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15ª semana de
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The Significance of Rail Systems in Developing More Sustainable and Livable Cities



Portland, Oregon, MAX-LRT at Saturday Market BART system in San Francisco, Fruitvale Station

by

Jeff Kenworthy

Curtin University Sustainability Policy Institute (CUSP)

Curtin University, Perth, Western Australia

Deutscher Akademischer Austausch Dienst-Guest Professor

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Context

There is a major policy debate about the virtues of buses compared to rail systems in cities, especially now that Bus Rapid Transit (BRT) systems are being promoted, largely on cost-effectiveness grounds.

- The issues in this debate do not just concern the most appropriate, efficient and cost-effective public transport technology to move people, but also many other synergies and impacts that public transport systems have on the urban system.**
- These impacts include urban form, urban design, parking requirements, car use, non-motorised mode use, the overall economics of transport, energy use, transport externalities such as emissions and transport deaths. It also includes the *image of public transport* that the public has and its attractiveness.**
- The choice of buses or rail as the structural backbone of a city's public transport system and the best way to extend and grow the public transport system, are therefore important urban and transport planning policy issues and critical urban sustainability concerns.**
- This presentation uses actual data from cities worldwide to see the urban systems differences in cities based on 'strong' rail systems, those based on 'weak' rail systems and those that have no rail system and use only buses.**



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Some Environmental and Systems Advantages of Rail Noted by Others

- **Comfort and convenience factors (bigger more comfortable vehicles, better station/stop environments, greater seat availability, better ride quality, width of aisles, smoothness);**
- **Generally better schedule reliability and safety;**
- **Better transfers between modes;**
- **No local odour/air pollution and low noise;**
- **"The Sparks Effect" - electric system over diesel system;**
- **Route clarity, strong system identity and security of rail systems including Light Rail Transit or LRT, compared to buses;**
- **Proven positive economic impacts on land values and rents in close proximity to stations;**
- **Attractive high density, mixed use development opportunities close to stations.**
- **Rail can achieve significant modal shift of car drivers to transit.**

Some Relevant Other Research: European Bus-Only Cities versus European LRT cities

- Comparison of 25 European cities with significant LRT (with no underground or metro systems), with 22 bus-only European cities between 1986 and 1996.
- LRT cities rose 20.3% in average per capita transit trips, including 4 cities that lost patronage.
- Bus-only cities declined 5.6% in average per capita transit trips between '86-'96, including a minority of cities that increased patronage.

“Its main advantages (LRT) turn out to be what are often considered to be disadvantages - its high cost and inflexibility... ‘Inflexibility becomes redefined as ‘security’... By the same argument, the main disadvantages of relying on conventional buses are what are usually assumed to be advantages - its cheapness and flexibility (p.5)...”

Source: Hass-Klau et al, (2003) Bus or Light Rail: Making the Right Choice: A Financial, Operational and Demand Comparison of Light Rail, Guided Buses, Busways and Bus Lanes. Environmental and Transport Planning, Brighton and Bergische Universität Wuppertal

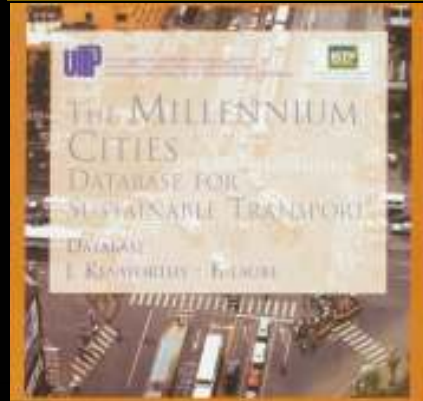
So let us look at these conclusions in the light of a large global study of cities.

Note: The Millennium Cities Database from which the data in this study are taken is currently being partially updated with a grant from the Helen and William Mazer Foundation of New Jersey.

STRONG RAIL CITIES	POPULATION (1995/6)	WEAK RAIL CITIES	POPULATION (1995/6)	NO RAIL CITIES	POPULATION (1995/6)
Washington	3,739,330	Calgary	767,059	Ottawa	972,456
New York	19,227,361	Atlanta	2,897,178	Denver	1,984,578
Brisbane	1,488,883	Chicago	7,523,328	Houston	3,918,061
Sydney	3,741,290	S. Francisco	3,837,896	L. Angeles	9,077,853
Wellington	366,411	Montreal	3,224,130	Phoenix	2,526,113
Barcelona	2,780,342	San Diego	2,626,714	Bologna	448,744
Berlin	3,471,418	Toronto	4,628,883	Taipei	5,960,673
Berne	295,837	Vancouver	1,898,687	Tel Aviv	2,458,155
Brussels	948,122	Melbourne	3,138,147		
Frankfurt	653,241	Perth	1,244,320		
Hamburg	1,707,901	Amsterdam	831,499		
London	7,007,100	Athens	3,464,866		
Madrid	5,181,659	Copenhagen	1,739,458		
Munich	1,324,208	Dusseldorf	571,064		
Oslo	917,852	Graz	240,066		
Paris	11,004,254	Helsinki	891,056		
Ruhr	7,356,500	Lyon	1,152,259		
Stockholm	1,725,756	Marseille	798,430		
Stuttgart	585,604	Nantes	534,000		
Vienna	1,592,596	Rome	2,654,187		
Zürich	785,655	Geneva	399,081		
Osaka	16,828,737	Glasgow	2,177,400		
Sapporo	1,757,025	Newcastle	1,131,000		
Tokyo	32,342,698	Manchester	2,578,300		
		Milan	2,460,000		
		Hong Kong	6,311,000		
		Singapore	2,986,500		
		Seoul	20,576,272		



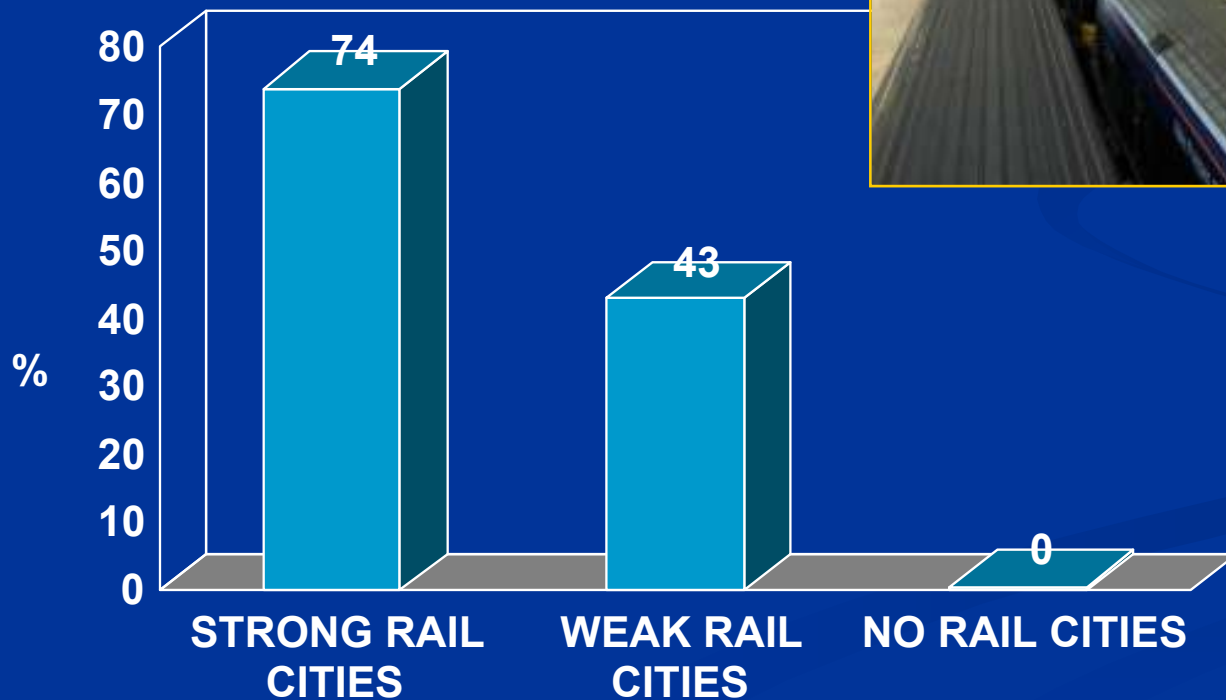
60 Cities in The Study



Note: This study excluded poorer cities because of the confounding issue of much lower wealth.

Percentage of Public Transport Passenger Kilometres on Rail

Strong rail cities are defined as (1) those having 50% or more of their total total public transport task or public transport passenger kilometres on rail (i.e. trams, LRT, metro, suburban rail) and (2) no less than 40% of boardings by rail modes. (3) Also the ratio of the overall rail speed to road traffic speed had to be 0.90 or higher.



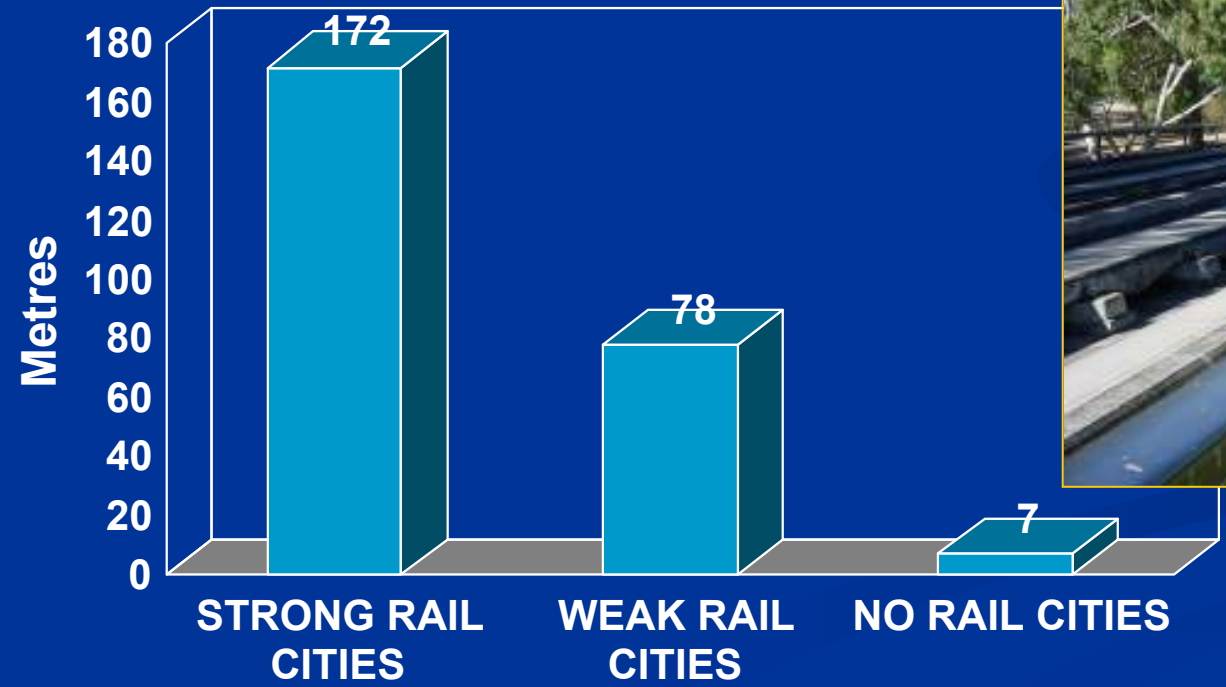
In 1995 Sao Paulo had only 18% of total public transport passenger kilometres and 23% of boardings on rail, so it needs to improve a lot to become a "strong rail" city.

BUT average weighted rail speed was 36.9 km/h compared to car speed of 24.1 km/h, a ratio of 1.53. Clearly S.P. NEEDS MORE RAIL SYSTEM.

Total Length of Reserved Public Transport Route per 1000 Persons



Strong rail cities have systematically more reserved transit right-of-way than weak rail and no rail cities.



Sao Paulo only had in 1995, 18.6 metres of rail per 1000 persons



Freiburg



London



Karlsruhe



Adelaide

Reserved rights-of-way are critical for transit's speed advantage over cars. Transit, walking and cycling can compete with cars when given traffic priority. Light Rail Transit systems can also green the city.



Mandurah railway line, Perth

Perth in Western Australia has opened a new 74 km intra-urban railway line on December 23, 2007 and is using some of the stations as sites of integrated higher density development.

Patronage on the line had reached predictions for the 1st year only 6 months after opening. It was already difficult to get on the train in the peak within 18 km of the city centre.



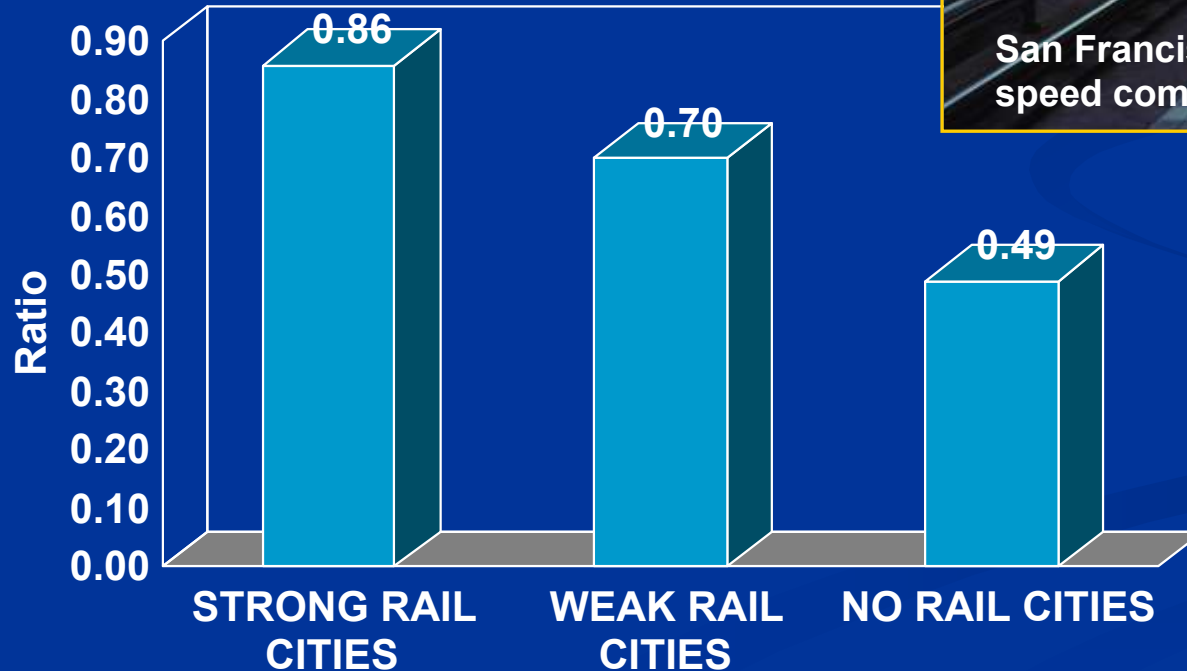
Ratio of Public Transport System Speed to Road Traffic Speed (km/h)

Strong rail cities have a much better ratio of overall public transport system speed to general road traffic speed due to their greater emphasis on rail systems.

SP in 1995 had a ratio of only 0.71 because of the slow buses. Rail, however, was 1.53 times faster than road traffic.



San Francisco's BART system provides speed competition with the car.



Speed-competitiveness with the car is fundamental to the success of public transport in any city. Cities with bus only systems have public transport systems with half the speed of general road traffic.

Length of Freeway per Capita in World Cities, 1995



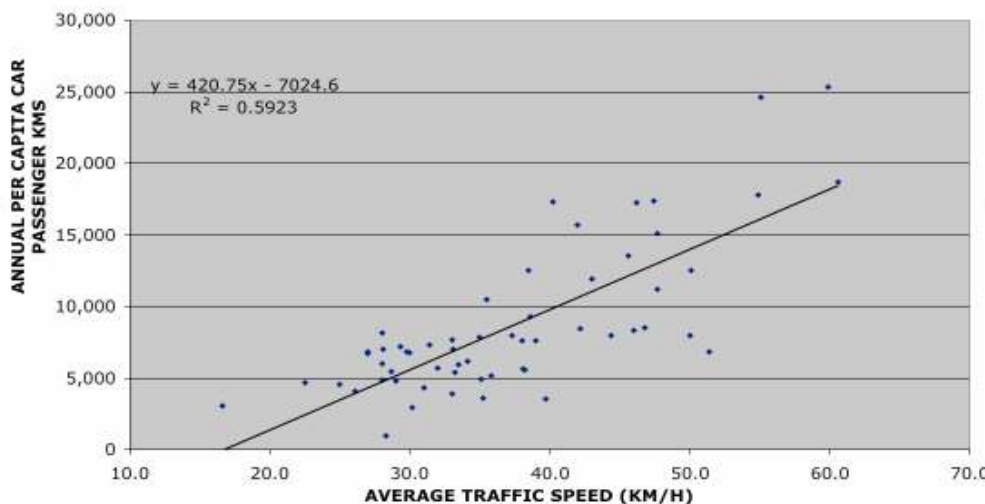
Higher congestion is strongly associated with less use of cars in a city.

Congestion appears to act as a brake on automobile dependence.

As average speed of cars increases so does car use.

As congestion rises, car use diminishes. Trying to remove congestion through freeway building pushes cities towards greater car use.

AVERAGE ROAD TRAFFIC SPEED VERSUS PER CAPITA CAR USE





The “predict and provide” urban transportation planning process that just produces more freeways is flawed...

- It creates a vicious circle of roads, sprawl, congestion, more roads, more sprawl, more congestion: It increases energy use and emissions.
- Transport planners in Europe in the 1970s were told: “Well, you’ve shown us the future, now show us how to avoid it!!...”
- “With every million we spend on roads we will be closer to murdering our city” (Mayor of Munich, 1975).
- “Unconventional” results began to appear:
 - Nürnberg (Nuremburg) pedestrianisation of city centre
 - 29% of traffic transfers to other roads; 71% disappears; no one knows where.
- Lesson: If you take away road space, a lot of traffic disappears.
- Traffic behaves more like a “gas”, than a “liquid”, but transportation planners and engineers are trained to think of traffic as a “liquid”, that floods everything if you don’t provide channels for it to run. Tearing down the freeway in Seoul proved this. There are many other projects world-wide where this has happened.



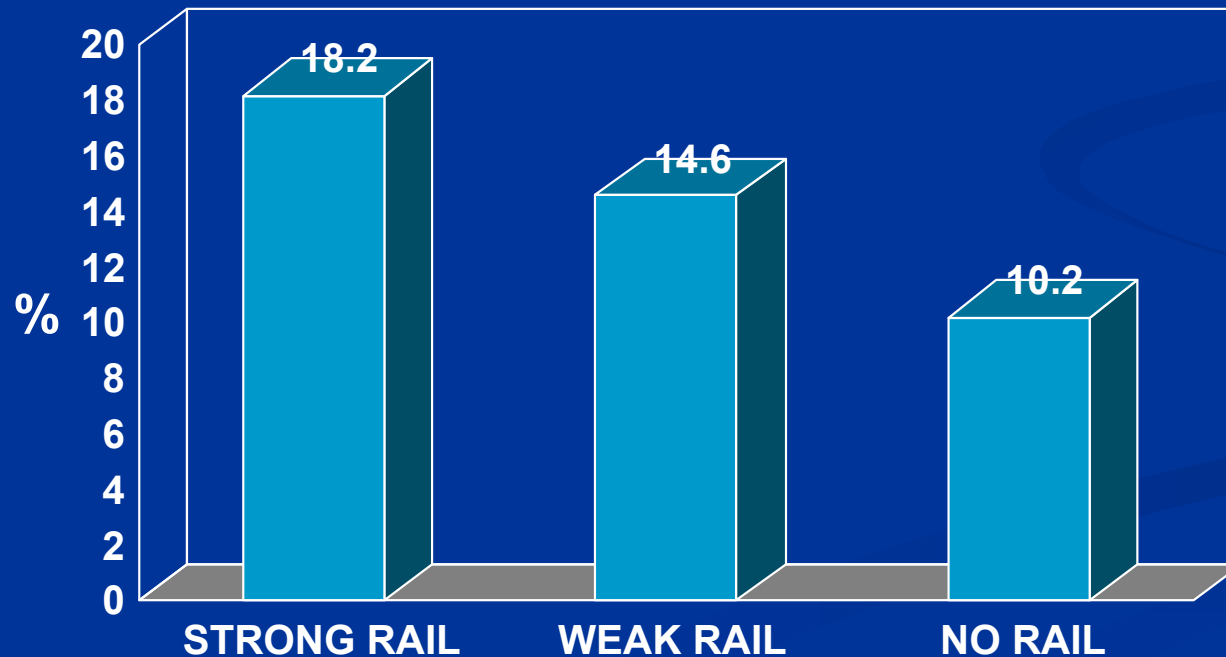
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As congestion increases in cities there is:

- ❑ Less car use
- ❑ More public transport use
- ❑ More non-motorised mode use
- ❑ So.....
- ❑ Cities should not be building or widening freeways which destroy the speed competitiveness of transit and increase car use.
- ❑ Cities should be building high quality transit lines, in particular rail systems, which improve the speed competitiveness of public transport and which allow us to avoid the congestion that is inevitably a part of all cities.
- ❑ Cities should also be considering strategic removal of road capacity, like in Seoul, which improves the livability of cities without any of the dire predictions of traffic chaos materialising.

Proportion of Jobs in The CBD



Strong rail cities are systematically more centralised than weak rail and no rail cities and tend also to have more compact mixed use sub-centres, centred on stations (more “decentralised concentration” rather than “urban splatter”.)

SP is highly centralised in jobs 29.6%...it needs rail!!



Munich's pedestrianised city centre is an attractive place for people of all ages. Barcelona's La Ramblas is the centre piece of the city. Strong rail systems help make such places in the CBD feasible because less parking and road space is needed for access.



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Large Sub-Centres in the Suburbs: Chatswood Station, North Shore Line, Sydney



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Nodal development at St Leonard's Station, Sydney.

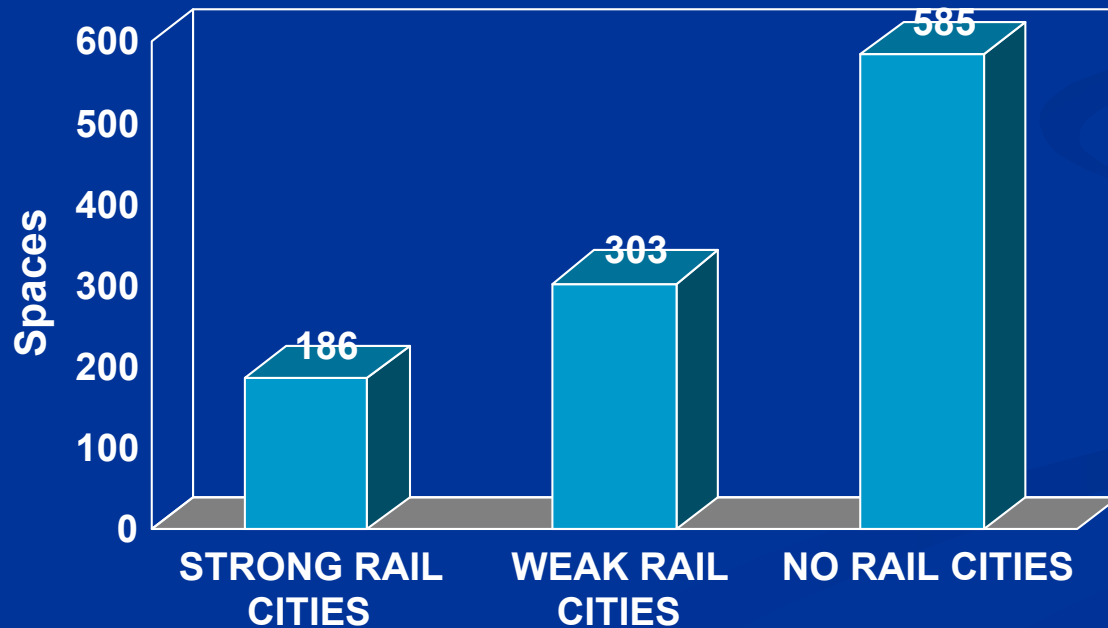
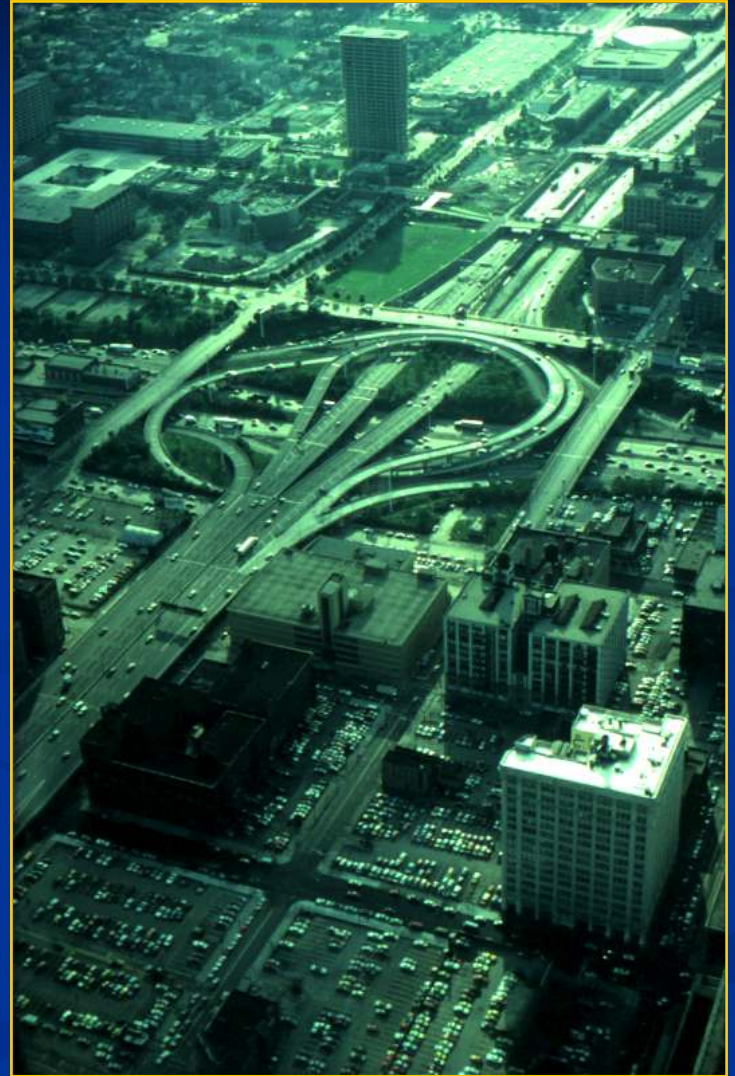
Cities must give priority to developing more extensive, high quality transit systems whose stations provide the anchor points for the development of viable town and sub-regional centres, but the land use planning system must also be supportive. SP's new Metro extensions offer 70 sq km of development potential around stations.

Reserved public transport right-of-way, especially rail can concentrate urban land uses into more compact, mixed use urban forms.



Parking Spaces per 1000 CBD Jobs

Strong rail cities tend to develop more attractive city centres and sub-centres due to less parking requirements



SP in 1995 had only 183 parking spaces per 1000 CBD jobs, so is a SR city in this respect.



Excessive emphasis on parking destroys the urban design qualities of centres and sub-centres by sterilizing vast areas and making the environment hostile to pedestrians and cyclists.
Auckland, New Zealand





Auckland, New Zealand...diesel urban rail service...a lot of single track. It is not surprising that the urban environment is so dominated by cars.



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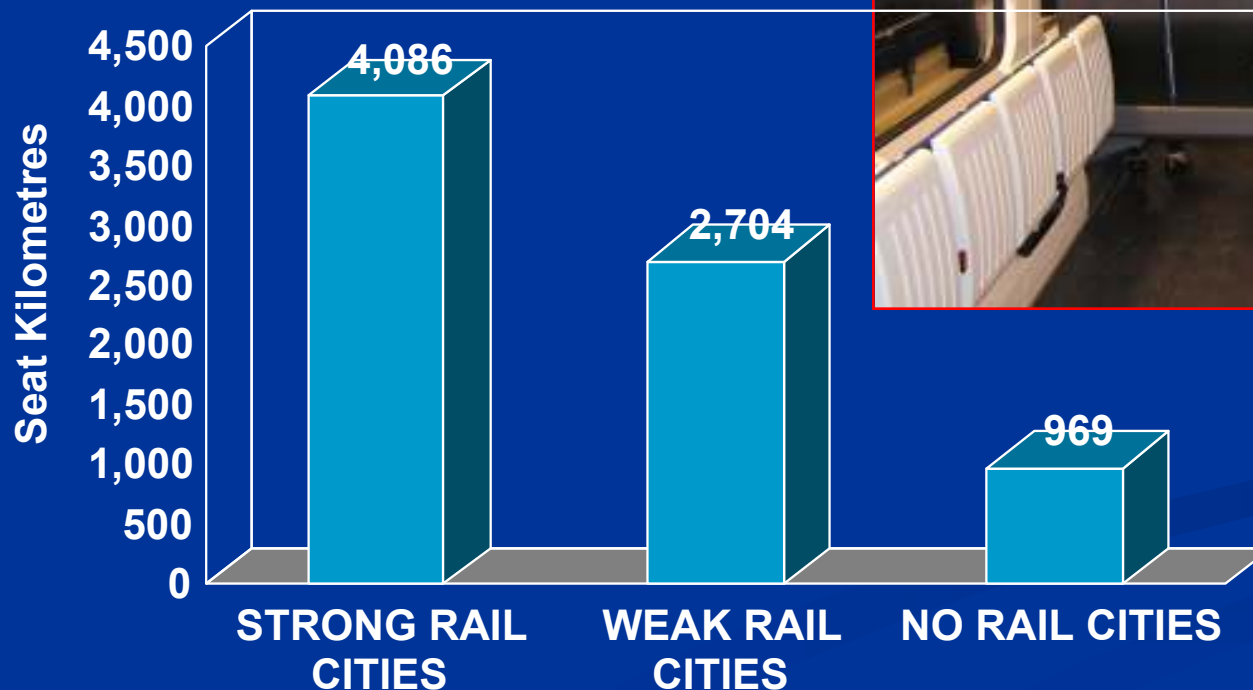
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Arabella Park Sub-Centre, Munich, Germany: 10,000 residents, 18,000 workers set in traffic free space and built around an U-Bahn station.

Annual Total Public Transport Seat Kilometres of Service per Capita

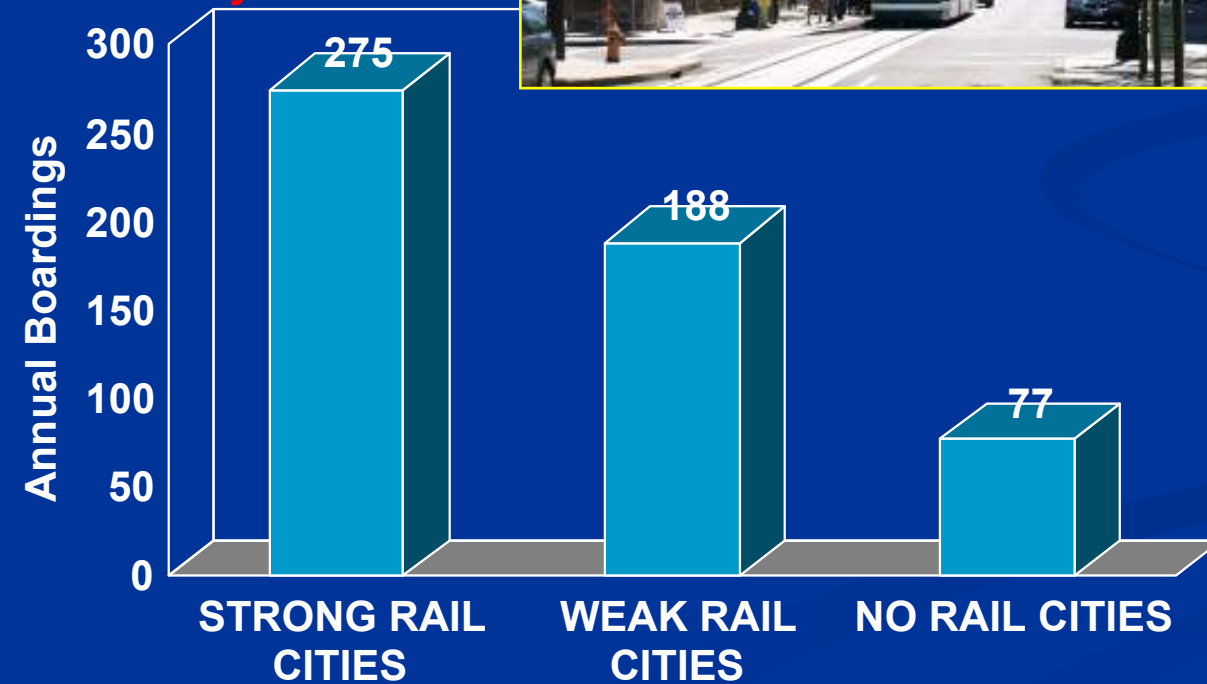
Strong rail cities have systematically more service supply, both in vehicle and seat kilometres of service provided per capita, than weak rail and no rail cities.



SP in 1995 had 3,759 seat kilometres of service per capita so is quite strong here...25% only was rail, however.

Annual Total Public Transport Boardings Per Capita

Strong rail cities have systematically more public transport passenger boardings than weak rail and no rail cities. SP in 1995 had 248 total boardings per capita. This can be grown with more rail system.



Rail systems focus the city into high density nodes of concentrated public transport use or - Transit-Oriented Development. Bus systems follow and support scattered development and find it hard to attract passengers.



Close integration of housing/mixed use development around rail: Zurich



Joyce Station,
Vancouver, 1987



Joyce Station,
Vancouver, 2004



Rail can be very powerful in influencing the form and scale of development



High rise development integrated with transit can have a high quality public environment.

**Joyce Station,
Vancouver, 2004**

Pedestrian linkages join the apartments to the station and bus interchange.

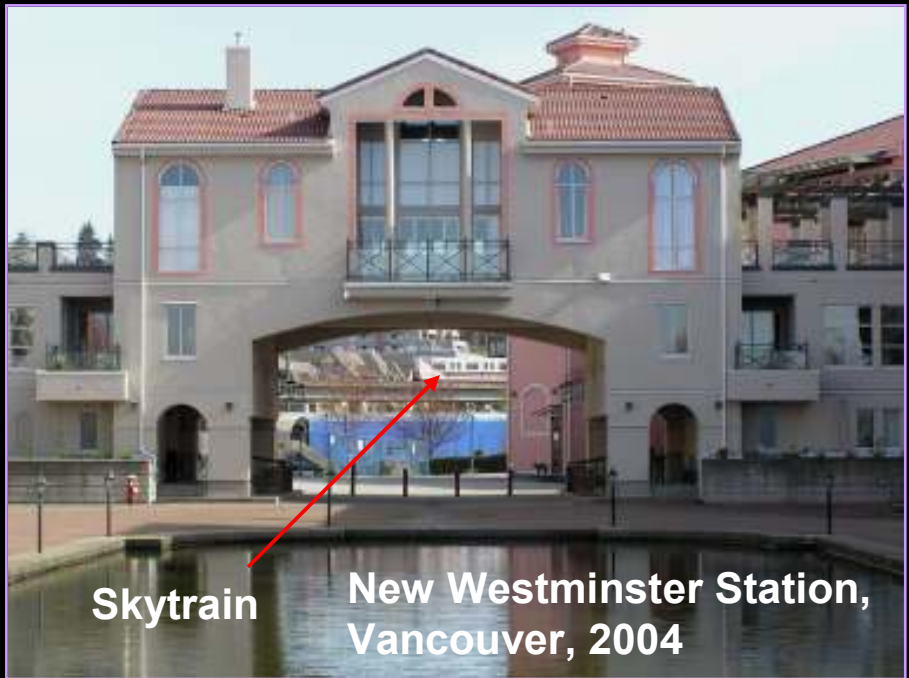




Metrotown sub-centre in Vancouver, Canada.

Vancouver's driverless Skytrain is a magnet for high density, mixed use development. BUT the system is over capacity in the peak. **SP has to be very careful in extending its Metro that it builds enough capacity.**







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**New Westminster Station Precinct,
Vancouver, 2004: A superb mixed use
development based on a boardwalk.**





Edmonds Station, Vancouver, 1987



2004



2004



2004

Rail can attract huge re-development over a 15-20 year period



Fruitvale Station on BART in San Francisco - TOD in a low income area.



West Edmonton Mall: Edmonton, Canada

Chinese bus systems
are heavily used and
crowded but will not
compete with the car.

↓

Bus systems in developed cities
operating without a rail backbone
attract much lower passenger levels.

In developing cities, where there are
many captive passengers, bus
systems can attract high passenger
levels, but are always under threat
from motor cycles and cars because
people want to get out of them as
incomes grows. **This is why SP needs
to grow its rail system more and
more.**



Appropriate Transit Oriented Development (TOD) is Good, but Inappropriate TOD is Not Good!

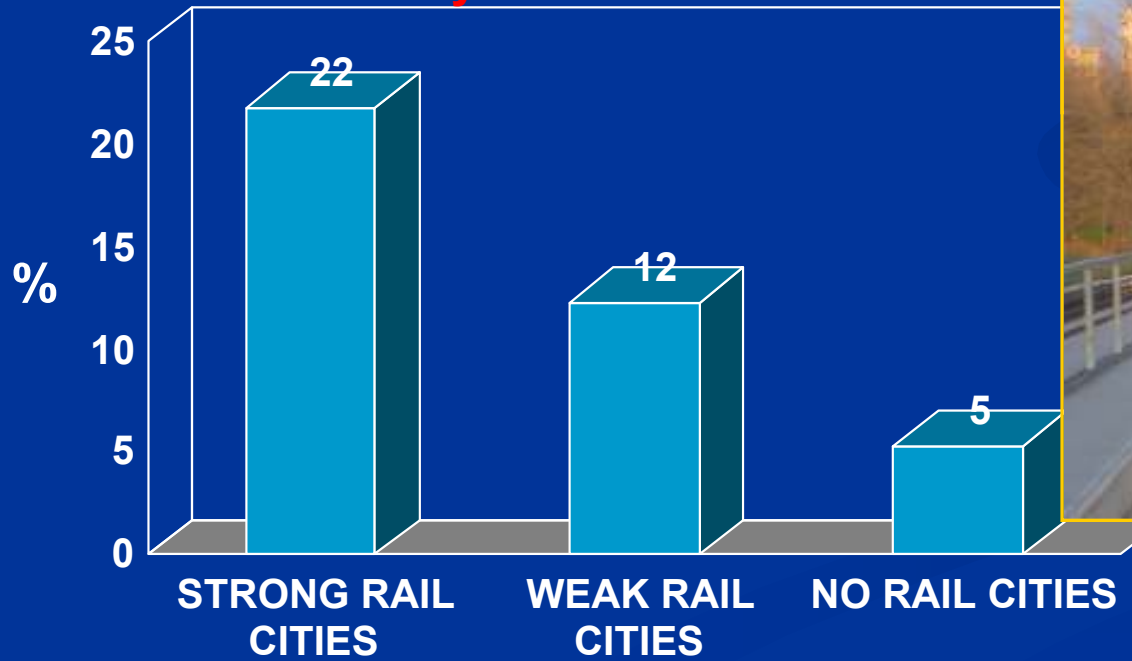


The two top pictures in Sao Paulo are good examples of linking commercial development to the rail system, to the advantage of both the Metro company and the passenger.

The example below of a commercial display taking needed space at the station foyer, is not a good example of TOD, for either the Metro or its customers.

Percentage of Total Motorised Passenger Kilometres on Public Transport

Strong rail cities capture more than a 4 times greater proportion of overall motorised passenger kilometres on transit than no rail cities. In 1995 SP had 46% on public transport, but this has gone down a lot due to car and mc competition. The only way to compete is to have more rail system.





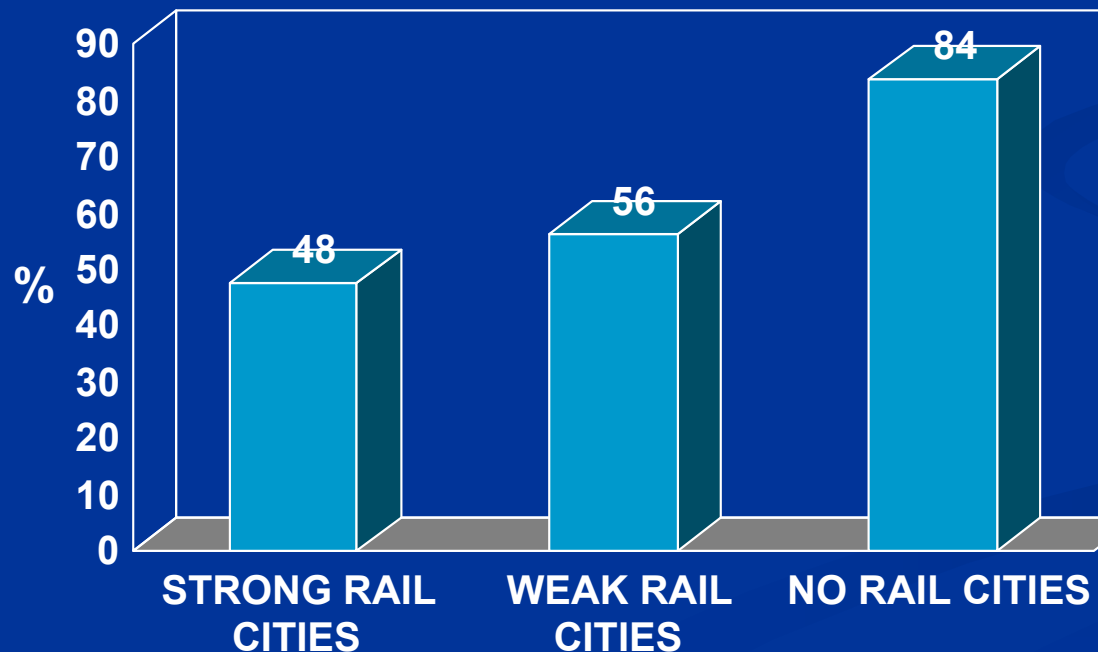
Perth's new rail system is significantly increasing the proportion of travel on public transport.

The opening of the 74 km Mandurah rail line in December, 2007.



Percentage of All Trips by Private Transport

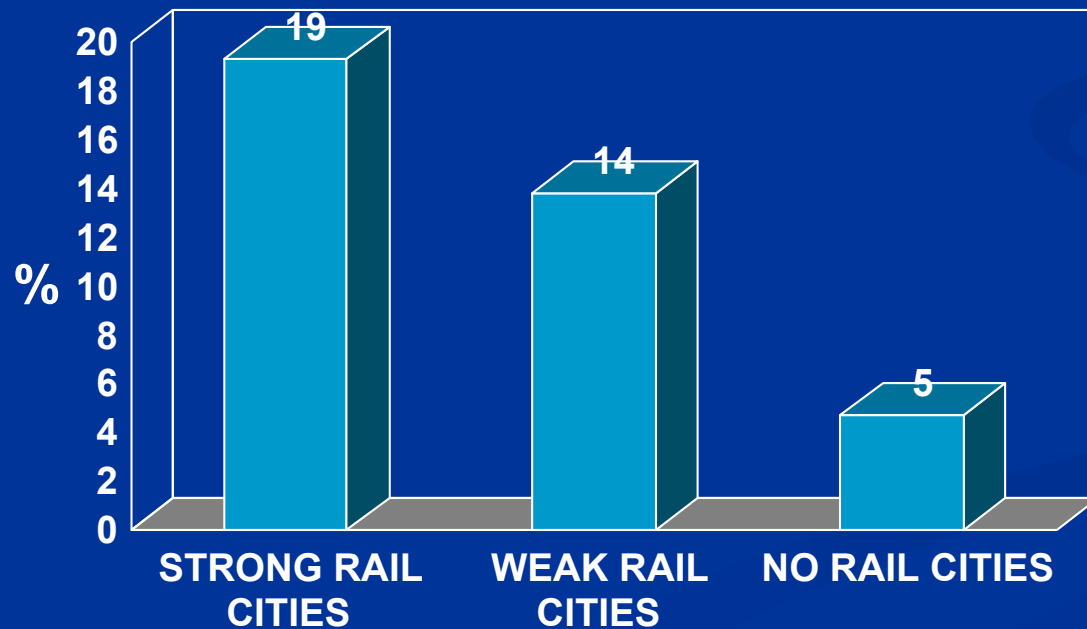
Strong rail cities have less than half of all daily trips by private transport, weak rail just over half, while no rail cities are highly dominated by private transport. SP in 1995 had 32% of daily trips by private modes, but again private transport will have gained ground.



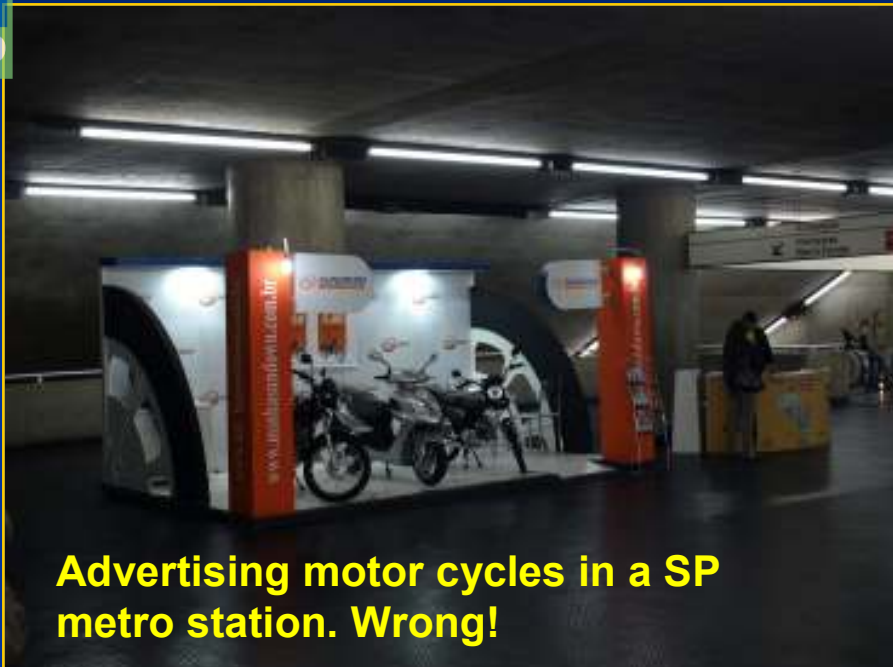
Percentage of All Trips by Public Transport

Strong rail cities have almost 4 times higher percentage of daily trips by public transport than cities with only buses.

SP in 1995 had 33% by public transport but public transport will have lost ground to cars and motor cycles. The way to compete better is more rail.



Competing for Mode Share: Advertising



Advertising motor cycles in a SP metro station. Wrong!

How many car manufacturers advertise public transport? Unlike public transport companies, car companies do not “shoot themselves in the foot”. They are too clever for that!

Public transport must compete aggressively against the car and m.cycle!

It is important to make the point that public transport operators **SHOULD NEVER** advertise their competition, the car or the motor cycle, even if advertising fees or floor space rental revenues seem attractive.



Advertising cars on Melbourne trams. Even a bigger sin!!

Competing for Mode Share: Cleanliness

Sao Paulo has one of the cleanest Metro systems in the world. It is a great source of pride and no matter how much it costs, *please* don't let that standard drop! That you do this with nearly 20 million people is a real achievement!!

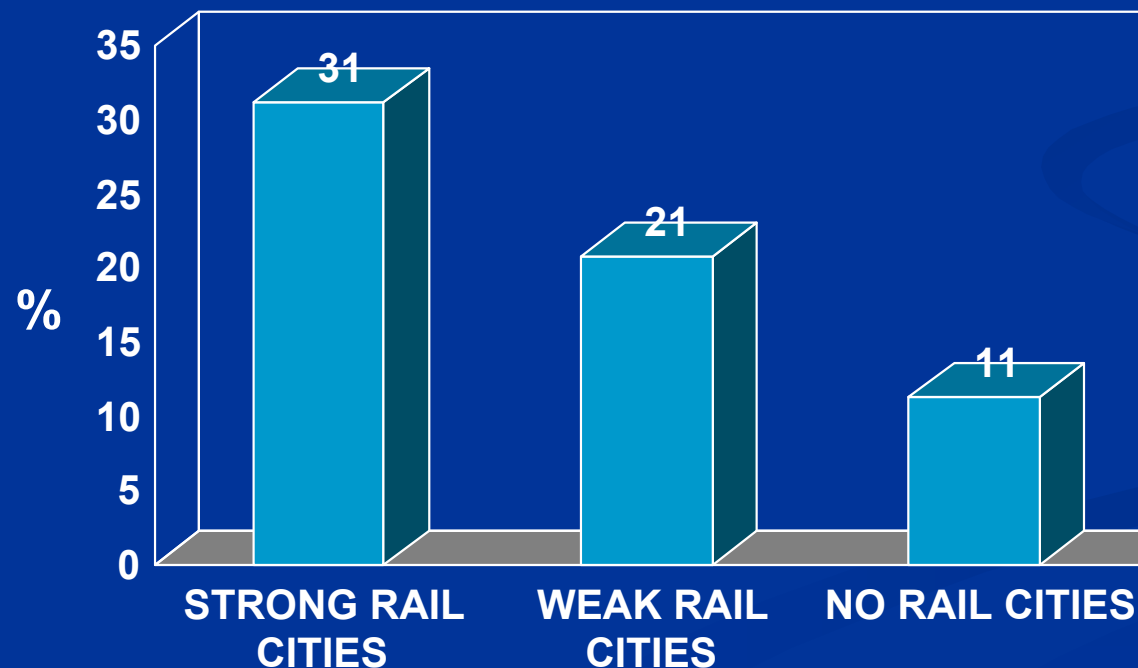


Outside of Japan I have never seen such a wonderful clean Metro system. This is something that SP should teach to cities all around the world!! Even your tracks are clean. How do you do it?



Percentage of All Trips by Non-Motorised Modes

Strong rail and weak rail cities are associated with much higher levels of walking and cycling than no rail cities. Most rail-based cities focus more attention on the quality of the public environment for pedestrians and have higher concentrations of activity that create shorter travel distances suitable for walking and cycling. SP had 35% of daily trips by NMM in 1995, but again this will have lost ground.





Portland, Oregon has totally transformed its CBD using LRT in association with major urban design and streetscape upgrades.



Geneva



Adelaide

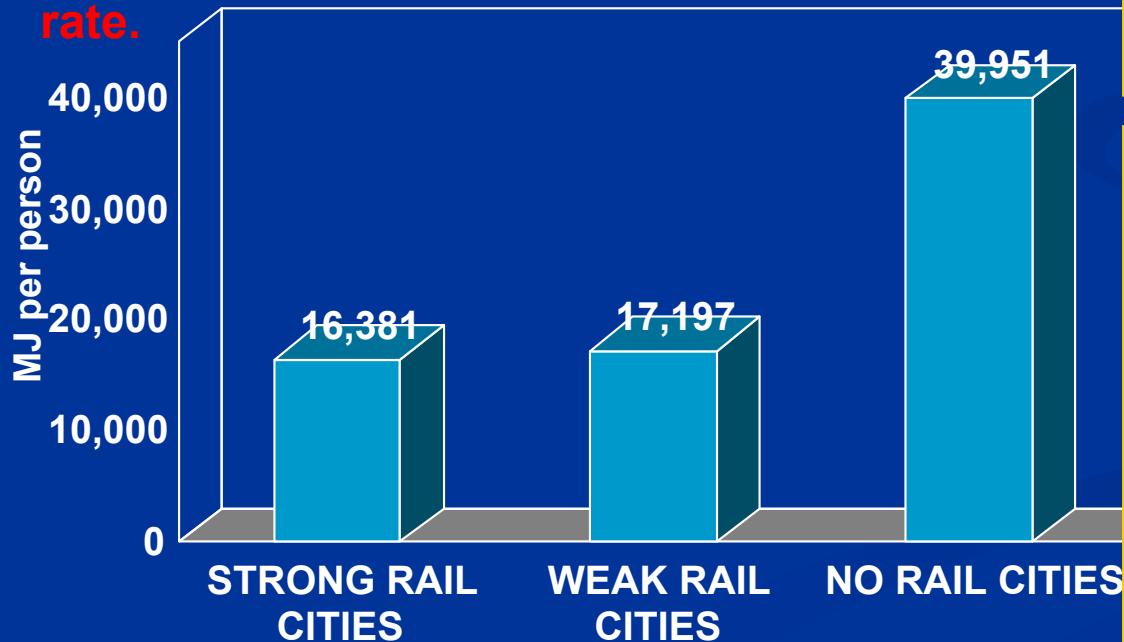


Zurich

LRT has been successful worldwide at improving urban centres, which in turn has increased use of walking and cycling.

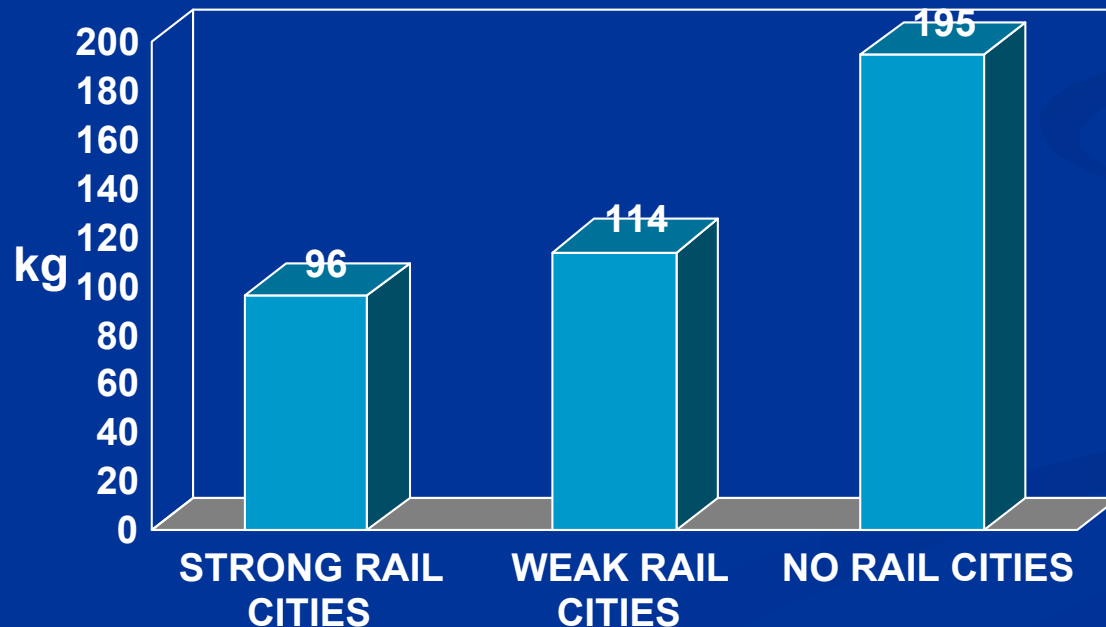
Private Passenger Transport Energy Use Per Capita (Megajoules)

Strong and weak rail cities are associated with much lower levels of energy use in private passenger transport than no rail cities. Cities with less dependence on oil are at a distinct competitive advantage due to 'peak oil'. SP in 1995 had 9,926 MJ per capita, but again this will have grown significantly. More rail is needed to slow down the energy consumption rate.



Total Transport Emissions Per Capita (kg of NO_x, CO, SO₂, VHC)

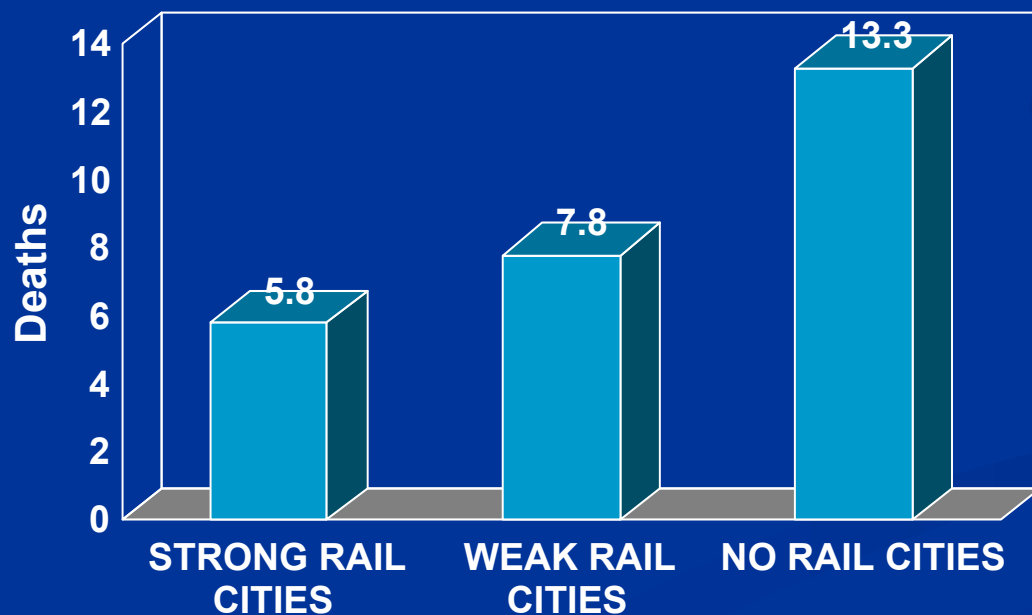
Strong and weak rail cities have much lower levels of transport emissions per capita than no rail cities. Much higher use of public transport walking and cycling helps to explain this result. In 1995 SP had 134 kg per capita was quite bad in this factor and will have gotten worse.



Total Transport Deaths per 100,000 People

Strong and weak rail cities have significantly lower transport-related deaths per capita than no rail cities.

This is largely due to greater exposure to the car in the more auto-oriented no rail cities.



In 1995 SP was shocking in this statistic at 24.1 transport deaths per 100,000 people. More rail would lower this.



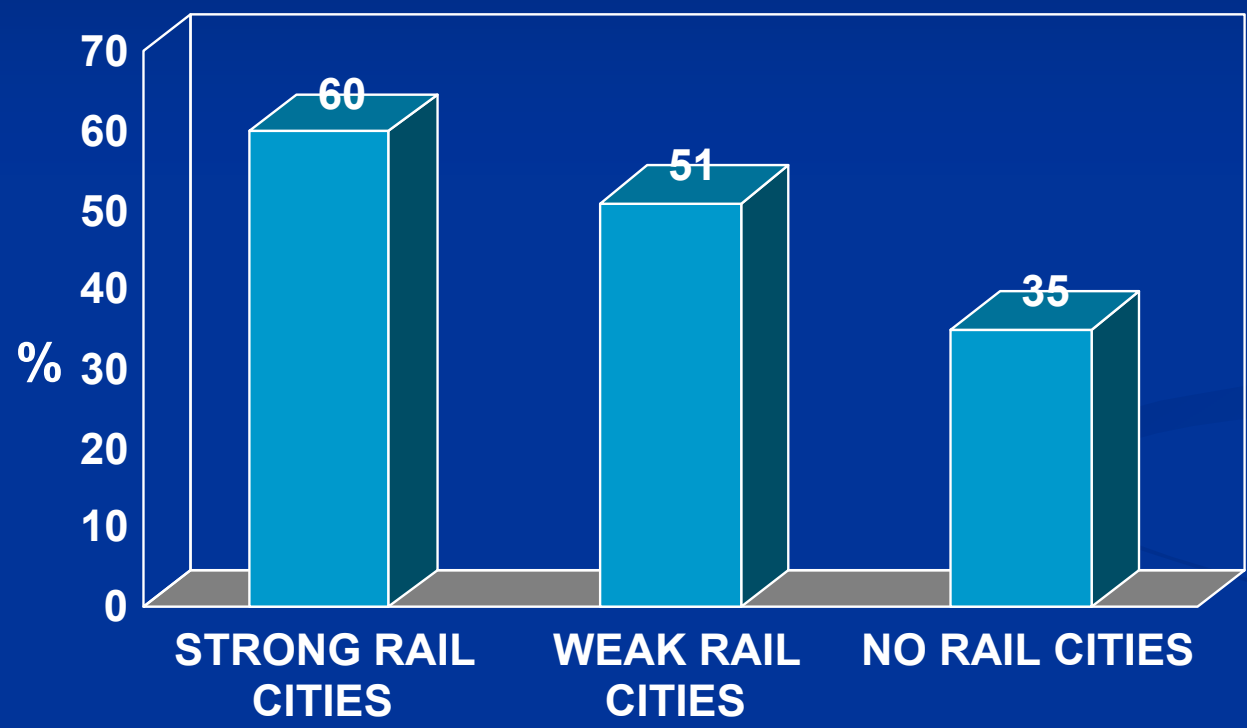
Road traffic exacts a huge human toll each year: 45,000 die in the USA and over 1.2 million worldwide in one year. Auto-dependent cities in the USA have the highest transport death rates of all higher income cities.



Would we tolerate these death rates in a war in the Middle East?



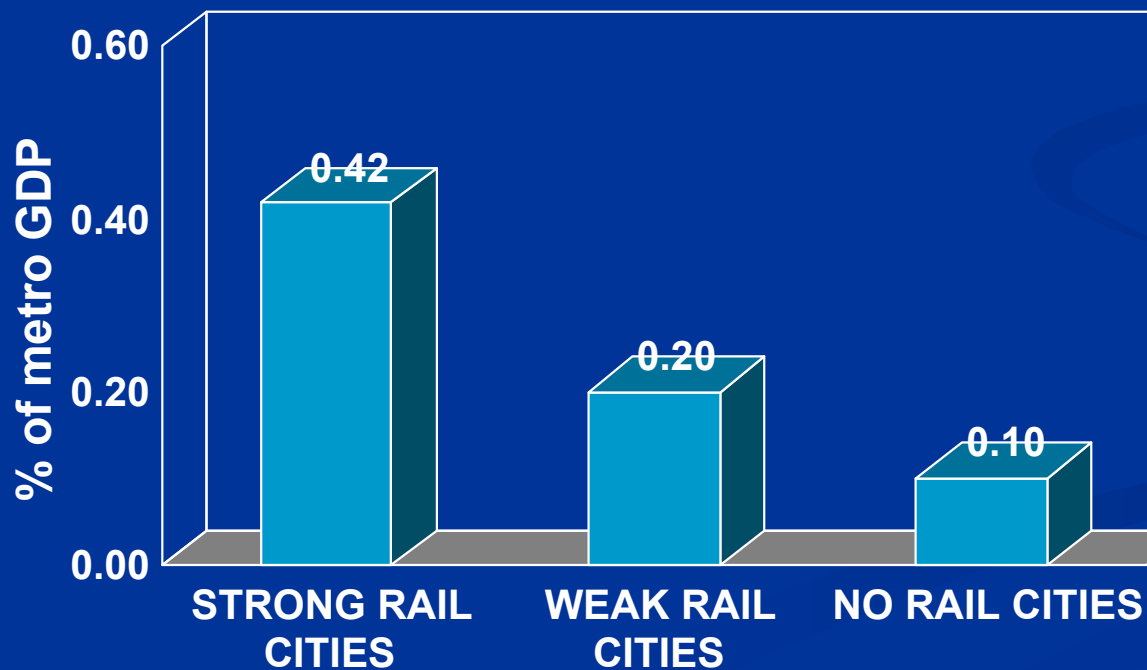
Public Transport Operating Cost Recovery



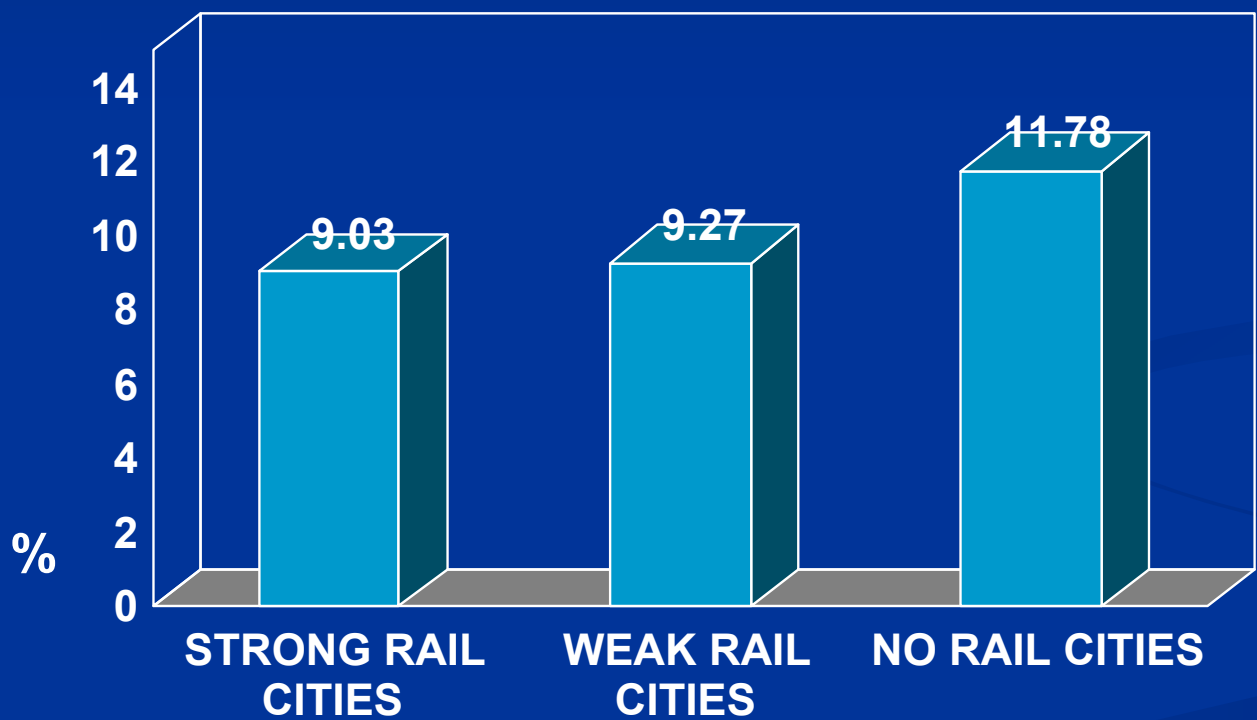
Cities with rail systems recover significantly more of their operating costs from farebox revenue than no rail cities. This is generally linked strongly to the higher patronage of public transport in rail-based cities, while buses collect fewer people over more scattered areas, but other factors are also important. In 1995, for example, SP recovered 93% of its operating costs in the total public transport system, which is very high.

Percentage of Metropolitan GDP Spent on Public Transport Investment

Strong rail cities spend 2 times that of weak rail cities on public transport investment and over 4 times more than no rail cities. Cities with only buses prioritise road investment, not public transport. The extra investment is worth the extra benefits it provides to the city and its residents. In 1995 SP had spent a 5 year average of 0.98% of metropolitan GDP on public transport investment, which is good.



Total Passenger Transport Cost as a Percentage of Metropolitan GDP



No rail cities have the most expensive overall passenger transport systems (all operating and investment costs for private and public transport).

Cities with rail spend less of their wealth on passenger transport and therefore have more money to spend on other activities.

In 1995 SP spent an average of 17.42% of total GDP on passenger transport, which is very high. As cars dominate more this will probably go up.



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Conclusions 1

Strong rail cities are systematically better performing in their transport patterns, their transport infrastructure, urban form, energy usage, environmental characteristics and their transport economics.

- **Furthermore, cities with rail tend to have a better quality, more human-oriented public realm because more space is conformed to human needs and less designed around the car. This is especially true of centres in cities.**
- **The mechanisms for the advantages of urban rail relate to**
 - **the legibility of rail systems**
 - **the greater permanence of rail services**
 - **the positive image of rail in the mind of the public and business community**
 - **people's willingness to use rail systems over buses for a variety of reasons, including more competitive travel speed and greater reliability and quality of service.**
- **This does not diminish the critical role that buses play in public transport systems.**
 - **Buses are essential public transport providers to areas that cannot be served by rail; many such areas in most cities**
 - **Buses provide critical feeder systems into major sub-centres and into rail systems.**



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Conclusions 2

- Well-patronised urban rail systems are usually associated with strong and healthy levels of bus use.
- Where well coordinated, rail and bus are highly complementary and are not in competition with each other.
- Rail and bus form an integrated, multi-modal public transport system that provides competition with the car.
- The best public transport systems emerge out of choosing the right mode for the right task for the multitude of situations in any city.
- Public transport should be seen as a multi-modal system whose chief aim is to compete with and reduce dependence on the car, building a 'virtuous circle'.
- **Sao Paulo has great potential to become a strong rail city. Already there are signs there in the data with many good features, but it needs to build more rail system if it is not to slip further behind because cars and motor cycles are competing aggressively. The case for more rail in SP is overwhelming.**
- **A city of this size and density simply CANNOT function without continuously expanding the rail system. There is no other mode that can provide the capacity, reliability and speed in most situations. But care needs to be taken in the choice of technology for rail in SP.**
- **If anyone is interested in studying further such matters, I co-teach a Masters in Urban Agglomerations in Frankfurt, Germany. I have brochures if anyone is interested.**