Chapter 2

Theory of Traffic Policy Development in Relation to Energy Efficiency

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Chapter 2

Theory of Traffic Policy Development in Relation to Energy Efficiency

The traffic jam is a typical modern social problem caused by the motorisation that accompanies urban development. While the demand for logistics increases with economic development as the economic model shifts from a focus on self-employment, through small to medium-sized companies, to major companies, the demand for transport for each individual increases as occupational and living areas become more separated by distance. Furthermore, in addition to population growth through the process of urban development, the use of automobiles also increases due to a rise in income levels, bringing about a cumulative increase in the total use of automobiles. However, not only is transport infrastructure typically increased only after a problem occurs, transport policy involves massive costs and time, making it difficult to address changing conditions quickly enough. Thus, the traffic congestion that occurs as a result of this time lag is an unavoidable social problem for growing cities.

While economic losses are listed as one of the primary adverse effects of traffic congestion, another negative effect is a drop in energy efficiency due to the worsening of fuel efficiency. As energy consumption for transport comprises roughly one-third of all energy consumption in the world,[1] transport-related energy loss is a vexing problem from the standpoint of both energy security and environmental conservation. Currently, the effective use of public transport is essential for supplying the demand for transport economically and efficiently from an energy standpoint. It is desirable to develop cities with a high rate of public transport use.[2]

Today, a growing number of cities are experiencing significant economic and population growth, particularly in Asia, and extreme traffic congestion is occurring in some of the region's major cities. Similar situations are expected to develop in other regions including Africa, Asia, and South America. With the demand for energy increasing every year and expected to continue to rise, improving energy efficiency is an urgent issue. Accordingly, the transport problem is one in which energy specialists must involve themselves proactively. Previously, energy research focused on impact analysis of constituent factors, such as improving fuel efficiency, and research on the transport problem as a whole has been inadequate. This report considers the measures that should be adopted in response to the transport problems faced by modern cities from the standpoints of both the transport economy and the energy economy by considering the basic mechanisms of those measures with a focus on qualitative analysis of urban transport.

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1 IEEJ, EDMC Handbook of Japan's & World Energy & Economic Statistics 2014.

2 Here, public transport refers to mass transport systems in cities such as trains, subways, buses, and light rail transit.

1. Transport Demand and Traffic Congestion

This report begins by examining the characteristics of transport demand and analysing how congestion occurs. These considerations enable the correct application of congestion-solving measures.

Transport refers to services related to the moving of goods and people. Currently, the supplying of transport services requires four elements: routes, transport equipment, power, and terminals. Notable characteristics of these services include the high demand, immediacy,[3] locality,[4] the effect of intangible factors, and wide fluctuations in demand. These elements and characteristics have a major effect on the transport problem.

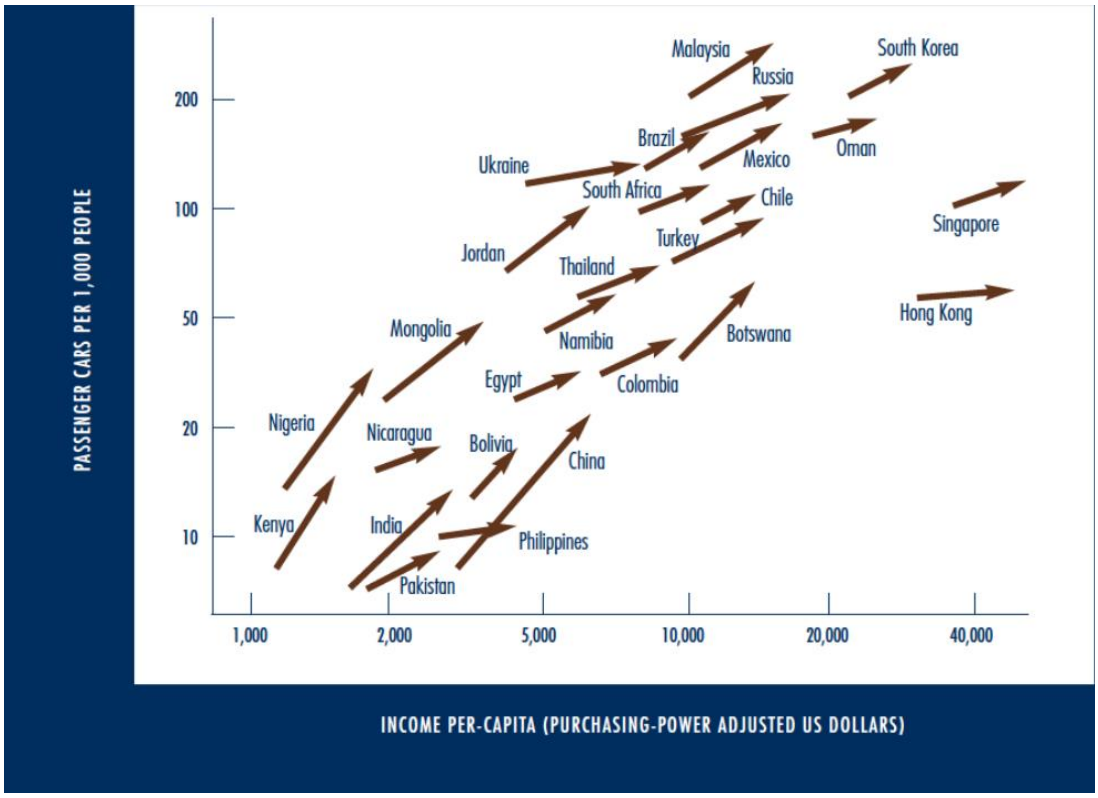
From a transport economy standpoint, traffic congestion represents a state in which transport demand for roads exceeds the transport supply. When congestion begins to occur in a city, it is usually caused by an increase in transport demand; a significant and sudden fluctuation in supply is unlikely. The nature of demand is related to the degree of need for transport. Generally, demand is comprised of intrinsic demand and derivative demand. Intrinsic demand refers to normal demand, representing the aim of a desire to 'do something'; while intrinsic demand refers to travelling for its own sake, such as going on a drive or taking a cruise for fun. Although intrinsic demand exists for transport, it is a somewhat unique form. Most transport demand in modern society consists of derivative demands that stem from the various intrinsic demands (the demand to move), including commuting to work or school and travelling to locations for shopping or leisure. Thus, any increase in demand is generally caused by changes in areas other than transport itself, such as in changes in economic demand and changes in social structure. Furthermore, the total sum of these activities is strongly correlated with population, and population increase is one of the primary factors behind the growth in transport demand.

In addition, the rate of automobile usage, which is directly connected to traffic congestion, is strongly correlated with income level (Figure 2.1). Generally, a rise in income leads to a rise in automobile usage, leading to traffic congestion. At the same time, public transport is often used more by lower socioeconomic groups, and its income elasticity is negative. When public transport takes on a negative image as the mode of transport of the poor, automobile usage trends become even more significant.

[3] Immediacy means that consumption occurs concurrently with the supply of services. Supply speed and timing become important as a result.

[4] Locality means that the locations of the supply of services are fixed. As a result, supply problems occur in areas where demand is inadequate. Further, regulations and control are important because monopoly conditions can occur easily due to the lack of competition between goods across multiple regions.

Figure 2.1: Income Level and Number of Cars Owned



Source: ACCESS Magazine. http://www.accessmagazine.org/articles/fall-2010/megacities-megatraffic/

Two frequently mentioned negative effects of traffic congestion are economic losses and energy losses. For instance, in Japan, the Ministry of Land, Infrastructure, Transport and Tourism estimates that the opportunity costs of traffic congestion represents an economic loss of ¥12 trillion per year. Meanwhile, in the United States, the average time spent in traffic congestion per person is twice that of Japan, representing a major economic loss. Furthermore, other negative effects of traffic congestion, including external effects, are often mentioned, such as a rise in traffic accidents and a deteriorating roadside environment. From an energy standpoint, driving at a slow speed during traffic congestion greatly worsens the fuel efficiency of automobiles. For instance, compared to driving at 25 kilometres per hour (km/h), driving at only 10 km/h drops halves fuel efficiency. The automotive industry goes to great lengths to improve fuel efficiency by several percentage points each year, but solving traffic congestion would have a much greater effect on improving fuel efficiency in a shorter period of time than technological improvements by automobile manufacturers.

In the coming years, road transport demand is expected to increase in regions where a rise in population and economic development is predicted. Traffic congestion is already becoming a significant social issue in developing countries in Asia. The same phenomenon is expected to occur in other regions, such as Africa and Central and South America, coinciding with economic development. Appropriate measures will be required to avert economic and energy losses in these regions.

2. Measures for Traffic Congestion

Logic dictates that the two available responses to the high transport demand on roads are to either limit transport demand or increase supply. In this case, when speaking in terms of the micro economics, the discussion will then generally proceed to a consideration of the relationship between price and demand. However, the characteristics of transport mean that this is not necessarily the case. Because traffic demand primarily consists of derivative demand, while the necessity is high, it is typically not elastic in terms of price, and thus adjusting demand via price cannot be expected to be effective.[5] Further, in the case of road-based transport, there are hurdles involved in collecting fees. Moreover, controlling demand through extreme price measures would be undesirable from a social welfare standpoint because it would interfere with the intrinsic demand of basic social activities such as employment in the case of commuting to workplaces, and academic learning in the case of commuting to schools. Accordingly, simply using price adjustment to change the traffic demand for roads is unrealistic.

2.1 Supply-side measures

Methods for improving supply capability can be categorised into (i) methods that directly increase supply, such as increasing road capacity or rationalizing road structure; and (ii) methods that improve the supply efficiency of the road environment, such as adopting cutting-edge technology, such as electronic toll collection systems,[6] or policing street-side parking (which impedes supply). Automobiles did not exist in pre-modern cities, and most roads, with the exception of city highways, were paved and designed primarily for pedestrian traffic and small vehicles such as carriages or rickshaws. Further, as populations were generally much smaller than today, handling modern motorisation is generally difficult in terms of volume and road quality without engaging in road improvements. Thus, improving roads to make them compatible with automobiles, including widening them to accommodate cars, paving them, and adding drainage, is a minimum condition that must be met in modern cities.

However, the improvements in the road environment lead to a further increase in road transport demand. If automobile use is to rise continuously with the rise in incomes, then not only will road capacity need to be increased accordingly, but this increased capacity will bring about a further rise in demand.[7] In cases where public transport services exist, the expansion of road capacity has the effect of lowering the overall appeal of public transport. Not only will this worsen traffic congestion, but it can pose a threat to the continued existence of the public transport system. Further, the land required for parking spaces that serve as terminals for automobiles becomes massive in scale, causing an extreme rise in the costs of preparing road

[5] Pricing theory is discussed in section 5.

[6] The electronic toll collection system is a method used to collect expressway fees electronically using machines.

[7] This is known as the Pigou–Knight–Downs paradox or the Downs–Thomson paradox. It states that the equilibrium speed of car traffic on a road network is determined by the average door-to-door speed of equivalent journeys taken by public transport.

infrastructure.[8] This then causes more demand for parking and brings about fuel waste and environmental problems, as well as externalities such as noise and vibration. Automobile-centric transport leads to the marginalisation of groups for whom such transport is difficult, such as the elderly, children, and the disabled. To tackle these issues, the demand for road transport needs to be reduced while improving the efficiency of transport to the extent possible without departing from the original purpose of meeting the intrinsic demand.

2.2 Demand-side measures

There are several approaches to controlling road transport demand. The first is to reduce the need for travel to meet the intrinsic demand. For example, those who need to travel to meetings could hold teleconferences and thus eliminate the requirement for travel. Another effective approach is to shorten the distance travelled. For example, situating occupational and residential areas in close proximity can greatly reduce the distance travelled. Further, unlike tangible or storable goods, transport is a characteristically immediate resource that cannot be stored, and therefore involves the so-called peak (demand) problem. However, by diversifying behavioural patterns, such as using flexible working hours or staggering days off, transport demand can be levelled out without adjusting the overall volume. This can have the effect of solving traffic congestion.

There are many other similar methods to limit demand without adjusting pricing, but the most effective method at present is likely to be a modal shift towards the use of public transport. The use of public transport is not only more efficient than automobiles in energy used per person, but it also tends to be more punctual and stable. It is therefore an excellent way of meeting transport demand. Further, introducing public transport as an alternative transport mode brings about price elasticity for road traffic demand. In other words, the increase in the number of options available causes transport demand, which normally does not react easily to pricing, to become more sensitive to pricing. This makes the various policies for mitigating traffic congestion more effective. For instance, it enables the mitigation of traffic congestion through lower congestion charges, with less loss of consumer surplus. Further, a degree of improvement in efficiency can also be expected through competition. Simply stated, the provision of alternative transport choices in response to intrinsic demand for road transport can be expected to bring about competition between transport modes and improved transport efficiency.

[8] About 25 square meters of space per automobile is required. When applied to the population of the Hong Kong Transit Oriented Development, discussed in section 5, and assuming an average automobile ownership rate of one per person, it would be necessary, albeit highly unrealistic, to secure roughly 80 percent of available land for parking space. This reality likely influences the strong relationship between high city density and public transport use.

3. The Traffic Congestion Trap and the Optimal Timing of Measures

While the above section explains the mechanism by which traffic congestion occurs and the solutions that may be used, many cities throughout the world still suffer from severe congestion. The primary causes are a lack of the necessary capital or technology, and the problems of determining the optimal scope and timing of projects.

In this section, the discussion will begin with an overview of the traffic congestion trap and a discussion of the optimal timing of measures. The typical pattern is that as the use of automobiles increases with urban growth, attempts are made to expand road infrastructure, but this is not done fast enough for the supply to meet the demand. Subsequently, the adverse effects of congestion are acknowledged only as the congestion grows severe, after which various measures are taken, including modal shifts. An increase in automobile use is typically seen as symbolic of social development and prosperity, and is viewed positively until traffic congestion becomes severe. Thus, any increase typically does not lead to an attempt to limit it.[9] Accordingly, any measures taken typically only happen after the adverse effects of congestion on the economy and environment become a problem for society.

However, as effective measures for traffic congestion involve massive scale construction, such as road expansion or the preparation of public transport, these measures cause temporary impediments to the very transport they wish to address. Traffic congestion may even grow worse during the construction period due to the construction itself, and thus solutions for traffic congestion incur considerable costs and losses. Furthermore, once traffic congestion occurs, measures cannot be taken right away. For instance, preparing a subway line takes at least five years for the construction work alone, and can require at least 10 years for the entire project, including obtaining the requisite land and carrying out all necessary paperwork. Thus, the defining characteristic of the traffic congestion trap is that it can come about easily but is difficult to solve. However, it is easy to prevent such a problem from occurring by taking advance measures. At the very least this means that cities should prepare plans that can be implemented with lower budgets. This would allow the economic and energy losses caused by congestion to be minimised.

To implement advance measures appropriately, their nature must be properly understood. The first thing to understand is that advance measures are by no means free. Large-scale road expansion or the construction of public transport systems are easier to implement as advance measures because traffic congestion is not yet severe. Thus, the major merits of advance measures are the larger number of options and the fact that large-scale measures for traffic congestion that include urban planning are quite feasible. However, advance measures involve a certain level of difficulty even at the stage of selecting whether or not to carry out the measures. It can be difficult to obtain the approval of city residents for measures when congestion has not yet occurred. Without residents' approval, politicians become less motivated to carry out advance measures and are unable to avoid the traffic congestion trap.

[9] Singapore is a notable exception.

Furthermore, even in cases where city residents are rational enough to support advance measures, there are yet more difficulties involved in the timing and scale of construction projects such as the construction of a subway. Although advance measures are required to avoid the traffic congestion trap, this does not mean that measures should be carried out thoughtlessly as soon as possible, and it must be remembered that funds invested become sunk costs that make pulling out impossible. Thus, transport projects characteristically involve the optimal stopping problem[10] due to the need for irreversible decision making. When there is a simple increase in transport demand, it is theoretically possible to calculate the timing for implementation using the first year rate-of-return method.[11] While the question of how to position the figures used as criteria is a difficult problem in the real world,[12] it is possible to make an automatic decision that an investment should be made when the transport demand exceeds a certain volume. In the case of measures taken after the fact, it is desirable that projects are carried out as soon as possible, and thus decisions on timing are unnecessary as a rule.

There are many other instances that require high-level decision making for advance measures. A state in which traffic congestion is not occurring suggests that the city's intrinsic demand is not yet particularly great. For instance, in terms of transport demand caused by commuting, it would mean that the labour demand by companies was not yet high. In that case, the question of where future demand develops can be greatly affected by the transport network itself. This has a major effect on city design, and thus must be tied closely to urban planning. Furthermore, with regard to scale, there is a considerable risk of over-investing and being unable to realise a profit when the current level of transport demand is not yet causing congestion. Under the optimal stopping problem, the timing of an investment is calculated based on the assumption that the amount of investment has been determined, whereas in fact, the determination of the appropriate scale is itself a difficult problem. While the Henry George Theorem[13] might be applied here, some creativity would be required as there are difficulties involved in the applicable conditions. In the case of measures taken after the fact, the scope of investment can be determined because the intrinsic demand is already clearly defined, and it is simply a question of designing the network to efficiently meet that demand. This is because if a subway were constructed in a location that was unrelated to commuting destinations, then it would not fulfil its role and would not bring about a modal shift. In that respect, measures taken after the fact will depend heavily on the city's structure.

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[10] The optimal stopping problem is a mathematical approach for choosing a time to take a particular action in order to maximise an expected reward or minimise an expected cost.

[11] Masayuki Doi, *Transport Economics.* In other words, if the difference between the net present value of a project and the net present value of that project were it implemented one year later is calculated, it will be smallest when the ratio of net benefit in investment for the first year is equal to the discount rate, so the net present value can be maximised by initiating the project in the relevant year.

[12] However, the method cannot be easily applied in practice depending on the interest rate or project timing.

[13] The Henry George Theorem estimates the optimal size of a city by comparing aggregated benefit and loss attained by the accumulation of economic activity.

Thus, there are several drawbacks to advance, pre-emptive measures compared with reactive measures taken after the fact (Table 2.1). Whereas measures after the fact identify solutions based on current problems the city faces, advance measures must be based on an expectation of future problems, and involve the work of creatively transforming existing cities. Thus it is necessary to adequately consider not only the importance of this work of developing a foundation for the city's economic future, but also the difficulty of doing so due to the inherent unpredictability and risk.

Table 2.1: Characteristics of Advanced and After-the-Fact Measures

Reactive Measures	Pre-emptive Measures
・Easily gives rise to chronic supply shortages ・Construction to increase supply itself causes further congestion ・Dependent on existing city structure	・Timing of measures is difficult ・Obtaining approval of citizens is difficult ・Alters city structure

Source: Study team.

4. Public Transportation Design

Before considering the design of public transport, its purpose must first be clarified as a precondition. The purpose of public transport is generally to meet the derivative transport demand. Public transport design that aims to shift hobby drivers to use public transport or to maximise benefits for tourism or train aficionados will not be discussed here.[14] Rather, the aim will be to understand the derivative requirements. It has already been explained that an approach that considers price alone is inappropriate for understanding derivative demand requirements. This leaves the problem of what basis to use. The domain of transport economics uses the concept of generalised cost.[15] This concept views the elements of transport – time, frequency, regularity, reliability, accessibility, safety, and comfort – as costs and aims to minimise those costs. While there are many elements to generalised costs, users base their decisions on bounded rationality, so it is not necessarily a requirement to consider every element. Rather, costs that are easy to detect take on a relatively high importance. However, this report will discuss the validity of this method or the algorithms used. Rather, discussions will be based on the rule of minimizing the amount of time required to reach the destination,[16] and to do so as swiftly, safely, comfortably, and cheaply as possible.

[14] There are transport services that aim to meet the intrinsic demand of tourism (such as leisure boats or tour buses), and this report does not intend to deny the importance of off-peak high value-added transport.

[15] The generalized cost concept has been criticized for the difficulty of seeing the effects of individual elements, and the high risk of preferentially benefiting the wealthy due to an emphasis on time cost. While these weaknesses must be acknowledged, the concept is still unquestionably an effective tool for understanding the effects of costs other than price.

[16] Wardrop's First Principle.

4.1. Rapidity

The basic issues for rapid transit are equipment, the independence of routes, operational frequency, and access. The existence of transport equipment that can travel swiftly is essential for rapid transit. If the rule of taking the minimum time is set as a precondition, then if there is a method of public transport for which the time required is greater than when using roads, then traffic congestion will continue to increase until the time required by road matches that required via public transport. In other words, as a rule, such a public transport system should not be designed. Street buses that lack their own independent roads are at a disadvantage, and it is thus difficult to mitigate traffic congestion using such buses. However, this is not to deny buses as having value as public transport. The quality and performance of buses have improved in recent times, and they are capable of travelling safely at higher speeds. For example, whereas it takes 60 minutes to travel from Tokyo Station to Narita International Airport via the Narita Express train service,[17] so-called limousine buses take about 80 minutes, which maintains a level of competitiveness. As the operating interval of these buses is roughly 20 minutes shorter than the train, the average amount of time spent in transit becomes the same from the standpoint of travellers without reservations. However, as the limousine buses travel on the general expressways, they can experience significant delays when traffic congestion occurs. The chance of delays for trains is relatively low. The routes used by trains are independent of general traffic, which leads to rapid and reliable travel. While the perception of buses is that they are generally affected by road conditions, some cities have achieved rapid and reliable service for their BRT by establishing dedicated lanes for buses (Figure 2.2).

[17] Narita Express is a limited express train service operated in Japan since 1991 by JR East, serving Narita International Airport from various Tokyo area stations.

Figure 2.2: Bogota Bus Rapid Transit System

Source: Institute for Transport & Development Policy. http://www.itdp-china.org/

From the standpoint of transport economics, public transport should be designed to achieve travel times that are equivalent to road travel under optimal congestion conditions. The optimal congestion conditions are found at the intersection between demand and marginal social cost, but when demand for roads is such that congestion occurs unless measures are taken, then some congestion will still occur under optimal congestion conditions. However, it may be difficult to calculate the marginal social cost accurately, and it is desirable to eliminate congestion completely from the standpoint of energy efficiency. Thus, it is recommended that public transport is sufficiently competitive with the travel time required via automobile when there is no congestion, for the sake of convenience. Travel time should include waiting time and access time, and it is thus necessary as a rule for the design to maintain an advantage in terms of travel time compared to private automobiles in non-congested conditions.

Private automobiles are available for travel at any time provided one is prepared to drive, whereas public transport does not operate according to individual whim, and thus a certain amount of waiting time is unavoidable. As this waiting time comprises part of travel time, it is important to limit waiting time in order to achieve rapid transit. Operational frequency is therefore an important factor. For example, on the Moscow subway a timetable is unnecessary because 40 trains operate per hour during peak times (the subways operate according to a 90-second frequency comprised of 20 seconds stopped at platforms and 70 seconds of arrivals and departures). As a result, waiting times are extremely short. However, even for public transport systems that operate at a lower frequency, it is possible to minimise passenger

waiting time through the use of timetables and punctuality. For example, in Japan, while train frequency is lower than on the Moscow subway, punctuality is extremely high, and thus timetables are very reliable. This allows passengers to arrive at stations immediately before the departure, allowing them to minimise their waiting time. Online services display current operating conditions, providing greater precision, and allowing passengers to further reduce waiting times. However, this still does not remove the disadvantage that availability is not 24/7 and is restricted to the operation schedule, which reduces the appeal of public transport as a transit method.

Similarly, reducing access time to terminals is another essential factor for rapid transit. In the case of advance measures, housing can be developed within walking distance of terminals to increase the convenience of using public transport for residents. Further, it is also important to consider that building taller structures can increase the population living within the access range of the terminals. When considering access by methods other than walking, such as bicycle, motorbike, or automobile, it becomes necessary to secure parking space near the terminal. Access from the parking area to the terminal itself is also important. Furthermore, additional public transport is sometimes provided to provide access to terminals for those who do not own or cannot ride automobiles or motorbikes, such as children or the elderly. These systems are called feeder lines. When designing feeder lines, it is necessary to apply the same principles used in other public transit such as travel time, waiting time, access, and transfer time. These feeder lines must provide an advantage in travel time over bicycles and motorbikes, but realistically, it is difficult to make such lines advantageous compared to motorbikes, even while bicycles might be feasible. In that case, the use of the feeder lines will drop, causing a drop in feeder line operational frequency, and a further widening in the competitive advantage of motorbikes. Thus, measures such as giving an access advantage over motorbike parking areas must be considered.

Transfer time is another major factor affecting travel time. To minimise transfer time from one route to another, it is necessary to design for cross-platform transfers or multi-level platforms (Figure 2.3). Furthermore, congestion within terminals themselves can be a major problem. Congestion at ticket counters can be addressed by the use of integrated circuit (IC) (or ‘smart’) cards and monthly passes, while congestion at ticket gates can be addressed through gate distribution and the adoption of automated gates. Congestion when boarding and exiting trains can be mitigated by installing wider doors, promoting queuing, and widening platform walking paths and stairways. As each of these elements affects l time, careful design is required during the planning stage.

Figure 2.3: Cross-Platform Transfer between Bullet Trains

Source: Country Renovation by Railways. http://rtpl.ce.osaka-sandai.ac.jp/ByRail/?p=829

4.2. Safety and comfort

The choice of transit method does not depend on travel time alone. Safety and comfort are also important elements. Very few would question the value of safety. When comparing the number of accident-caused deaths per passenger-kilometre, commuter trains, railways, and aeroplanes are incomparably safer than automobiles. This is because for those methods of travel, it is much less likely to collide with other vehicles or objects. The key to accident prevention for these travel methods are appropriate equipment maintenance and operation. Safety can is a greater an issue for buses. While the number of accidents per kilometre travelled is less for buses than for automobiles in Japan, this is dependent on regional characteristics, and the likelihood of bus accidents is not universally low. Although buses are more commonly the perpetrators of accidents and damage to the bus is often limited, it cannot be said that buses are safe as a result. Most bus accidents are caused by human error, and thus driver training is the most important factor in their prevention. Training is important not only for avoiding collisions on roads, but it is also essential for the prevention of accidents on board. As the weight of buses is relatively low, they have a high rate of acceleration and deceleration compared to trains, and the passengers are not necessarily seated, as they would be in automobiles. For that reason, accidents within the buses when starting and stopping are very common. The establishment of independent lanes for buses, as was done with BRT, is effective in preventing accidents through steadier driving.

The element of comfort is not easy to process in terms of transport economics. Not only is the definition of comfort subjective, but it is also difficult to measure.[18] However, as comfort is an extremely important element in the choice of travel method used, it would be inappropriate to use the excuse that it is not objective avoid discussing it. This report will therefore mainly consider common perceptions while examining some specific examples. Firstly, there are likely countless ways to interpret the reasoning as to why comfort is important. As comfort itself is an added value, it is possible to say that its improvement represents a discount if the price remains unchanged, and use of the relevant mode of transport will increase. However, from the standpoint of transport, the explanation that comfort represented a practical reduction in travel time could also be suggested. Borrowing the concept of perceived time, time spent in fun and comfort is perceived to go by faster, whereas in the opposite case, time is perceived to go by slower. Air conditioning can serve as a typical example. In regions where the external temperature is hot or cold to an extreme, public transport can make use of air conditioning to create a comfortable environment. Other possible measures that may lead to comfort during transit include the reduction of motion vibration or the provision of useful information within the vehicle.

However, the difficulty in creating comfort is that it is not always clear what comfort is. For example, there is no universally comfortable temperature setting for air conditioning. While some might find the setting too cold, others might find it too hot. In that case, setting the temperature in the middle range would lead to a maximisation of comfort.[19] Another proviso when considering methods to improve comfort is should be something that cannot be provided separately and its provision does not cause a loss of overall benefit. For example, on-board television is a service that could be replaced by individual smartphones, and should be approached with caution when considering the possible drop in benefit due to noise. The practice in Japan of using video without sound is one reasonable option. One interesting trial will be the installation of aroma diffusers in ticket gates for trains by the Tokyu Corporation. Fragrance is a factor that cannot be provided separately for each individual, yet individual preference for fragrance is even more varied than for temperature. Thus, the trial will limit the number of gates that give out the fragrance, allowing passengers to choose. Using measures such as this in areas where smells tend to reduce comfort, such as in toilets, may be another way to improve overall comfort.

These examples suggest that, to improve comfort, it may be more reliable to focus first on reduce externalities related to the use of public transport, rather than working on areas in which personal preference may vary – a policy of removing discomfort rather than aspiring to comfort. For instance, an air purifier might be installed to improve air quality. Because nobody would object to cleaner air, it is highly likely that this would improve comfort. Ensuring the cleanliness of vehicle interiors would be a similar measure. For measures such as air

[18] There are several methods available, and the method used typically depends on the subject being covered. Typical methods include contingent valuation, conjoint analysis, the replacement method, and the basic unit method.

[19] Using the median voter theorem. However, in the case of temperature, the deviation is likely to be small, thus realistically speaking, using the average may be enough.

purification, where it is difficult to become aware of air quality, proactively informing passengers of the efforts to clean the air may result in an improvement in comfort.

One reason why it is important to be sensitive to passenger comfort on public transport is because automobiles are a mode of transport with a generally high level of comfort. Automobile interiors are completely private spaces that users can customise to their liking, setting the temperature, applying fragrances, or playing music according to their preferences. Not only is the level of comfort generally high, but the mental concentration on driving has the psychological effect of accelerating the perceived passage of time. Even when traffic congestion and other driving troubles lengthen travel time psychologically, the level of comfort is still higher than what can be achieved by public transport. When designing public transport, adequate awareness of the competitive advantage of the automobile is needed to ensure that the environment is not uncomfortable.

However, public transport also has the intrinsic advantage that most of the cost related to travel time can be reduced. For most people, the greatest cost incurred by travel is not the travel fare itself, but the opportunity cost from the standpoint of economics. Were an individual not required to travel, they might have spent that time relaxing and reading a newspaper, or studying for a test at their own pace. However, it is still possible to make effective use of time spent travelling on public transport. Except when congestion is extremely bad, it should be possible to read a newspaper or listen to music on one's cell phone inside the vehicle. Screening educational videos inside school buses might even be the equivalent of time spent in the classroom. The provision of imaginative services on long-distance rail that is unaffected by congestion can lead not only to profits for the line operator, but a reduction in opportunity cost for the passengers.

Other issues faced by public transport include maintaining security in the enclosed spaces of the vehicles. Another would be that when vehicles contain objects within them unrelated to the purpose of transit, they have the effect of reducing the supply of transport in practice. This represents an increase in opportunity cost for the transport operator, and thus it would be possible to charge not only for distance but also for time. When installing shopping malls or restaurants in train stations, it may be necessary to develop a system for exempting users from time charges while they use those facilities. Yet another issue is disadvantage regarding transportability when comparing public transport with automobiles, though this may not be a major issue in terms of the focus on urban transport in this report. Automobiles are more convenient for those with a great deal of luggage to carry. One possible measure to address this would be tie-ins with freight delivery services, but there is currently no way to provide a service that is equivalent to the convenience of the car for public transport, and thus such improvements should be expected primarily in long-distance transport.

5. Operational Policy for Public Transportation

This section will discuss management issues related to realising the design of public transport operating in a manner that maximises its social value. The latest trends in management will be considered with a focus on finance and pricing.

While there are cases where public transport is operated by private companies, in many cases it is operated publicly. Public use is described as the shared use of a resource by an indeterminate number of customers. This definition could be used to describe supermarkets or restaurants. However, there are almost no examples of publicly operated supermarkets or restaurants.[20] Public management of public transport is common because it is difficult to manage and the management risks for private companies are great. The three major reasons for this are the massive initial investment required, the size of the external economy, and the fee-reduction-based industry structure. The issues facing management in light of these reasons will be discussed.

When starting to manage a public transport investment, managers are faced with the complex problem of initial investment. The entry into the market by newly emerging companies that lack capital resources is almost impossible because of the extremely high initial investment amount and the high risk of losing money. The logical optimum timing for project implementation has already been explained. However, the problem is that as the logical optimum timing is calculated according to the profit of the transport project, it may not necessarily result in a timing that could considered an advance measure. For instance, applying the method of the first year rate of return on a massive scale public transport investment project, such as a subway line, shows that a considerable number of potential users is a requirement. If no other public transport exists until then, it would not be surprising if congestion was already severe. In that case, the project would be indistinguishable from a project implemented after the fact. In other words, it is not always possible to avoid the traffic congestion trap using optimal timing theory alone. At the same time, it should not be considered appropriate to force public transport operators to accept losses. This problem can be addressed through internalisation of the external economy or balancing pricing policy with competition.

5.1. Internalisation of the external economy

Firstly, the benefits accumulated through the preparation of public transport can also be collected from areas other than the income obtained by the operator. Generally, the improvement of public transport leads to an improvement in benefit for the surrounding area. For instance, this would mean more sales in a commercial area, or an increase in the number of potential residents for a residential area. As a result, these benefits would ultimately be

[20] Public management of these establishments may be seen when there are state level restrictions or when there is inadequate private management capacity, such as in state-run restaurants in North Korea, or the former Bando (Peninsular) hotel in Seoul, as well as in cases where high-level management is required in addition to the pursuit of profit, such as in the Paradors of Spain.

reflected in land value.[21] In this case, the final recipients of these benefits are the managers of the commercial areas or the residents, and ultimately the land owners, and as long as they have not invested in public transport, they enjoy the free ride of a windfall profit in terms of the external economy precipitated by the public transport project. This means that the public transport operators themselves cannot enjoy the profits of their own investment. This can lead to underinvestment in the infrastructure required by society, which necessitates that land owners should return these unearned profits gained from the external economy. If this were to happen, then the profits gained from public transport projects would better fit the investments made, and might enable the timing of projects to be advanced.

There are examples where the government has mediated to prepare policies to redistribute the investment benefits of the external economy of surrounding areas back to the public transport operator. For instance, in the United States, higher sales taxes are collected in areas that benefit from the provision of public transport facilities,[22] while special taxes can also be collected from areas designated as special tax zones.[23] In Northern Virginia, the establishment of a special tax zone is expected to provide funding of up to $1 billion for the development of the Silver Line.[24] In France, property and residency taxes are collected from companies and residents located along train routes, and companies that meet certain criteria are taxed based on total salaries paid as a transport contribution.[25] The tax rate is 2.6 percent in such regions as Île-de-France, where Paris is located, and the department of Hauts-de-Seine. When the social benefits are redistributed to public transport operators as taxes in this manner by the government, the benefits of investment other than actual fare income is returned, improving the profitability of the investment for the operators. In Japan, funds were collected for the construction of the Midosuji Line from land owners and shops located within a radius of 700 meters from stations. As the Osaka Municipal Electric Bureau, owner of the Midosuji Line Project, was a publicly owned utility, this project follows the same pattern. While collection efficiency is improved by utilizing government tax policy, it is difficult to calculate the actual benefit; hence it is not easy to decide where to draw the borders of the collection zones and how to set the level of collection. Residents would generally claim that they were already paying for the costs of the benefits they receive in the form of train fares, or that the benefits of public transport development are already reflected in property taxes with the rise of land value. Furthermore, there are likely to be cases where redistribution does not benefit public transport. For example, Japan has an urban planning tax that taxes land and buildings located within the municipal area based on fixed asset tax valuation. However, this is not done only

[21] This is known as Capitalization Theory. In fact, criteria include the ease of transit, city conditions (small/open), and perfect competition in property trading. If the effects of issues such as noise or environmental contamination are greater than the benefits, then land value will drop.

[22] This special tax zone is known as a special assessment district, and can be applied to infrastructure other than transport.

[23] This is similar to consumption tax and value-added tax, but it is not applied to purchases made for resale. As the tax rate differs per state, purchases made outside the state are sometimes applied with a use tax representing the difference.

[24] This line will extend the existing metro to reach the Dulles International Airport and Ashburn.

[25] This is called versement transport and was first adopted in Paris in 1973.

for the purpose of developing transport, these taxes are commonly applied to general finances, and the relationship between burden and benefit is unclear. Obviously, such cases would not promote investment in public transport. However, from the standpoint of promoting a modal shift, it would be reasonable to collect funds from surrounding residents who choose to use automobiles rather than the subway. Thus, based on these issues, a system of funding must be designed that matches the goal.

A variant on this theme is the internalisation of social benefits brought about by transport investment by the investing organisation itself. This would entail the investors undertaking development along train routes at the same time as investing in the transport infrastructure in order to include the profits of these developments in the total business profits. This approach is also desirable from an economic standpoint. When the operator carries out transport development and development along routes at the same time, if fares are set too high, then residents will leave, sales will drop for commercial establishments, and land value will drop to a new equilibrium point as a result. The drop in the number of residents will lead to a reduced transport demand. Therefore, fare prices are set via the marginal cost pricing principle, which maximises the social benefit. Furthermore, in theory, investment in transport continues until the optimal point where the social benefit of the investment becomes equal with the marginal cost of the investment.[26]

Examples of this approach include the development along routes by the Tokyo Corporation and the Hankyu Railway Company in Japan.[27] Land surrounding train stations is bought up as new routes are established, and profits are obtained by selling the land once the route is completed or by using it for the construction of housing or commercial areas. Only 40 percent of the Tokyu Corporation's operating profits[28] are obtained from transport operations – a smaller return than is obtained from real estate. Similarly, the operating profits for the Hankyu Hanshin Group are also slightly over 40 percent, and the amount generated from real estate is similar. This does not mean that these ratios are economically justified. In both cases, the operators are also involved in businesses such as supermarkets, hotels, and advertising, while Hankyu also operates the Hanshin Tigers baseball team and the Takarazuka theatre group. Each is engaged in a wide range of businesses, including some for which the possible synergy between the location and the transport business is unclear (Figure 2.4). This might be assumed to be for the purposes of optimisation of the business portfolio. In any case, regardless of whether the behaviour of each operator is intentional, it would be inappropriate from the standpoint of transport economics to simply interpret route-side development on the part of rail operators as only the creation of demand. Rather, the development is required to recover the losses incurred by investing in infrastructure.

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[26] A criterion for this is the developer theorem that the areas along routes are developed exclusively, while a state of competition exists with another operator in other areas.

[27] This company began as the Denentoshi Company, whose purpose was the development of housing. They entered the rail business to serve residents, which is the opposite approach. In contrast, Hankyu grew out of the Minoo Arima Electric Railway and entered into route-side development as part of their transport business.

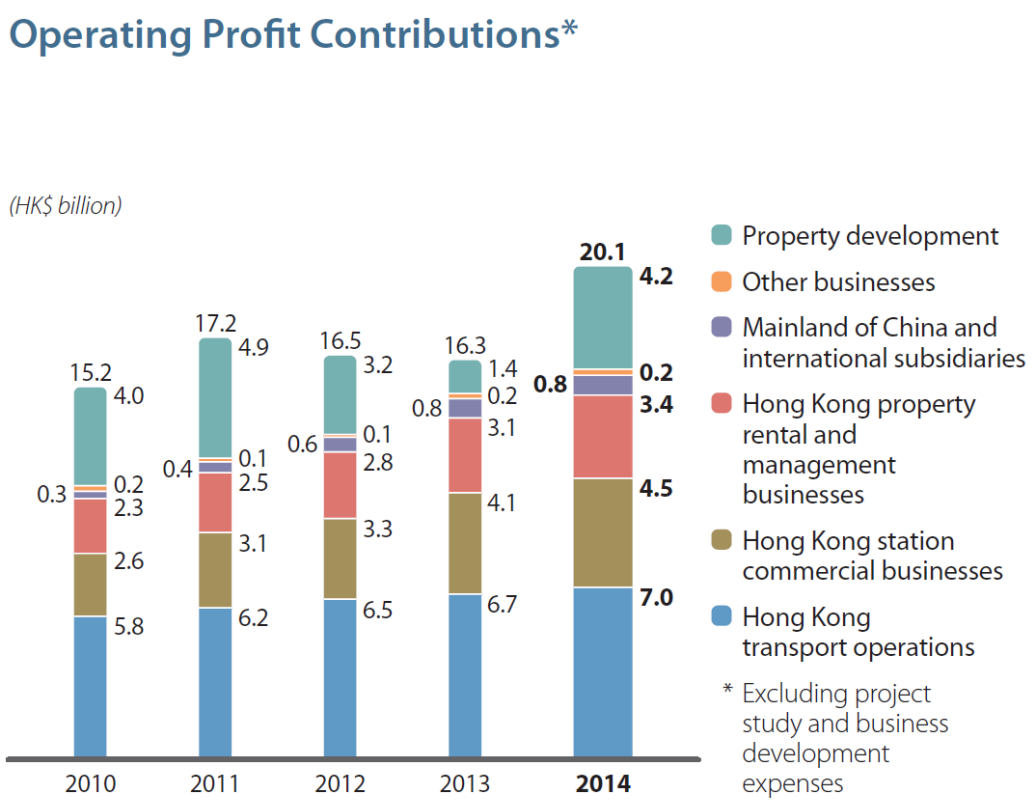
[28] Operating profit is defined under Japanese accounting standards.

Figure 2.4: The Business Model of the Tokyu Corporation

Source: Tokyu Corporation website.
http://www.tokyu.co.jp/global/english/company/about.html

Similarly, when developing subway routes in Hong Kong, the MTR selects developers for the land above through competitive bidding and achieves returns from the external economy they create by either receiving a portion of the income according to contracts from the facilities developed there or by taking partial ownership of the assets. Profits from purely rail operations represent less than 40 percent of the operating profits[29] for the Hong Kong railway that operates the MTR (Figure 2.5). The scale of income from related businesses precipitated by transport investment is considerable. The unique aspect of the Hong Kong example is that the rail-side development is being carried out using developer capital. In the case of both Tokyu and Hankyu, there is the risk of incurring losses for both the rail and real estate businesses were the development to fail. Thus the approach of managing risk by having the development carried out by developers while securing a certain level of the social benefit brought about by transport development can serve as a reference for transport operators for which finance is a weakness. The example of the Hong Kong MRT is likely to contribute to the optimisation of transport investment by providing returns to operators on the benefits brought about by the public transport.

Figure 2.5: Breakdown of Operating Profits for the Hong Kong MTR



Source: MTR website. http://www.mtr.com.hk/en/corporate/investor/financialinfo.html#01

[29] Here the operating profit is defined as operating profit before depreciation, amortization, and variable annual payment.

However, this method of internalizing the external economy on the part of the business operator requires that development along the routes where transport is being improved has not progressed extensively. The approach is normally not feasible for transport investments taken after the fact, where development has already taken place, because of the cost of negotiating separately with each business and land owner in the relevant area, and thus it would be recommended for the government to take an intermediary role. Further, even for areas where route-side development has been limited, it would be expected that a large amount of speculative investment would flow into local real estate the moment it was learned that a decision had been made to invest in transport for the area. To avoid this situation arising, land use should be legally designated beforehand and sufficient land should be secured for infrastructure such as roads, parks, schools, and libraries. As can be seen, it is necessary to tie transport investment closely to urban planning.

5.2. Balancing pricing policy with competition

The second effective measure for improving the operation of public transport is the design of pricing policy. As is clear from the discussion so far, investment in transport is highly risky. Not only is the amount of initial investment high, the external economy is also large, and if care is not taken, the benefits will be lost to third parties. Further, the market for public transport can easily fail, and this factor becomes extremely important if the aim is to implement advance measures. Initial investment for public transport is large, yet demand will not necessarily be adequate. In that case, it is highly probable that the equilibrium point between supply and demand will be found in the range in which long-run average costs decline. If, accordingly, pricing is carried out according to the marginal cost pricing principle, then the price will drop below the average cost and the business will lose money. Furthermore, the cost reduction structure will mean that the operator will aim to expand the scale of the business. If multiple operators do this in a competitive market, then only one winning company will remain, along with the massive-scale assets of the losing companies.[30] A single company will then dominate all profits, pricing will be based on profit maximisation, and the maximisation of the social surplus will not be achieved.[31] Hence, public transport businesses not only are there the risks associated with the size of the investment and the difficulty of recovering the benefits, but they also face the risk that the large investment can cause a decline into a state of competition while money is being lost. It goes without saying that one cannot expect there to be investment in such a business in the face of such risks. To minimize this risk, pricing need to be managed in such a way that destructive competition and structural losses are avoided. Accordingly, pricing design must take these factors into account. Prices should be set with the primary aim that the transport operator should not lose money so that its competitiveness

[30] This type of competition is called destructive competition, and ultimately leads to a state of natural monopoly.

[31] There are arguments that suggest this would be optimized through the threat of new market entry, or that the second-best fare would be formed according to contestability theory, it is rare for either of those conditions to work due to the existence of technical advantage or sunk costs of investment.

can be increased and social benefit can be maximised. As these policies arise from market failure, it would generally require government intermediation and regulation.[32]

a. Full-cost pricing

One method to avoid losses is to design pricing based on full-cost pricing that aims to secure the appropriate level of costs and profits. There are two approaches to full-cost pricing: the cost-stacking approach, whereby fares are set by adding an appropriate profit to the operating costs; and the rate-based approach, also known as rate-of-return regulation,[33] in which fares are set by adding asset values multiplied by the fair rate of return to operating costs. Under the rate-based approach, the fair return must match the opportunity costs, so the profits must not be seen as excess profits but as the normal profit that should be obtained from the invested capital. However, these pricing approaches have problems. First, they do not encourage companies to improve profits by reducing operating costs, therefore they can serve as a disincentive for improvements in company management. Second, they aim for equilibrium in the balance of payments, and do not consider the optimal allocation of resources. Thus, the social optimum is lost in pursuit of equilibrium in the balance of payments. Third, there is a limit to the extent to which losses can be avoided. For instance, in the case of electricity and water, price elasticity of demand is extremely low as both services are required for daily life and there is no substitution. However, public transport can be replaced by the use of automobiles and bicycles. Thus while price elasticity is generally not very high, an extremely high price may lower transport demand. If the price is too high, then a vicious circle can be created where the number of users falls, the smaller number of passengers causes a reduction in train frequency, and convenience is further reduced. The rate-based approach in particular can become an incentive for inefficient investment,[34] and can cause a drop in social benefit due to price distortion. Therefore, pricing policy must be designed with an adequate understanding of these challenges.

b. The franchise method

Several approaches promote management efforts on the part of companies. For instance, rail privatisation was carried out in the United Kingdom in 1994.[35] The operation of infrastructure, such as stations and tracks, was consigned to Railtrack; while the operation of the trains was

[32] Intermediation could also be handled by a cartel if the government chooses not to be involved. For instance, in the transport domain, the number of flights and pricing adjustment is carried out by an airline consortium. The shipping alliance was also once considered outside the scope of anti-monopoly law, but the alliance ceased to exist in 2008, and today there is intense competition in pursuit of scale with the creation of groups through mergers and maritime shipping alliances.

[33] As the name implies, there is freedom in pricing decisions because the policy aims for controlling the upper limit of fares.

[34] This incentive towards over-investment is called the Averch–Johnson effect.

[35] There are several formats for this method of dividing the rail companies into infrastructure and operations, which are called a 'two-tiered system'.

divided into zones for consignment to train operating companies using a franchise format via bidding.[36] Problems typically highlighted for this approach include bid-rigging between bidding companies, the high hurdles to participation, and the disposal of the assets of existing companies; but the worst outcome in the case of the United Kingdom was inadequate maintenance caused by the introduction of the principle of competition. For example, a defect in the automatic warning system caused the Southall rail crash in 1997 to be a severe accident. In another example, the Ladbroke Grove rail crash (Figure 2.6) of 1999 could have been avoided if automatic train protection had been in use, despite the conductor's lack of sufficient operation skill. It was not used because of the cost of the system.[37] The problem of lack of maintenance became obvious with the Hatfield rail crash in 2000. In that accident, the intercity train derailed when metal fatigue caused the rails to break, killing four people.

It would be overzealous to blame this series of accidents on the adoption of franchising. However, it does highlight important issues regarding the competition principle.

First, the reader might recall the film *Class Action*. The subject of the film was the fuel tank controversy surrounding the Ford Pinto. The salient point was that Ford had used cost–benefit analysis to determine that the payment of lawsuits was more economical than measures to fix the defect. However, it is difficult to make valid calculations for cost–benefit analysis that consider all of the numerous indirect effects,[38] and even the calculation of direct benefits is subject to the assumptions and limitations of the person doing the calculation. Calculations of the ripple effect from the social impact caused by anger, suffering, and fear over accidents in the real world often lack validity. Analyses made before the accident merely calculate how much compensation to pay the victims. However, Railtrack lost the public trust, and the comprehensive repairs it subsequently undertook bankrupted the company. As shown through the discussions so far, the transport industry is typically a cost-reduction industry that can easily lose money. It is thus necessary to fully understand that if the competition principle is adopted carelessly under these conditions, then necessary costs will be reduced by sacrificing safety and comfort, and there is a risk of destructive competition occurring if losses continue. Thus competition policy must be combined with related regulations to ensure that safety is not sacrificed in the name of competition.

[36] The franchise format was established by the Railways Act, 1993. Bidding was originally managed by the Office of Passenger Rail Franchising. The function was taken over by the Strategic Rail Authority according to the Transport Act, 2000, and has been carried out by the Secretary of State for Transport since 2006. The franchise period is generally seven years.

[37] Vigorous debate on transport took place in the UK in 2000 as a result of those accidents, but the ironic outcome was that support grew for not using automatic train protection because of its high cost.

[38] Usually, only direct effects are considered. For instance, cost–benefit analysis for road projects in Japan cover the direct time-saving benefit, drive cost saving benefit, and accident-reduction benefit.

Figure 2.6: Ladbroke Grove Rail Crash

Source: Swindon Advertiser.
http://www.swindonadvertiser.co.uk/news/11514267.Paddington_rail_tragedy_remembered_15_years_on/

Second, although revenue for non-competitive part of separated business, in this case ownership of rails and cars, is typically thought to be stable, the adoption of the principle of competition to other part of separated business, in this case operation of train system, raises the risk of bad debt. Furthermore, there is the possibility of bankruptcy if revenue and costs become unbalanced as in the case of Railtrack. The separation of operations (competitive division) and infrastructure (non-competitive division) precludes optimisation that combines both; therefore, a system to secure revenue centred on full-cost pricing is necessary, as well as provision of both regulations and higher-level administrative authority to the non-competitive division from the competing division.

c. The yardstick method

Another typical approach to pricing policy is the yardstick method. In this method, the standard cost is calculated by comparing the operating costs of multiple companies managed under the full-cost pricing, and fares are then set based on the standard cost. Under this pricing scheme, more-competitive companies are able to turn a profit and less-competitive ones are weeded out. Problems with the yardstick method include bid-rigging between companies, information asymmetry, and the validity of comparing costs across different regions. For instance, the standard price for route buses in Japan is calculated using the

average price of operators that meet certain criteria after dividing the country into 21 blocks. Currently, about 70 percent of bus companies are operating at a loss. The ratio of personnel costs is high for the bus industry, and companies have reduced salaries to deal with it. However, there are downsides to this approach. If competition continues to intensify, the industry will face not only the elimination of uneconomic routes, but personnel reduction following salary reduction, which would increase the workload of each driver. It remains to be seen whether high morale and safety can be maintained, and talented personnel recruited as salaries are reduced.

d. The price cap method

The price cap method is another typical pricing scheme. It calls on operators to carry out management improvements compared to the standard fare level for a specific year and a productivity improvement rate established by the governing body. While this method has the major benefit that calculation of the cap price is easy, the difficulties include the additional information cost incurred in determining the productivity improvement rate, and the impossibility of eliminating arbitrariness from the validity of that rate. There is also the fundamental problem of what to do with use of the cap price results in losses. The price cap, franchise, and yardstick methods all suffer from the problem that safety and comfort are lost due to the worsening employment conditions and cost reductions incurred when the competition principle is introduced into an industry that can easily lose money.

e. Congestion pricing

The important points regarding congestion pricing and peak load pricing schemes will also be explained briefly. Congestion pricing is an approach typically applied to roads for automobiles, rather than to trains, which deals with the question of whether to collect transit fees during congestion. Provided the appropriate rate of congestion is exceeded, collecting congestion fees is seen as desirable, because those who continue to use the roads despite the fee are those who are receiving a great benefit from the roads.[39] Drivers who cease using roads because of the congestion fee are those for whom the benefit is small, or for whom the alternate cost of public transport is less. Thus, from the standpoint of resource allocation, it is desirable to shift such drivers to alternative resources to mitigate the congestion. However, the problems of collection costs and fairness remain.

Peak load pricing is another option for public transport organisations that is similar to congestion pricing. This policy is effective in controlling demand at peak times by setting fares high for those times without affecting demand for off-peak times, which are relatively inexpensive. This policy has been adopted for numerous subway operators such as those in London, Sydney, and Washington DC. One reason that pricing policy is necessary is that the marginal cost pricing principle would not work. To maximise social surplus under those

[39] As with Dupuit's bridge, efficacy is considered high for people with a high willingness to pay.

conditions,[40] fares should be set high inversely to the price elasticity.[41] Normally, peak times for public transport are during peak times for commuting to work and school, and thus are highly necessary. Thus, although peak load pricing may be a rational pricing scheme from the standpoint of social surplus, it has a major problem from the standpoint of fairness. Ramsey pricing is a form of discriminatory pricing. Given that there is little room to adjust work and school commuting demand through pricing, other policy support would be required through cooperation with society, such as flexible working hours and telecommuting, and the placement of schools and factories outside of central business districts.

In summary, we have observed pricing policy that promotes competition while avoiding destructive competition in light of the tendency of public transport toward natural monopoly as a cost reduction industry. Some policies are expected to cause the weeding out of less-competitive companies. From the standpoint of private companies, weeding out through competition may seem valid. However, there are markets where competition between private companies does not work. If public investment can meet the transit demand for the relevant area in the most economical and environmentally friendly manner under current operation, then one should not depart from the standpoint of avoiding losses and keeping the company alive, because weeding out that company would reduce social benefit. For example, if a certain route was eliminated with the adoption of the yard stick method, and there were no more efficient transit methods available for that route, the residents in that area would have no choice but to purchase automobiles. Such a contingency is not what the pricing policies aim for, and could simply be described as destructive competition backed up by that policy.

5.3. The use of private companies

To this point, we have primarily discussed the difficulty of managing public transport in comparison to normal businesses in terms of finance and pricing policy. To conclude, we will discuss the various approaches to leveraging the capabilities of private companies to provide public transport. When the characteristics of public transport are considered, it is a natural outcome for there to be many public enterprises. However, there is a limit to the funds, personnel, and skills available to government. Thus it is pertinent to ask how to leverage the vitality of the private sector. This type of initiative is being leveraged for improving infrastructure in numerous forms through public–private partnership (PPP). This can take the form of a private finance initiative approach where the private sector contributes funds,[42] or some other format, and the type of contribution can be divided into involvement in design, construction, operation, and/or maintenance. Further, there are numerous patterns regarding the degree of freedom in operations and planning in terms of whether the project is run by

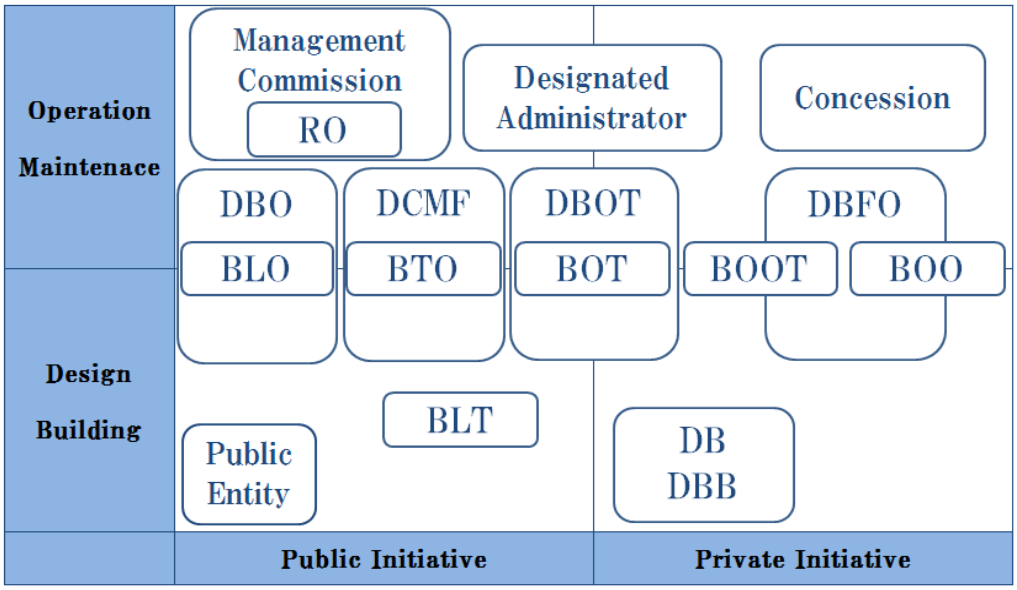
[40] This is called second-best pricing.

[41] The rate of deviation from the marginal cost of fares is set inversely to the price elasticity. This type of approach is called the Ramsey rule, and the approach to pricing based on it is called Ramsey Pricing.

[42] Private finance initiative describes the use of private sector assets in public investments. In addition to the use of private capital, this approach aims to leverage private human resources and management capabilities and to improve the efficiency and quality of public services.

the government or the private sector (Figure 2.7). For instance, the franchise method used in the United Kingdom could be considered a type of concession.

Figure 2.7: Public–Private Partnership Categories



BLO = build–lease–operate, BLT = build–lease–transfer, BOO = build–own–operate, BOOT = build–own–operate–transfer
BOT = build–operate–transfer, DB = design–build, DBB = design–bid–build, DBFO = design–build–finance–operate
BDO = build–develop–operate, DBOT = design–build–operate–transfer, DCMF = design–construct–manage–finance
RO = rehabilitate–operate.
Note: The positioning in the diagram does not necessarily reflect actual conditions. For example, in the BLO approach, construction is carried out by the private sector and government-owned assets are leased for operation by the private sector; so the approach can thus be said to be similar to the concession approach, but it could also be considered similar to a management commission if the government has strong command constraints on management. Thus the actual situation depends largely on the contract. Further, as the relative position depends on what is considered leadership, readers are recommended to consult a specialist publication for details.
Source: Study team.

Common examples of PPP include airports, expressways, and waterworks infrastructure. For transport infrastructure, the mass rapid transit (MRT) project in Kaohsiung, Taiwan, is known as a build–operate–transfer project. The private sector Kaohsiung MRT was created primarily by Taiwan's largest steel manufacturer, China Steel, which is headquartered in Kaohsiung. The two lines currently operating are the Red Line and Orange Line, while a light rail loop line is under construction. Revenue from fares is only about 20 percent of transport income, and the operation is still running at a loss as the income does not yet cover asset depreciation. The number of daily passengers – currently about 150,000 people – is increasing, it is still

inadequate. About 60 percent of transport in the city is by scooter, while automobiles comprise roughly 20 percent. As the population density of the urban area is high enough, it is likely that policy support for a modal shift will be required. As an incentive is needed to design a better public transport system and increase the number of passengers, a policy of raising or lowering a subsidy depending on passenger volume, such as the 'shadow toll'[43] used for roads, could be considered as a form of support. Other examples of development patterns for public transport through PPP include the Manila Metro Rail Transit System, the Bangkok Skytrain, the Kuala Lumpur Monorail, and the Adelaide–Darwin railway.

Incentives for companies to enter public enterprise primarily include extending the main business into other regions, a synergistic effect for the main business, and the nurturing of new business. These incentives match the growth strategy of Ansoff's matrix[44], and are rational choices on the part of the companies. Thus, if an attempt is to be made to attract companies to participate in PPP projects, it is important to consider such company motives and proactively approach companies with which synergies can be cultivated, rather than to publicly solicit for participants. Furthermore, although compatible legal policy is not a requirement for carrying out PPP projects, the preparation and execution of laws has been inadequate in some cases. This presents an uncertainty that can reduce private companies' incentive for investment. Further, the most important point for investors is business profitability. Hasty projects that cause bankruptcy for the private company that operates them would be pointless. Thus it is most important to keep in mind the topics discussed so far including internalisation of the external economy, such as through real estate development or government mediation, and pricing policy, in order to make the transport project sustainable.

5.4. Examples of new initiatives

In addition to rational design based primarily on the principle of time minimisation and an emphasis on comfort and safety as discussed so far, public transport initiatives should also be carried out based on the return on investment and pricing policy described in this section. After considering the above, this report will discuss other management-related issues with a focus on new initiatives seen in actual transport projects.

a. Automation

Automation can be seen in numerous areas of modern society, and its merits for public transport are great. Areas where automation can be applied include ticket-selling machines, ticket gates, and train operation. The merit of automation for public transport is typically seen as simply the reduction of personnel costs. Other merits of automation include reducing operation mistakes, increasing speed, and preventing fraud and corruption. However, the

[43] A shadow toll is a contractual payment made by a government per driver using a road to a private company that operates a road built or maintained using private finance initiative funding.

[44] Ansoff's matrix is a framework for segmenting business strategy, which consists of the market development, diversification, market penetration, and product development.

installation of expensive advanced equipment incurs great cost and maintenance costs are considerable, and in regions where labour costs are low, or where operations are efficient, it may not directly contribute to reducing costs. For instance, in Europe and North America, where a proof-of-payment method is used, the adoption of automated ticket gates would cause a reduction in revenues except in major cities with a large transport demand, or where the ratio of non-paying passengers is extremely high.[45] It also brings risks, including the risk of all functions ceasing to operate when there is a bug in the software or when the central system goes down, and the risk of exposure to cyber terrorism. For ticket sales, where machines are most commonly adopted, full automation is currently difficult for transfers and seat reservations, or complex criteria for receipts.

b. Increased convenience

Improving convenience is an important factor in promoting the use of public transport. Widely implemented measures that improve convenience include the optimisation of ticket purchasing using IC cards, the provision of internet access within trains and train stations, and advance reservations of tickets via the internet. The use of IC cards, for example, is important not only from the user's standpoint, but from the company's standpoint as well, not only in terms of customer retention, but to conserve paper used in tickets and for the optimisation of ticket selling machines and automated ticket gates. IC cards are often used as a payment method for shopping as well, and recently, it has become possible to use them for security or transit data capture for companies, and for making use of reservation services via smartphone apps. If the IC cards contain information that identifies the user, it will be possible to leverage them for services that require registration of personal information, such as hotel check-in or bicycle or video rental. When the scope is extended to increasing convenience in areas other than transport, the creation of a synergistic effect on convenience may be a form of added value.

c. Station area development

It may be a good choice of public transport company to contribute directly and indirectly to the promotion of development in the areas surrounding train stations. For example, Harvard University, Massachusetts Institute of Technology, and Nagoya University are almost collocated with subway stations. In these cases, the existence of university promotes ridership on the subway. Similarly, simultaneous development of commercial building, shopping malls, and/or residential houses together with train station will increase the utilization and thus profitability of public transport.

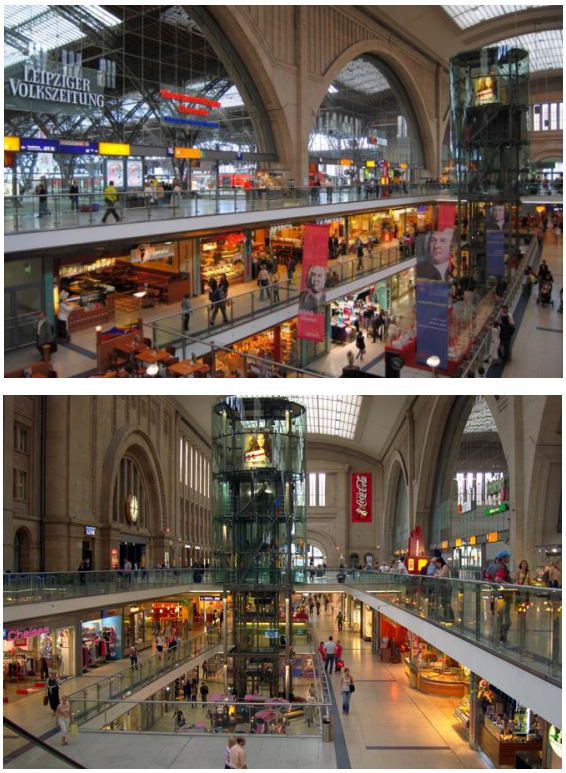
[45] Non-paying passengers are believed to be only about 6 percent because ticket inspectors are deployed on trains and large penalties are incurred for non-payment, and in many cases, the adoption of automated ticket gates is put off for financial reasons in cities with low numbers of public transport users.

The convenience of the station itself is also an important theme. Although a station is merely a public transport terminal, the fact that many people use the station means that there is considerable potential for business. Improving the convenience of busy train stations can contribute to a major improvement in convenience for the area, and to greater use of public transport. While such facilities typically focus on shops that cater to basic transport user demands, such as kiosks and restaurants serving light meals, the separation between these facilities and those found in towns is narrowing with the addition of convenience stores, proper restaurants, bookstores, and apparel shops, well as banks, drug stores, and other services. From the standpoint of commerce, stations and the surrounding towns should not be clearly separated, and it is increasingly necessary to pursues efforts for improving mutual appeal through adding values. This should include pedestrian pathways and improvements to the station atmosphere carried out with an understanding that the seamless integration of station and town strengthens the town's appeal (Figure 2.8).

d. Handling tourist demand

Finally, although the major issue for public transport is meeting the normal transport demand of work and school commuting, it is also important to provide convenient transit for tourists. To date, this has primarily consisted of basic measures such as the deployment of station staff able to speak foreign languages, the installation of signs in foreign languages, and station announcements made in foreign languages. However, the use of smartphone apps should be developed more for this purpose. Convenience for tourists would increase considerably if, in addition to providing information on routes, transfers, timetables, and surrounding tourism resources in their native language, tickets could be purchased with an IC card using smartphone apps. The provision of transit with the same level of convenience as in the tourists' home country is growing ever more feasible through the use of information and communication technology. Furthermore, measures to highlight the appeals of the communities surrounding train stations have hardly been implemented, with the exception of certain tourist destinations. If the train station jointly advertises with the surrounding communities, it may greatly benefit both the public transport company and the local community.

Figure 2.8: The Promenade at Leipzig Hauptbahnhof (main station)



Source: Leipzig main station promenade.
http://www.leipzig.travel/jp/___1393.html,
http://www5d.biglobe.ne.jp/~ma-sat/travel/2009/2009de-18.html

This concludes the brief discussion of the issues of value addition in the management of transport systems. The important common viewpoint for each is the passenger-oriented approach. Transport is a mid- to long-term service that cannot be separated from its region, and thus a management strategy that pursues short-term profits is inappropriate. In the long term, the creation of communities and public transport systems that are highly convenient for passengers can improve the appeal of a city, and by doing so, attract new residents and lead to an increase in passengers, and thus can ultimately improve the profitability of the public transport business.

6. Government Transportation Policy

So far, this report has discussed the mechanisms and measures for traffic congestion and the design and operation of public transport systems. There is great potential for finding effective improvement measures based on an examination of the actual urban transport conditions and a consideration of the issues discussed so far. However, this will not solve all of the issues faced. Even if the same transport system is developed and managed by the same operator, the outcome would be entirely different depending on the city. This report will next consider what the root cause of this gap might be from the standpoint of city structure and government policy.

6.1. Public transport and city structure

First, city structure has the greatest direct effect on transport. The city's population that provides the context for the number of passengers, and the location of industry in the city determines the directions for transit. The question is: what type of city structure is desirable from the standpoint of transport? Given that the most basic type of transit in modern cities is transit from the home to the workplace, it can be assumed that distance travelled is proportional to the distances between homes and workplaces. In that case, if the minimisation of energy consumption for transit, and the idea that transit itself should be minimised as a derivative demand, then it would be desirable for the distances from homes to workplaces to be short. Furthermore, when city structure is considered from the standpoint of the transport company, a high passenger rate would be desirable. A high passenger rate would require there to be many passengers living within access of the train station. Conversely, a situation with urban sprawl, where regions with a low potential passenger rate are spread about in a disorderly manner, would be undesirable for the transport operator. When both factors – the shorter distance from homes to workplaces and the higher passenger rate – are considered, high-density city structures are desirable both in terms of energy efficiency and for the profitability of the transport operator.

Furthermore, then when the city is made more compact, it will be possible to prepare more terminals for public transport in a smaller area because there are more potential passengers. This would create a positive feedback loop as between the transport system and the city itself as the increased convenience of the area attracts more accelerates immigration into the area. Conversely, in cities with a declining population, a vicious circle would be established in the opposite direction as the public transport system would typically attempt to maintain profitability by reducing the frequency of trains or buses, even though this reduces convenience. One reasonable approach to escaping from the vicious circle would be to reduce services on the less dense fringe of the city while maintaining the level of services in the city centre to promote making the city more compact and maintaining highly efficient management. This would incur the hurdle of relocation for residents living in fringe areas. However, if the problem is ignored, then the public transport system would ultimately be forced to choose between bankruptcy and lowering convenience, either of which would lower the vitality of the city and ultimately cause its decline through competition with other cities.

Thus, to generalize, a certain degree of density is required for public transport to be successful, and the size of the city must be limited relative to population to maintain the necessary population density for public transport. While there is no established theory on what constitutes a desirable density, Hong Kong, with its planned residential area of about 30,000 people/km, provides an example of the density of a transit-oriented development (Figure 2.9). [46] Density is increased through the use of high-rise apartment buildings, and a

[46] Transit-oriented development is urban development that is based on public transport and aims to achieve a society that is not dependent on cars. It promotes the use of public transport by building more commercial facilities intensively around the public transport stations in the centre of cities and developing residential areas systematically in the vicinity of public transport stations in the suburbs.

comfortable environment is created by securing parks and open spaces. The balance with commercial areas is considered to achieve the ideal urban development for pedestrians. Transport with an appropriate capacity for the population must also be prepared. The city structure and transport are influence and regulate each other.

Figure 2.9: Images of Transport-Oriented Development in Hong Kong

Source: ATKINS.

When such ideas are raised, there are typically many arguments against them. The arguments often tend to cherry pick data, including convenient data on agricultural towns, special industrial cities, or examples that forget about subsidies from the central government. But it must be remembered that, as a rule, this is a discussion of cities that are focused on the tertiary industries, and not a discussion of places such as agricultural towns or Silicon Valley.

6.2. Concentrating city density

High-density city structures do not occur naturally. Rather, if the city is left alone, it will tend to spread out. As increasing a city's density requires technology and considerable cost, it can be difficult to achieve in low-income areas. Thus government policy is extremely important for the development of highly dense cities. Policy can promote the advanced utilisation of cities

See_http://www.epd.gov.hk/eia/chi/register/profile/latest/cdir137.htm. It can be seen that there are many similar projects being carried out by the MTR.

by improving related laws. For example, Japan's City Planning Act specifies the purpose, height, building-to-land ratio, and floor area ratio for buildings under a consistent plan for the overall city. Further, tax advantages for high-rise apartments can serve as an incentive that guides city structure. The choice between renting and purchasing homes can also influence city structure, as home purchases can lead to rigidity in transit patterns, which can further increase the risk of obsolescence for those areas. Extreme disproportion of resident's age distribution can lead to sudden changes in transport demand. When the rate of purchased homes is high, there is a greater risk of immobilisation of residential areas if the home resale market is not vigorous.[47] Regular planned redevelopment is therefore necessary. The obsolescence of areas will affect transport demand, which can also threaten to the region's transport infrastructure. To avoid such obstacles, urban planning must balance planning at the city level with that at the local level.

Furthermore, some countries exempt commuting costs in salaries from taxation,[48] but as land prices generally fall with distance from the central business district, they serve as an incentive for living in the suburbs. On the other hand, a tax-free allowance on the housing tax that is proportional to land price might contribute to increased city density. There are easy arguments offered against these points.[49] However, such policies do not determine overall structure, and this rule is not limited to city policy. Rather, efforts to bring about major change in structure through individual policies are a type of imposition, and while they might be successful in achieving one goal, they run a high risk of causing distortion elsewhere. The structure of the city is the outcome of the collection of related policies. While the effect of each policy on the overall situation might be minor, city policy and transport policy must be assembled with care and balanced from multiple standpoints through the skilful combination of force, encouragement, and guidance.

6.3. Public infrastructure efficiency

From the standpoint of regulated pricing, there are many cases where full cost pricing has been applied to infrastructure, and while overall cost is typically considered, there are many cases where cost per area has not been reflected correctly. This is a vexing problem that needs to be improved. In some cases, the profits from highly dense areas are used to cross-subsidize less-dense area. This relates to the earlier discussion on the closure of loss-making routes. While it is true that such discussions are affected by questions of efficiency and fairness, when management is facing a moral hazard through full cost pricing, irrational fairness is often seen.

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[47] The optimal residential area generally changes according to life stage, including the elements of location, function, and spaciousness. For instance, living environments appropriate for child raising and those appropriate for retirement are likely different. However, immobilized residences can serve as an impediment to these changes in life stage.

[48] Examples include Belgium, the Netherlands, and Japan, although there are criteria such as distance and price.

[49] See, for example, http://blog.japantimes.co.jp/yen-for-living/how-employer-transport-allowances-helped-create-commuter-hell/

For example, 58 stations operated by JR Hokkaido serve only one or no passengers per day, representing 15 percent of the total, while 30 percent of stations serve 10 or fewer passengers.[50] Police stations, roads, and waterworks face the same problem. While this type of situation would clearly be renounced from the standpoint of economics, it should also be questioned from a viewpoint of social fairness to determine whether it represents true fairness or simply an end to thinking in the shadow of full-cost pricing.

Further, such situations are also extremely inefficient from the standpoint of the energy efficiency. From the standpoint of city structure, it would mean that those living in the city centre must not only pay high land prices, but they also bear the burden of costs for people living in the suburbs through public utility fees, and this is yet another factor that would promote the suburbanisation of cities.

This situation is sometimes justified from the standpoint of redistributing income or correcting income disparity because those with higher income have a higher capacity to bear the burden. But this discussion totally misses the point because it stands on an incorrect precondition that richer people live in urban areas and poorer people live in rural locales. The point here is that the pricing policy for infrastructure incentivises suburban living by offering the benefits of a lower than cost infrastructure price together with lower land prices, which lead to inefficient energy use.

However, considerable cost and energy is required to roll back a state of suburbanisation that has already progressed.[51] Increasing the density of cities that have been suburbanised is a task that must be carried out carefully over time. Furthermore, as the discussion so far assumes the formation of commercial districts that concentrate capital in urban centres, and centralised infrastructure policy, any significant advance in information and communication technology or distributed infrastructure would require a review of the discussion. However, as long as systems such as roads and power grid carry the role of connecting people, the principle that higher density leads to greater efficiency is unlikely to change in the foreseeable future.[52] Nevertheless, given that future technological developments could render cities obsolete, planners may need to move beyond maximizing concentration effects, and focus instead on making infrastructure more efficient or building meeting places that enable high added value.

[50] http://headlines.yahoo.co.jp/hl?a=20160210-00010003-norimono-bus_all

[51] When new investment in urban areas is required through the abandonment of suburban assets with high asset value, problems include investment efficiency or energy wasted for construction. However, these do not apply for moving due to ageing homes or when there is excess housing.

[52] However, the appearance of technologies that are not dependent on fixed infrastructure, and technologies that make distance meaningless, such as wireless or remote technologies or the ability to warp location, would completely overturn these conditions.

6.4. Elements for transport policy

This report will now discuss policy that has a direct effect on transport rather than on cities. Before discussing tools for transport policy, we will review several rules that should be considered preconditions.

First, when transport policy is considered for the purpose of energy optimisation, the key question is how to trigger a modal shift from private cars to public transport successfully. The existence of public transport as an alternative to private cars is therefore a precondition. In areas where no public transport system exists, it is impossible to push forward a modal shift except in very small cities, highly dense cities, or cities with unique shapes.[53]

Second, transport demand is essentially an unnecessary demand, and the real goal is optimization. When attempting to increase transport mobility, for example, to mitigate traffic congestion, the problem will not be solved simply by expanding the roads.

Third, while it is typical to focus entirely on the outcome of policy, transport policy often incurs a massive financial burden, and thus it is important to secure financial resources.

Fourth, the side effects of policy must also be carefully considered to ensure compatibility with other policies. A balanced bundle of policies can serve as a powerful weapon, but how they are combined and how they are used is extremely important. As is clear from the discussion so far, there would be nothing wrong with including city policy within the collection of transport policies.

Finally, it is always necessary to consider uncertainty. While policies can possess a degree of logic and universality, they cannot be replicated like scientific experiments. The outcome of policy is greatly affected by the executor, recipient, external environment, related policies, and timing. Considering these uncertainties, the policy should maintain adequate flexibility and elasticity to allow adjustment according to the conditions.

a. Controlling demand through taxation

To control demand and road mobility, a combination of policies is needed to reduce congestion. Taxation of automobiles is one such policy that is used in many countries. Taxation is the natural thing to do in view of the transport infrastructure costs of the shared assets of roads and signals, and the externalities created by driving.[54] Furthermore, unlike regulations, taxation can serve as a financial resource for other policies. If taxation policy is used effectively, it should be possible to achieve both control of transport demand and financial stability. Taxation is generally categorised into taxation on fuel and on acquisition and ownership.

[53] If the city population is 500,000 people or less, then increasing density in an area of approximately 10km^2 can be successful in creating a modal shift toward bicycles and walking. The same would also be possible in theory for cities with multiple hubs.

[54] However, it is difficult to quantify externalities, so the recommended approach would be one similar to the environmental tax suggested by Baumol Oates.

Further, it can include licensing fees and road usage fees in terms of collection method. The following points provide an overview of these taxes.

First, any taxation will lower demand for automobiles, although it may appear to have no effect. Second, different automobile taxes work at different speeds. Acquisition tax that has the greatest immediacy. However, it cannot reduce the number of automobiles already in use. A fuel tax would have an effect on automobiles already in use, but the short-term effect would be low,[55] and thus a mid to long term viewpoint would be required. This shows that although taxation is an effective method, is difficult to solve existing congestion in a short time through taxation alone. However, if public transport offers a very good alternative, the adoption of a fuel tax can make great progress towards a modal shift. Taxation examples include the certificate of entitlement, used in Singapore as an acquisition tax, and the aggressive implementation of gasoline taxes in Norway and Turkey.

Third, the purpose of tax collection does not need to be limited to road-related improvement costs. Rather, the funds should be applied to improving the appeal of public transport or to increasing the density of the city. it also does not need to be limited to automobile-related taxes. The special assessment tax in the United States and versement transport in France are taxes on residents of areas that reap the benefits of public transport that are used to fund improvements in transport infrastructure.

Finally, there is the issue of taxation timing. Taxes implemented only once not only have no effect in controlling subsequent use, but they also risk becoming an incentive for use. For example, a high automobile tax could lead to a mentality of using the automobile more frequently to justify the greater cost incurred.[56] Thus, taxation is an effective method that should be included in policy early on and strengthened continuously to promote a modal shift. This includes taxes on fuel, automobile renewal, licence renewal, parking, and transit.

b. Transport regulation

Regulation involves the application of certain limits to the freedom of transport to make it more efficient. This is mainly done through licensing and prohibition, and the establishment of conditions and standards. The taxation, licensing programs, and pricing policy described so far can also be considered a form of regulation. The following is an overview of the main points of regulation.

First, the relationships between regulatory goals and methods should be clarified. For instance, if a certain road were closed to solve traffic congestion, while the congestion on the road itself would clearly be solved in a sense, congestion in the overall area may worsen. Thus such a

[55] It is generally considered that the fuel has a mid- to long-term price elasticity rather than a short-term one. This trend is consistent with the prospect theory and ratchet effect described on the following page.

[56] This is a form of prospect theory. While not necessarily consistent with typical economic concepts, such as lifecycle costs or sunk costs, further theoretical research would be desirable because it is highly persuasive.

regulation would be appropriate if the goal was to solve congestion on that road alone, but it might be incorrect if there were other goals.

Second, and related to the first point, such that regulations often create negative effects because they interfere with freedom. When the goal of the regulation is for some social benefit other than the economic benefit, the regulation is typically not positive in economic terms. For example, environmental regulations that limit the use of inexpensive but fuel-inefficient automobiles might contribute to the improvement of the environment, but they may also have a negative economic effect by reducing the purchase or use of automobiles. There are already examples of transport regulations where the establishment of a gasoline tax led to an increase in gasoline smuggling, and the introduction of a high-occupancy vehicle lane led to the start of ride-sharing businesses.[57] There are also many cases where prohibition causes a rise in price, creating financial resources for organised crime via black markets. Some cities in China are limiting the purchase of automobiles.[58] When used effectively, such regulations are powerful, but they can also cause negative effects, and thus unnecessary prohibitions and regulations should be aggressively avoided.

Third, there can be problems with the execution of regulations. For example, when something is prohibited, then the act of prohibition only takes on meaning when people become aware and behave accordingly. Therefore, people need to be made aware of the prohibition, and those who violate it must be met with penalties and enforcement. Without education and enforcement, regulations become a mere facade. Where regulations function properly without such measures, the regulations themselves may be unnecessary. Spreading awareness and carrying out enforcement both incur costs, and although the application of fines can be an effective way of recouping those costs, the income may not necessarily exceed the costs. The effectiveness and side effects of regulations vary according to their severity, ranging from loose regulation to total prohibition, and each type should be used accordingly.

c. Subsidies

Subsidies are another important tool. The continued operation of public transport in unprofitable areas is due largely to government subsidies. However, regular expenditure in the form of public transport subsidies is not cost effective because they reduce the incentive for the transport company to improve. It is also difficult to stop the subsidies in a reasonable manner. Effective subsidies are those that stimulate a change in the structure of transport, for examples, by promoting an increase in urban density, or improving or expanding walking and bicycle paths. Subsidies for developments that increase the convenience of areas surrounding stations would also be effective. Simply extending routes in pursuit of increased convenience should be avoided, because that might risk increasing public transport management overhead

[57] High-occupancy vehicle lanes may be used when the number of occupants of a vehicle exceeds a specified amount.

[58] This is implemented in Beijing, Guangzhou, and Shanghai, and is expected to be expanded in the future. However, some experts claim that the limit on purchases has not led to a fundamental solution, and that the transport system should be improved.

and reducing transport efficiency. Whereas subsidies for route extension should be unnecessary if there is adequate demand. When demand is insufficient, a combination of route extension through subsidies and development of the surrounding area to increase transport demand should be considered. It is important to include clear goals and time limits to subsidies to avoid promoting dependency.

Toyama, Japan, is an example of a city where homes in the city centre are subsidised.[59] Indirect incentives for living in urban areas can also be created by adding criteria for eligible properties, such as in the residential subsidy for low income earners in Hong Kong.[60] Although subsidies may be necessary to maximise social welfare, they should be managed carefully because of their 'drug-like' effect. It is important to keep subsidies to the absolute minimum required when carrying out an operation to drastically alter the city, otherwise abuse of subsidies runs the risk of creating a zombie city that cannot survive without them. Furthermore, the overprovision of subsidies makes their management more complex, and risks fomenting political corruption. Subsidy policies should therefore be managed with wisdom and logic.

d. Policy combinations

It is important to carefully combine policies because each one has a limited effect but often has side effects. There is a risk that certain policy combinations will cancel each other out. Given that costs are incurred from creating policy through execution, such situations must be avoided and efforts should be made to create synergistic effects.

For examples of parking-related policies, regulations against street-side parking will not lead to the control of road congestion or transit volumes unless adequate parking lots and parking reservation programs are made available at the same time. This is a problem that occurs from the distortion caused by attempting to regulate a natural demand. For example, if an excessively high purchase tax is applied to automobiles to try and force drivers to stop using cars, then consumers will simply start using motorbikes. Similarly, a rise in the gasoline tax is likely to cause a shift to the use of hybrid or electric vehicles. However, the existence of an excellent public transport system that meets the latent travel needs of consumers might solve such problems. Finding the right combination of policies is extremely important.

Accordingly, we will next consider the basic principles of policy combination. For simplicity, the discussion will consider hypothetical policies rather than existing ones. First, let us assume that the goal of a certain policy is to cause positive effects or eliminate negative ones. Policies are implemented to achieve these goals, and their outcome can be divided into three general

[59] Toyama's Unique Compact City Management Strategy. http://www.uncrd.or.jp/content/documents/7EST-Keynote2.pdf#search='compact+city+subsidy+high+building

[60] A Report on the State of Sustainable Building in Hong Kong (2008), http://www.iisbe.org/sbconferences/Hong%20Kong%20Report%20for%20SB08-%20final%20r1.pdf#search='compact+city+subsidy+high+building

categories. First, they may have no effect whatsoever. In this case, the policy is fundamentally mistaken, and should be rescinded from the standpoint of cost. However, policies that fit this category are rare unless they are irrational policies based on fallacy. Such policies may be designed to support fundamental structural change at the national level, such as the Great Leap Forward and the Aral Sea policy for cotton growing based.[61] There is also the risk that supply-side economics based on Say's Law can bring about policy mistakes.[62]

Policies that fall into the second category have an extremely minimal effect. For example, a low rate of gasoline tax would be unlikely to cause a major change in automobile usage. It would have a controlling effect on automobile use but the effect would be minimal. However, applying a high gasoline tax rate in response to this minimal effect would be inappropriate because of the side effect on the oil industry when consumers simply started using electrical or natural gas driven vehicles. Therefore, policy should be combined with other automobile taxes, such as transit fees or parking fees. The important thing is to effectively combine related policies with similar effects, rather than stick to a single policy and take it to extremes.

Some policies that are effective may also cause additional problems. For example, while it would be a mistake to consider a gasoline subsidy to be a policy of income subsidy only for the poor, it nevertheless does subsidise their income. This would clearly cause other problems such as triggering excess demand or subsidies for the rich. In that case, stopping the subsidy would have the merit of preventing the other problems from occurring. Such problems might also be solved through minor adjustments such as setting an upper limit to the amount of subsidy, though that would create problems of cost, or by establishing a system so that only the poor are subsidised. If, alternatively, such a policy were combined with others rather than changing the policy, this could be done by simply providing the poor with other subsidies, or imposing a levy on the rich, but that approach would have a high risk of simply making the policy more complex. If the additional problems caused are small or easily solved, executing the policy together with others that handle those issues would be recommended. (This is the principle of problem simplification.) For example, let us say that improved fuel economy was achieved at low cost as a result of policy that aimed to protect the environment. While this should cause a reduction in the consumption of gasoline, the total consumption could increase because of an improvement in fuel efficiency.[63] In that case, the cost of fuel would drop in practice, so the gasoline tax should be raised in steps according to price elasticity and the improvement rate in fuel economy. In other words, the paradox is created by the inappropriate combination of policies rather than by an improvement in fuel economy. While the additional

[61] The Great Leap Forward caused a major failure in agricultural crops due to the promotion of extreme close cropping and deep ploughing. Similarly, the policy of using water from rivers feeding the Aral Sea for cotton cultivation caused the sea to contract greatly, leading to severe smoke pollution which damaged the nearby environment and led to damage to the health of nearby residents.

[62] Say's law states that 'the value we can buy is equal to the value we can produce, the more men can produce, the more they will purchase', which means demand will increase according to increase of supply.

[63] This is known as the Jevons paradox. This phenomenon occurred with the early spread in coal use. Similar examples would include Pigou's paradox, the fact that there are few traffic accidents in snowbound regions, and that accidents increase with the use of seatbelts.

problem of an increase in fuel consumption was caused by the improvement of the poor fuel economy, this can be solved relatively easily through taxation or similar measures, and thus it should be handled through the combination of policies. As another example, if public transport was made free of charge in order to promote its use, then urban sprawl would increase because travel from remote areas via public transport would be free, and ultimately there would be a higher risk that the use of automobiles would instead increase. The issue could be mitigated by making public transport use in the urban areas free or inexpensive, while collecting a transit fee for more remote areas depending on distance. However, if the likelihood of moving to the urban areas was low, the policy would still serve as an incentive for car use. There are also cases where older policies create major issues as times change. In such cases, it may be possible to solve the problems by eliminating the policies rather than implementing new ones. There are many other similar examples, but the important point when considering the effects of policy is to adequately consider policy combinations.

e. Other points

Other points to consider include fairness, the need for careful road design, the problem of inertia, and technological innovations.

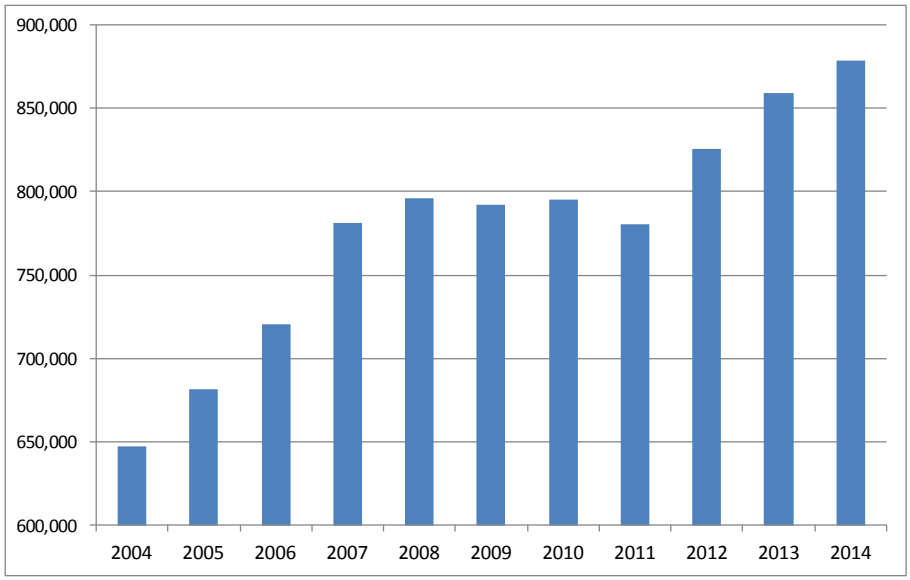
While fairness is certainly important for us, it is also true that its application must be limited. One needs to be careful to apply fairness unconditionally in infrastructure development even in sparsely populated areas. As in the case of housing, it must be understood that fairness also involves a certain degree of arbitrariness.

Also, we have already discussed the risks involved with the careless expansion of roads, and even for changing the routes of roads. For example, simply adding a shortcut can have the effect of reducing overall transport efficiency.[64] Thus it is necessary to work with civil engineers to determine in advance what the effects would be of changing routes.

An understanding of inertia is also important. The Oedo subway line began operating in stages in Tokyo starting in 1991. However, although the line provided more logical routes, many passengers preferred to use the familiar older routes, and it took time for them to switch to using the Oedo line (Figure 2.10). This underscores that it takes time to change people's habits. Similarly, when attempting a modal shift away from automobiles, is important to create a new habit of using public transport.

[64] This is called Braess' Paradox and it is said that this phenomenon occurs in Manhattan, Oslo, and Stuttgart.

Figure 2.10: Changes in Daily Passenger Numbers on the Oedo Line in Tokyo



Source: Tokyo Metropolitan Bureau of Transport.
http://www.kotsu.metro.tokyo.jp/information/service/subway.html

Advances in technology can also provide major breakthroughs. The development of new systems, such as Uber and Lyft, has the potential to provide efficient transit methods in areas with low density. In California, some traditional taxi companies have gone out of business, and this phenomenon is likely to spread to other low-density areas. However, new technologies also give rise to new problems. For example, taxi dispatch systems brought about a proliferation of unlicensed taxis. Thus, when promoting technological innovation, it is also necessary to adequately consider the problems it may cause. Policy that leverages market competition is also extremely important, but competition should be kept at a sustainable level in light of the special characteristics of the public transport industry.

f. Policies from the viewpoint of the citizens

Finally, citizens' involvement and acceptance are an important factor in the success of policy. Some policy makers try to prepare high-minded policies that may, for example, benefit the environment or national security. However, even if the general public can understand such policies and the motivation behind them, they may not change their behaviour. Few would trade their own money or safety for environmental benefits. Similarly, most would not take action that would benefit national security unless the problem is apparent in their own region. In this sense, it is necessary for the policy maker to provide a message to the public that policy will lead to the high level of service and comfort that the general public aspires to, or to keep in mind the implementation of policy that does actually improve those things.

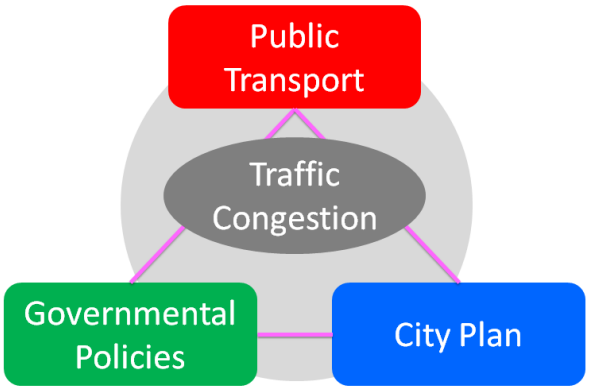
It is meaningless to solely pursue the achievement of numerical policy targets. Rather, a policy must stand on the basis of seeking greater welfare for general public. The precondition for improving energy efficiency in transport is that it ultimately contributes to the development

of a comfortable society by making the lives of the people more abundant and increasing their safety and convenience. In this light, policy will be successful only when it can involve citizens and gain their acceptance.

7. Summary

To recap, the requirements for dealing appropriately with traffic congestion are an excellent public transport system, appropriate government policies, and the design of smart transport-oriented cities (Figure 2.11). To realise a rational transport system, it is necessary to develop comprehensive transport policies by working jointly in those three domains.

Figure 2.11 Diagram of Comprehensive Transportation Policy



Source: Study team.

Table 2.2: List of Considerations for Transport Policy

Item	Specific Improvement Points
Public Transportation Design	
Rapidity	Equipment (trains, tracks, management systems); dedicated lanes; access; operation frequency; operation punctuality; transfers; ease of transit through stations
Safety	Vehicle (specifications, interior structure, impact resistance); maintenance; safety devices; dedicated lanes; driver skill; labour environment
Comfort	Interior temperature and humidity; drive safety; elimination of unpleasant factors (noise, odours, air contamination, crime)
Infrastructure investment	Recovery of the external economy (taxation and subsidies, real estate development)
Price and competition	Full-cost pricing, franchising, yardstick, price cap, congestion charges, peak load pricing
Public–private cooperation	Public–private partnership, private finance initiative, concession, management commission, build–operate–transfer, etc.
Application issues	Automation, information and communication technology, internet, integrated circuit cards, station development, attracting universities and factories to the suburbs, handling tourists, collaboration with the community
City Policy	
Design	Urban planning (land zoning, height limits, floor area ratio, building to land ratio); high-rise buildings; preparing spacious and comfortable walking and bicycling routes; ample space between buildings; construction of parks and libraries; securing population fluidity
Tax policy	Handling of commuting costs and housing subsidies, residency tax, property tax
Infrastructure	Pricing that reflects population density, withdrawal from inefficient areas
Transport Policy	
Taxation	Types: Gasoline tax, automobile acquisition tax, automobile tariffs, licensing fees Considerations: Taxation effects, speed of taxation effects, application of tax revenue, taxation timing
Regulations	Clarify purpose and method, side effects, the problem of effectiveness and cost
Subsidies	Effectiveness of subsidies, the problem of dependency on subsidies
Combination	The three patterns of policy effects, the principle of problem simplification
Other	Fairness, altering roads, inertia, technological innovations, citizen's viewpoint

Source: Study team.

Each domain is an important element in its own right, and at times there may be pressure to compete with the others to maximise a domain. At these times it is particularly important for the policy maker to return to the initial goal of realizing balanced and efficient transport by

examining the overall picture with a wide-ranging and long-term outlook. In addition to the benefits to the economy and company competitiveness, the construction of an excellent transport system can make a major contribution to reducing the physical and psychological burden of travel for local residents, and to the realisation of excellent cities. Table 2.2 provides a summary of the considerations for any transport policy.