a row beginning in fiscal year 2005.

[21] Asia’s first passenger car production started in 1959 in Toyota’s Motomachi plant in Koromo, today Toyota city (40km south east of Nagoya in Aichi prefecture).

3.3 The Top-Runner Regulation

The Japanese Top-Runner Regulation (TRR) is a "regulatory scheme designed to stimulate the continuous improvement of the use-phase energy efficiency of products within selected segments of markets for household and office appliances, vehicles, etc." (Nordquist 2006: 5) It is designed to stimulate exclusively supply-side activities of product markets. To date eighteen product categories have been brought into the Top Runner scheme and an additional three – heavy vehicles among them – are currently considered for inclusion. Among these eight product categories, two concern vehicles.

Table 1 *Vehicle related product categories in the Top Runner scheme*

	Product category	Target year	Expected energy savings
1.	Gasoline passenger vehicles	2010	~23 % (cf. 1995)
	Diesel passenger vehicles	2005	~15 % (cf. 1995)
	LPG passenger vehicles[22]	2010	~11.4 % (cf. 2001)
2.	Diesel freight vehicles	2005	~7 % (cf. 1995)
	Gasoline freight vehicles	2010	~13 % (cf. 1995)

Source: Nordquist 2006: 7.

Nordquist points out that the Japanese Top Runner program does not address actual energy use as such, because it is oriented towards actors on the supply side, and that the overall energy-savings effect of the program is thus no assessment criteria. Concurrently, however, the supply of energy efficient products is one side of the coin to realize energy savings. The expected energy savings mentioned in the table partly correspond with a fuel consumption standard for passenger vehicles and small freight vehicles aiming at 15.1km/l gasoline by FY2010. Already in FY2005 Japanese manufacturers could announce to have

[22] Liquefied petroleum gas

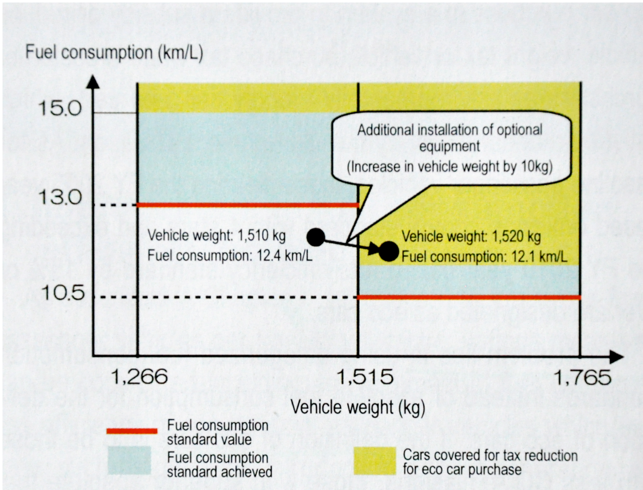
achieved the target. The market penetration of such vehicles, however, can hardly be estimated.

In the light of road traffic being the major source of CO_2 emissions in transport, unanimous agreement prevails that the improvement of fuel consumption is of utmost importance to the reduction of CO_2 emissions from passenger and freight vehicles. As a major automobile manufacturer and exporter, TRR safeguards Japanese automobile competitiveness within the market toward more fuel-efficient vehicles. The Toyota Prius is one such case in point. The Prius first went on sale in Japan in 1997, making it the first mass-produced hybrid vehicle. It was subsequently introduced worldwide in 2001 with its largest markets in Japan and the United States. As of February 2012 a total of 2.5 million Prius have been sold worldwide.[23] The latest generation, the 2012 Prius Plug-in Hybrid (ZVW35), for example, has a 2.5 L/100 km (95 mpg-e) city and 4.7 L/100 km (50 mpg-US) highway driving performance. In comparison to the Prius 1st gen (NHW11), which was produced between 2001 and 2003, city and highway mileages amounted to 5.6 L/100 km (42 mpg-US) – almost twice as much than a decade later – and 5.7 L/100 km (41 mpg-US) respectively. Also tailpipe emissions could be reduced by more than one third from 135 g/km (217 g/mi) to 82 g/km (133 g/mi).[24]

Nevertheless, the 2010 Environmental White Paper issued by the Tokyo Metropolitan Government points to the shortcomings of the regulation as they come to bear domestically. As the FY2015 fuel consumption standard distinguishes 16 vehicle weight categories the crux of the matter lies in applying the weight criteria instead of absolute fuel consumption for the definition of eco cars. In such way, the weight thresholds allow manufacturers to legally stretch the actual standard – a regulatory phenomenon dubbed "Ohikkoshi".

[23] http://www.timesunion.com/news/article/Prius-Expands-the-Brand-2012-Toyota-Prius-c-3386045.php (accessed May 21, 2012)
[24] http://www.fueleconomy.gov/feg/PowerSearch.do?action=HySbs (accessed May 21, 2012)

Figure 4 Transitions of vehicle weights and fuel consumption standard values

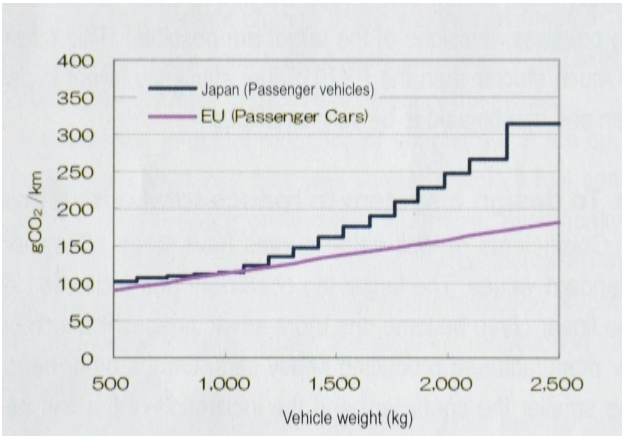


Source:
Environment White Paper 2010, p. 10.

Similarly distorting, cars with inferior absolute fuel consumption are receiving preferential tax treatment, since the tax charge increases with growing vehicle weight. In other words, the same tax reduction proportion applies: the heavier a car becomes, the larger its reduction in tax charge becomes. Thus, through inconsistent regulation and taxation, the Top-Runner Program has failed to become a determined instrument toward low-carbon mobility. In such way, it rather follows the U.S. American model, which prioritizes free consumer choice.

One major difference (see the graph below) between the European and Japanese regulation is that the EU's fuel consumption limit shows a line set by a linear function of vehicle weights. This prevents loopholes for manufacturers to occur. In addition, the linear standard set by the European regulation is markedly more rigid than the Japanese counterpart. Furthermore, whereas in Japan fuel consumption regulations target at energy consumption rates per 1 liter of fuel, the European Union regulates CO_2 emissions per fuel consumption. In that sense, the EU more clearly targets emissions than fuel consumption. [cf. Environment White Paper 2010:8ff.]

Figure 5 Comparison of the EU's CO2 emissions limit value curve and Japanese fuel consumption standard values by vehicle weight category



Source:
Environment White Paper 2010, p. 12.

The European Union has submitted far-reaching proposals to significantly reduce passenger vehicle CO_2 emission levels by 2020. Fuel consumption and CO_2 emission levels of all European-manufactured passenger vehicles are to be reduced to 130g/km of CO_2 through drive train-related measures. An additional reduction of 10g/km of CO_2 has to be achieved through biofuels and "complementary measures" (including gear change timing gauges, efficient air conditioning systems, and tire inflation control systems) so that a set target of 120g/km of CO_2 is realized in 2012. By 2020, vehicles must comply with a value of 95g/km of CO_2. According to the German Association of the Automotive Industry (VDA), more than 260 passenger car models produced in Germany already meet or are below the 130g/km of CO_2 target.

3.4 Electric and Plug-In Hybrid Vehicles

Beyond the Top Runner Regulation regime electric vehicles (EVs) or plug-in hybrid vehicles (PHVs) achieve much better fuel efficiency than any conventional car. Concurrently, however, a purchase subsidy similarly encourages automakers to produce EVs/PHVs. In order to create initial demand 18 towns[25] have been selected as test sites. With a number 15.000 test vehicles, Tokyo is by far the largest pilot site. According to the Ministry of Economics, Technology and Industry (2011) the projections and targets for the diffusion of EVs/PHVs are as follows:

Table 2 *Diffusion projections & targets for EVs/PHVs*

	Projections (private-sector efforts)	Government targets
	2020 / 2030	2020 / 2030
Conventional vehicles	80% > / 60-70%	50-80% / 30-50%
Next-generation vehicles:	< 20% / 30-40%	20-50% / 50-70%
HEV[26]	10-15% / 20-30%	20-30% / 30-40%
EV/PHEV	5-10% / 10-20%	15-20% / 20-30%
FCV[27]	Miniscule / 1%	0-1% / 0-3%
CDV[28]	Miniscule / 1%	0-5% / 5-10%

More in depth information on opportunities, barriers, and requirements for the uptake of electric vehicles as part of sustainable urban mobility plans in Tokyo, Berlin, and San Francisco can be found in my dissertation.

4. Quality of Life and urban mobility

Robert Cevero (2011) acknowledges that in the face of “knowledge- and service-based industries driving economic growth in many sectors of the modern economy,

[25] Nigata, Gifu, Fukui, Kyoto, Tottori, Okayama, Saga, Nagasaki, Kumamoto, Osaka, Okinawa, Aichi, Shizuoka, Kanagawa, Tokyo, Saitama, Tochigi, and Aomori.
[26] Hybrid electric vehicle
[27] Fuel cell vehicle
[28] Clean diesel vehicle

creating functional yet livable cities is essential to global competitiveness." The livability of cities can be assessed by indicators for quality of life which usually include (1) wealth, (2) employment, (3) the built environment, (4) physical and mental health, (5) education, (6) recreation, (7) leisure time, and (8) social belonging. (Sinha/Labi 2007) Whereas science painstakingly distinguishes all those aspects, they are actually quite obviously interrelated to a greater or lesser extent.

4.1 The polarity of quality of life and populousness

When it comes to Tokyo city two critical aspects are salient: first, congestion on Tokyo's streets and crowding in public transport[29] during peak hours plus daily commuting distances of up to 4 hours in total, which severely restrict recreation and leisure time and on top of that hamper community-building objectives. Thus, rather than the transport system, the amount of people that need to be accommodated within and around the economic, political, and cultural center of Japan cause discomfort. The second point concerns the predominance of concrete over open green spaces in large parts of the city. All this may lie within acceptable limits for Japanese citizens, but creates daunting effects for outsiders.

Moreover, rather than burdened with large-scale infrastructure such as limited-access elevated inner city freeways, already the first private rail company president – Ichizo Kobayashi – president of Hankyo railways (Osaka – Kobe – Kyoto) and owner of Takarazuka opera in Takarazuka city knew how to strike a balance between transport infrastructure as an economic conduit and cultural/recreational objectives. Similarly, the Odakyu line between Tokyo and Hakone, attracts those who want to get away from all the city's turbulences.

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[29] To give you an example, the congestion ratio compares the number of passengers to train capacity. A capacity of 100% means that 3 persons stand in 1m^2 of floor space (Ieda, 1995). The congestion ratio of 172%, for example, concerns a section of the Toyuko line (i.e.Yutenji-Naka Meguro), which connects Yokohama and central Tokyo.

4.2 What can be learned from the Tokyo style transport system?

The Tokyo Metropolitan Area in terms of the demographics is by far the largest agglomeration worldwide. In the face of rapid urbanization, especially in the most populous countries Tokyo can be one example to learn from. Its transportation system is comparably clean, as it is extensively rail-based and runs on electricity, which will be increasingly generated by renewable energies. It is reliable, affordable, and accommodates many million people every day in a safe way.

Beyond those thoughts, an assessment of the applicability of the Tokyo model to cities in developing countries requires close examination of existing conditions in each city at stake. However, a general observation of cities in developing countries from within the World Bank (2000) reveals the following points:

- Institutions for urban transport policy making and administration are relatively weak in developing countries. There is a lack of sufficient staff with technical and financial competency in both the public and private sectors.

- There is a chronic shortage of financial resources to support capital intense urban rail investments.

- Policies are often not well coordinated; bus services may compete with railways (e.g., as in Bangkok)

- The urban rail system is either nonexistent or underdeveloped, and therefore there is no consensus that urban rail is an essential part of urban transport. Existing railways have been developed to serve long-distance traffic, and service levels within urban areas are not sufficient for rail to function as part of urban transport system. Since railways are not elevated there are at-grade (level) crossings within urban areas, and trains have to slow down before passing through the crossings. Sometimes, illegal settlements are found in and around rail corridors, making modernization of the system difficult.

- In some countries, motorization progressed rapidly before urban rail was developed (particularly in Thailand, Malaysia, Indonesia, and the Philippines); however, in other countries (e.g., China, Vietnam, Cambodia, Myanmar), motorization rates are still relatively low.

- Public railway management is not very efficient, and in most cases, even operating costs are not recovered.

Thus, although there are many lessons to be learned from the success of the Tokyo-style urban rail development along the lines of (1) a strong regulatory and institutional framework, (2) appropriate spatial planning strategies, and (3) investment decisions in an appropriate socio-economic environment, the portability of the model faces many counterfactual conditions such as the weakness of institutions for urban transport policy making and administration, the lack of sufficient staff with technical and financial competency in both the public and private sectors, and the chronic shortage of financial resources to support capital intensive urban rail investments. Since capital costs for urban rail systems are comparatively high they are either nonexistent or underdeveloped in an emerging urban environment. Consequentially, the debate over urban rail as an essential part of an urban transport system oftentimes leads to an alternative analysis in which Bus Rapid Transit (BRT) gains higher acceptance. However, some of the causes for Tokyo's success could be emulated in favor of mass public transport other than rail-based modes. Those causes are an integrated and coordinated institutional set up with market protective elements for the specific mode of transport. How important behavioral aspects are to the frequently consumed rail services, for example, would be revealed, if the commuter allowance and corporate tax deductibility would be redirected and exclusively applied to bus transit.

5. Conclusion

After ten weeks of intensive research in the field, a big step has been made in explaining Tokyo's success in the Millennium Cities Database study through land-use and energy related performance indicators.

A second goal has been to examine ways in which implications of climate change are addressed in current transport related policies. Fuel efficiency standards (the Japanese "Top-Runner Regulation") are one such approach, as lower levels of fuel consumption also mean lower levels of emissions. The “No Diesel Vehicle Campaign” is not perceived as directly relating to climate change. The regulation of SPM and NOx emissions has rather health concern related origin. It could, however, under such prerequisites also sell in the international automobile market.

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