Location Planning for Companies and Public Facilities: A Promising Policy To Reduce Car Use

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One promising instrument for reducing car travel is the coordination of land use and infrastructure planning. Traditionally, this coordination has been tried by encouraging high-employment densities near public transportation stations. A more sophisticated strategy is based on the observation that companies generate a mobility of persons and goods that varies with the type of company and, naturally, its location. Companies are classified according to their potential use of public transportation. The land use strategy presented essentially consists of locating companies with a high potential use of public transportation near public transportation facilities, and locating those with a low potential use near highway exits. The results of an empirical investigation into the relationship between the mobility generated by companies (the mobility profiles), the type of company, and the accessibility characteristics of the locations (the accessibility profiles) are presented. These profiles have been elaborated for practical use in regional planning by the Netherlands Organization for Applied Scientific Research. An overview of the main results of these studies is given: first, a tentative classification of firms is introduced; then, the typology of locations is defined and operationalized. Evaluation and demonstration results of the developed profiles are presented. It is concluded that, with the use of the profiles, more integrated and comprehensive policies for land use and transportation planning can be developed.

One of the main goals of current Dutch transport policy is to reduce the growth in car traffic. A promising way to achieve this is to encourage use of public transportation through better coordination between the planning of transportation facilities and land use, particularly for jobs. Industrial plants, public facilities, and offices for business or government all generate the mobility of persons and goods. The amount of mobility generated and the use of various transport modes depend heavily on the characteristics of these companies and their locations. It is well known that locating employment near railway stations and other public transit facilities enhances the use of public transportation. Many examples can be found that demonstrate the influence of the location of a company on the mode choice of commuters. The recent location of the University of Utrecht in the Netherlands, for instance, which moved from the city center to a peripheral suburban location (the "Uithof"), has led to an increase in the car share from 25 to more than 60 percent.

Clearly, suburbanization of employment may lead to a dramatic increase in car use. Locating companies near public transit facilities can reduce this undesirable effect. However, stimulating the development of locations well served by public transportation requires a balanced policy: a promising and innovative land use strategy exploits the differences between companies as to the mobility they generate. Attention should therefore be paid to the large variation among companies with respect to their potential use of public transportation and the role of the car in business travel and freight transport. Because space near public transit stations is limited, and because some companies depend heavily on road facilities, locations with excellent public transit facilities should be reserved mainly for companies with a high potential for using public transportation. Companies with low potential that are heavily dependent on road transportation and business travel by car can be better located near highway exits.

To implement this location policy in urban regions, a key instrument for regional planning has been developed in the Netherlands [see a general overview by van Huut (*1*)]. The planning instrument is based on two classifications: one of locations with respect to their multimodal accessibility characteristics (the accessibility profile) and another one of companies according to their mobility characteristics (the mobility profile).

To establish optimal locations for each type of company, several types of locations are distinguished. In the first concept of the planning instrument, the classification distinguished three basic location types:

- *A-locations*: locations that are highly accessible by public transportation. Examples of A-locations are major public transportation nodes such as central stations in the larger urban areas.
- *B-locations*: locations that are reasonably accessible by both public transportation and car.
- *C-locations*: locations that are defined as typical car-oriented locations. Examples can be found near motorway exits in fringe areas having poor public transportation access.

Figure 1 illustrates the difference between these A-, B-, and C-locations.

This paper presents the key results of various empirical studies carried out by the Institute of Spatial Organization, Netherlands Organization for Applied Scientific Research (INRO-TNO) that constitute the basis of this so-called ABC location planning instrument. Most of these studies have been commissioned by the Dutch Ministry of Transport and the Ministry of Housing and Planning. In the paper, we will pre-

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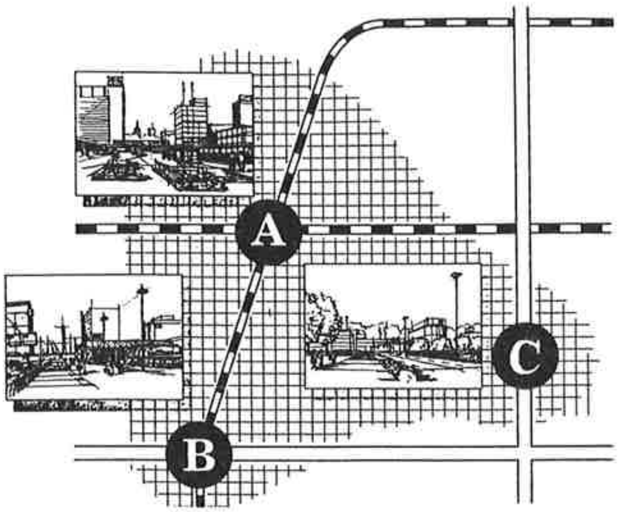

FIGURE 1 Concept of A-, B-, and C-locations.

sent the developed typology of companies and locations. The effectiveness of the ABC location planning instrument will be demonstrated on the basis of a simulation study in The Hague. The value of this planning instrument is evaluated on the basis of the experiences so far. Suggestions for further refinements are described.

MOBILITY PROFILES OF COMPANIES

Definition

A mobility profile describes the mobility generated by a company. The characteristics of commuting travel, visitor's travel, and freight transport are taken into account. Important indicators constituting the composite measure of a mobility profile are

- Employment density,
- Potential modal split shifts from car to public transportation and bicycles,
- Expected average level of car use in commuting travel,
- Car dependency of workers for business trips,
- Number of visitors, and
- Importance of the truck for freight transportation.

Research in the past has shown that these indicators depend heavily on the characteristics of the companies and their activities. Key factors are

1. The business activities at the particular establishment of the company, such as goods handling, type and amount of visitors, and business travel by staff, and
2. The socioeconomic characteristics of the workers (age, sex, income, level of education, working hours), which are also related to the type of company.

In principle, the mobility profile of a company does not depend on its location. The mobility profile refers to the average values. The influence of locational aspects is expressed in the indicators describing the modal split margins between A- and C-locations. The mobility profile is also independent of the size of a company. The aspect of space consumption is elaborated only in relative terms with the indicator for employment density (in square meters per employee).

Typology of Companies

Mobility profiles have been determined for different homogeneous classes of companies in the Netherlands (*2*) with comparable mobility characteristics. The starting point was a standard classification of companies and public organizations developed by the Dutch and Central Bureau for Statistics. Because mobility characteristics can vary substantially within one class of companies—for example, the combination of production and office activities within an industrial company—the standard classification has been modified somewhat for this study. This resulted in a classification with 62 types of companies, public organizations, and public facilities. For each of these company types, the values of the different indicators of the mobility profiles are estimated. As a first step, these values were based on general statistical data and relevant literature. In the second step, extensive empirical research was carried out among various companies and their personnel (e.g., interviews and surveys). The results were used to adjust the first concept resulting from Step 1. Finally, the developed mobility profiles were evaluated on their reliability and applicability.

To make the typology easier to handle, the 62 company classes were further clustered into a typology of 11 main company types, using the method of single pairwise clustering. Table 1 gives an overview of these company types and the estimated values of the various indicators of their mobility profile. The final estimations are based on a combination of empirical data, such as the Dutch National Travel Survey and additional surveys among many companies. The table also illustrates the indicators we were able to elaborate in the profiles with the available data. Because most of the data were related to commuting travel, most indicators describe the travel according to numbers of personnel. Travel by visitors and freight transportation are not worked out in detail. Clearly, further research on travel components in these categories would be welcome to improve the mobility profiles on this point.

The values in Table 1 are meant to roughly differentiate between the main company types. The indicators for the modal split margins between A- and C-locations have broad confidence intervals, and the modal split figures can vary with the service level of the public transportation system in various urban regions. In Table 1, the values are presented for the larger urban areas in the western part of the Netherlands (the Randstad).

ACCESSIBILITY PROFILES OF LOCATIONS

Definition

The accessibility profile describes the accessibility of the location for personnel, visitors, and goods with various travel modes. In view of the policy goals of the ABC location planning instrument, our main concern was to describe the ac-

TABLE 1 Characteristics in Mobility Profiles of 11 Major Company Types (*2*)

Indicator:	Main company type: 1	2	3	4	5	6	7	8	9	10	11
Employment Density (m2 per worker)	200	500	30	200	30	30	30	30	30	60	60
Public Transport Share (perc)	15	15	15	15	17	19	19	17	19	19	21
Public Transport Margins (perc)	15	15	15	15	25	30	30	25	20	25	15
Car Share (perc)	65	60	65	60	65	55	60	60	50	60	55
Car Margins (perc)	15	20	15	30	30	10	25	15	15	15	15
Car Dependency Workers (perc)	15	15	15	50	50	15	15	5	5	5	15
Share Slow Modes (perc)	24	24	24	32	24	28	24	24	36	28	32
Average Commuting Distance (km)	19	17	19	19	19	17	19	19	13	15	15
Visitors intensity (m2 per visitor)	450	900	150	450	150	450	50	50	150	15	50
Car Share Visitors (perc)	90	90	90	10	90	90	90	70	90	50	70
Importance Road Freight Transport	Great	Great	Mod.	Great	Mod.	Great	Small	Small	Mod.	Mod.	Small

Note: 1. Industrial plants with low density
2. Agricultural firms
3. Trade companies
4. Transport companies
5. Business offices with high car dependency
6. Industrial plants with high density
7. Business offices with low car dependency
8. Governmental offices
9. Social services
10. Public facilities
11. Medical facilities

Some definitions:

- The share of a mode is defined as the percentage of commuting trips made with this mode.
- The margins are defined as the differences in the share of a certain mode in commuting travel between A-type and C-type locations. For instance, if an average the PT share of a company type at A-type locations is 40 per cent, and at C-type locations 12 per cent, then the PT margins for this company type are 28 per cent.
- The car dependency of workers is defined as the percentage of the workers of a company which need the car during their working time for business trips.

cessibility by public transportation and by car. Slow modes were not taken into account explicitly in this stage.

We found that the distinction in A-, B-, and C-locations was too limited to give a meaningful and exhaustive categorization of all employment locations. Therefore, two additional location types were added to the typology: Al (A-local) locations, which are defined as locations reasonably accessible by public transportation and poorly accessible by car, and R-locations, which are considered to be poorly accessible by both public transportation and car. The resulting typology of locations by accessibility profile is summarized in Table 2.

Accessibility Indicators

During the past decades, an impressive number of methods has been developed to measure the accessibility of locations (*3,4*). To keep the accessibility indicators easy to apply in daily planning practice, we have chosen criteria based on the "egress" aspects of locations. The position of locations with respect to highway exits and public transit nodes are the most important indicators of the accessibility profiles. The criteria chosen can be briefly described as follows:

1. Easily accessible by public transportation:
   –Near a railway station with high service levels for both local and interlocal public transit.

TABLE 2 Profile of Typology of Locations by Accessibility (*2*)

Accessibility by car:	Accessibility by Public Transport: Well	Reasonable	Poor
Well	A-type	B-type	C-type
Poor	A-type	Al-type	R-type

–No more than 800 m or 15 min away from a station entrance by urban public transport.

2. Reasonably accessible by public transportation:
   –Near a public transit node with several local public transit (rail) lines with high frequencies.
   –No more than 800 m away from a station entrance.
3. Easily accessible by car:
   –No more than 500 m from an urban arterial road.
   –No more than 2000 m from a motorway exit.
   –Limited parking restrictions on B-locations (at least one parking space for every four workers) and no parking restrictions on C-locations.

These criteria vary among various urban areas in the Netherlands, taking into account the general level of service of the public transportation system. In this paper, the criteria for the larger urban areas in the Randstad are presented.

A great advantage of the chosen method is that it takes only a look on a road map, a time schedule for public transit, and an inventory of the parking restrictions to determine the accessibility profile of a location. Clearly, this gives only a rough description of the actual accessibility, because total travel times, congestion, and travel costs for potential travelers to the location are not considered explicitly. Later we will evaluate the validity of the approach in greater detail.

RIGHT COMPANY AT RIGHT LOCATION

Given the mobility profiles of companies and the accessibility profiles of locations, we now face the question of what type of company ideally should be located at what type of location, given the policy goals we want to achieve. Which strategy will yield a maximum reduction of "avoidable" car travel and will guarantee the accessibility by car for companies that depend heavily on business travel by car or road freight transportation, or both?

This is the key question in the ABC location planning instrument. The answer is complicated. First, both governmental policy targets and company objectives must be considered in combination. These two can lead to conflicts of interest. Second, the locational behavior of companies is a complex process. Many factors are taken into account when companies choose their locations, of which accessibility is only one. Locational choice of companies can be influenced only partially by public policy.

To keep the method transparent, judgment of the suitability of certain combinations of companies and locations is based on the expected travel demand effects only. Regional economic and financial aspects are not considered in this stage. Given the different goals that must be achieved, a multicriteria approach is chosen. The suitability of a company type for a certain location type is determined by designing an "ideal" mobility profile for each location type. The more the mobility profile of a certain company matches this ideal profile, the more suitable this company is for the specific location.

Ideal profiles are theoretical mobility profiles that are considered to fit optimally with the accessibility profile of a certain location type. For instance, the ideal mobility profile of an A-location is a profile with high scores on indicators such as employment density, public transit shares and margins, car use margins, visitors per worker, and travel distances, and low scores on indicators such as car share, car dependency, car use by visitors, and the importance of road freight transportation.

TABLE 3 Preferable Locations for 11 Major Company Types (*2*)

	Preferable location type:	
Company type:	First priority	Second priority
1. Ind. plants, low dens.	C	-
2. Agricultural firms	C	R
3. Trade companies	B	C
4. Transport companies	C	-
5. Bus. offices, high car dep.	B	-
6. Ind. plants, high dens.	B	Al
7. Bus. offices, low car dep.	A	Al/B
8. Governmental offices	A	Al
9. Social services	B	Al
10. Public facilities	A	Al
11. Medical facilities	B	Al

Many versions of this multicriteria approach have been tested using various ideal profiles and weight factors for the 11 selected indicators in the mobility profiles. The results indicated that the chosen method is not very sensitive to these assumptions. For further details see Verroen et al. (*2*). Table 3 presents the results of the version that was judged best and that has been used in Dutch planning practice since the conclusion of our investigations. The table shows that the preferred location type for the 11 main company types varies substantially. This confirms the usefulness of the more sophisticated approach of the land use and transportation planning coordination as realized by the ABC planning instrument.

DEMONSTRATION OF EFFECTIVENESS IN REAL-WORLD CASES

The ABC location planning instrument has been developed to improve the coordination between land use and infrastructure planning for employment. Given this objective it is interesting to determine the distribution of companies in the Netherlands over the various location types in the current situation: How many companies are located on less suitable locations from the perspective of the transportation policy goals? Which company and location types are causing the greatest discrepancies? What are the alternative planning strategies to improve the adjustment of mobility and accessibility profiles? Which strategies are preferable?

To answer these questions, we carried out several simulation studies in different urban regions. As an example, the results of one case study for the region of The Hague (*5*) are summarized in Figure 2. The region of The Hague is in the highly urbanized western part of the Netherlands (the Randstad) and accommodates about 1 million inhabitants. Figure 2 illustrates the size of the problems in the Dutch urban areas today. In The Hague, it appears that more than half of the employment (57 percent) is located on unsuitable locations.

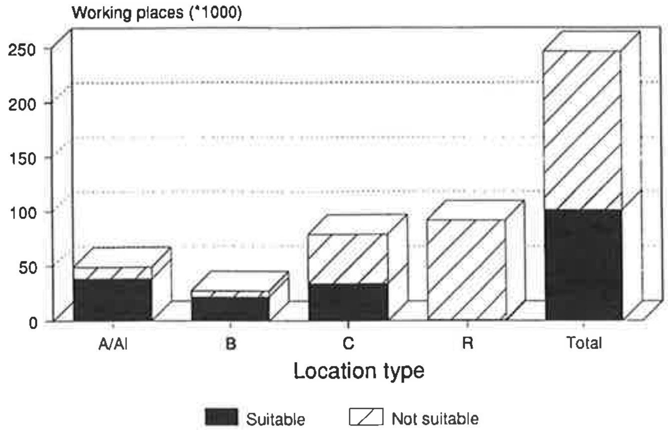

FIGURE 2 Current distribution of employment in The Hague over different location types and their suitability for these locations.

A minority of the jobs can be found at locations that are easily accessible by public transportation (A-, Al-, and B-locations). The majority of the employment is on C- and R-locations. Office buildings for business companies and governmental organizations (Types 7 and 8) and facilities for higher education (Type 10) are causing the adjustment problems between companies and locations. In terms of the ABC planning concept they should be located at least near public transit facilities. Case studies in other urban areas have shown similar results.

Given the problems in the current situation in The Hague, it is interesting to analyze ways to reduce the share of employment located on unsuitable locations. In principal, there are two policy options:

1. Infrastructure planning—improving the accessibility of companies at their current locations.
2. Land use planning—regulation of locational choice for new or relocating companies.

Figure 3 shows the possible effects of these two options for the region of The Hague in the next 15 years. It becomes clear that especially the assumed development of new A-, Al-, and B-type locations by improving the public transportation network with the investments planned for the region can have a substantial effect. The share of employment at unsuitable locations will decrease by about 20 percent, from 57 to 37. If this policy is combined with a strict land use planning strategy, allowing companies to relocate only in suitable areas according to Table 3, an extra reduction in poorly located employment of 10 percent can be achieved.

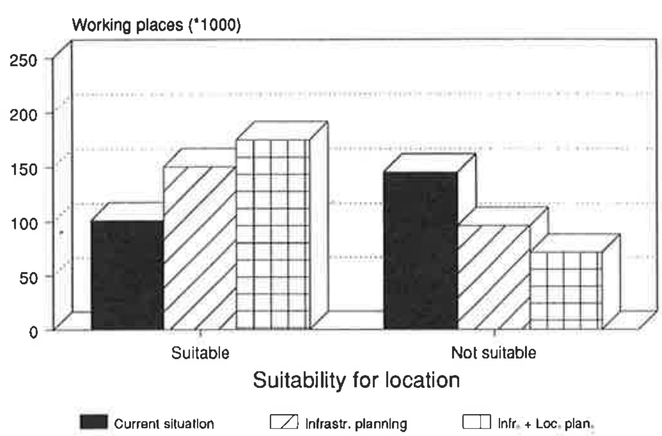

FIGURE 3 Estimated effects of two policy options on share of employment on unsuitable locations.

At this stage, it is not easy to accurately estimate the overall effects of the policy options on the share of the car in commuter travel in The Hague. Rough calculations indicated that the reduction could be about 8 percent (from 50 to 42 percent).

EVALUATION OF ABC LOCATION PLANNING INSTRUMENT

Modal Split Effects

The main objective of the ABC location planning instrument is to stimulate a shift in the modal split from car to public transportation. The effectiveness of the instrument depends heavily on the margins in the use of these modes (differences in average share) between company and location types. Table 4 gives an impression of the margins we found in our surveys in The Hague. In the table, the companies we analyzed are categorized into three groups: companies with mobility profiles most suitable for A-locations (Types 7, 8, and 10), companies with mobility profiles suitable for B-locations (Types 3, 5, 6, 9, and 11), and those suitable for C-locations (Types 1, 2, and 4). AL- and R-locations were not taken into account.

The table shows substantial differences in both companies and locations in the use of the car and public transportation. The average share of the car varies by about 20 percent between both company types and location types, proving that it is relevant to incorporate both company and location characteristics in location planning strategies. The table also shows that the differences in modal split between A- and B-locations are much larger than the differences between B- and C-locations. Apparently, car use is influenced more by accessi-

TABLE 4 Comparison of Commutes by Car and Public Transport for Various Company and Location Types in The Hague (*2*)

	Accessibility profile:			
	A	B	C	Average
Car				
Mobility profile most suitable for location type (see table 3):				
A	32	58	55	48
B	44	72	54	57
C	59	71	76	69
Average	45	67	62	-
Public Transport				
Mobility profile most suitable for location type (see table 3):				
A	41	15	12	23
B	37	17	14	23
C	13	11	6	10
Average	30	14	11	-

bility to cars than by accessibility to public transit. This conclusion is in accordance with other research findings in the Netherlands.

Intraclass Variations

Mobility Profiles

Our analyses show that in practice there is a considerable variation in the characteristics of individual companies and locations. The typology developed only explains a part of this variation. The results of multivariate analyses indicate that the classification of companies explains about 50 to 70 percent of the total variation in the different indicators that are part of the mobility profile (Figure 4). The typology offers only a rough classification. We conclude that the mobility characteristics of individual companies can differ substantially from their class average. Restrictive planning regulations should therefore be based ideally on the individual scores of companies with respect to indicators and not only on the average values of their group.

Accessibility Profiles

The same conclusion about variation is valid for the accessibility profiles developed. We conclude that the homogeneity of the classification can be further refined. Surveys among the personnel of companies at various locations showed that the ratio between car and public transit travel times for commuters may vary strongly within one location type (see, for example, Figure 5). Similar variations were found with respect to the parking facilities for personnel (Figure 6). The indicator for parking restriction used in Figure 6 is the sum (divided by 3) of the percentages of the personnel who have no parking spaces on private grounds, who must pay for their parking spaces, and who must walk more than 250 m to their workplaces. Although the average parking restrictions tend to be as expected, the restrictions vary substantially between companies at the same location type.

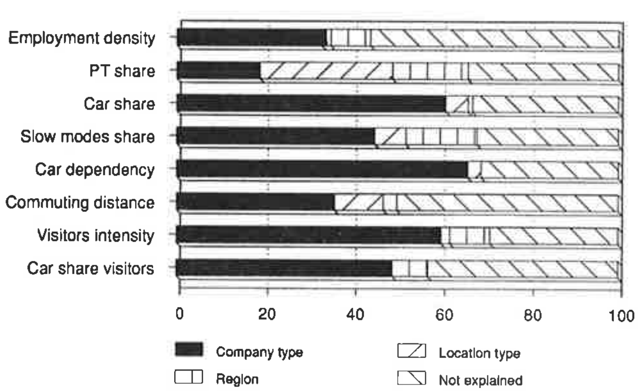

FIGURE 4 Variation in some indicators of mobility profiles with classification of companies.

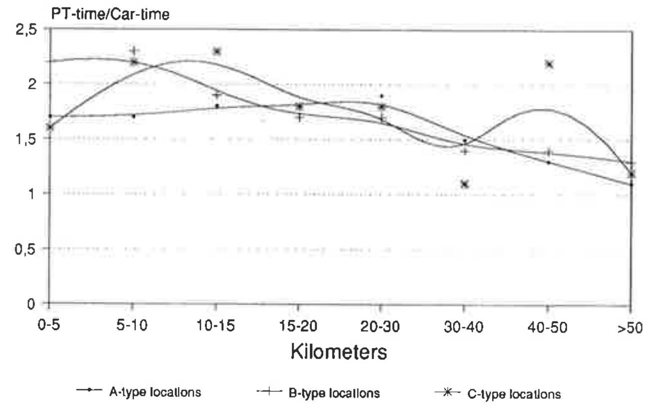

FIGURE 5 Travel time ratio between car and public transportation in The Hague for various location types and distance classes.

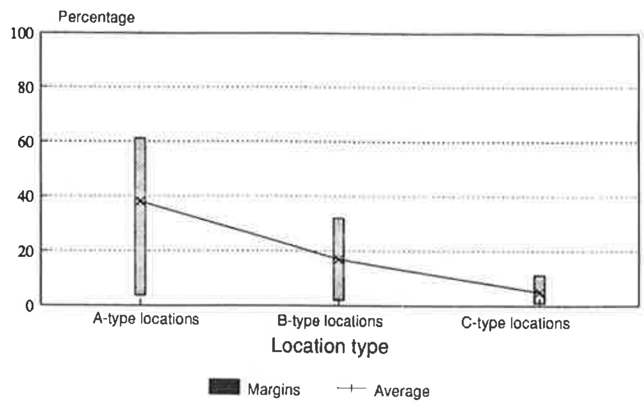

FIGURE 6 Parking restrictions on various location types in The Hague.

Suggestions for Further Research on Accessibility Profiles

There are several ways to further refine the measurement of accessibility. We already indicated the need for differentiation by type of urban area. There is a large variation in the level of service in public transportation between urban areas. In regions with poor public transportation facilities, public transportation tends to be no alternative for the car. In these regions, the stimulation of slow modes (e.g., cycling and walking) and carpooling appear to be promising additional strategies to reduce car traffic. It is therefore interesting to take these modes into account more explicitly in the accessibility profiles.

Another refinement can be achieved by incorporation of travel distances in the accessibility profiles. This would make it possible to deal with locational strategies that are based not only on modal split shifts but also on the reduction of car kilometers by reducing the home-to-work distances, for instance by improving the proximity of employment locations to the major population centers.

Given these possibilities for further improvement, more sophisticated methods can be elaborated to measure the accessibility of locations. At the moment of writing, INRO-TNO is working out more accurate criteria for accessibility profiles. As far as commuting is concerned, these methods are based on centrality indicators for accessibility (in travel times) and proximity (in travel distances) of locations. The following indicators are used:

$$B_{jvm} = \frac{\sum_i I_i * p_m(T_{ij}) * T_{ijv}}{\sum_i I_i * p_m(T_{ij})}$$

$$D_{jm} = \frac{\sum_i I_i * p_m(T_{ij}) * d_{ij}}{\sum_i I_i * p_m(T_{ij})}$$

where

B_{jvm} = average accessibility of zone i with mode v for purpose m,
D_{jm} = average travel distance to zone i for purpose m,
I_i = number of inhabitants, zone i,
$p_m(T_{ij})$ = distance disutility for average travel generalized time between zone i and zone j for purpose m,
T_{ijv} = travel time between zone i and zone j with mode v, and
d_{ij} = distance between zone i and zone j.

With these indicators, the competitiveness of alternative modes to the car and expected travel distances can be determined for use in classification criteria of locations, as well as their suitability for certain company types. For business travel of personnel and visitors, the measurement of accessibility will be based on graph theory (*6*). The network position of locations in relationship with other economic centers will be described with the Shimbel index.

APPLICATION OF PLANNING INSTRUMENT

Appropriate Policy Measures

The example of The Hague proves that both the improvement of public transportation supply and land use control can be effective. The ABC location planning instrument can be used as a planning method for improving the public transportation system and selecting infrastructure improvements. The instrument can be implemented in several ways in land use planning. First, Dutch urban and regional planning laws offer several possibilities for land use regulation. The activities permitted on certain locations can be restricted, although it is juridically not easy to distinguish among various types of employment. It is also possible to regulate land use by building regulations, such as space-floor indexes, building heights, parking facilities, and so on. Still another option is a pricing policy for selling and hiring land, to influence market price developments.

So far, it has not become clear which measures are most appropriate for implementing the ABC location planning instrument in daily planning practice. Local and regional governments are just starting to work with the instrument. At the moment, their main concern is to identify the various location types within their region. At this stage, local authorities still have a lot of freedom in how they should interpret and implement the planning instrument.

Political Acceptance

The introduction of the ABC location planning instrument triggered some interesting political discussion in the Netherlands. Companies and local governments were especially critical, each arguing from the perspectives of their own interests. Companies and chambers of commerce stated their concerns over limitations to their freedom to select the location they regard most appropriate for their activities. An inadequate location is seen as a threat to the profitability of the companies. Local governments are especially afraid of conflicts over regional economic development plans because of the important role these plans have in the acquisition of companies in competition with other regions. Land use restrictions based on transportation policy goals can (in the short term) damage the competitiveness of certain regions and cities.

Discussions are still ongoing about the ways in which the ABC location planning instrument can be further improved. In particular, the definition and role of the B-locations cause some concern. Because of their accessibility by car, B-locations are, on the one hand, more popular with companies (and therefore local governments) than are A-locations. On the other hand, stimulating B-locations is less effective because of the small differences in modal split compared with C-locations. A-locations should do the job but are not attractive enough. An oversupply and liberal use of B-locations may therefore decrease the effect of the planning instrument.

Given these political and methodological backgrounds, it might be interesting to refine the instrument with regulation methods based on mobility impact analysis. This means the development and setting of standards for the generation of car kilometers by various company types in various regions. Whether and by what means they fulfill the standards—by locational choice or other measures—is the responsibility of the companies. Mobility impact fees can stimulate the companies to meet their standards. This approach has much in common with policies for transportation demand management in certain parts of the United States [for an extensive overview, see Ferguson (*7*)]. It is interesting to learn from experience when further developing the ABC location planning instrument in the Netherlands.

CONCLUSIONS

The ABC locational planning instrument for companies and public organizations appears to be a promising and challenging concept. Proper application in infrastructure and land use planning may result in a substantial reduction in car use in commuting travel. Compared with traditional land use control, the use of mobility and accessibility profiles offers the possibility of a more balanced and sophisticated location planning strategy that takes into account the large variation between companies and locations. The concept has been put into operation and tested empirically for the Dutch situation. We are convinced, however, that the general approach also can be of great use to other countries that are confronted with environmental problems and congestion in urban areas.

Practical experience indicates that the ABC location planning instrument has several possibilities for further refinements. The accessibility profiles especially deserve further elaboration. Nevertheless, there will always be political opposition against the planning instrument because it tries to limit the freedom of choice of companies and local governments. This will also be the case when the planning instrument is aimed more explicitly at the main policy goal (reduction of car kilometers)—for example, use of mobility impact fees and mobility impact standards.

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