‘White Paper’

The Future of the Passenger Train

Prepared for Inter American Development Bank by

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1.0 Future of the Passenger Train

Globally, there is an increasing interest in passenger trains and the reason for this is often quoted by the proponents is that trains are, ‘environmentally friendly’. In addition they can be time competitive with car and bus travel for short and medium distances and with air travel for expensive to build and to operate. In many situations they are the most expensive of the alternative modes of transportation. By looking at the historical trends of passenger transportation, the desire for personable mobility, and the few self-sustaining passenger operations around the world, it is possible to make suggestions and recommendations for creating viable rail passenger services.

1.1 As incomes increase, people travel more

Personal travel in terms of km per year varies - to a certain extent - by culture and tradition. Either way, per capita km is directly proportional to income. The more people earn, the more they travel for business and pleasure.

In the example of the USA, figure 1, there is a nearly perfect correlation between passenger km and per capita income. It is interesting to note that during the Second World War incomes went

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up quickly but because of gasoline rationing, lack of leisure time, and other several reasons, travel dropped.

There are several important variations to this close correlation, such as the need to travel to find work or the traditions and cultures of a country. For example, in India there are several holidays when the tradition is to spend the holiday with a specific relative. Given the increasing migration of the population, the actual km travel, relative to the USA is different, but still proportional to income. In comparison to the Indians, the Chinese per capita travel is about 30% that of Indians, but during the spring festival it is traditional to go home. With the Chinese migration for work, the amount of such travel is increasing dramatically. There are significant negative financial implications since peak travel demand is for about one week a year.

As a rule, as income increases, the km/$GDP/capita decreases. Clearly there are influences from geography to country size, but for 120 countries with railways, the range is 0.4 to about 1.2 km/$ income. This does not include urban commuting.

1.2 As income increases car ownership increases

The desire for personal mobility starts with a bicycle. As income improves, it graduates to a motor cycle, and eventually a car. With more cars there is increased demand for better highways. Since each driver and many passengers are also voters, the highways receive funds whereas the railways are often ignored.

Motor vehicles and specifically cars are inevitable as seen in Figure 2, unless the government like in Singapore legislates heavily against their ownership. Japan also has strong legislation against cars but people still buy them but do not use them very much, the average annual km/car is about 50% that of the USA.

**Figure 2 Cars Are Inevitable unless there are Restrictions**
As income increases not only does the amount of travel increase, the mode of travel shifts as can be clearly seen in Figure 3. The pace of the USA modal shift to a certain extent reflected the development of transportation technology. As illustration, the introduction of the commercial jet plane in the early 1960's had a major negative impact on the rail mode. The car oriented suburbs also encouraged the shift away from public transportation. Today, a developing country's pace of modal shift can be much faster since the transportation technology already exists. For these countries, the rate of change is governed only by the growth of per capita income.

![Figure 3: Annual Km per Capita by Mode for USA](image)

Source: Compiled from several sources by Randal O'Toole and Joel Schwartz²

The independence offered by a car makes it an object that nearly all people desire. There may be an intermediate step of the motorcycle, but it is quickly replaced by the desire for the comfort of a car. The Tata Nano is expected to speed up this process by making a car available at almost motorcycle prices.

Ownership of cars is proportional to income and, with few exceptions, closely follows the ratio shown in Figure 4. In a developing country the rate of ownership of cars increases at rate faster than income growth since no cars are scrapped.

² Highway Statistics Summary 1930 to 1995, American Public Transportation Association's Transit Fact Book, Data prior to 1945 based on 5.6 miles per trip, which was the average in 1945. Bureau of Transportation Statistics, "National Transportation Statistics," and Census Bureau, "Historical Statistics of the United States: Colonial Times to 1970."
1.3 Types of passenger trains: urban and intercity

There are five basic types of rail passenger operations. They are usually characterized as the following: light (LRV), metro, commuter or suburban, intercity and high speed. Each has discrete technical criteria, and capital and operating cost per unit capacity, which are summarized in the table 1 below:

Table 1 Comparison of Various Types of Passenger Rolling Stock

<table>
<thead>
<tr>
<th></th>
<th>LIGHT RAIL</th>
<th>METRO (1)</th>
<th>COMMUTER</th>
<th>INTERCITY</th>
<th>HIGH SPEED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical Route Length</strong></td>
<td>Less than 20</td>
<td>20 to 60</td>
<td>40 to 200</td>
<td>50 plus</td>
<td>100 to 1000</td>
</tr>
<tr>
<td>(km)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum Speed (km/hr)</strong></td>
<td>40 to 80</td>
<td>60 to 100</td>
<td>80 to 120</td>
<td>120 to 225</td>
<td>200 to 350</td>
</tr>
<tr>
<td><strong>Station Spacing (km)</strong></td>
<td>Less than 1.5</td>
<td>1.5 to 5</td>
<td>5 to 20</td>
<td>20 plus</td>
<td>40 plus</td>
</tr>
<tr>
<td><strong>Station Dwell Time (sec)</strong></td>
<td>15</td>
<td>20 to 40</td>
<td>30 to 120</td>
<td>60 to 240</td>
<td>60 to 180</td>
</tr>
<tr>
<td><strong>Train Frequency (min)</strong></td>
<td>2 to 10</td>
<td>2 to 10</td>
<td>10 to 30</td>
<td>15 plus</td>
<td>10 plus</td>
</tr>
<tr>
<td><strong>Acceleration (m/s/s)</strong></td>
<td>1.0 to 1.3</td>
<td>0.8 to 1.2</td>
<td>0.4 to 0.8</td>
<td>0.4 to 0.5</td>
<td>Up to 0.8</td>
</tr>
<tr>
<td><strong>Type of Equipment</strong></td>
<td>LRV</td>
<td>EMU</td>
<td>EMU, DMU or Loco</td>
<td>Loco, DMU or EMU</td>
<td>Loco or EMU</td>
</tr>
<tr>
<td><strong>No. Coaches/Train</strong></td>
<td>1 to 3</td>
<td>4 to 12</td>
<td>4 to 20</td>
<td>6 to 26</td>
<td>6 to 12</td>
</tr>
<tr>
<td><strong>Type of Coaches Single or Double Deck (2)</strong></td>
<td>Single</td>
<td>Single</td>
<td>Single or double</td>
<td>Single or double</td>
<td>Single or double</td>
</tr>
<tr>
<td><strong>Seats per Coach</strong> (3)</td>
<td>75 to 100</td>
<td>Up to 80</td>
<td>80 to 180</td>
<td>80 to 160</td>
<td>80 to 160</td>
</tr>
<tr>
<td><strong>Powered Axles</strong></td>
<td>50 to 100%</td>
<td>50 to 100%</td>
<td>5 to 40%</td>
<td>5 to 40%</td>
<td>30 to 100%</td>
</tr>
<tr>
<td><strong>Passengers/hr/track</strong></td>
<td>Up to 15,000</td>
<td>Up to 75,000</td>
<td>Up to 50,000</td>
<td>Up to 40,000</td>
<td>Up to 20,000</td>
</tr>
<tr>
<td><strong>Approx. Capital Cost per Seat relative to Metro Coach</strong></td>
<td>125</td>
<td>100</td>
<td>60 to 80 for single 45 to 55 for double deck</td>
<td>40 to 50 for double deck</td>
<td>200</td>
</tr>
<tr>
<td><strong>Approx. Operating Cost per Seat relative to Metro Coach</strong></td>
<td>150</td>
<td>100</td>
<td>55 to 75 for single 40 to 50 for double deck</td>
<td>40 to 45 for double deck</td>
<td>150</td>
</tr>
</tbody>
</table>

(1) Metro rolling stock, depending on the length of the route and the capacity demand, can have a wide range of seating configurations ranging from, essentially, no seats to a comprehensive arrangement.
(2) Double deck coaches are becoming increasingly popular, where station dwell time permits, because of approximately 40% lower capital and operating costs and the ability to increase line capacity.

(3) Based on a standard track gauge. Broad gauge the seating capacity could be higher.

It is clear, from the above, that there is considerable variation in capital cost per unit of capacity. While there is some crossover between types, the Metro capital cost is usually considerably more expensive than the other types (excluding LRVs); therefore, it is important that rolling stock is utilized to the maximum. Conversely, when the operating costs are higher, and their route usage should be restricted.

Metro trains are constantly accelerating and braking, usually every 2 or 3 kilometers; therefore, it is very important to minimize the tare weight of this type of rolling stock. Since usually metro trains are running on separate tracks from the intercity and freight trains, one of the common practices to reduce weight is to reduce the buff load (longitudinal strength) of the coaches. By having a separate system, to save energy it is possible to design the track’s vertical profile so that the train’s kinetic energy is converted to potential energy at the stations by raising the track height at the stations.

1.4 Rail in South America

Argentina, Brazil, Chile, Costa Rica, and Uruguay each have about 150 motor vehicles per 1000 population, or about 20% of the eventual number, while the rest of the South American countries are in the range of 10%. As each of these countries develops, there will be more people that can afford cars, and unless there is a rail orientated society they will purchase them. Since the future is known, now there is the opportunity to introduce quality mass transit coordinated with transit orientated development and, at the same time, introduce legislation to restrict car ownership. Much of what is needed cannot easily be introduced after the car dependent suburbs and vehicle ownership is 800 per 1000 population. Most countries have a population density of 15 to 60 per sq. km and would have difficulty, with a few possible exceptions, justifying intercity trains. If Central American countries are included, there are three: El Salvador, Guatemala, and Costa Rica have a population density that may warrant an intercity service. But the countries are so small the railway would be an urban railway.

Roads are essential for a country to develop, so railways can only be justified if there are large volumes of freight and passengers. There may be some routes in the regions that could justify a passenger service, but in most cases a quality bus operation will serve the intercity needs. There are currently about 50 cities in the region that have populations of 1 million, the threshold for urban railways. It should be noted that most of the region’s cities with populations over 2 million either have or are in the process of constructing urban railways. Given population growth, urbanization, and income growth, it could be possible to predict the need for urban railway construction or expansion.

1.5 The Purpose of White Paper

The purposes of the following sections of this paper are to outline, in the general case, the roles and problems of the urban, regional and intercity rail transportation. This information should assist in the development of improved or new passenger railway services.
2.0 Urban Rail
As population and incomes increase, so do the number of cars on the road. This increases the need for urban rail to relieve the resulting road congestion. A review of recent new starts of urban rail construction shows that at about $3000 per capita income and a population 10 million, cities start to construct urban railways. A city of 1 million can delay construction until the per capita income is 10 times higher. See figure 5.

Figure 5 Timing of New Metro Rail Starts Relative to Population and Income

<table>
<thead>
<tr>
<th>Population (million)</th>
<th>Per Capita Income (PPP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0</td>
</tr>
<tr>
<td>2</td>
<td>$5,000</td>
</tr>
<tr>
<td>4</td>
<td>$10,000</td>
</tr>
<tr>
<td>6</td>
<td>$15,000</td>
</tr>
<tr>
<td>8</td>
<td>$20,000</td>
</tr>
<tr>
<td>10</td>
<td>$25,000</td>
</tr>
<tr>
<td>12</td>
<td>$30,000</td>
</tr>
<tr>
<td></td>
<td>$35,000</td>
</tr>
</tbody>
</table>

Source: World Bank, Jane’s Urban Transport Systems

2.1 Global comparisons
With respect to urban mass transit market in developed countries, rail market share varies dramatically by city, but is seldom more than 30%. A review of the percentage of urban travel, by city, that is by public transportation can give an indication as to what is required for urban transit systems to be successful, in terms of ridership.

- Dallas: 4.5%, the city is based on low density housing and the use of a car for almost all travel, yet a new light rail system is changing the travel patterns of the city. The light rail system can be directly attributed to the resurgence of the city center.
- New York: 20%. In the central area, with high density housing, the percentage is much higher, approximately 50%, this is because of a very good transit service plus owning a car and parking are very expensive.
- Paris: 24%, while not extensively high density housing, it is a very compact city with excellent public transportation systems and it is an ideal city for walking or bicycling. Parking very expensive.
- Tokyo: 57%, Osaka: 60%, Singapore: 65%, high density housing, excellent public transportation systems, and car ownership is almost prohibitively expensive.

A Shortsighted Policy
Until about 1995 China had a policy of requiring off street overnight parking, but to promote an car industry, all large cities except Shanghai rescinded the law. To quote an official from the Ministry of Communications, “Just as soon as Beijing rescinds the law I will buy a car!”
From this it is possible to conclude that high density housing and restriction on the ownership and use of cars is the key to encouraging the use of public transportation. It also shows that laws against the ownership and/or the use of cars are critical for higher rail market shares, but this type of legislation is almost politically impossible to implement retroactively.

Another criteria for success, is operating cost fare box recovery and very few achieve more than 60%. So the question is how to fund the capital cost and the operating revenue deficit?

### 2.2 Urban Railways can be Very Expensive

Construction of urban railway in an already developed city is very expensive because of land acquisition and disruption of existing traffic flows, and can be made even more expensive if the ground conditions are difficult. The following are examples of construction cost for metro rail systems:

- Beijing - $75 million per km
- Delhi - above ground, $24 million per km
- Delhi – underground, $56 million per km
- Bangkok - above ground, $55 million per km
- London - $75 to $360 million per km, very difficult ground conditions.
- Los Angeles - $100 to $200 million per km

In a situation where significant urbanization can be expected, then these cost differences show that if you construct the urban railway ahead of the housing development, the cost will be much lower.

There are a number of cities in developing countries that will, unquestionably, grow to a size that will require extensive urban rail systems. An illustration of how extensive the problem is or will become is metropolitan Tokyo which has 56 urban railway routes for a population of 35 million, see figure 6.

**Figure 6 The Urban Rail Network for Metro Tokyo with a Population of 35 million**
An example of the problem, Dhaka, the capital of Bangladesh, currently has a population of about 18 million and is expected to expand to about 35 million within the next 20 years. To create an urban rail network similar in size to that of Tokyo after the fact, will cost billions if not hundreds of billions of dollars. Given that there will be little that can be done to prevent the growth of the city, then the city must be planned beforehand with road and rail service being an integral part of the planning.

2.3 The Bus Rapid Transit Alternative
Bus Rapid Transit (BRT) is a relatively recent approach to mass urban transit and basically is operating buses in a similar way to light rail or even metro rail. One of the primary reasons for its slow development is that, unlike rail, there are no large companies promoting its implementation. Its original development was largely on the initiative of the Mayor of the Brazilian city of Curitiba.

By comparison to rail, Bus Rapid Transit (BRT), is usually much lower in cost, as low as $8 million per km. The lower cost comes from basically using an existing or a limited expansion of the existing road network and rail infrastructure such as power supply and signaling. However, one of the primary reasons is that the buses are mass produced and much lower in cost than rail coaches. This mode has many similar operating characteristics to the light rail listed in table 1 above; except capital costs are lower and operating costs are slightly higher.

A BRT line can handle about 10,000 passengers an hour in a single direction similar to light rail. By comparison, metro and heavy rail can handle 20,000 and 35,000 passengers an hour respectively. In uncomfortable conditions, BRT can handle possibly double the passengers.

Figure 7 Bus Rapid Transit in Mexico City
BRT's low capital cost makes it financially attractive, but it can have a higher than rail operating cost, especially in an environment of high labor costs. As income increases, more people have cars and will be reluctant to use crowded BRT, but experience shows that they will use light rail, if it replaces the buses. Capacity is subject to limitations that are lower than rail, especially heavy rail.

2.4 Getting People to Use Public Transit, Especially Rail
The average person, once he can afford a car will more often than not, use it for urban travel, because of the door to door convenience and the option of travelling in an environment of his choosing including air conditioning, music, leather seats, etc.
Singapore has a first class urban transport system, yet people are increasingly using private cars for urban travel because they do not want to walk a few hundred meters to the bus stop or from the train station to their destination in the high heat and humidity.

2.5 Peak Demand a Problem
Besides the high cost of infrastructure construction, urban train coaches are expensive and required capital recovery can easily be $500 per day on a coach. If the coach has 80 seats, then the cost, per seat per day is about $6. If the coach is used twice a day, one round trip, then the cost is $3 and that is before maintenance and operating costs! Clearly the coach has to be used multiple times a day; most cities have major demand peaks as illustrated in Figure 7. An even worse problem is where cities are allowed to expand in an uncontrolled manner. The length of each ‘run’ can be such that most of the coaches can only make one round trip a working day.

Figure 7 Typical North American Urban Railway Ridership Demand by Time of Day

To be able to manage the demand requires coordination with the city with respect to urban planning and requires a transit agency to develop or at least promote business that would encourage ridership at off peak times and at weekends. The most common approach is to offer off peak fares, which typically has the impact of flattening the peak as passengers wait until the
lower fare becomes available. A more effective approach to this is to make stations destinations, like shopping centers, or dispersing offices around most stations, instead of just in the city center. Urban planning must take into consideration the utilization of transit rolling stock. One Japanese private urban railway owns a baseball team. The stadium is above a station. By controlling game times, it encourages people to ride the train off peak.

2.6 Problem of Financial Viability

Urban transit essentially caters to all income levels. This raises an interesting conflict in the pricing structure since, for the poorly paid worker, the transit fare can represent a substantial part of his income there is a need to keep the fare affordable. On the other hand the well paid manager would have no problem paying a much higher fare for a better quality of service. In the early years rail transit systems tried to solve this problem by having a first class and second class coaches and fare structure. Almost all have settled on a single class because it is almost impossible to ensure the rider is in the class for which they have paid. See text box.

One of the few urban transit systems that is actually profitable on fare box revenue alone is Mumbai where the demand is so high that passengers are prepared to ride like sardines at 16 people per square meter of floor space. This is not sustainable since, in the long term, just as soon as passengers can afford higher quality transportation, they will no longer use the suburban service. The system is not generating sufficient revenue to fund expansion and, as a result, there are totally new systems being constructed that will have a separate fare structure at a price only the well paid can afford.

With few exceptions all rail transit systems require both capital and operating subsidies. Where should the money come from? Usually the capital and operating funds come from different sources. There are several methods, but all have their problems:

Government: It is relatively common for the central or state government to contribute as much as 80% towards the capital costs on the theory that much of the economic benefit is national or state wide. The local government is expected to also contribute. The real question is where do they get the money? Usually it comes from some form of taxes, ranging from an income tax to fuel tax.
Operating Subsidy: Most governments insist that this be from the local government, the primary beneficiary of the transit service.

### 2.7 Problems of Funding Rail Mass Transit

Logically, taxes to fund mass transit should come from the beneficiaries of the system. One of the obvious sources is the highway users who have less traffic congestion as a result of the people using the mass transit system. A common approach is a fuel tax, but then it unfairly taxes people for whom the mass transit system is not a viable alternative. Extra property tax for locations that are close to mass transit stations is a possibility, but then there is the property owner who was there before the station was constructed and derives no financial benefit until the property is sold. Suffice it to say, taxation to fund mass transit is extremely difficult to develop and requires very careful analysis of the alternatives and practical and political implications.

A fuel tax might discourage use of cars as would a toll for the use of specific highways. Congestion charging can also be an effective method of raising funds for mass transit subsidy. However, while congestion charges seem to be very effective in ‘encouraging’ the use of mass transit systems; there is little evidence that it makes a significant contribution to the subsidies needed, as has been found in London.

The most important fact is that the revenue stream to the transit system must not be subject to a annual legislative budgetary appropriation.

Hong Kong government recognized the need for a funding source, when it decided that it needed a rail transit system. It created a company that had the authority to fill in part of the harbor. This land was then used for the railway station, workshops, and coach storage yard. Using the air rights, they constructed about 20 high rise apartment blocks. Money from this property development funded the majority of the construction of the first phase of the transit system. Since then there have been several additional construction phases, a large proportion of which have been funded by property development, see figure 8.

**Figure 8 Hong Kong Mass Transit Railway Property Development**

<table>
<thead>
<tr>
<th>Hong Kong Mass Transit Railway Revenue Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property Development 48%</td>
</tr>
<tr>
<td>Property Management 10%</td>
</tr>
<tr>
<td>Station Businesses 11%</td>
</tr>
<tr>
<td>Railway Tickets 31%</td>
</tr>
</tbody>
</table>

In Japan there are a number of very profitable private urban ‘railway’ companies that are not really railways. They are companies with multiple investments that are tied together with railways. One such company is the Hanshin Electric Railway, which owns retail stores (Figure
9), baseball team, housing complexes, hotels, and travel agency. Property development is 48% of this company’s revenue, and as it is a long established company, it shows this source of revenue can be a continuing income stream.

**Hanshin Electric Railway Co., Ltd**

**revenue sources**

- Urban Transport 26%
- Real Estate 20%
- Entertainment & Communications 12%
- Travel 13%
- Hotels 9%
- Retail 16%

![Figure 9 Hanshin-Department-Umeda-Store Adjacent to an Osaka Station](image)

### 2.8 Urban Railway Conclusions

The future of the urban railway is assured particularly where they are necessary since the cities are of such a size and income that road traffic causes congestion and there is a requirement to transport large volumes of passengers per hour.

Bus rapid transit will have an increasing role since it is much less expensive than light rail, even for lower passenger demand metro rail. In locations of higher per capita incomes, rail will be the preferred mode.

The capital cost of urban rail is the largest constraint on its expansion, especially in an already developed city. Many early urban rail systems were constructed as a method of giving access to new areas for property development. In many cases the construction of the railways was funded by the actual property development, Japan, Hong Kong, areas of London, New York and Los Angeles were also examples of this approach. Urban railways must be actively involved in urban planning - not the reverse, in fact the railways must be proactive in the development of a city.

National and city governments must actively discourage car ownership and use and develop funding mechanism for urban rail systems.
3.0 Regional and Inter-City Trains

By the early 1900s in most developed countries there were networks of regional and intercity train routes. As the car became more affordable, people stopped using regional and then intercity trains. Figure 10 shows the impact of the car on the United States passenger train, with the rate of decline slowing during the depression and dramatically increasing during the Second World War, before continuing the decline. North American low population density and distances could not support more than one or two trains a day on many routes. The lack of train frequency encouraged the transfer to the road and hastened the decline of the passenger train. After the Second World War, although the railroads invested heavily in passenger trains, the construction of the expressways and the advent of the commercial jet airplane reduced the rail market share to the 0.3% it is today.

Figure 10 Percentage Intercity Travel by Rail for USA

![Figure 10 Percentage Intercity Travel by Rail for USA](image)

Source: Compiled from several sources by Randal O'Toole and Joel Schwartz³

The modal shift that took place in North America has been repeated, with country specific variation around the world, as the various populations have gained access to cars and flying has become affordable. A review of a sample of countries can indicate the trends and factors affecting the use of regional and intercity passenger trains:

Britain 6% British railways were generally considered to be well managed, government subsidies were limited, and they were able to retain about a 5% market share. The 200 km and 225 km/hour conventional high speed trains were partly responsible for their retaining this 'high' market share. After privatization they have gained maybe an additional 1.5% market share, but the level of government subsidy has increased significantly. When the railway was a government owned company, the government had clear control of the budget and funding. As a

³ Highway Statistics Summary 1930 to 1995, American Public Transportation Association's Transit Fact Book, Data prior to 1945 based on 5.6 miles per trip, which was the average in 1945. Bureau of Transportation Statistics, "National Transportation Statistics," and Census Bureau, "Historical Statistics of the United States: Colonial Times to 1970."
series of private companies, investment capital is more expensive, and majority of the companies are basically too important to fail.

**France 9%** Followed Japan in developing a high speed rail network, promoted by the rolling stock manufacturers and heavily subsidized by the government. To encourage the use of the passenger trains the government encouraged high tolls on the expressway and, until recently, banned intercity buses and heavily regulated domestic airlines. The emphasis on passenger trains has to a certain extent been at the expense of freight trains. The French freight market share is one of the lowest (14.5%) for a high income country of its size, see the section on combined passenger and freight operations. On the more popular high speed corridors, the passenger market share appears to be in the 30 to 40% range.

**German 8%** Very similar experience to France, except there are few high cost toll ways and intercity buses were allowed, but only between Berlin and Frankfurt.

**Switzerland 12%** In some senses the country’s railway could be considered to be an urban railway since the distances are short and the density of rail lines resemble those of a city. In fact, the railway is essentially considered by the population as an urban railway, and they have a ‘railway mentality’. For example, in or close to most railway stations it is possible to find quality restaurants. To a certain extent the geography of the country, the mountain range, promotes rail travel and as does transit traffic.

**Japan 30%** After the Second World War Japan recognized that the country would have significant transportation problems, high population density, lack of oil, difficult topography, and a meter gauge railway. So with World Bank assistance it constructed the world’s first high speed line on a new alignment and standard gauge. However, at the same time, it passed strong laws limiting the ownership of cars. At that time the ownership of all types of motor vehicles was 19 per 1000 population, compared to the USA, which were 411. All cities have excellent public transportation (see figure 5 above) enabling easy access to the intercity trains. There is also a comprehensive, well served rail network with, for example, up to 10 trains per hour between Tokyo and Osaka. Even with restrictions on cars, the railway’s passenger market share has recently lost several percentage points to the discount airlines.

With the availability of cars and the construction of expressways high income countries’ rail modal share has declined to, with a few exceptions, the mid to high single digit percentages. This is clearly reflected by the fact that the availability of the low cost car was slower to develop in Europe than in North America. So Europe retained market share longer.

**Why do the Japanese Use the Train?**

- Train fare Tokyo Osaka $130
- Plane fare Tokyo Osaka $130
- Highway toll Tokyo Osaka $80
- Must have off street parking to own a car
- Annual car inspection $1000
- Gasoline $1.50 per liter
- Tokyo Osaka 10 trains per hour
Many useful facts and conclusions can be gained by reviewing rail market share for passenger travel. Lack of investment in the railway and the lack of geographic coverage in most low and middle income countries is reflected by the low rail passenger market shares. There are countries that are exceptions. Most are as a result of central planning in which restrictions were placed on car ownership and travel by railway was ‘encouraged’. India also fits into the exception category for several reasons since it has a relatively comprehensive railway network and, until recently, very strong airline regulation. The country was very slow in constructing expressways, which restricted the growth of intercity buses.

3.1 Trains are Expensive
Regional and intercity train services are very capital intensive. The railway has the cost of the infrastructure, train control systems, locomotives and coaches. Whereas the bus has virtually no infrastructure capital cost and a substantially lower vehicle cost as a result of mass production. The airplane may be expensive, but the airline has no capital cost for the airspace, and since it is much faster; its capital cost per seat km is competitive with the train. Fortunately for the railway it uses more fuel per seat km.

Passenger rail costs can be reduced if the track is also used for freight. But the incremental cost assigned to the passenger train can be much higher than its proportion of the total tons of traffic, because the track quality for passenger trains is higher than for freight and the faster passenger train will use multiple freight train paths.

Few, if any regional or intercity passenger trains services cover their cost of operation, and they almost never cover their fully allocated costs. Therefore, they have to be subsidized, sometimes by as much as 60% just for operating costs.

3.2 Buses are Cheaper
A typical intercity bus carries about 60 passengers and can cost $400,000. Some double deck versions have a capacity of 90 passengers and cost about one thirtieth of the cost of a typical 8 coach intercity passenger train. In addition, the bus operates on public highway and it is just paying a user charge, which incidentally probably does not fully cover the usage cost.

Some bus routes have all the conveniences that you might find on an intercity train. In China they offer sleeping serves with entertainment. Some European intercity buses have waitress service for food and drinks, entertainment, and even tables with electrical service for laptop computers. Bus travel time is longer than train travel time, but for distances of up to 150 km the time difference is often insignificant, and the cost can be 25% of the cost for same train trip.

The Rebirth of the Intercity Bus
In the 1930s many railways developed intercity bus service as a means of reducing train operating costs. Over the years the bus lost status partly because it was the cheapest mode of travel. The introduction of high quality, low cost bus service has sparked a major resurgence of intercity buses in USA and, recently, in Europe.
Buses generally take longer than the conventional train, but – globally - ticket prices seem to be 20 to 50% of the cost of a train ticket, so for short and intermediate distances, even compared to high speed trains, they are becoming increasingly competitive.

### 3.3 Speed Not That Important
The primary competition to the train is private car. It offers door to door service at a schedule that will meet the traveler's need. The car journey offers privacy, air conditioned comfort, your own background music, and (if you are a passenger), the ability to read or sleep. While there is no food service, you can stop wherever you choose to buy food of your choice! So in making the modal choice, schedule and convenience are the primary factors. Overall journey time is of consideration, but the actual travel time in the primary transport mode is often secondary. Overall journey time starts at the point that it is convenient to depart, which usually fits to a pattern indicated in Figure 6 above. Therefore, for example, for two equally timed trains a day, the wait could be as long as almost 12 hours. The average wait is considered 6 hours. The actual median wait would be based on the train departure time and the shape of the demand curve. When the train mode is being considered, the 6 hour wait will often be included in the overall ‘travel’ time. Therefore, the wait time needs to be minimized and so frequency is of critical importance.

In looking at the future of the passenger train it is important to understand the relationship between the car, airplane, and train with respect to speed and between train frequency and train speed. It is also important to understand the relative convenience of the modes, see table 2.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Changes in Mode</th>
<th>Number of Periods of Waiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Train</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Car</td>
<td>0</td>
<td>Congestion</td>
</tr>
</tbody>
</table>

Waiting time at a bus stop, a train station, or an airport is an important consideration as subconsciously the public perceives wait time to be 3 times longer than it actually is. While car travel may involve time loss due to congestion, the traveler is in the comfort of his own car.

For every hour of waiting time, the train has to go faster to make up the lost waiting time, see table 3. On a journey of 300 km, in a 150 km/hr train, with an hourly frequency, the considered total travel time is 2.5 hours. For a 2 hour frequency, the train will have to have an average speed of 200 km/hr. If there were 3 hour frequency, the train would have to have an average speed of 300 km/hr, for the same overall time. It also should be noted that for 2 trains a day train speed as a percentage of total time makes little difference.
It can be seen from Figure 11 the traveler may opt for the car for journeys of 200 km even if there is a 300 km/hr train. If the traveler has to wait for an hour for the train, then it is faster to drive up to 400 km. In fact, at 350 km, it may be faster to fly. With a passenger train, at 300 km/hr, the train is faster than the plane up to about 500 km. Above 500 km, the plane will be faster. This shows the primary market for 300 km/hr high speed trains is in the range of 250 to 500 km. It may be as high as about 600 km because the train usually is more comfortable than the plane.
At 400 km the airplane starts to come into contention and, if the wait is 2 hours for the train, the train has little hope of competing with the car and the airplane. Either way for the train to be competitive with a car, there must be an excellent urban transport system which seamlessly connects the modes.

Intercity trains can serve small intermediate cities where there may not be an air alternative. If there is a train station, there would probably be bus service. The bus will probably be more frequent than the train, so again the train will still have to go faster to compensate for the additional waiting time. However if there is no alternative to the train, then frequency does not matter.

Should demand exist for frequent intercity service on routes that are both freight and passenger, there is a problem of having sufficient train paths. The most common solution if the route capacity exists is to schedule freight trains, if possible, in off peak periods. Generally the freight shipper is not concerned about waiting a few extra hours.

The train frequency versus speed is generally not that important for urban transport because distances are short and commuters have a simple choice - car with congestion and parking problems or public transport. In this case train frequency is largely and a capacity/comfort issue.

### 3.4 Frequency Needs Passengers

Key to the future of the intercity and, to a certain extent, the regional passenger train is train frequency. For at least 12 hours a day there has to be a train frequency of at least one per hour. To justify frequency you need passengers, and for passengers you need population! See the text box.

In a developed country the average person makes about 5 long distance trips a year. If 10% of the trips are by rail, for hourly service population centers of 4 to 8 million are required to fill an 8 coach intercity train. If 30% of the trips are by rail, for hourly service population centers of 1.5 to 2.5 million are required. If a higher percent choose to ride the train, it reduces population centers size requirement.

### 3.5 Who Should Pay for Regional Train

The regional train could be considered an extension of the urban commuter railway, so it is used primarily for longer distance commuting. Aside from long distance commuting, a regional train provides access to the long distance train, but possibly more importantly; it provides or should provide access to the major city airports. In so doing it can improve living standards and promotes development in a region. Unfortunately, trains are expensive and this service could probably most cost effectively be provided by buses or coaches, but there are reasons for continued use of trains. Trains have the ability to promote regions more than buses, they can (if required) carry more passengers, and a rail route may be preferable to a road. The best

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**Tōkaidō Shinkansen**

It is the world's busiest high-speed rail line, carrying 151 million passengers a year between Tokyo (Population 35 million) and Osaka (Population 18 million), the two largest metropolises in Japan. They are 550 km apart and ten trains per hour with 16 cars each (1,300 seats capacity) run in each direction with as little as 3 minutes between trains.
approach is probably a combination of buses and trains with user friendly intermodal terminals. The problem is then how to ensure coordination between rival modes and an integrated fare structure. In Sweden the train timetable includes connections to regional bus services. While the urban train is generally subsidized by city, the regional government should be subsidizing this type of train for the purpose of developing the region. In some countries the national government subsidizes the regional trains.

3.6 How Effective are High Speed Trains?
In direct competition to the airplane the high speed rail corridors may have 85% of train and plane passenger traffic, but seldom more than 30% if cars and buses are included, except in Japan. In France TGV market share on some corridors may be 30 to 40% but overall the railway’s market share is only 8%. Washington to New York corridor is only about 8% which compared to national average of 0.3% is very good!

One of the major problems of high speed trains is that there are periods of peak demand that cannot be accommodated by permitting standing passengers, as all seats are reserved. In the case of high speed trains there tends to be more on a weekly pattern than a daily pattern, with peak demand being Friday evening followed by Sunday evening or early Monday morning. People are going home for the weekend, whereas before high speed trains is was not practical. This is an extremely expensive demand in that the extra equipment may only make one round trip a week!

3.7 Problems of Joint Track Usage
Historically, all railways, except for light and commuter rail, were used for both passenger and freight trains. With the growth of road competition, some railways accepted the loss of passengers and concentrated on freight, or others increased the competitiveness of the passenger train primarily by increasing speed. On a few route tracks have been constructed specifically for high speed passenger trains, but on most routes the tracks are still used by both types of trains. Where this is the case, it has often been to the detriment of the freight traffic.

When railway track is used for freight and passengers, especially where there is a significant speed differential between the types of trains, there are a number of technical and accounting problems. A brief summary of these problems follows:

- Track quality – The track quality, especially in terms of line and level, increases significantly as train speed increases.
- Out of balance in curves – In curves it is necessary to elevate the outer rail relative to the inner rail to balance the weight and the force of the wheel flange. The amount of elevation is based on train speed. This is especially important for heavy axle load freight trains and higher speed passenger trains. There are many costs associated with this problem. When there is an imbalance in the number of trains, the question to be addressed is should the track be elevated for the larger percentage of freight trains or for the few high speed passenger trains? There are train and passengers safety issues if
there is insufficient elevation for the passenger train. This problem of elevation in curves is one of the strongest restrictions on the speed of passenger trains.

- **Gradients** – Passenger trains have a much higher power to weight ratio because power requirements increase exponentially with speed. This extra power and lighter trains allows passenger trains to climb gradients faster than a freight train. On new dedicated passenger routes steeper gradients are possible.

- **Speed differential cost** – In a mixed operation passenger trains that are going faster than freight consume much more track capacity than freight trains. A 160 km per hr passenger train uses the track capacity of 2.2 80 km per hr freight trains.

- **Loading gauge** – To speed up loading and unloading of passengers, high level platforms are required. These platforms restrict the moving dimensions of freight wagons. There is the option of low height platforms with double deck coaches.

- **Coach Design** – All railways require additional longitudinal strength\(^4\) for coaches that are operated on the same tracks as freight trains (Exceptions are granted if there is a total embargo on freight trains during the time period of the passenger trains). This adds considerable weight and cost to a coach, especially on railways that operate heavy axle load trains.

- **Signal problems** – Conventional train control systems require signal masts be placed within the braking distance of the train. Passenger and freight trains have different braking characteristics. The latest positive train control technology eliminates this problem.

- **Operating preference** – Historically railways have given operating preference to passenger trains, but as losses increased railways started to give preference to the profitable freight train. The problem becomes more difficult when the passenger train is operating on a privately owned freight railway.

- **How are the costs allocated?** – Track wear is largely proportional to axle load and exponentially proportional to speed, so what proportions of the track cost should assigned to the passenger train? There are costs based on out of balance speed in curves, additional track quality, and track capacity. None of these costs are simple to calculate.

In the USA and Canada intercity passenger trains are operated by subsidized government owned corporations. Under the law the passenger companies are allowed to use the tracks of private companies by paying the incremental cost of operating their trains. Any additional cost directly assignable to a passenger train, such as a station or a new track connection, must be paid for by the passenger companies. Accident costs directly associated with a passenger train are covered by the passenger companies. The direct costs are relatively easy to calculate since the accident costs are clearly identifiable, but incremental costs are very difficult to calculate. Many research studies and lawsuits have addressed these situations.>  

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\(^4\) In Europe the strength is 200 tons, and USA 500 tons without permanent deformation.
The problem of train priority has been partly solved by substantial incentive payments for on time performance.

### 3.8 Passenger Trains Generate Environmental and Economic Benefits

The argument is often given that trains are ‘Environmentally Friendly’ as they have a lower ‘carbon footprint’. This may be the case, but certainly not always. Economic benefits as well as environmental benefits can be ascribed to rail travel. Trains reduce the number of cars on the roads, reduce the need for roads, and help make roads safer.

In theory the mass transportation aspects of the intercity train give the impression that it is environmentally friendly, especially in comparison to the airplane. While it can be, if considered in the full range of situations, the train is only the most environmentally friendly under certain circumstances. For example, a large airplane with a high percentage of seat occupancy uses less fuel per passenger that a partially full passenger trains. Similarly to car with four passengers can be more fuel efficient than most trains. There are many environmental comparisons that can be considered in evaluating the passenger train: passenger km per liter fuel, energy source, emissions, noise, and rubber particles. Some of these are easier to quantify than others, and all are highly route specific.

While specific fuel or energy consumption is commonly used as the basis for environmental impact, the type of fuel and the resulting emissions are very difficult to quantify. Potential for railway electrification is often quoted as a major environmental benefit, but then it depends on how and where the electricity comes from (see text box) and line losses in delivering the electricity to the train. The development of electric cars could impact the future environmental benefit comparison to the train.

If energy consumption per passenger km is considered as a measure of environmental impact, then the vehicle load factor used is critical. To a large extent the load factor is dependent on the vehicle size and the ease of changing seat capacity. A train is in units of 70 to 80 or even 150 seats if double deck is considered, but seldom can an intercity train have fewer than four coaches. So an intercity train has the minimum capacity of 280. An airplane has the option of using units of transport capacity ranging from 60 to 500 depending on demand, while a bus is in units of 50 to 80. A car or minivan is also a single unit and can have a capacity of two to eight passengers. In this respect the train has the least capability of sizing capacity to demand. It does, however, have the option of adjusting frequency to fill a train, but key to service and overall ridership is frequency!

Another problem in evaluating environmental impact is the train’s difficulty in keeping all the seats full. An airplane is a point to point operation; it starts out with a high proportion of seats filled and arrives with the same number of passengers. Trains on the other hand invariably will

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Indian Railways are electrifying their railway, yet are the same time the country has a major shortage of electricity. Indian coal, used to generate electricity, is of poor quality as a result every electric locomotive is generating 6 tons of toxic ash a day. In addition using the electricity for railway instead of industrial production is resulting in a GDP loss of about $6 million per locomotive per year.

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stop enroute usually losing or gaining passengers; this can have a significant impact on the environmental efficiency if a high proportion of seats will be empty.

To illustrate the problem of energy efficiency and environmental impact of trains, an analysis that was prepared by the US Department of Energy is shown as table 4. It indicates that the intercity passenger train is 30% less energy efficient than an airplane largely because the intercity train only has 14 passengers per coach over the ‘average’ route. Clearly there needs to be more passengers in a coach. The energy efficiency of transit buses is very low because of the stopping and starting and off peak limited ridership, but an intercity bus with 21 passengers can be as high as 65 passenger km per liter. In this table the airplane appears environmentally attractive, but it is more damaging to the ozone layer because the nitrogen oxide generated directly into the stratosphere. The environmental damage caused by the plane is equivalent to having a fuel consumption of about twice that listed in the table.

The typical car, with only 1.57 passengers, appears to somewhat average, but with 4 passengers with 37 km per liter it is a very effective mode.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Ave. Load</th>
<th>Pass. Km/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>1.57</td>
<td>14.7</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>1.22</td>
<td>23.2</td>
</tr>
<tr>
<td>Intercity Buses</td>
<td>21.0</td>
<td>65.3</td>
</tr>
<tr>
<td>Transit Buses</td>
<td>9.1</td>
<td>12.8</td>
</tr>
<tr>
<td>Airlines</td>
<td>95.8</td>
<td>14.2</td>
</tr>
<tr>
<td>Intercity Trains (Amtrak)</td>
<td>14.0</td>
<td>10.9</td>
</tr>
<tr>
<td>Intercity Train (UK)</td>
<td>40.0</td>
<td>21.4</td>
</tr>
<tr>
<td>Commuter trains</td>
<td>33.5</td>
<td>19.4</td>
</tr>
</tbody>
</table>

Source: The Center for Transportation Analysis of the United States Department of Energy 2002, Roger Kemp, Lancaster University

Amtrak fuel consumption is relatively low because of the inability to be able to fill trains over long distances and long distances dictate on train facilities, such as dining cars and sleeping accommodation that are heavy and occupy seating capacity. There are segments of routes operated by Amtrak that, on some trains and days, have 100% capacity, but on other days during its overall journey less than 10% of the seats may be full. British trains operate over shorter distance, lighter because of lower crash test standards, higher ridership at 50% capacity (load factor of 40), are twice as efficient.

By comparison, Japan has a much higher seat capacity unitization, shorter distances, electric traction, and regenerative braking that results in these trains being about four times more energy efficient than Amtrak.

While the locomotive specific fuel consumption is continually improving, the coaches have been increasing weight per seat as increased comfort, facilities for the disabled, and more crash protection are required. These increased facilities are largely offsetting the fuel savings.
However, the double deck coach is a technology that is becoming increasingly important to reduce weight per seat and is vital in that it reduces operating cost by about 40%.

The commuter train when full, or even better with standing passengers, is very efficient in terms of fuel consumption and relieving highway congestion, but in most locations the trains are seldom full more than four hours a day, five days a week. The rest of the time they are running with as low as 5% of capacity. At these times the highways have surplus capacity, and that encourages the use of the highway. The off-peak negative impact on fuel consumption can be partially offset by reducing the number of coaches in a train or operating less frequently, but again this discourages ridership. Conversely, intercity rail will not reduce highway congestion problems unless there is an unusually significant passenger ridership.

The environmental and economic benefits of railways, and specifically passenger trains, are many. See table 5. All accrue to the general population, but how does these benefits convert to a financial benefit for the railway to fund its service? In the case of passenger trains, this is a very important question.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Railway</th>
<th>Government</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased passenger travel</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>New industries</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Industrial expansion</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lower cost freight transport</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Increased community</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reduced land-take for road</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reduced road congestion</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Reduced road maintenance</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Value of time savings</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Energy Savings</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Reduced pollution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Particulate emissions</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Gas emissions</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Improved transport safety</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

The wide variation in environmental and economic impact applies to all modes, so a comparison can only be made by specific route, type of train, and energy source.
Will the traveler choose the train because it is ‘Environmentally friendly’? Probably only a few travelers will do so. Given the human desire to travel when people want in their own environment, global experience shows that they must be ‘encouraged’ to make use of mass transit and intercity rail. In all cases where there is a degree of success, there are very strong financial disincentives to use their car. See text box.

Undoubtedly there are a number of economic benefits, but who will pay the railway for them? One of the common economic arguments given for railways is that they save time, and it is possible that businessmen are prepared to pay a premium ticket price. According to the British Ministry of Transport the value of the businessman’s time is $60 per hour saved. Even if the businessmen are prepared to pay $60 per hour more, they are typically only 30% of passengers.

### 3.9 Capacity Management

Information technology is having an increasing impact on passenger travel. Before computers there were basically two ticket prices: first and second class! Largely driven by the competition between the airlines, today there can be dozens of ticket prices between two cities. Intercity trains have been forced to follow this trend. This has been reinforced by the fact that intercity buses are also adopting the capacity management ticketing. On every Megabus, for example, there is at least one seat that sold for $1, available to the passenger who books early enough. As the bus’s capacity is filled, the ticket price increases. However, the passenger booking at the last minute is still typically only paying about 40% of a last minute train fare.

Capacity management ticketing is a major problem to the intercity train. Airlines operating between major cities will offer heavily discounted tickets. A railway may be able to match the fare, but the train will probably stop at towns in between. The discounted end to end ticket price could easily be below the ticket price for the intermediate stations which will either result in the passenger buying an end to end ticket and getting off at a mid station, or becoming upset when he/she find out that the end to end ticket was cheaper than the ticket bought for the shorter distance.
Intercity buses today are also using this capacity management method and are creating major revenue problems for intercity trains. Also, at fare prices that is significantly lower than the train’s. Is there an answer other than significantly lowering train fares, probably not!

3.10 Concessioning is Seldom the Long Term Answer

Often a public private partnership or concessioning is considered an option for taking over or creating a new passenger train service. In the short term this may be a viable option since private companies tend to be more efficient. However, there is usually a need for subsidy and often the government’s participation is not sufficient for long term viability.

As a business opportunity rolling stock manufacturers and infrastructure contractors are major promoters of new passenger railways, particularly for expensive high speed routes and expensive urban railways. With the acquisition of a concession, these companies usually borrow money, from which they pay themselves to build and equip a new route or service. Should the service prove to be a financial success then these companies have the added benefit of a stream of profits. On the other hand, should the service be not sustainable, the banks, share and bond investors usually must pay for the loss. This approach to concessioning is a viable one provided the government fully understands the financial implications and is prepared to contribute an appropriate subsidy, which will almost certainly be required.

Manufacturers and contractors are less likely to invest heavily in an existing passenger railway because there is a lower opportunity for contributing to their basic businesses.

3.11 Regional and Intercity Trains have a Transport Role - Conclusions

In a situation where a person has modal choice of car, intercity bus, train, and plane, what are the factors that go into the choice? Convenience, service quality, cost and time are factors, but only price can be quantified for comparison, but even then, private car ownership is difficult to cost accurately. Most potential passengers only look at the car’s incremental cost, often only gasoline cost when making a comparison. The question becomes how do you compare convenience or cost the value of time? There are a number of theoretical models for this comparison and, maybe on a macro basis, they can project an overall demand. However, individually the judgment as to which to choose is a personal one. Usually for rail to be considered, convenience is a major factor. Besides convenience, other obvious factors are ease of getting to and from the stations, and the intangible of rail being a pleasant experience. For this to happen there is a need to make rail a part of everyday life, not as a necessity, but as a choice. Stations must be conveniently located and must be in themselves a destination. In other words, there is reason to go to the station other than to catch a train, see figure 12. The Japanese example of a shopping mall and the baseball park are good examples.

For all but the rail-competitive longest distances, driving in your own car is usually most convenient. If there are more than two people in the car, it is probably the cheaper than train or plane. Large passenger volumes are required to justify adequate train frequency, thereby limiting routes to major city pairs. To extend the route coverage to smaller cities, there has to be
legislation to discourage the ownership and use of cars, as in Japan. Such legislation is politically very difficult to implement, especially retroactively.

There is considerable misunderstanding as to the need for ‘High Speed’ trains. Frequency is far more important than train speed, and on many routes ‘high speed’ is of little importance. Speed is very expensive and, while it may have a marketing appeal, it is doubtful that it would attract enough extra passengers to offset the extra cost. Speeds above 200 km/h are of little importance for distances of less than about 350 km.

People like to ride trains, but are only prepared to pay a limited amount over the cost of a bus for relatively short distances. For longer distances some people may prefer a high speed train over an airplane, but again they are only prepared to pay a limited amount extra to travel by train. This clearly indicates the range of prices or tariffs that are available to the railway are limited. Road and air have insignificant infrastructure capital costs, so it will be very difficult, if not impossible, for a railway to compete on a new route unless the construction cost is covered by the government.

**Figure 12 An Example of a Destination Station**

Regional and Intercity train stations must be an integral component of multi modal urban transport system, and they must be specifically designed for easy and convenient transferring between modes. The train station should be in a weather protected environment. Given that the car is the primary competitive mode, the stations must have convenient low cost parking and a road network that permits easy dropping and picking up of passengers.

If comprehensively developed, the major stations and the surrounding property is a very valuable asset than can be used to subsidize the railway’s operation. Unfortunately few nationalized railways have the authority or the skills necessary to develop these assets. Typically, when the...
assets are developed, they can contribute about 20% of the cost of a railway’s operation. But the Honk Kong and Japanese experience shows that a much higher percentage is possible.

Almost all passenger railways must be subsidized for capital construction cost, possibly the equipping of the line, and operating the railway. The source of the operating subsidy is critical to the future of the railway, as the source must be consistent and dependable.

Since intercity passenger trains connect a country as a whole, a federal subsidy is logical. However, regional trains are promoting the development of the region in which they operate, and so they should be subsidized by the regional government.

The argument that trains are environmentally ‘Friendly’ may be correct, but few travelers will consider this in making a modal choice. The economic benefit of ‘Friendly’ accrues to the country as a whole or the region and should be considered by the government in determining the level of subsidy.

To create a viable passenger train service it is necessary to create a ‘railway mentality’ in which people consider the railway an integral part of their lives. Additionally, financial viability can be achieved if the railway is a limited part of an operation that includes housing, offices, shopping, and entertainment. Likewise for viable intercity passenger trains, there has to be a high quality urban mass transit system to enable the passenger to go ‘painlessly’ to and from the intercity stations.

In summary, the regional and intercity passenger trains have a future if the number of passengers warrants frequent service, if there is a price-competitive tariff, and if there are enough sources of other revenue to ensure an appropriate, consistent subsidy. Above all, it is necessary to create a ‘Rail Mentality’. When travel is required, travel by railway must be seen as an option with desirability factors equal to those of the car, bus, or plane.

‘It does not matter how fast the train goes so long as there is a frequent service, they are on time, and they look as though they go fast!’ Statement by a US State Governor to an Amtrak Director