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1995

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Faculteit der Economische Wetenschappen en Econometrie

Serie Research Memoranda

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Research Memorandum 1995-27

vrije Universiteit *amsterdam*

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DRAFT VERSION

JULY 1995

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Abstract

Quick **scan** methods aim at a fast and transparent analysis of altemative solutions to planning problems in a situation of shortage of information. They **generate** new knowledge about solutions in early stages of decision **making** and in **'creative** experiments' in scenario analysis. The **importance** of quick **scan** methods is growing within the trend toward more flexible and **interactive** approaches in decision **making** in policy and planning.

This article presents a quick **scan** of altemative technology options to transport problems, in view of their adoption in the market. The **technologies** involved represent good efforts to **contribute** to energy efficiency and a reduction of air pollutants. The perspective used in this quick **scan** is spatial by emphasizing the influence of spatial settlement patterns in scenario thinking on future transport.

Key Words: Quick **Scan,** Multicriteria Analysis, Transport Technology, Urbanization Pattem.

1. PROBLEM FIELD

In the past decades, transport has continued to increase its consumption of non renewable energy sources, to lead to increasingly higher levels of congestion, and to emit substantial levels of gases (including greenhouse gases).

Major allies in coping with transport pollution and energy use are usually expected to be in behavioral changes (e.g. mobility and life style patterns), and changes in geographical patterns of living, working and recreating [1, 2, 3]. In addition, technological progress is usually considered an important means in coping with the problems. Therefore, a systematic assessment of the opportunities offered by new transport technologies may bring to light new policy perspectives. This article will address the potential of such new technologies by means of a quick scan approach.

The technologies in this quick scan procedure exemplify good efforts to contribute to a sustainable passenger transport, in terms of energy efficiency and emission of greenhouse gases (Table 1) [4]. Their potential use is on different spatial scale. In addition, both foreseeable developments with a relatively short lead time (conventional systems) and developments further away (advanced systems) are taken into account. Of course, the list of technologies is not exhaustive but mainly indicative.

Table 1 Transport technologies and spatial scale

The need for transport emerges where functionally dependent human activities are separated in space. In the 1960s and 1970s, the spatial separation of working and living was enlarged to an unprecedented degree. This suburbanization was primarily residential and caused therefore, a focused pattem of longdistance commuting from suburbs and outer areas to centra1 cities. Later developments were considerably more complex because the sprawl of living quarters was coupled with a substantial suburbanization of employment, leading to an increased cross-commuting as well as relatively shortdistance intra-suburban commuting trips. Aside from living and working, also a separation of living and recreation took place in the past decades.

Spatial planning for a reduction of transport is stil1 limited in scope, because there is a shortage of knowledge on the underlying principles [5, 6]. Much research has focused on the relationship between urban form (size and density) and passenger transport. One of the major conclusions so far is that larger, dense cities are associated with a high use of public transport and with a low gasoline consumption [7]. What however, also matters is where the interdependent workplaces, service centers and houses are located within the metropolitan area, particularly also where populations with different life styles are living. In other words, the socio-economie composition of the city seems to be a further important element in the generation of passenger transport flows.

One particular planning concept is important here, namely the 'compact' city. Such a city is suggested to provide highdensity housing and a concentration of employment in the centra1 city-area and subcentres [8, 9]. The compact city is currently adopted in Europe as a leading principle in urban planning [10, 11], under the assumption of two major merits in terms of sustainable transport, namely short private joumey lengths and good prospects for public transport. In a decentralized city, however, jobs and houses tend to disperse further in and beyond the metropolitan area (a process named counter-urbanization), causing larger and more diffuse traffic flows [10]. Uncertainty about these developments will be dealt with in the quick scan procedure here.

2. INFLUENCES ON ADOPTION

Three types of factors influence the prospects for adoption of new transport technology from a spatial point of view:

(1) spatial inertia
(2) the technology's critical system features
(3) future urbanization patterns.

The most important barrier to adoption of new transport technologies seems to be spatial inertia. Once traffic infrastructure and other artefacts of human activity (such as houses, industrial premises and buildings) have been established, it will be used for a long time, at least the time needed to generate a sufficient return on investment. Spatial inertia holds particularly for historica1 buildings and sttuctures in inner city areas.

Critical system features are the set of specific attributes of a transport technology which determines the spatial conditions for implementation as well as (un)desired impacts of this implementation. For example, a critical system feature of public transport modes is the need for a minimum amount of travel demand (threshold level) in an area. Barriers to adoption arise when threshold levels of demand for the advocated technology are not reached, due to a low population density. In addition, upper levels are concemed with the maximum distance which particular vehicles can bridge. Accordingly, barriers may arise when distances in transport needs exceed the upper level of spatial reach. This barrier holds, for example, for particular types of electric car.

Different critical system features of transport technologies also cause a differentiation in the spatial impacts of these technologies. The most common negative impacts are noise, emission of gas, danger of accidents (crashes) and vibration. These may constitute a barrier to adoption when an accepted maximum leve1 of inconvenience is exceeded. New transport technology may, however, also cause various positive impacts, such as a fluid traffic instead of congestion, and potential creation of emission-free zones.

The way in which critical system features influence adoption, is very much dependent on the urbanization pattern that will develop in next decades. Future patterns of urbanization will therefore, be given particular attention in the current quick scan procedure.

At the metropolitan scale we take into account the previously discussed compact city and as a contrasting perspective, the decentralized city (Table 2). At the (inter)national scale, we will consider two contrasting perspectives designed by the Physical Planning Agency in the Netherlands [12], named (1) specialization and concentration and (2) chains and zones. The former articulates an ongoing concentration of population as a result of the location of leading economic (world) functions in leading (large) cities. This process will enforce a hierarchy of functions and a hierarchy of locations (including metropoles at the top, followed by europoles and smaller cities) which is likely to be associated with a hierarchy of transportation systems. Accordingly, metropoles are the center of a radial system (mainports) that connects them with europoles, and the europoles are the center of a radial system that connects them with smaller cities, etc. In contrast with this, the chains and zones pattem is weakly oriented toward a hierarchy of functions. Companies are increasingly footloose in such a way that the concomitant spatial processes lead towards dispersion on various scales. This pattem is associated with a criss-cross character of main traffic and transport relationships, whereas (national) spatial strategies tend to focus on the bundling of these relationships (in chains).

Table 2 Future urbanization patterns

3. METHODOLOGY

Scenario analysis has increased in importance in the past few years. Particularly for complex problems with a relatively long time horizon and concomitant shortage of information, scenario analysis has moved towards 'creative leaming' processes including various 'cycles' of activities to discuss, evaluate, register, synthesize and present information on potential development processes [13]. Within this framework, quick scans intend to bring new information to light which can be used in starting and restarting 'cycles' of scenario activity . Due to their simple and transparent character, they also allow for a more interactive participation of various stakeholders in policy processes. An essential component of quick scans is sensitivity analysis, in view of different policy assumptions (e.g. diverse community interests) and assumptions on developments which are beyond control (e.g. macro-economic conditions, urbanization patterns). Thus, by means of sensitivity analysis the stability of quick scan outcomes under different assumptions can be made clear.

A quick scan approach is used here in order to assess the chance for adoption of new transport technologies. It needs to be emphasized that there are three specific circumstances in this quick scan procedure. First, the altemative technologies will not be 'scanned' on their effectiveness in reaching sustainability aims in terms of energy use and air pollution. This is taken for granted [4]. Secondly, among a set of further conditions to adoption only spatial criteria will be explored. As a consequence, economic (cost) criteria and behavioral (attitudinal) criteria are excluded from the analysis. Third, only circumstances in the stage of exploitation of the technology will be taken into account (leaving most of the construction stage aside). We distinguish six spatial evaluation criteria as follows:

(1) **Spatial connection aud range:** the better the technology in terrns of bridging distances in a fast (smooth) way, the larger the chance for adoption.

(2) **Spatial demand**: the higher the threshold level of demand, the smaller the chance for adoption.

(3) **Infrastructure needs (spatial inertia):** the smaller the needs for new (additional) infrastructure, the better the chance for adoption.

(4) **Efficiency of land use:** the more efficient land (road) use, the larger the chance for adoption.

(5) **Local positive/negative impacts on surrounding land:** the less negative impacts (such as noise, vibration, danger for crashes), the larger the chance for adoption.

(6) **Landscape impairment:** the less impairment, the larger the chance for adoption.

In the current quick scan, scores will be assigned to each of the above criteria by using a five point rank scale, running from very positive conditions for adoption (5) to very negative conditions (1). The results will be processed by means of multi-criteria analysis (MCA), merely for illustration purposes.

The assignment of scores of the transport technologies on the above evaluation criteria is based upon a concise study of the literature. The head lines of this study are the subject matter of the next two sections.

4. CONVENTIONAL TRANSPORT SYSTEMS

This section will discuss three transport technologies which are already adopted on a smal1 scale and may be further adopted on the short term, i.e. High Speed (HS) Train, Maglev, and Improved Car.

The most important designs of HS Trains are the French TGV, the German ICE and the Japanese Shinkansen [14, 15, 16, 17]. Less mature systems are the Italian Pendolino ETR450 and the British IC225. In densely populated areas in Europe and Japan, HS train systems can very well compete with cars and jet aircraft between cities roughly 160 to 800 km apart.

The major positive feature of HS trains (in relation to adoption) is their smooth connecting of large metropolitan areas. At the same time, HS train is a transport mode with a relatively high threshold level of demand, i.e. the urban centers to be connected should be sufficiently large and sufficiently interdependent. A strongly positive feature of HS train operation is its compatibility with existing rail systems, and its smooth integration into conventional hierarchical systems. The voltage (in e.g. TGV) is however, higher than provided on most conventional tracks causing the need for a separate track (which cannot be used by other trains) or an adaptation of the power train. Further negative features include noise, vibration, and landscape damage in the case of completely new infrastructure.

When (inter)national urbanization patterns develop according to the chains and zones model, the interdependent metropolitan areas need to be sufficiently large (around a few million inhabitants) and the distance in-between needs to be sufficiently long to take advantage of the high speed. When urbanization patterns develop according to the specialization and concentration model, there seems no restriction to adoption.

Maglev systems make use of magnetic levitation (either through electromagnetic or electrodynamic suspension) while propulsion of the trains is realized by means of a linear induction motor. Presently, there is one High Speed Maglev system available for commercialization, i.e. the German Transrapid 07 [18]. Low Speed Maglev systems have been developed in Japan, Great Britain (Maglev People Mover) and Germany (M-Bahn). Like HS train, HS Maglev has clearly the positive feature of connecting city-centers of densely populated metropolitan areas in a fast and smooth way . Due to investment levels associated with a completely new infrastructure, it can however, only operate when there is a very high demand for transport, such as in Japan between Tokyo and Osaka [19]. A strongly negative feature of (high and low speed) Maglev systems is the need for a completely new infrastructure for accommodating trains, which is totally incompatible with existing rail systems. A further negative characteristic is the need of the new infrastructure to penetrate deeply into the city-hearts in order to be effective. There are also some unfavorable local impacts foreseen, such as aerodynamic noise (at high speed) and landscape impairment.

When urbanization develops according to the chains and zones pattem, the interlinked metropolitan centers need to be sufficiently large and the distance in-between needs to be sufficiently long to take advantage of the high speed. Adoption may be further hindered when the corridors between the metropolitan centers lack easy available land for a new infrastructure. When urbanization patterns develop according to the specialization and concentration model, adoption seems only realistic when there is a sufficiently large interdependency between the top metropolitan centers of a country. Similarly, the adoption of LS Maglev is dependent upon a relatively high demand for transport. On the scale of the metropolitan area (region) therefore, adoption seems only to be realistic under conditions of a high-density compact city. However, here comes a further complication because land for new infrastructure will not be easily available in densely populated areas.

The last conventional transport technology to be discussed here is Improved Car. A major example is the electric car based upon various energy devices such as an electric battery, a hybrid system and fuel cells [20]. Battery-electric cars will soon be introduced to the market in a number of niches. The technology has the positive critical feature of contributing to emission-free zones, provided that also regulatory measures are taken. The range of battery-electric vehicles (BEVS) is, however, stil1 limited to 70 to 100 km, whereas the top speed is about 100 km/h. The use of BEVS will therefore, mainly focus on urban traffic. Furthermore, a large scale introduction of BEVS makes the establishment of public charging stations necessary, including investment in grid and facilities. Hybridelectric vehicles (HEVS) may combine various benefits of electric contraction with the longer range, better performance and fast fuelling characteristics of conventional cars. A further type, fuel-cell powered vehicles, is similar to HEVS in tbat they also have an electric drive train combined with an on-board power source. The power source in this case is a fuel-cell, i.e. an electro-chemical device which directly converts chemical energy from fuel into electrical energy .

Except for the hybrid-electric (and perhaps also the fuel-cell vehicle), the most negative feature in view of adoption is the small maximum distance which can be bridged. When urbanization on the metropolitan scale develops according to the decentralized city, the option of improved cars with a short range seems hardly feasible. In the compact city, land use and transport planning largely favor public transport. When however, specific attention is given to road infrastructure and parking facilities at employment sites, the option of improved (small distance) cars may well be feasible in the compact city.

5. ADVANCED TRANSPORT SYSTEMS

This section will discuss three transport options of which market adoption may only occur merely on the longer term, i.e. Subterranean Systems, Hydrogen Aircraft and Guided Vehicles.

Advanced Subterranean Systems are different from all other modes in that they aim at a drastic reduction in both environmental and energy cost, due to their (almost) vacuum tubes. There are currently two designs of such systems available, i.e. the Dutch High Speed Tunnel Transport System (HSTT) [21] and the Swissmetro Project [22]. The Dutch concept of HSTT includes a network of tunnels in which a bullet-shaped vehicle is propelled by a linear motor. The maximum speed amounts to 500 km/h, while energy use will be extremely low. The HSTT system is designed for both passengers and freight transport, and is intended to compete with air and rail transport over distances exceeding a few hundred kilometers. A complementary feeder system ensures an efficient linkage with existing transport infrastructure. The Swissmetro Project is intended to connect the major Swiss cities, but different from the HSTT, it is only designed for passenger transport.

Subterranean Systems have the potential of connecting major cities in a very fast and smooth way . In addition, land use is typically very smal1 witness the need for land only for entrance and exit, and stations for air-conditioning. Investment costs are certainly very high so that the technology is restricted to heavily populated areas and corridors of very dense good transport. As a consequence, Subterranean Systems will be feasible on the interurban (national) and international leve1 when the trajectories include a considerable number of large and strongly interdependent population and industrial centers. The presence of natura1 barriers, including water, mountains and valuable nature reserve area, may also justify long-distance tunneling. Unlike High Speed Train and Maglev it is difficult to assess the influence of future urbanization patterns on adoption of Subterranean Systems. The ideas about the spatial scale of the systems, density of terminals, etc. are still too much speculative at present.

Our second example of advanced transport technology is Hydrogen Aircraft. Although aviation is currently responsible for a smal1 share in the world's carbon dioxide emission (3%), it needs to be realized that this mode is very fast growing. The use of hydrogen is one of the very few options for reducing emission of carbon dioxide [20]. A negative critical feature of Hydrogen Aircraft is the need for construction of a completely new hydrogen production, storage and distribution infrastructure, which is incompatible with the existing infrastructure of kerosene. Because the life-time of airplanes is roughly 25 years, the penetration of the Hydrogen Aircraft will be slow. As a consequence, both kerosene and hydrogen fuel systems will have to be in operation simultaneously for a certain 'transition' period. This requirement may put a heavy pressure on land in and around airports. At the same time, strong safety measures for distribution and storage seem to be necessary on a permanent basis, which may ask for additional use of land.

With regard to future urbanization patterns, it seems reasonable to assume that the high investment level associated with the new fuel system is only justified at mainports of very large cities, emerging particularly in the specialization and concentration pattem of urbanization.

The last advanced transport technology to be discussed is Guided Vehicles. This mode embraces two different systems, namely physically guided vehicles and electronically guided autonomous road vehicles. Physically guided systems work by means of mechanica1 interaction (rails) or electromagnetic energy (Maglev). There are two variants, namely systems of inseparable vehicles and guide-ways, and systems in which the guided vehicles can als0 drive like normal passenger cars.

A major example of the inseparable system is TAXI 2000 [23]. This urban transportation system operates under automatic control between stations in a network of narrow, unobtrusive guide-ways. Empty vehicles can be ordered continually so that they can anticipate demand and wait for people. Both passenger and freight vehicles may operate on the same network. A positive feature of this type of guided vehicles is the relatively small use of land. At the same time, it is associated with two negative factors for adoption, namely a limited reach and a high level of demand. Accordingly, when cities develop in a 'compact* way the inseparable system may be feasible on particular highdensity trajectories. Its use seems to be unrealistic in decentralized cities and (on higher spatial scales) in urbanization patterns where passenger flows are rather diffuse.

Systems of electronically guided autonomous vehicles (navigation) may range from route information systems to fully automated route guidance [23, 24, 25, 26]. Developments in electronic guidance are already taking place, for example in Europe in the DRIVE program. When all vehicles are centrally controlled, distances between them can decrease and speed can increase, leading to an avoidance of congestion. Electronic guidance systems contribute significantly to an efficient road use through the enforcement of rational driving behavior and efficient route selection. In addition, these systems claim a smal1 amount of extra land for infrastructure. From this point of view therefore, no restriction for adoption seems to be at work. When we come to the future pattem of urbanization on various scales, all pattems which generate traffic in relatively dense bundles may be subject to a fast introduction. On the metropolitan level, this means that compact cities have a higher chance for (a fast) introduction than decentralized cities.

The above insights serve as the principal basis for the assignment of scores on the evaluation criteria. For simplicity reasons, no priorities will be expressed for evaluation criteria (equal weighting). The associated evaluation matrices will be discussed in the next section.

6. QUICK SCAN RESULTS

The assignment of scores aims to be consistent between the three sets of altemative technologies (Table 3) although the amount of speculation is inevitably larger for advanced systems compared with conventional systems. A particular aim of our quick scan is to investigate the sensitivity of the outcomes to variation in future urbanization. The scores under the assumption of two different urbanization pattems are given in Table 4. The matrices show large differences in scores only on selected criteria. For example, we assume that the major difference in chance for adoption of Low Speed Maglev is based on spatial demand factors (criterion 2). In the compact city, a high leve1 of demand will contribute to the adoption of this technology (score of 4) while in the decentralized city a low (diffuse) demand will clearly hamper such development (score of 1). Although score differences like these are realistic and can be argued, there is nevertheless a certain amount of arbitrariness involved.

Table 3 Evaluation matrices

Table 4 Evaluation matrices from an urbanization perspective

To summarize the matrices a concordance analysis [27] is used. This method deals with qualitative (ordinal) measurement scales and is very simple to apply. It is based on a pairwise comparison of all altemative options, and subsequent substractive summation. Various more advanced techniques are available, but not strictly necessary in view of quick and transparent procedures [27, 28, 29].

The results of the quick scan can be summarized as follows (Table 5). With respect to conventional technologies and metropolitan scale, Improved Car has clearly better opportunities for adoption than LS Maglev. On higher spatial scales, again Improved Car (hybrid types with long range) has the best outlook for adoption, closely followed by HS Train. Regarding advanced transport systems, the best chance for adoption is clearly for Subterranean Systems, leaving Hydrogen Aircraft and Guided Vehicles far behind.

Table 5 Results of quick scan

Regarding the metropolitan scale, it appears that future urbanization pattems do not lead to fundamental shifts in results. In both compact cities and decentralized cities, the outlook for adoption is better for Improved Car. With respect to higher scale levels, one can observe a basic difference in outcomes between the specialization and concentration pattem and the chains and zones pattem. HS Train appears to be superior in the former (albeit with smal1 difference) while Improved Car (long range) has clearly the best outlook on adoption in the latter. At the same time the results for HS Maglev are similar under all conditions. It can thus be concluded that the current quick scan results are sensitive to future urbanization to a limited degree and only for higher spatial scale levels.

Quick scan results need to be visualized clearly in view of an efficient intetpretation by policy makers, future users of transport, and other consultants and experts in scenario writing. The 'spiders' used here (Figure 1) express the previously given evaluation scores for four separate technologies, under the assumption of different pattems of urbanization. Each axis represents one evaluation criterion and is accordingly scaled 1 to 5. The figure shows for example, the superiority of Improved Car over Low Speed Maglev, particularly a large score difference on spatial demand factors (decentralized city), local impact factors (particularly compact city) and infrastructure needs (both urbanization pattems). The visualization by means of 'spiders' makes the following information readily available:

(1) **the overall outlook** on adoption: **the** larger the 'web' the **higher** the chance for adoption.

(2) the **dominance of certain classes of criteria:** an orientation (high scores) towards the **left-hand side** in the **figure means** a favourable outlook on adoption based **upon** ecological (quality of life) criteria.

Figure 1 **Transport technology and chance for adoption**

7. CONCLUDING REMARKS

Quick **scan** methods are helpful in early stages of planning by providing new knowledge on altemative solutions in a simple, flexible and transparent way. There is a growing need for **such** methods within the trend for participatory approaches in decision **making**. Quick **scan** methods enable decision makers and other stakeholders to **participate** interactively in the **process** of **identifying** altemative solutions to planning problems, and identifying pros and **cons** of these solutions from different perspectives.

The quick **scan** in this article aimed to explore the adoption of **selected** new modes of passenger transport from a spatial perspective. With **regard** to conventional technology, Improved **Car** appeared to have the best opportunities on various spatial **scales**. Particularly on **higher scales,** High Speed Train **also** offers good outlooks for adoption. Regarding advanced technology, Subterranean Systems appeared to have **the** best **prospects** from a spatial point of view.

The front position of quick **scans** in scenario experiments clearly **causes** a need to 'test' the outcomes on stability while using different assumptions. Accordingly, the quick **scan results** here have been explored on the **influence** of different future patterns of urbanization. It appeared that our **results** are sensitive to future urbanization to a smal1 degree and only for **higher** spatial **scales**. On the **latter scales** different outcomes could be observed for Improved **Car** (long range) and High Speed Train. In **general,** the role of different assumptions **may also** be explored by assigning different priorities (and concomitant weights) to the **evaluation** criteria.

Now two questions need to be **answered,** namely (1) is the quick **scan used** here transferable to other policy situations, and (2) what is the validity of the achieved results? As to the first question, it seems to be that quick scans are useful in all policy situations where there is a need for a fust exploration of altemative options based on smal1 information. One example is the front stage in Environmental Impact Assessment [30]. In such situations, data may be of a mixed qualitative and quantitative type (instead of one type in the current analysis). Multi-criteria analysis however, offers various ways to handle such data situations [28]. As to the second question, it needs to be emphasized that a certain amount of arbitrariness is evident in all steps of the procedure where choices are at hand, i.e. the precise assignment of scores, the expression of priorities, and the selection of the processing technique. In fact, for all of these aspects the robustness of results should be ensured. However, in quick scan procedures a balance needs to be found between the speed (and transparancy) of achieved results and the robustness of these results. Because the balance needs to be in favour of the former, the best thing that can be done is to make arbitrariness explicit.

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Figure 1 Transport **technology and chance** for adoption

Evaluation criteria
(1) Spatial **reach** and connection
(2) **Demand**
(3) Need for new **infrastructure**
(4) Land **use**
(5) Local impacts
(6) Landscape.

URBANIZATION
c+z **chains and** zones
S+C specialization and concentration
DC **decentralized** city
CC compact city

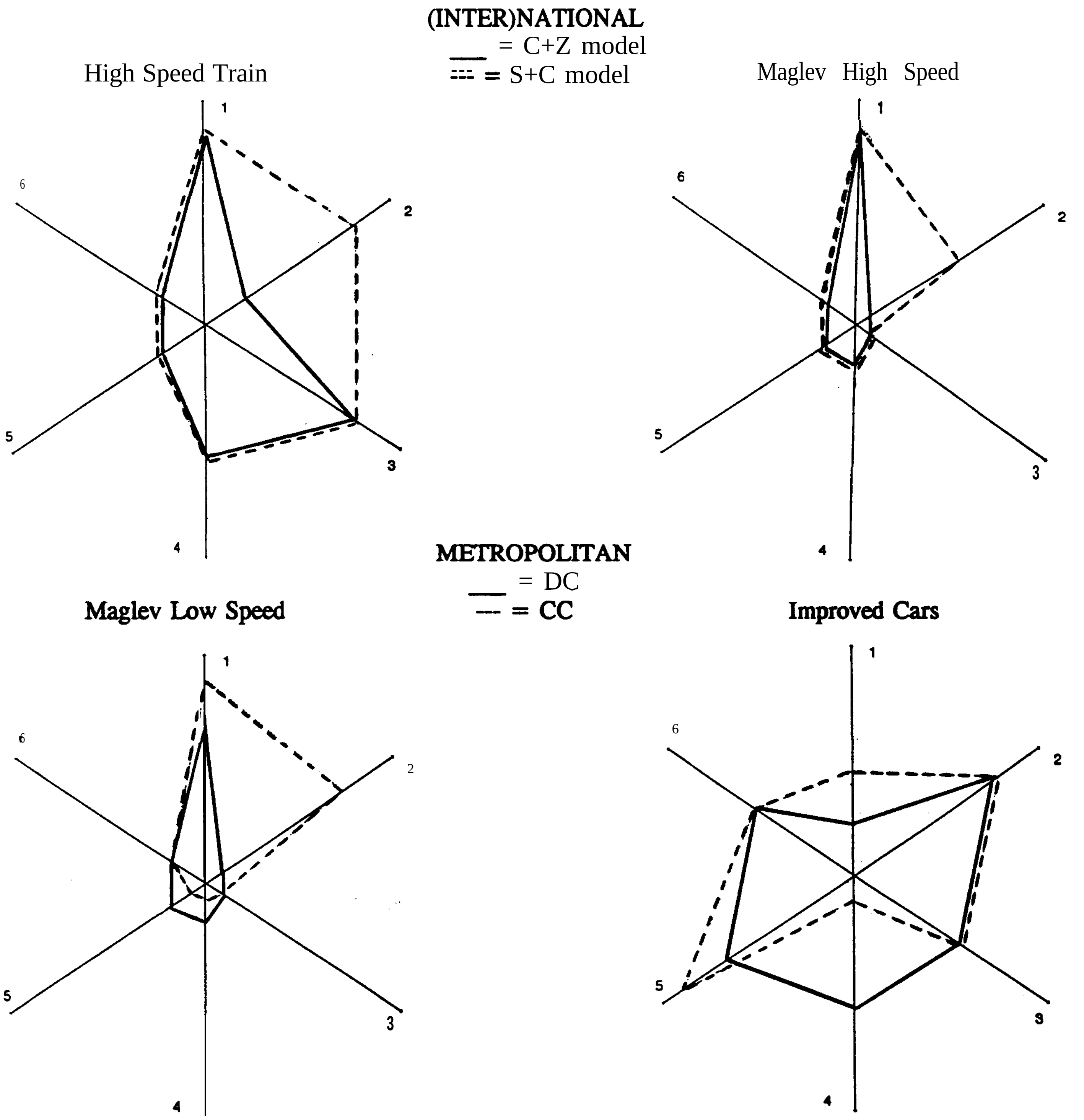

Table 1 Transport technologies and spatial scale

Technology	Metropolitan	Interurban/ National	International
Conventional			
High-Speed Train		x	x
Maglev Low-Speed	x		
Maglev High-Speed		x	
Improved Cars	x	x	
Advanced			
Subterranean Systems		x	x
Hydrogen Aircraft			x
Guided Vehicles	x	x	

Table 2 Future urbanization patterns

Metropolitan	*COMPACT CITY*	*DECENTRALIZED CITY*
Process	High density living and jobs close to public transport infrastructure	Ongoing suburbanization
Functional Structure	Strong mix of living and working Hierarchy of (sub)centres	Separation of living and working Flat structure
Traffk Pattem	Short and dense	Criss-cross
(Inter)national	*SPECIALIZATION AND CONCENTRATION*	*CHAINS AND ZONES*
Process	Specialization and concentration in large urban centres	Spread over urban regions (potentially some self-supporting)
Functional stlllchlre	Hierarchy of functions and hierarchy of cities	Flat structure based on increased footloseness
Traffk Pattem	Hierarchical radial	Criss-cross (potentially bundled)

Table 3 Evaluation matrices

Sets of altematives	Evaluation Criteria (a) (1)	(2)	(3)	(4)	(5)	(6)
Conventional, Metropolitan						
LS Maglev	5	1	1	1	2	2
Improved Car (short range)	2	4	3	2	5	3
Conventionul, High Scales						
HS Train	5	2	4	3	2	2
HS Maglev	5	1	1	1	2	2
Improved Car (long range)	2	4	3	2	5	3
Advanced, High Scales						
Subterranean systems	5	1	3	5	4	5
Hydrogen Aircraft	4	3	2	2	2	2
Guided Vehicle	2	2	3	5	3	2

(a) The numbers correspond with the ones in the preceeding text (Section 3).

Table 4 **Evaluation matrices from an urbanization perspective**

Set of altematives	Evaluation Criteria (a) (1)	(2)	(3)	(4)	(5)	(6)
Conventional, Metropolitan						
Compact city						
- LS Maglev	5	4	1	1	1	2
- Improved Car	3	4	3	1	5	3
Decentralized city						
- LS Maglev	4	1	1	2	2	2
- Improved Car	2	4	3	3	4	3
Conventional, High Scales						
Specialization-concentration						
- HS Train	5	4	4	3	2	2
- HS Maglev	5	3	1	2	2	2
- Improved Car	3	4	3	3	5	3
Chains and zones						
- HS Train	5	2	4	3	2	2
- HS Maglev	5	1	1	2	2	2
- Improved Car	2	4	3	3	4	3

(a) See Table 3.

Table 5 Results of quick scan

Sets of altematives	Genera1	Urbanization Pattem (a)	
Conventional, Metropolitan		***cc***	***DC***
Low Speed Maglev	-4	-2	-4
Improved Car (short range)	4	2	4
Conventional, High Scales		***s + c***	***c + z***
High Speed Train	3	4	2
High Speed Maglev	-7	-7	-7
Improved Car (long range)	4	3	5
Advanced, High Scales			
Subterranean Systems	6		
Hydrogen Aircraft	-5		
Guided Vehicles	-1		

(a) CC = Compact city; DC = Decentralized city
s + c = Specialization and concentration
C+Z = Chains and zones