Transportation and Territorial Development in Singapore Extended Metropolitan Region¹

Jean-Paul Rodrigue²
Department of Geography
Centre for Research on Transportation
East Asian Studies Centre
Université de Montréal
C.P. 6128, Succ. A
Montréal, Québec
CANADA, H3C 3J7

Abstract: This paper brings a preliminary viewpoint on the interface between port cities, urban regions and their transportation systems in the particular context of Singapore. The development of the regional Singaporian transactional space includes the province of Johor in Malaysia and the Riau islands in Indonesia. The resulting spatial pattern and linkages form an Extended Metropolitan Region (EMR). We present an EMR spatial model where transportation is a key factor explaining four processes of territorial development, which are densification, dissemination, extension and contraction. Densification is a process of spatial accumulation of economic activities within an area. It aims higher levels of productivity. Dissemination is a spatial relocation of unproductive economic activities towards productive areas. Extension is a space / time collapse enabling economic activities to extend over a large territory while maintaining low distribution costs. Contraction is a rationalization of distribution systems facing growing transportation costs and competition from other systems. Based on the framework provided by the spatial model and available evidence, we undertake an assessment on transportation and territorial development in Singapore EMR. The analysis mainly underlines the role of Singapore as a regional transhipment centre and its maritime / land interface function.

Key Words: Transportation, Urbanization, Extended Metropolitan Regions (EMR), Singapore.


¹ This research is supported by a grant from the Social Sciences and Humanities Research Council of Canada, grant #752-91-0318.

² The author would like to thank Terry McGee, Claude Comtois, Francois Soulard and anonymous referees for helpful comments.
Introduction

Over the last decade, the Pacific Rim has taken a growing part of the international trade and industrial production. Economic development changes the level, pattern and extension of urbanization in that region with maritime transportation playing a crucial role, notably along coastal areas where accessibility to that mode is optimal. Therefore, the territorial context where urban development occurs is mainly coastal based and relies on the maritime / land interface. This is quite different from the more continental based urban system that is found in North America and Europe. Even so, port cities were always very important in those urban systems (Marcadon, 1991). As part of the Pacific Rim, Southeast Asia is affected by fast economic development and urbanization. The political history of several nations of Southeast Asia has influenced the pattern of urbanization and economic development. Colonial incorporation, especially by Great Britain (China, Malaysia), France (Indochina) and The Netherlands (Indonesia) created urban systems oriented towards ports of call.

Singapore represents a particular case of coastal urbanization in Southeast Asia. Established in the 19th century as a port of call for the East and Southeast Asian British trade, Singapore became an entrepôt (Chew and Lee, 1991). Its strategic location at the strait of Malacca, has put Singapore at the crossroads of important maritime routes between economic blocs, mainly Europe and Japan. From an entrepôt, Singapore has emerged in the 60s ! with its independence ! as an important manufacturing centre and transportation hub. Singapore is also known as one of the "Four Dragons" with Hong Kong, South Korea and Taiwan, forming the Newly Industrialized Countries (NICs) of the Pacific Rim.

As a city-state, Singapore depends highly on international trade and on its accessibility to the international market for economic growth (Krause, Koh and Lee, 1987). In fact, one third of Singapore's gross domestic product is based on trade, mostly maritime. With limited land available, the authorities of Singapore were applying efficient urban planning policies, constraining industrial development in specific zones and equipping the city-state with modern transportation infrastructures. However, due to those policies it appears that urban development has occupied most of the national territory. Large areas must be reserved for housing, water catchment, intermodal transportation and conservation to sustain economic and environmental integrity. Singapore faces an increasing economic and transportation demand, but there is very limited space for expansion within the city-state, even with land reclamation. Presently, we observe in Singapore a growth of the density of land use, a decline of the secondary employment sector and a strong growth of the tertiary employment sector. The main strategic goal of Singapore is to become the financial, service, communication and transportation centre for all Southeast Asia thus playing a major role in the Pacific Rim transactional space. All those processes occur in a context of intense urban restructuring, important investments in transportation infrastructures, industrial relocation and a reorientation of the economic system towards management and high technology. The resulting territorial structure is no longer a single metropolitan area inside a city-state, but intensive transactional networks of goods, people and information over a large territory. The considered area is exceeding the city-state and composed of several urban centres with industrial activities in rural areas: Singapore's extended metropolitan region.
The objective of this paper is to identify transportation factors affecting territorial development in Singapore Extended Metropolitan Region (EMR) and to address notions and processes of urbanization over a vast territory. This would provide a theoretical and empirical framework of large scale urbanization. We suggest that Singapore is integrating a large economic space that includes southern Malaysia (Johor) and northern Indonesia (Riau islands) but also other regions. Transportation is a key factor in the emergence of extended metropolitan regions. We first present an EMR spatial model in order to provide a theoretical framework for territorial processes affecting the Singapore region. Secondly, we look upon the location of Singapore in the international transportation system by underlining the effects of global factors on its regional transportation system. Thirdly, we undertake a preliminary assessment of the territorial development of Singapore's extended metropolitan region based upon our model. Fourth, a discussion on transportation / land use development strategies for Singapore EMR is made. The paper will then conclude on the role of transportation in the territorial development of extended metropolitan regions in general and for Singapore in particular.

An EMR Spatial Model

Large scale urbanization is a process that began – or at least started to be acknowledged – in the 50s (Gottmann, 1987). It involves the distribution of urban-related activities over a large territory, creating a new transactional space. The result is a fundamental change on the spatial structure of what we consider a city. Basically the city structure has evolved from a nodal structure to a multi-nodal one (Huth, 1983). At a regional scale, transportation converges at hub centres, adding a new dimension to the concept of multi-nodality that must be understood as a regional division of economic activities regulated by hub centres.

Asian urbanization is focused on the emergence of urban regions (Costa, Dutt, Ma and Noble, 1988; Ginsburg, Koppel and McGee, 1991, Paderanga, 1990). One such aspect considers them as extended metropolitan regions (Ginsburg, 1991). The EMR is a regional distribution of economic functions using the comparative advantages of the territory to enhance productivity. A scattered production system obviously more relies upon a transportation system than a concentrated one. The transportation system of the EMR rests on its capacity to convey movements of goods, people and information within and outside its regional transactional space. This place the emphasis on the intermodal capacity of hub centres having an interface with the maritime transportation system.

Figure 1 presents a spatial model of an extended metropolitan region in the Asian context. From our perspective, the EMR is basically composed of four types of spatial entities performing specialized types of economic activities (A) and having different types of linkages (B): 1) the metropolitan area; 2) urban centres; 3) desakota areas and; 4) rural extraction areas.

(1) Metropolitan area. It is the main transactional centre of an EMR; its core. The purpose of transactional related activities is to manage, control and distribute the production, resources and capital of a vast territory. Production related activities are oriented towards high value-added goods requiring skilled labour. Transportation activities transits the production of the EMR to the international urban system (and vice versa), thus making the metropolitan area the main hub centre of the region. Ports are the dominant infrastructures for that purpose, but airports play an
increasing role as the economic activities of the metropolitan area become more related to international transactions. The metropolitan area is a transhipment centre of goods and resources, a transiting place for people, and a distribution/accumulation point of information, investments and capital.

(2) **Urban centres.** A set of urban centres is performing some production, consumption, transportation and management activities as part of the transactional space of the metropolitan centre. They represent regional production and distribution nodes having control over an administrative division. Some centres can exchange goods and resources with the international market via small intermodal centres, but the exchanges are mostly of small scale and of a very specific nature.

(3) **Desakota areas.** They are rural areas in transformation where industrial production and rural extraction exist concomitantly (McGee, 1991). Asian economic development mainly takes place in those territories, creating a strong growth of movements of people and goods. This space is highly affected by its gradual incorporation inside the regional and international transactional networks. As economic development occurs, desakota regions become important production and consumption centres with increasing linkages with metropolitan areas and urban centres.

(4) **Rural extraction areas.** They mainly provide resources, like agricultural products, to the EMR and experience changes in agricultural extraction technologies that free labour. This labour either migrates to production centres or engages in non-rural activities and thus gradually transforms the space into desakota regions. Rural extraction areas are within the transactional space of the EMR, but are less attractive to investments and not well served by transportation infrastructures.
Figure 1: An EMR Spatial Model

The economic development inside an EMR occurs most of the time along a transportation corridor. Historical conditions have created an urban system structured by an unequal distribution of transportation infrastructures. Corridors give a higher accessibility level to its surrounding space and thus favour spatial accumulation. Current patterns of large scale urbanization are therefore influenced along the existing transportation corridors. When the transportation corridor of an EMR extends to another EMR, it is likely that the resulting economic area will form a mega-urban region.
Large urban regions are thus the overlap of transactional spaces of several hub centres.

Our EMR spatial model is rather static and descriptive. The next logical step is to include some spatial processes underlying territorial dynamics. We suggest that four general processes of spatial accumulation are the reflection of large scale urbanization and the emergence of a multi-nodal urban system along corridors. We define those processes as densification, dissemination, extension and contraction of a transactional space (see figure 2-A). It is important to understand that those four processes are not unidirectional but cyclic. During an urbanization cycle of an EMR, processes are favouring spatial transformation (figure 2-B).

1) **Densification and dissemination.** Densification is a process of spatial accumulation of economic activities, which is placing more infrastructures (transaction, production, transportation and housing) within the same area. The objective is to generate more capital through higher levels of productivity. In contemporary economic systems, productivity is related to value-added knowledge-intensive activities (Castells, 1985). This requires high level of investments on new economic structures in order to increase the general economic output per unit of surface. Activities that do not generate enough capital are disseminated to places where their establishment will raise the productivity. Surplus capital generated by economic activities can be reinvested in the densification process or invested outside where they will produce a transformation of the spatial structure. Within an EMR, densification of certain types of activities favours the spatial dissemination of others. For instance, the densification of tertiary activities in a metropolitan area promotes the dissemination of industrial activities towards peripheral areas, notably desakota regions.

2) **Extension and contraction.** Extension is a space / time collapse allowed by the development of transportation infrastructures and related technologies. It involves the creation and the strengthening of linkages within and outside an EMR. Extension raises the area of influence of a hub centre, which is its transactional space. Travel time and travel costs have considerably decreased, and many activities that where dependant on the location of factors like labour, resources and/or market are no longer limited to labour pools, extraction sites and/or central areas. Those activities can be located almost anywhere as long as they have access to an efficient transportation system. The road network is the transportation mode that affects the most extension of Asian urban regions. Contraction can result if transportation costs sharply increase and/or competition from other transportation systems is in place. It implies a restructuration of the transportation system that aims on reducing distribution costs.

3) **Transformation.** It is a shift from extraction to production, notably from rural activities towards industrial economic production. Transformation can also include a shift in rural production and landscape towards specific demands, like foodstuffs and leisure. Transformation is mostly the result of the densification, dissemination, extension and contraction of economic activities within an EMR. With new transportation infrastructures, an area that was previously lightly affected by urbanization can find itself in a transformation process with new economic activities and shifts in rural production.

On figure 2-A, densification, dissemination, extension and contraction are represented individually to simplify the spatial processes involved. In reality those processes never occur alone,
but concomitantly. An overlay of the densification, dissemination, extension and contraction processes produces figure 2-B, which is our representation of an urbanization cycle forming an EMR. We must understand that the territorial definition of a transactional space is not discrete in the sense of boundaries. It is difficult to tell where an urban region ends and where other spatial entities (urban or rural) begin. The same can be said about the territorial definition of different spatial entities within an EMR.

![Figure 2: Spatial Processes of Large Scale Urbanization](image)

Now that we have a representation of the spatial structure, linkages and processes behind the territorial development of an EMR, we will apply that model to Singapore and investigate how transportation affects urban regions. We first look upon international and regional transportation factors to assess the maritime/air/land interface function of Singapore. This approach will focus on the nature and types of linkages supported by transportation systems.

**International and Regional Transportation**

The main tendency of the international transportation system is an adaptation of nodes to the international division of production facing a new transactional environment. The importance of a transportation node can be measured by its position relative to other transportation nodes. A set of nodes is a transportation chain linking economic areas. This has tended to imply fewer transportation
nodes, larger shipments and high capacity transportation chains to achieve economies of scale. Each hub centre must develop an efficient regional transportation network to coordinate and transit the production of a vast territory and maintain or increase its importance at a global scale. If a node has efficient intermodal infrastructures, it probably could strengthen its position within the transportation system. Such a node is a point of origin, destination and transit of large quantities of goods, people and information. Therefore, transportation is a general measure of the efficiency of a spatial system. Transportation, more precisely intermodal infrastructures, does not cause economic development, but is a predominant factor, among others, favouring the spatial accumulation and convergence of capital, resources, labour and infrastructures. In some cases transportation infrastructures precede spatial accumulation, in others they follow investments, and sometimes they are concomitant to it.

As a city-state with limited raw resources, Singapore has created and maintained strong linkages to support its economic viability and its service sector. The function of maritime crossroad between important economic blocs is central to the wealth of Singapore. Economic blocs represent countries that have strong economic linkages, but not necessarily cultural homogeneity. Two majors (North America and Japan) and four minors (Oceania, ASEAN, China and South America) economic blocs are adjacent to the Pacific Rim. China is also on the verge of becoming a major economic bloc. To this, we must add the four highly dynamic NICs that have made heavy investments to become regional intermodal centres. Therefore, the Pacific Rim is not a homogeneous economic bloc, but a set of more or less integrated economic areas. With the growth of trade, transportation linkages, economic development and more political stability, it is likely that the Pacific Rim will become a more coherent economic and transactional (if not cultural) space than it is today. The articulation points of that complex economic area are likely to be main maritime intermodal centres that will control the flows, the spatial accumulation and distribution of economic activities at a regional level. Major articulation points for the Pacific Rim are the West Coast of the United States (Los Angeles, San Francisco and Seattle), Japan (Tokaido), Korea (Seoul-Pusan), Taiwan (Taipei-Kaohsiung), Shanghai, Hong Kong and Singapore.

**International trade**

An analysis of trade reveals that the international trade of Singapore is mostly regional, notably with Japan and Malaysia, but strong linkages exist with the United States and Europe, mainly for exports. The trade of Singapore with Asian countries represents 58.6% of the total trade in 1990 and the trade balance is highly negative, especially with Japan (Singapore, 1990). A preliminary explanation of that situation is that Singapore is a regional hub for trade and a transhipment centre for commodities.

**Table 1: Value of Imports and Exports by Commodity, Singapore 1990**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Imports</th>
<th>Total Exports</th>
<th>Domestic Exports</th>
<th>Share of Domestic Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food, Beverages, Tobacco, Animal &amp; Vegetable Oils</td>
<td>6,493</td>
<td>4,882.7</td>
<td>1,931.1</td>
<td>39.5%</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>Raw Materials</td>
<td>2,371.1</td>
<td>2,914.6</td>
<td>460.1</td>
<td></td>
</tr>
<tr>
<td>Petroleum &amp; Fuels</td>
<td>17,398.9</td>
<td>17,295.3</td>
<td>17,136.7</td>
<td></td>
</tr>
<tr>
<td>Chemicals</td>
<td>8,440.5</td>
<td>5,970.1</td>
<td>3,618.6</td>
<td></td>
</tr>
<tr>
<td>Manufactured Goods</td>
<td>14,167.5</td>
<td>6,651.3</td>
<td>2,126.9</td>
<td></td>
</tr>
<tr>
<td>Machinery &amp; Transport Equipment</td>
<td>49,065.1</td>
<td>47,732.6</td>
<td>32,351.8</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous Manufactured Articles</td>
<td>10,450.2</td>
<td>8,499.7</td>
<td>4,866.4</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1,419.6</td>
<td>1,259.7</td>
<td>262.5</td>
<td></td>
</tr>
<tr>
<td>Technological Goods¹</td>
<td>17,391.7</td>
<td>28,593.1</td>
<td>21,997</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>109,805.9</strong></td>
<td><strong>95,206</strong></td>
<td><strong>62754.1</strong></td>
<td></td>
</tr>
</tbody>
</table>

in million S$  
¹ Includes Telecommunication Apparatus, Office Machines, Scientific & Optical Instruments and Printed Matters.

**Source:** Yearbook of Statistics (1990), Singapore, Department of Statistics.

Table 1 presents the transhipment role of Singapore by type of commodity. The higher the share of domestic exports is for a commodity, the more the industrial production of that commodity is concentrated in Singapore. A low share emphasizes the function of Singapore as a distribution centre for goods. Trade linkages vary by types of commodities and are the reflection of the regional distribution of economic activities. The fact that domestic exports account only for 15.8% of the total exports for raw materials and 39.5% for food and related products support the assumption of a distribution centre for resources (see table 1). Overall, 34.1% of the value of exports of Singapore concerns re-exports. It thus benefit from a regional convergence in goods through a distribution network controlled by Singaporean firms. In fact, Singapore is importing more manufactured goods than it is exporting (12.9% versus 7.0% of its trade in 1990). Only 32.0% of exports in that sector are domestic, confirming changes in the industrial structure towards a regional distribution of the production in specific sectors (table 1). Technological goods like telecommunication apparatus and office machines now account for 35.1% of Singapore's domestic exports and 76.9% are domestically produced.

International trade and transhipment functions of Singapore rely upon two major transportation modes, which are maritime and air transportation. Telecommunications have also an important role in the regulation of transactions. Those modes are the support of linkages in a regional distribution of economic activities.

**Maritime transportation**

The prominent position of Singapore in the international transportation system is mainly attributed to the efficiency of its port as an intermodal maritime centre having deep water berths. Singapore has benefited from its strategic position and developed intermodal infrastructures and
related activities. As a result, Singapore is the biggest port in the World in terms of total tonnage of ships, and in Asia it ranks first in containers handled, not far in front of Hong Kong, Kobe and Kaohsiung. One important aspect to the development of maritime transportation is the presence of international maritime transportation firms and services like insurance and shipping companies. We mainly assess maritime transportation by an analysis of the cargo handled by the port of Singapore.

Table 2: Singapore: Sea-Borne Cargo Handled, 1980-1990

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Containers</th>
<th>Unloaded</th>
<th>Loaded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>General and Bulk</td>
<td>General and Bulk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral Oil</td>
<td>Total</td>
</tr>
<tr>
<td>1980</td>
<td>12,550</td>
<td>18,490</td>
<td>31,633</td>
</tr>
<tr>
<td>1985</td>
<td>23,862</td>
<td>23,656</td>
<td>38,430</td>
</tr>
<tr>
<td>1990</td>
<td>76,631</td>
<td>52,888</td>
<td>53,335</td>
</tr>
</tbody>
</table>

in thousand freight tonnes.

1 Including containers.


Table 2 shows the evolution of the activity of the port of Singapore since 1980 where the share and volume of mineral oil handled over the total cargo is very important but decreasing (46.3% in 1990 versus 60.8% in 1980). Petroleum products account for approximately 25% of the value of trade. This is related with the fact that Singapore is the third largest refining centre in the World, with a capacity of 1.1 million barrels per day (Fesharaki, 1989). Clearly, the domestic demand does not justify that capacity even if Singapore is a refuelling centre for a large fleet. Singapore serves as an oil refining and distribution centre for all Southeast Asia (Sharma, 1989). Countries like Malaysia, Brunei and Indonesia are important oil producers, but they lack the capacity, skilled labour and technology to process all their oil production in specific petroleum products. With its efficient port infrastructures, deep water berths and shore based refineries, Singapore can accommodate large tankers, process the oil and re-export it. Over that aspect, table 1 shows that 99.0% of petroleum exports are domestic exports and that Singapore exports approximately that same value of petroleum than it imports. Its strategic position between oil producing countries in the Middle East and big consumers like Japan, Hong Kong, Taiwan, South Korea and to some extent Western United States, has favoured the development of Singapore’s petrochemical industries. The logistics behind regional oil distribution obviously requires heavy use of maritime transportation.

The spectacular growth of containers handled in Singapore since 1980 (+510.6%) underlines its importance as a load centre (see table 2). With an average turnaround time of 20 hours and an average waiting time of seven hours in 1986 (Fesharaki, 1989), Singapore is a major hub for the round-the-world container shipping introduced in 1984 by the Evergreen maritime company. This
service uses very large, high speed container vessels that require a maximum handling capacity of the port's intermodal infrastructures and a limited number of ports of call. The regional accessibility and convergence that the intermodal transportation system of containers offers is tremendous. The strong growth of containers can also be used as an indicator of a structural shift in the economy. Considering the nature of freight carried through containers, which are consumption goods with high added-value, Singapore is not only producing more goods of that type, but also spreading this type of production over a larger territory. It thus plays an important role as maritime transhipment centre for bulk goods (mostly petroleum) and containers (manufactured goods).

**Air transportation**

Air transportation is a key factor in the integration of a hub centre to the international transactional network. A growth in the service sector, especially in international management and financial services, is always accompanied by a growth of air traffic (Taneja, 1988). This is even more true with visitors (business people and tourists), which requires important accommodation infrastructures like hotels. Airports are therefore a fundamental intermodal infrastructure for transactional related activities of a World city. Service activities were always important in the Singaporean economy, but recent changes in the service sector underline the growing role international contacts. In 1990 the airport of Singapore (Changi) accommodated a traffic of over 14 millions persons (Singapore, 1990). This ranks Singapore 18th in the World, but fifth in Asia not far after Hong Kong (more than 18 millions persons in 1990).

**Table 3: Air Traffic of Singapore, 1980-1990**

<table>
<thead>
<tr>
<th>Year</th>
<th>Aircraft Landing</th>
<th>Passengers</th>
<th>Air Cargo¹</th>
<th>Discharged</th>
<th>Loaded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Arrival</td>
<td>Departure</td>
<td>In Transit</td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>37,956</td>
<td>3,140,723</td>
<td>3,151,032</td>
<td>1,002,794</td>
<td>90,713</td>
</tr>
<tr>
<td>1985</td>
<td>36,600</td>
<td>4,323,587</td>
<td>4,397,908</td>
<td>1,135,335</td>
<td>167,388</td>
</tr>
<tr>
<td>1990</td>
<td>48,803</td>
<td>7,237,233</td>
<td>7,166,347</td>
<td>1,217,178</td>
<td>324,157</td>
</tr>
</tbody>
</table>

¹ In tonnes.

**Source:** Yearbook of Statistics 1990, Singapore, Department of Statistics.

Table 3 shows that in 1990 the airport of Singapore accommodated approximately 40,000 passengers a day, of which 3500 were in transit. While the number of passengers in transit has remained stable, the number of arrivals and departures has more than doubled since 1980 and air cargo has more than tripled (table 3). Thus, the role of Singapore as a place of origin, destination and transit of air traffic is increasing. This fact is also underlined by the important growth of the number of visitors. From over 5 millions in 1990, recent tendencies show that the number of visitors has
passed to 6 millions in 1992 and 6.4 millions in 1993 (China News Digest, 26-01-94). Also, 36.3% of the total kilometers flown in Southeast Asia by civilian aircrafts were handled by Singapore (ICAO, 1990). Available evidence underlines that Singapore is limited to be a regional air transportation hub, not an international platform. Only several major airports within a highly integrated urban system can attain that status. There are three such platforms in the World: Japan, Western Europe and Eastern United States. For instance, the three major airports of Japan (Haneda, Osaka and Narita) handled a traffic of 83 millions persons in 1990. Air transportation thus emphasizes the developing transactional network of Singapore and its function as a service centre.

**Telecommunications**

Growing information exchanges are the result of profound modifications in the nature of economic activities and the emergence of a new regional transactional environment (Bakis, 1987). Over this, telecommunications encompass the dimension of movements of information, which can take numerous forms (Gillespi and Williams, 1990), and where transactions must be supported by efficient telecommunication infrastructures. The transformation of the Singaporian economy towards transactional activities requires an increasing reliance on telecommunications. For instance, the number of international phone calls has grown from 3.5 millions in 1980 to 73.9 millions in 1990, a 2011% increase (Singapore, 1990). While Singapore is becoming a major hub in Southeast Asia for the transportation of goods and people, the city-state is also investing massively in modern telecommunication infrastructures to support the emerging transactional environment.

**Transportation Assessment**

The simultaneous growth of maritime and air transportation and telecommunications has a strong synergistic effect on all aspects of the economy and transforms the territorial structure and linkages within the EMR. The position of Singapore in the international and regional transportation systems can be summarized by the following points:

1. **Transportation interface.** Singapore emerges as a regional transportation hub and intermodal centre. It offers a multimodal (maritime, land and air) interface between regional and international transportation systems that regulates transactions. The Singaporean economy draws out value from this transhipment function and reinforce its handhold on regional distribution systems.

2. **Trade relations.** Singapore is experiencing changes in patterns and nature of trade underlining new international and regional linkages. Regional trade is increasing, mainly because of a vertical distribution of production systems where Singapore remains an important oil refining and distribution centre and a centre for technological innovation and production.

3. **Containers.** The growth of containers transportation underlines the convergence of movements from a regional production system and a new logistic in goods transportation. From that point, Singapore is an efficient transhipment and distribution centre that has mastered containers logistics (just-in-time / door-to-door strategies).
(4) Contacts and information. There is a growing role of air transportation and telecommunications facing a new transactional environment that requires contacts and information exchanges. They reflect new types of linkages related to new economic structures.

Considering international and regional transportation assessments for Singapore, let's look upon the regional urbanization processes and how they transform the territory.

Territorial Transformations

Our perspective of territorial transformations in the Singapore EMR consider them within processes of densification, dissemination, extension and contraction (see figure 2).

Densification and Dissemination

The spatial accumulation of economic activities and infrastructures has been intense in Singapore over the 80s. While the population has only increased by 250,000 (+11.4%) from 1980 to 1990, bank assets have quadrupled (+302%) and the gross domestic product has more than doubled (+150%, see table 4). This means that the economic system can is approximately 2.5 more productive in 1990 than in 1980. It is unlikely that the same economic structure could achieve those results. Singapore is also investing in an efficient public transportation system that is extending towards Johor Baru (Varaprasad, 1989). Individual mobility has so increased that the authorities have restrained the use of cars and favoured public transit. This mode has a much higher capacity but is less flexible. With the same road surface, Singapore can cope with the growth of mobility demand.

<table>
<thead>
<tr>
<th>Year</th>
<th>Population Density¹</th>
<th>Value Added per Worker³</th>
<th>Built-up Area¹</th>
<th>% of Total Area</th>
<th>Banks: Total Assets²</th>
<th>Gross Domestic Product²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>3,907</td>
<td>30,027</td>
<td>275.1</td>
<td>44.53</td>
<td>33,316.1</td>
<td>25,090.7</td>
</tr>
<tr>
<td>1985</td>
<td>4,122</td>
<td>42,436</td>
<td>298.8</td>
<td>48.15</td>
<td>70,618.0</td>
<td>38,923.5</td>
</tr>
<tr>
<td>1990</td>
<td>4,250</td>
<td>60,488</td>
<td>311.6</td>
<td>49.23</td>
<td>134,002.0</td>
<td>62,711.3</td>
</tr>
</tbody>
</table>

¹ In square kilometre (population per square kilometre for population density).
² In $S Million at current market prices.
³ In S dollars. This measure is for the manufacturing sector.


Table 4 shows several available measures of densification of Singapore over the 80s. Some spatial characteristics have remained relatively stable like the population density and the built-up
area, but the value added per worker, bank assets and the gross domestic product have all shown important increases. The most important change is in bank assets, which are strongly linked with the available capital for investments. Densification in Singapore is concomitant to a period of dissemination of many unproductive economic activities. Labour shifts are a good way to illustrate that tendency.

**Table 5: Changes in the Gross Domestic Product and Labour by Industry, 1980-1990**

<table>
<thead>
<tr>
<th>Industry</th>
<th>1980</th>
<th>1985</th>
<th>1990</th>
<th>Δ% 80-90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture &amp; Fishing</td>
<td>1.28</td>
<td>0.75</td>
<td>0.28</td>
<td>-78.12 (-75.80)</td>
</tr>
<tr>
<td>Quarrying</td>
<td>0.33</td>
<td>0.29</td>
<td>0.13</td>
<td>-60.60 (-50.00)</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>29.14</td>
<td>23.59</td>
<td>29.14</td>
<td>+0.00 (-5.52)</td>
</tr>
<tr>
<td>Utilities</td>
<td>2.21</td>
<td>2.04</td>
<td>1.98</td>
<td>-10.41 (-41.77)</td>
</tr>
<tr>
<td>Construction</td>
<td>6.43</td>
<td>10.71</td>
<td>5.61</td>
<td>-12.75 (+36.91)</td>
</tr>
<tr>
<td>Commerce</td>
<td>21.66</td>
<td>17.05</td>
<td>17.27</td>
<td>+3.48 (+3.48)</td>
</tr>
<tr>
<td>Transport &amp; Communications</td>
<td>14.04</td>
<td>13.45</td>
<td>13.09</td>
<td>-6.77 (-15.52)</td>
</tr>
<tr>
<td>Financial &amp; Business Services</td>
<td>19.70</td>
<td>27.37</td>
<td>32.80</td>
<td>+66.50 (+36.53)</td>
</tr>
<tr>
<td>Other Services</td>
<td>9.12</td>
<td>11.76</td>
<td>10.12</td>
<td>+10.96 (-5.05)</td>
</tr>
<tr>
<td>Total GDP(^1)</td>
<td>25,090.7</td>
<td>38,923.5</td>
<td>62,711.3</td>
<td>+149.94</td>
</tr>
<tr>
<td>(Total Labour(^2))</td>
<td>(1,073.4)</td>
<td>(1,154.3)</td>
<td>(1,485.8)</td>
<td>(+38.42)</td>
</tr>
</tbody>
</table>

All statistics are in percentage. Labour is within parentheses.

1 In $S million at current market prices.
2 In thousand persons.

**Source:** Yearbook of Statistics, Singapore 1990, Department of Statistics, Singapore.

Table 5 indicates the negligible contribution of the agricultural sector in the economy. The availability of land is scarce and land prices are very high. Agriculture cannot generate enough capital per unit of surface to justify its usage of land near Singapore, which has been for a long time relying on external food supplies, supported by a distribution system. Manufacturing, construction, commerce, transport and communication are stagnating, even decreasing in their part of the total GDP. The greatest increases are within the financial, business and other services sectors. The growth of productivity of the financial and business services sectors is underlined by the fact that labour
force has grown by 36.5% while its part of the GDP has jumped by 66.5% (table 5). Drops of labour share in the manufacturing sector and a stabilization of its part of GDP suggest that the production is more technologically oriented, generating more capital with less labour, thus more productive. At a global scale, a growth of 38.4% of the total labour force was accompanied with a growth of 149.9% of the GDP (table 5), confirming that Singapore can generate more capital per unit of surface. Those changes are generating a process of dissemination. The higher the productivity, the more some production activities having less productivity are "expelled" towards the periphery. The densification and dissemination of economic activities in the Singapore EMR rest upon an efficient, low cost multimodal transportation system providing accessibility for peripheral areas.

Extension and Contraction

The space / time collapse within Singapore EMR can be understood with the rising accessibility of the Johor region and Riau Islands to the Singapore intermodal centre and a drop in transportation costs. For instance, a newly established boat shuttle service links a Riau island (Batam) with Singapore in 30 minutes, while a new one billion S$ causeway linking Singapore to Johor is planned. Over the past, Singapore has successfully managed its internal transportation system (Pendakur, 1989; Varaprasad, 1989), and now it is providing transportation infrastructures and logistics at a regional level. This implies a strong growth of linkages and the spatial distribution of the production system. Another important factor of extension is related to location costs, mainly land and labour costs in areas adjacent to Singapore. The high growth of land price in Singapore is forcing labour-intensive industries to relocate while knowledge/capital-intensive activities settle in. With an average wage of 90 and 150 US$ a month in Batam and Johor respectively (1990 figure for unskilled labour), multinationals can maintain knowledge-intensive operations in Singapore while relocating labour-intensive activities in Johor or Riau (Lee, 1991). This is a regional distribution of labour scattered over a large territory and generating movements of people, goods and information. Spatial extension for some economic activities is also well exceeding the EMR, like the implication of Singapore in the transportation and industrial development of China, notably in the Changjiang delta.

The contraction of the Singapore EMR is more difficult to assess. We suppose that the development of modern transportation systems competes with more traditional means. Also, Singaporean transportation firms are often in a better position than Malaysian and Indonesian firms for providing a distribution network, even over their respective territory. In those conditions transportation firms could experience a spatial contraction of their transactional networks in regard of an extension of the ones of Singaporean firms.

Transformation

Although our processes are transforming the landscapes of several areas (mainly in East and Southeast Asia), the developments most related to the Singaporean transactional space are in the Riau islands and the Johor province.

(1) Riau islands. We have seen that the restructuring of the Singapore economy towards
transactional functions forces certain economic activities to relocate outside the metropolitan area. In the Riaus, an island based transformation occurs when investments are done and labour is imported into scarcely populated islands where proximity to Singapore confers low distribution costs. For instance, the population of Batam, the nearest island from Singapore, has grown from 43,000 in 1983 to 106,800 in 1990, a 148% increase. The transformation of the economic structure in Riau islands is mainly focused in two sectors, leisure and agriculture, while other parts are more oriented in manufacturing activities (Batam for instance). From 1985 to 1990 the number of tourists in Batam has grown by 865%, confirming the fast development of the leisure sector.

(2) Johor state. In 1990, the population of Johor was 2.2 million (12.4% of Malaysia), and Johor received 7.4% of total foreign investments in Malaysia (Lee, 1991). Its industrial output has increased by 25% between 1988 and 1990 and accounted for 28% of the Malaysian GDP (11% in 1980, idem). The industrial penetration occurs mainly in industrial estates where foreign enterprises receive special advantages like tax reductions and use nearby labour pools. However, shortages of labour are already occurring, causing a raise in wages. In 1990, 27.0% of Johor's foreign investments came from Japan, 22.7% from Singapore and 13.7% from Taiwan. Even if most of foreign investments do not come from Singapore, a great part of the production of Johor must transit through the intermodal infrastructures of the city-state. Also, Singapore provides financial services for firms investing in southern Malaysia. Therefore, the territorial transformation of Johor is oriented towards some labour intensive industrial sectors having strong linkages with Singapore as a gateway to the international market.

Territorial Assessment

The territorial assessment of Singapore EMR can be understood within a transportation / land use perspective:

(1) Transportation. Singapore is emerging as an international/regional transportation hub for movements of goods, people and information, the result of heavy investments in maritime, land and air transportation infrastructures.

(2) Land use. Singapore is transforming its economic structure towards services and "World City" activities, controlling a regional transactional space. There is a regional distribution and vertical integration of production systems to enhance the viability of the city's service sector and to compete in a global economy. This transforms the territory through new types of land uses and new relationships between them.

Figure 3 represents the spatial structure of Singapore EMR, which can be divided in two distinct spatial systems: the continent and the seaboard (A). The continental system is a growth corridor that starts from Singapore and extends in Malaysia towards Kuala Lumpur. Areas in transformation correspond to main roads (B). To underline the growth corridor, a highway will be built, linking Singapore, Johor Baru and Kuala Lumpur. The rail network plays a limited role in the structure of the corridor, since most shipments are using the road network.
The seaboard system is multipolar because it is not constrained by land factors like the topography and by the presence of road transportation infrastructures. Each island is therefore a spatial entity performing a specialized economic function. Areas in transformation are mainly Batam and Bintam islands that can be reached from Singapore within 30 to 45 minutes by ferry. For instance, the number of ship port calls has grown by 650% in Batam between 1983 and 1990 (Lee, 1991). The EMR is rapidly extending towards the Riau Islands because of available land, imports of cheap labour from Indonesia, and their high accessibility to Singapore's intermodal centre.

The main territorial function of Singapore is to act as the maritime/land interface for the region (A). This underlines the strategic importance of intermodal infrastructures and multimodal transportation logistics.
Discussion

Territorial development, spatial accumulation and linkages within Singapore's extended metropolitan region raise several questions including the following: 1) What will be the spatial pattern resulting from large scale urbanization? 2) What kind of transportation / land use problems are likely to emerge? 3) Are there any applicable planning strategies for EMRs? We discuss here introductory aspects of those problems.

Spatial Pattern

Road transportation is the main mode affecting Singapore EMR. Even if road transportation is flexible in terms of distribution and configuration, the existing urban system imposes a structure of the network along corridors. Road transportation corridors favour a linear distribution of economic activities, while intermodal transportation has a radial influence over space. This radial influence is the result of the location of intermodal infrastructures at a specific point forming a hub centre where movements converge. Since EMRs are resting upon a set of linear transportation infrastructures with nodes at radial intermodal centres, it is likely that corridors of economic development will emerge between main intermodal and economic centres. A set of highly developed EMRs will form a mega-urban region characterized by several transportation corridors linking many intermodal points (hub centres). Past examples of urban regions like the Boswash (Gottmann, 1987) and Tokaido (Rimmer, 1986) megalopolises show that all transportation corridors are oriented along historical places of spatial accumulation where metropolitan centres play the role of articulation points.

The regional context of Singapore prevents the emergence, within a foreseeable future, of a complex urban system, which is a mega-urban region. The main reason is that Johor and the Riaus have a low population density. The spatial pattern of the Singapore EMR is extending towards Kuala Lumpur, so it is likely that eventually a regional (Singapore-Kuala Lumpur) transportation corridor will emerge. There is also an island based development towards Indonesia, which offers a high labour supply. The seaboard side of the Singapore EMR is likely to be multipolar, with a set of production and leisure centres linked to Singapore by air and sea transportation. This type of island economic development is original and potentially highly productive because it requires very few investments in transportation infrastructures. Islands offer numerous coastal areas where investments (notably in leisure) are performed, while the island mainland is most of the time disregarded.

Singaporean authorities have advocated the notion of "Growth Triangle" to describe the emerging spatial pattern between Singapore, Johor and the Riaus (see for instance Lee, 1991). Since Singapore is the only major intermodal centre, the notion of "Growth Triangle" is subject to discussion. The weight of Singapore in that "triangle" imbalance it to the point that it must rather be viewed as a corridor (see figure 3-A). Thus, from a transportation point a view, there is only a "Growth Corridor" with Singapore at the centre with Johor and the Riaus as peripheral extensions being incorporated in the Singaporean transactional space.

Transportation/Land Use Problems
With the emergence of diversified economic activities in urban and in formerly rural areas, acute transportation/land use problems are likely to appear. Cheap and available land with basic road transportation infrastructures and nearby labour pools are attractive to investments and scatter economic activities over a large territory. As the density of economic activities, the production level and shifts in labour increase, so do the linkages and the transportation demand. Transportation infrastructures that were initially sufficient will soon become congested. Adding new transportation infrastructures will be a difficult task because very few areas will have a sufficient land use density to justify investments. Scattered production is economical for individual investors (accessibility, land price, labour, etc...), but expensive for the state and the society (congestion, pollution, redundancy, external costs, etc...). Therefore, interactions between different types of land uses (e.g., agricultural zones, light factories, residential estates, warehouses) will be of great concern to planners trying to understand and order the territorial logic of those urban regions.

One of the major land use problems of EMRs is that urban and industrial development often occurs over highly productive rural areas, reducing at a regional level the cultivable land. This has high potential repercussions since Asian countries face strong demographic growth and limited development areas. What will occur is a redefinition of food supply sources and of the function of rural extraction areas. Imports are to compensate shortages in food supply. EMRs are also characterized by rapid unplanned development in rural areas where environmental control policies are nearly nonexistent, thus creating potential health problems and fast environmental degradation. Environmental problems are likely to occur in Johor with rapid industrialization in rural areas with few control policies. In the Riaus those problems involve the degradation of shores and marine life by the construction of resort complexes and the destruction of natural habitat by industrial and agricultural estates.

**Planning Strategies**

Planning strategies involve an appraisal of economic and transportation developments over an extended territory with scattered economic activities. There are many municipal, regional and even national governments involved. Thus a comprehensive planning scheme is highly problematic within all those administrative divisions that favour conflicts of jurisdiction. If no "Extended Metropolitan Board" or any large scale management agency is established, it is likely that contradictions in local policies will soon become a negative factor in development. Over that aspect, it is quite a challenge for Singapore since there are three national governments involved: Singapore, Malaysia and Indonesia. A preliminary policy could concentrate on regulating transactions inside the EMR. For instance container transportation firms operating from Singapore require fast custom procedures if they want to provide "door-to-door" services in Johor. Malaysian and Indonesian transport enterprises should have the same accessibility to intermodal infrastructures in Singapore. Obviously, this is subject to agreements between respective firms providing transport services.

A potential way to overcome the "over-extension" of economic activities is to concentrate most transportation investments along a linear corridor. Linear development is apt to answer varied transportation demands with limited transportation investments. It covers an extended territory with enough land for the needs of most development projects. A corridor minimizes transportation costs
but must have a very high capacity since most movements will occur along it. Considering the conflicting needs for cultivable land, production activities and transportation infrastructures, especially road transportation, it is not an easy undertaking. The general problem is giving a sufficient level of accessibility to each land use zones, from rural extraction to high technology production.

Another challenge lay in the development of the multimodal transportation system. Creating efficient intermodal nodes, like road-rail, at strategic locations along a linear transportation corridor could alleviate congestions and raise the capacity of the transportation system. However, this requires a standardization of loads and a transportation logistics that containers transportation firms already offer. An efficient maritime / land interface is also of prime importance. This strategy is highly applicable to the Singapore EMR since the port of Singapore has a high handling capacity for containers and has developed a strong expertise in transportation logistics.

**Conclusion**

Singapore is integrating a large transactional space that includes the Johor province in Malaysia and the Riau Islands in Indonesia. Regarding this, we have presented an EMR spatial model that provides a framework to understand the emergence of this regional transactional space. Transportation is a key factor related to four processes of territorial development in Singapore extended metropolitan region, which are densification, dissemination, extension and contraction. Through densification - a process of spatial accumulation of economic activities aiming higher levels of productivity - the territorial function of Singapore changes towards new sectors of activity. Dissemination - a spatial relocation of economic activities towards productive areas - is the process behind the industrial development in Singapore’s peripheral areas. Extension - a space / time collapse within transportation systems - enables economic activities to within the EMR while maintaining economies of scale and low distribution costs. Contraction - a rationalization of distribution systems - is imposed by Singaporean transportation firms over other firms in competition with them.

Transportation systems therefore support the exploitation of the comparative advantages of a territory mostly in terms of resources, labour and land. We have suggested that nearly all the international trade generated inside the extended metropolitan region transit through Singapore. The main reason is that Singapore has invested in efficient intermodal infrastructures for people, goods and information and thus offers a good transactional network and environment. Container terminals are an example of Singapore's efficiency for intermodal transportation. Considering this, Singapore is likely to become the transportation hub of all Southeast Asia thus controlling most of the transactions and the distribution of spatial accumulation.

Large scale urbanization is mostly based on the growth of economic activities in linear transportation corridors. However, factors favouring the extension of urban space are also creating acute environmental and transportation/land use problems. The extended metropolitan region is mostly an unplanned territory were the economic forces of the international market play an
important, but divergent role. There is a high potential for territorial disintegration, like the loss of the comparative advantages of scattered production units.

Among the numerous research perspectives related to extended metropolitan regions, an investigation in the role and function of port cities with their foreland and hinterland deserves some consideration. Also transportation / land use relationships within urban regions are of prime importance to understand processes of spatial accumulation and to elaborate subsequent planning strategies. This paper has attempted to bring a preliminary viewpoint on the interface between port cities, urban regions and their transportation systems in the Singaporean context.

Bibliography


China News Digest (1994) Electronic news service, Internet CND-editor@CND.ORG.


International Civil Aviation Organization (1990) Civil Aviation: Total Scheduled Service, Montréal, Canada.


