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TOWARDS A TYPOLOGY OF EUROPEAN INTERURBAN TRANSPORT CORRIDORS FOR ADVANCED TRANSPORT TELEMATICS (ATT) APPLICATIONS

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Abstract

In recent years the awareness has grown that ATT may offer a significant contribution to the solution of problem situations on European transport axes. Such problems are inter alia congestion, lack of safety and environmental decay. However, the use of road transport informatics is not meaningful under all conditions and on all European roads. Therefore, it is necessary to develop a priority scheme of roads that lend themselves in particular for the application of ATT.

The present paper intends to develop a practical typology of European interurban corridors aiming at tracing the effects of ATT applications. In this study the identification of typologies will be based on relevant attributes of a set of European transport corridors by gathering all appropriate information on these corridors in order to determine in a systematic way the potential of these corridors for ATT introduction and application. Furthermore, ranking(s) of corridors according to needs of ATT will be developed by means of multi-criteria analysis.

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1. AIMS AND GOALS

Europe is increasingly moving towards a network economy, in which physical flows of people and goods form the connecting elements. This means that European corridors - especially those between major metropolitan areas or centres of economic activity in Europe - are playing a critical role in the new evolving map of Europe. At the same time it has to be recognized that traffic congestion on many European transport corridors is dramatically increasing, while also the environmental implications and the poor safety conditions cause unacceptable social costs. Conventional transport policy is apparently unable to keep up with Europe's growing demand for mobility.

Advanced Transport Telematics (ATT) is nowadays generally regarded as a potentially powerful tool for coping with future transport problems on European corridors. The present paper is based on results derived from MARTA project (Monitoring Attitudes towards Road Transport Automation) in the context of DRIVE/EC research program. In particular the MARTA project is unique in that it aims to develop and provide a structured assessment of the user and producer size of the market for ATT equipment for European inter-urban transport corridors (both passengers and freight), with a particular view on road transport.

The project uses a methodology based on a CASCADE system (see Nijkamp, 1993) in which background information on European trends, the responses of key users and operators to ATT technologies, and awareness and the perceptions of experts/planners are systematically recorded and monitored.

It is clear, however, that not all European corridors present the same characteristics. Therefore, it is necessary to develop an appropriate typology of European corridors on the basis of the indigenous relevant features of these corridors and also of relevant ATT applications.

The rationale behind the identification of European corridors typologies is the idea that European policy resolutions (like the ATT introduction) may generate different behavioural responses for each corridor type, so that it is necessary to have relevant information in light of European integration.

In this context particular attention will be given to the necessity of constructing further 'hierarchies' displaying 'socio-economic transport' disparities within Europe, and hence to appropriate methods, such as Geographical Information Systems (GIS). These are useful for the visualization of the various types of spatial data related to corridor areas, facilitating the creation of profile maps and diagrams for the various corridor sites.

2. DESCRIPTION OF THE CORRIDORS INVESTIGATED

The first step of the present study is selection of the inter-urban corridors, i.e. the identification of those inter-urban corridors whose characteristics may be considered significant for studying the different potential impacts of ATT.

In particular, this issue can be specified according to two aspects of the problem, viz. the ATT impact (on system efficiency, on network reliability, on environmental quality, etc.), and the different actors interacting within a broad transport system (i.e., users, operators, public decision-makers and decision-makers in the economic and social system).

These interacting factors lead to the following three categories of criteria, that are useful for the selection of the corridors:

- the **≪spatial location≫** of the corridor, which refers both to the different territorial coverage (in order to consider not only central, but also central-peripheral and peripheral patterns of interaction) and the strategic relevance of the corridor (which means the different strategic importance of the corridor within the European communication network and also in the increasing process of regional integration);
- the **different mobility patterns** within the regions crossed by corridors (and the related aspects of traffic flows typology, degrees of congestion, pollution, network reliability, safety, etc.) in combination with different socio-economic situations (in terms of wealth, productive specialization, etc.);
- the **cooperation level from DRIVE projects** in order to better identify the importance of ATT functions in relation to different traffic typologies and situations. In addition to four pilot projects in the first stage of DRIVE (PLEIADES, METAFORA, MELYSSA, ADS), three other DRIVE projects will be considered (INVAID, COMBICOM, FRAME) which all together cover Centre-East and Centre-West directions. However, in order to represent a more balanced mobility pattern, an additional five corridors is taken into account reflecting East-West directions (such as Trieste-Lisbon and Vienna-Nantes corridors) as well as inner links in the core of Europe (such as London-Berlin, Amsterdam-Milan and Amsterdam-Utrecht).

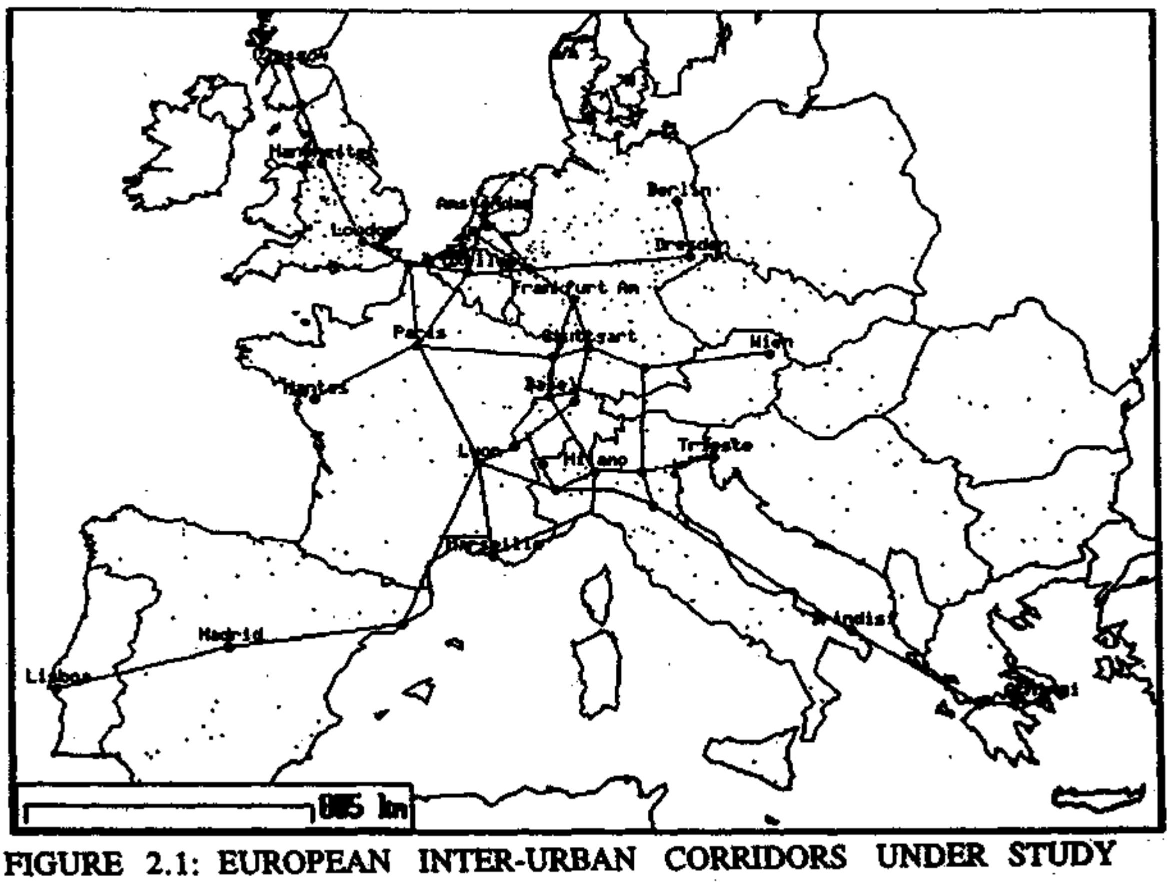

FIGURE 2.1: EUROPEAN INTER-URBAN CORRIDORS UNDER STUDY

Consequently, **after an exploratory analysis on the basis of the above criteria the following list of corridors has been identified:**

1. Glasgow-London-Paris-Marseille (PLEIADES-DRIVE)
2. London-Athens (METAFORA-DRIVE)
3. Stuttgart-Lyon-Barcelona (MELYSSA-DRIVE)
4. Aosta-Athens (ADS-DRIVE)
5. Amsterdam-Madrid (INVAID 2-DRIVE)
6. Rotterdam- Munchen-Verona (COMBICOM-DRIVE)
7. Amsterdam-Athens (FRAME-DRIVE)
8. Trieste-Lisbon
9. Wien-Nantes
10. London-Berlin
11. Amsterdam-Milan
12. Amsterdam-Utrecht

Each corridor route is identified on the basis of the main road infrastructure (firstly motorway, otherwise highway; see Figure 2.1). Figure 2.1 also shows that corridors are subdivided into shorter segments connecting two relevant nodes along the route; this disaggregation can be fruitfully utilized in the traffic indicators analysis.

Thus, the selected — twelve — corridors are able to reflect the main characteristics of the European transport network:
- the greater number of corridors in North-South direction than that in the East-West direction;
- a denser network of corridors in the European core area in comparison with the infrastructural links between centre and periphery.

3. CORRIDOR ATTRIBUTES SELECTION: DATA BASE AND INTERPRETATION

3.1 THE ATTRIBUTES SELECTION

In order to study the differences in the potential ATT impact as consequences of different corridor contexts (defined by a corridor typology), a first stage is the construction of the ≪states≫ of the corridors, i.e. the main categories of criteria necessary for identifying the characteristics of an inter-urban corridor consistent with the objective of assessing ATT potential.

Thus, these ≪states≫ of the corridors select the relevant variables or corridor features in the light of ATT introduction.

In particular we have taken into account the threefold ATT potential effect on:
- mobility system efficiency, particularly with regard to lower management costs and use by operators, to new network services and capacities, etc.;
- network reliability, with regard to a better safety, information and service levels for users;

- environmental quality, particularly with regard to pollution reduction,
from which a (preliminary) list of interesting ≪states≫ of the corridors can be deduced. These are:

- **socio-economic conditions** (within the regions crossed) which refer to different mobility patterns and, as a consequence, to different needs in terms of ATT functions as well as to different behavioural responses;

- **geographical position** (in other words, the comparative locational advantage or the strategic network position of the corridor) which is useful to capture the importance and the effective function of the particular corridor, as well as to provide indirect (quantitative or qualitative) information on ATT ≪supply-side≫ impacts: this is despite the fact that all the selected corridors could be defined as ≪strategic≫ from a social and economic perspective, the different relative position in the general context of national and European networks differentiates the importance of this characteristic [1].

- **network institutional organization**, which deals with the network organisational/managerial perspective and tries to capture the level of the infrastructure supply as well as the degree of complexity of such management. This concept is quite evocative, but aims to underline that the different degrees of interrelation/cooperation among transport operators along the corridors, the different complexities of infrastructural management, the different numbers of managers in infrastructural administration, the different operative strategies adopted and, finally, the different levels of technological innovation already achieved, all influence the ATT impact;

- **traffic conditions**, with particular reference to: i) the degree of congestion (i.e. the identification of bottlenecks along the corridors which are generated by an insufficient supply of infrastructure or, by an excess of demand), owing to its impact on corridor management efficiency and on costs to the user; ii) to safety (reliability or accident rates on the corridor), which could effect the share of social (direct or indirect) benefits which would be linked to the introduction of ATT;

- **environmental quality** (acoustic or air pollution), which appears to be one of the principal stimuli for implementing ATT.

First indications on the association between ≪states of the corridors≫ and the potential impacts of ATT are provided in Table 3.1 (for details on the various kinds of potential impact of ATT see Nijkamp, Pepping and Reggiani, 1992). They are specified in summary below.

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[1] The strategic network position could be defined in relation to the different functions developed by corridor, like internal integration, interregional exchange or regional crossing (transit).

- The differences in **socio-economic situations** on corridors can be identified by the regions crossed with respect to the ≪core≫ of Europe (see next Section 4). Moving from the centre towards the periphery, the residential density as well as the per-capita value added decreases while production activities become increasingly

TABLE 3.1 Relationships between the state of the corridors and the potential impacts of ATT.

socio-econ. conditions			locational conditions			network institut. organizat.			traffic conditions: congestion			traffic condition: safety			environm. quality		
LO	ME	HI	C	SP	P	LO	ME	HI	LO	ME	HI	LO	ME	HI	LO	ME	I
+++	++	+	+	++	+++	0	+++	+	0	+++	+	+++	++	+	+++	++	+

Legend: LO, ME, HI = respectively low, medium/high and very high levels of states of the corridors

C, SP, P = respectively central, semi-peripheral and peripheral locational conditions
0 = neglectible impact
+ ++ +++ = increasing impact levels

industrial. Consequently, it is plausible to argue that in the central regions, the principal aims of ATT functions are to provide traffic information and route guidance, driver support, automatic debiting, etc., which will have a high impact (both in term of market potential and behavioural responses), while in the peripheral regions, in which the share of heavy vehicles is high, the ATT functions in the field of freight and fleet management will be more relevant in investment decisions.

- The **strategic network position** shows a large positive influence on ATT introduction, particularly for direct effects on users, but also for indirect effects (social and organisational efficiency). It may be that by increasing the levels of corridor importance, the introduction of ATT has (in a ≪ceteris paribus≫ situation) a larger and larger impact, owing to economies of scale arising from the liaison with higher level corridors. Within these indirect effects, we can quote other locational effects, which are probably related only to high levels of strategic network position of the corridors.

- By considering the state of the **≪network institutional organization≫**, we can suppose that the maximum ATT impact will result in a medium to high level of management complexity. However the potential effects on the specific indicators will be different: great influence on organisational structure, secondary influence on direct and indirect user benefits and marginal influence on locational shifts.

- One of the synthesis criteria of ATT impacts on overall corridor efficiency is the **≪degree of congestion≫**, owing to its direct influence on potential impacts of ATT. Even though, in general, there is a negative relationship between overall levels of efficiency and the degree of congestion, a maximum gain in efficiency (deriving from ATT) is supposed to be reached for a medium to high degree of congestion. In this situation, the new technologies have the greatest potential to influence behaviour. In a situation of low or very high congestion, the ATT impact will be marginal/negligible: in the first case since the intervention is superfluous, in the second one because it is insufficient. Probably the degree of congestion directly influences the benefits to users and indirectly the quality of life (indirect social benefits). Less important is the ATT influence (by reducing the congestion degree) on the location decisions of firms, unless there are significant reductions in transport costs.

- Both the last two states (safety and environmental quality) have an effect on social indicators: the former directly affects users, the latter has indirect social effects. The influence on organisational and locational effects is marginal. Probably the ATT impact on safety is high where reliability is low, while the ATT impact is relevant for maximum and medium to high levels of pollution.

Thus, on the basis of the above considerations, data will be selected and will focus on specific indicators which will be outlined in the next subsection.

3.2. THE DATA MATRIX

In this subsection, the corridor characteristics useful for the construction of an inter-urban corridor typology will be presented. In total, 19 different features are included. As mentioned before, they are seen as factors influencing potential impacts of ATT in terms of user benefits, efficiency, safety and environmental quality.

The following classification of these features is used:

A. criteria related to social and economic condition
B. criteria related to geographical position
C. criteria related to road infrastructure
D. criteria related to road traffic demand
E. criteria related to environmental impact of road traffic.

A. Social and economic features concern characteristics of the areas where the corridors are located. Criteria related to social conditions include population densities and stock of dwellings. Criteria describing economic activities in these areas include economic productivity and employment figures. Characteristics of the surrounding areas are approximated by the NUTS I regional subdivision of Western Europe (see Section 2 for details).

B. Criteria related to specific locations on the corridors include the large agglomerations on the corridors and the number of different Community member states that are crossed. The former feature refers to the economic strategic importance of corridors, the latter to the complexity of the mixture of the different (national) policies towards road infrastructure that affect the same corridor.

C. The criteria related to road infrastructure include motorway densities in the surrounding areas of the selected corridors and the ≪accessibility≫ of important agglomerations connected by the corridors. These variables are an indication of possible alternative routes between corridor origins and destinations. In this respect, motorway densities are a valid proxy for short-distance alternative routes (relevant in the case of dynamic route guidance systems), while the latter provides insight into the quality of infrastructure at a broader European level.

D. Criteria related to road traffic demand include private car ownership, road traffic accident rates, vehicle flows and related growth, flows of heavy vehicles and overall utilization levels on the corridors. The first two are variables referring to traffic demand conditions in the surrounding corridor areas. Private car ownership is an indicator for car traffic generating potential in the various regions. Numbers of road traffic accidents are a measure for safety conditions. The latter four features concern the characteristics of the motorways themselves, as defined as the shortest routes between the respective city pairs (see Section 2). These data concern characteristics on the potential user groups of the corridors, and therefore are very valuable for this project.

E. As an environmental criterion, the levels of NOx emissions have been taken. The general assumption that more the 60% of total NOx emissions in Europe are caused by car traffic makes this feature a valid proxy for the environmental implications of road traffic in regions crossed by the selected corridors.

TABLE 3.2: LIST OF FEATURES FOR THE CORRIDOR TYPOLOGY WITH SOURCE, YEAR AND EXPRESSION

	Variable	Source	Year	Expression
	Socio-economic related			
1	population density	Eurostat	1985	habitants per km2
2	(Total) GVAMP (*)	Eurostat	1984	ECU per habitant
3	GVAMP of industrial sectors	Eurostat	1984	ECU per habitant
4	GVAMP of market services	Eurostat	1984	ECU per habitant
5	employment	Eurostat	1984	employment places per km2
6	employment in industrial branches	Eurostat	1984	employment places per km2
7	employment in market service branches	Eurostat	1984	employment places per km2
8	stock of dwellings	Eurostat	1985	dwellings per km2
	Locational related			
9	large agglomerations on corridor	-	1992	number of large agglomerations on corridor
10	crossed EC member states	-	1992	number of national borders crossed by corridor
	Infrastructure related			
11	motorway density	Eurostat	1985	length of motorway (km) per km2
12	accessibility of crossed zones	Keeble	1983	accessibility index, see explanation

Traffic demand related			
13 private car ownership	Eurostat	1985	private owned cars per km2
14 road traffic accidents	Eurostat	1985	motor vehicle traffic accidents per km2
15 vehicle flows	NEA	1985	passing vehicles in yearly daily averages
16 growth of vehicle flows	NEA	1985	relative growth of vehicle flows between 1980 and 1985
17 heavy vehicle flows	NEA	1985	share of heavy vehicles
18 traffic flow smoothness	NEA	1985	level of service, see explanation
Environment related			
19 NOx pollutions	Europe 2000 (CEC)	1985	NOx pollution in tons per km2 per year

(*) GVAMP gross value added at market prices.

A summary of the characteristics used with source, year and definition is shown in Table 3.2. Most of these indicators concern measurable variables. Many of them are taken from Eurostat Regional Statistics, in which extended definitions can be found. The defined 'accessibility index' and 'level of service' (LOS) need further explanation:

Accessibility indices for European regions are taken from Keeble et al., 1983. The underlying methodology is the measurement of the accessibility of European zones by following simple gravity type formulation in which distance is the main indicator:

$$A_i = \Sigma_j M_j/d_{ij}^{\,c}$$

where

A_i = accessibility of zone i

M_j = regional gross domestic product in ECU

d_{ij} = shortest distance in Km between centre of zones i and j

c = impedence parameter.

The gravity parameter c is assumed to equal 1. The road accessibility index for a given corridor is the average of the indices of the respective zones crossed by the corridor.

The 'level of service' index used (LOS) is a theoretical concept, based on a number of assumptions. This variable relates road capacities to (measured) actual traffic volumes. Therefore, it gives an approximation for the smoothness of the traffic situation on a given road segment. The assumptions made involve estimating the road capacities of European highways. While for the American situation, the (theoretical) road capacities are assessed by observations, in Europe no structural research has been carried out so far on this subject. Therefore, for the European situation, little is known.

The concept is the existence of an optimal average speed (the so-called 'critical speed'). At this speed, the theoretical capacity of the road is at its maximum. This theoretical capacity is dependent on various factors, related to the characteristics of vehicles using the road and the road infrastructure itself (see, for details, Nijkamp et al., 1993)

4. COMPARISON OF CORRIDORS: COMMON ELEMENTS AND DIFFERENCES RELATIVE TO POTENTIAL ATT APPLICATIONS

As shown in the previous section, the selected attributes of corridors can usefully provide relevant (qualitative) information on the potential impact of ATT applications. Thus, in this section the main differences/similarities will be examined in order to show fundamental characteristics of the selected inter-urban corridors and to identify preliminary categories and classifications.

From the point of view of the **'socio-economic' dependent attributes** (see Figures 4.1 and 4.2) a net subdivision between central (C) and peripheral (P) European regions immediately emerges. In particular it can be noted that by shifting from the European peripheral regions towards the central ones (in other words, moving from the corridors connecting centre-periphery towards the corridors joining central nodes in Europe), the residential density increases as well as the service share on total employment.

In addition, by considering only the centre-periphery corridors, differences in the residential density appear since those in the North-South direction have an intermediate level of residential density with respect to those in the East-West direction (which show a low value).

As a consequence, from these different combinations of socio-economic attributes **different needs**, both in terms of mobility and of specific ATT implementations as well as **different reactions** of potential users, are likely to emerge. The differences in mobility (both in terms of the functioning of the system and user needs) are confirmed by considering the **infrastructure supply-side** (see Figure 4.3). In particular, Figure 4.3 shows, on the basis of the motorway density, the emergence of a two-fold classification, viz. central corridors and peripheral corridors, while on the basis of an indicator of accessibility (which reflects the different effects of dominance and dependence among the regions) a further subdivisions between quasi-peripheral (QP) and peripheral (P) corridors appear. This is mirrored by a high, medium and low supply of infrastructure.

By synthesizing with respect to **transport supply and socio-economic attributes**, a **classification** emerges (i.e. C, P and QP corridors) based mainly on the **geographical position** of the corridors with respect to the ≪core≫ of Europe.

With reference to the **transport demand attributes**, it is possible to identify the same type of classification which mainly reflects the different congestion situations. In particular, by investigating Figures 4.4 and 4.5 we can see that the peripheral corridors are characterized by a low accessibility index as well as a low value of traffic flows. Next, by considering the level of services related to traffic flows and share of freight transport on total flows (see Figures 4.6 and 4.7, respectively) again the peripheral corridors (P) appear to be clustered and clearly separated from the other central corridors.

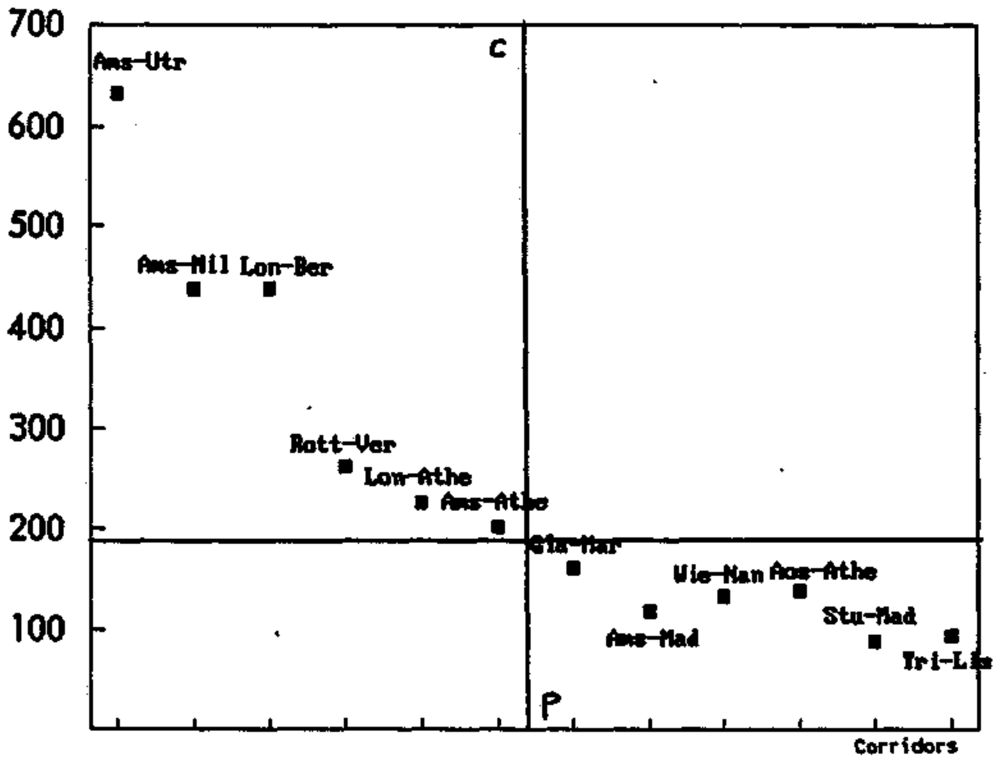

FIGURE 4.1: RESIDENTIAL DENSITY - 1987 (Habitants per km2)

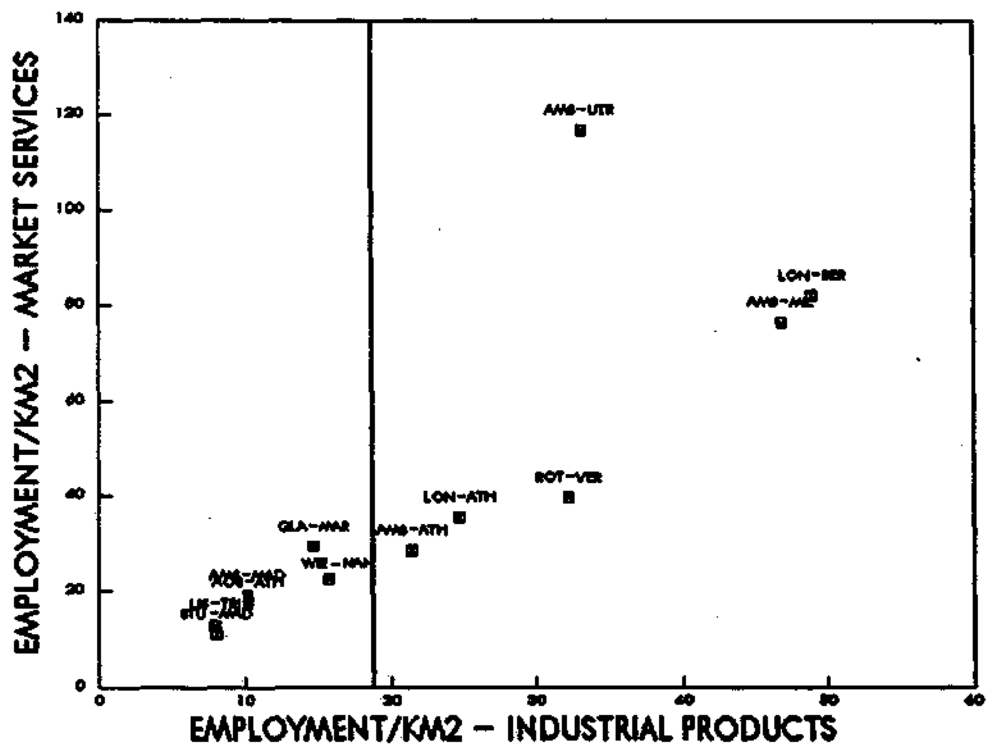

FIGURE 4.2: INDUSTRIAL PRODUCTS VERSUS MARKET SERVICE EMPLOYMENT DENSITY (1987)

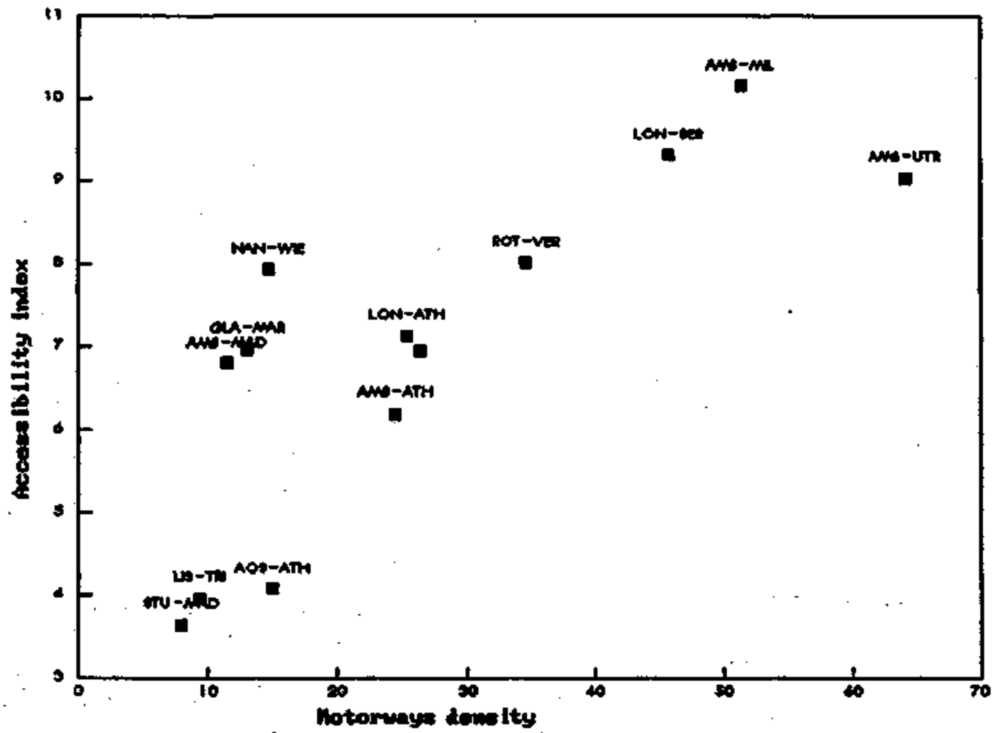

FIGURE 4.3: MOTORWAY DENSITY VERSUS ACCESSIBILITY INDEX

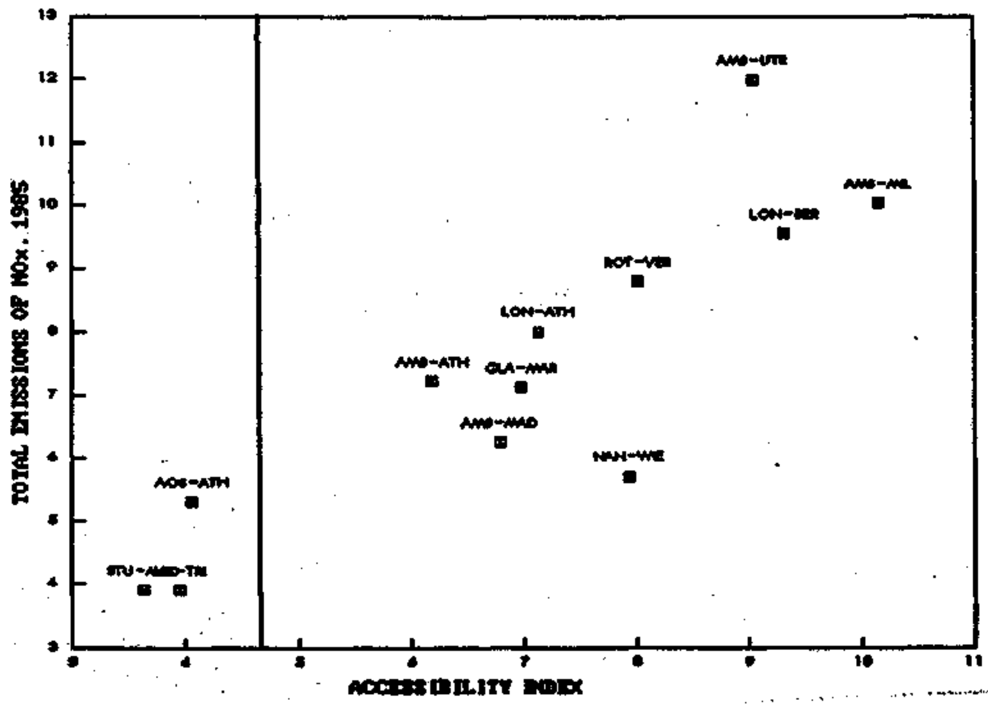

FIGURE 4.4: ACCESSIBILITY INDEX (1988) VERSUS TOTAL EMISSION OF NOx (1985)

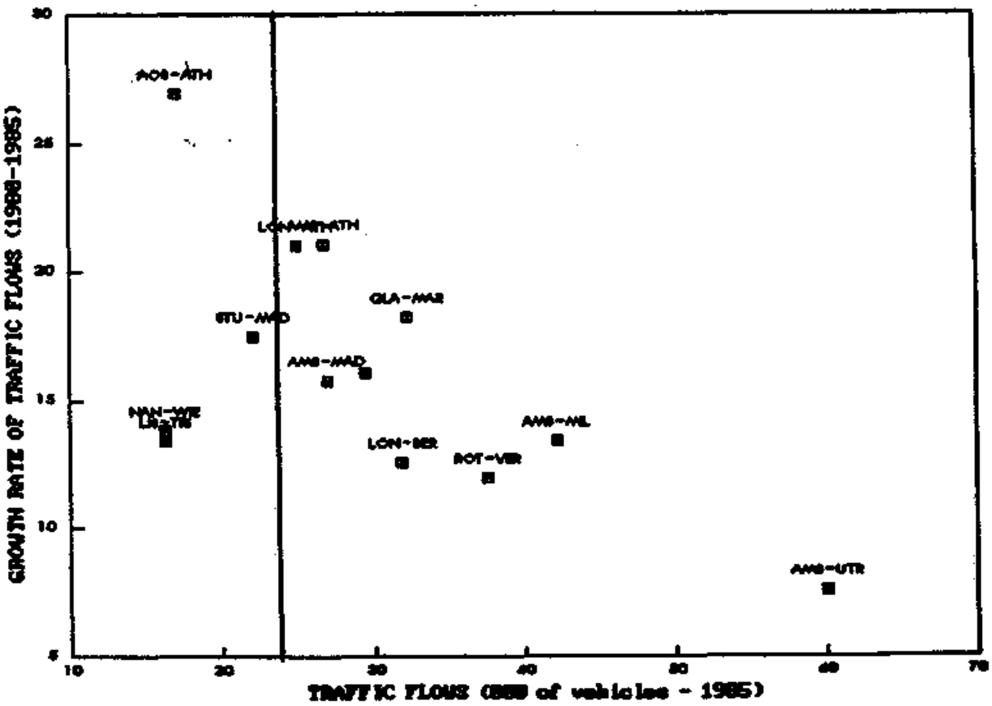

FIGURE 4.5: TRAFFIC FLOWS (1985) VERSUS TRAFFIC GROWTH RATE (1980-1985).

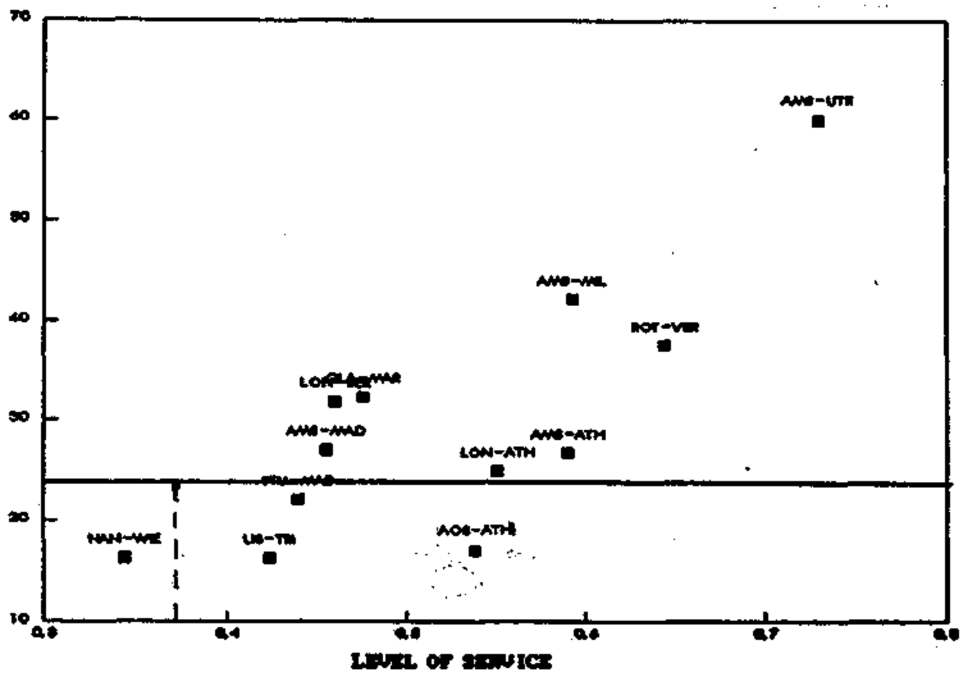

FIGURE 4.6: LEVEL OF SERVICE VERSUS TRAFFIC FLOWS (1985)

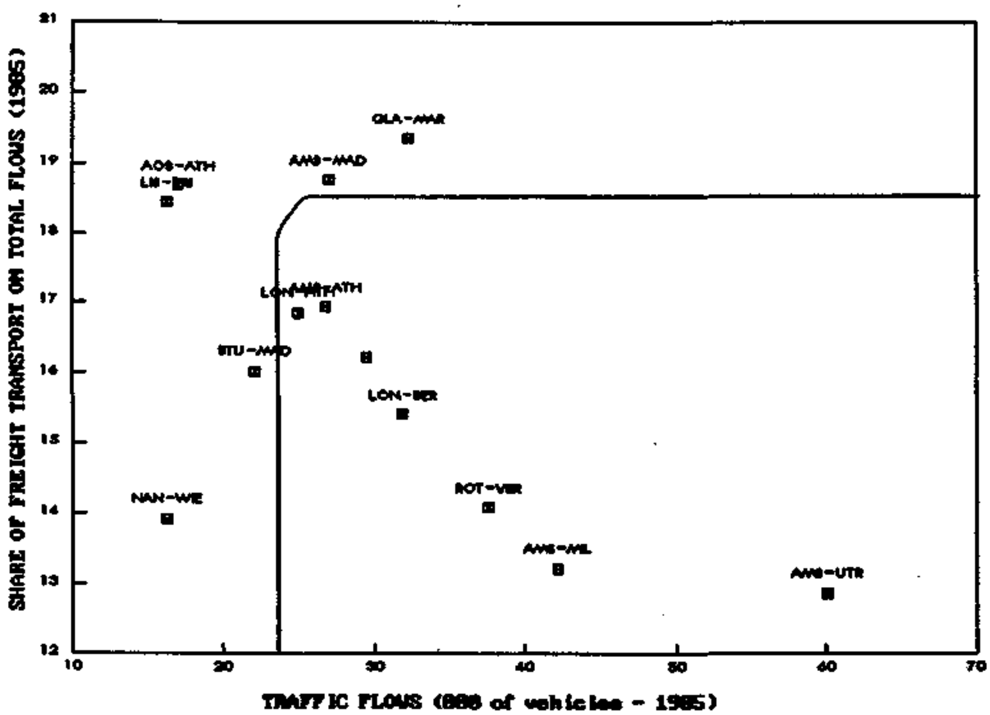

FIGURE 4.7: SHARE OF FREIGHT TRANSPORT ON TOTAL FLOWS (1985)

In conclusion, on the basis of the above diagrams reflecting quantitative information on socio-economic, transport supply and transport demand attributes, two main categories of European corridors emerge:

a) Central corridors (C):
AMSTERDAM-UTRECHT
AMSTERDAM-MILAN
ROTTERDAM-VERONA
LONDON-BERLIN
LONDON-ATHENS
AMSTERDAM-ATHENS

They are characterized by a high infrastructural density and accessibility degree, but clearly insufficient in satisfying the total traffic flows (see the high congestion level and pollution emission);

b) (Quasi)/Peripheral corridors (QP/P):
AOSTA-ATHENS
GLASGOW-MARSEILLE
AMSTERDAM-MADRID
STUTTGART-MADRID
TRIESTE-LISBON
WIEN-NANTES

They are characterized by medium congestion level and low accessibility by showing the necessity of infrastructural investment in order to avoid a rapid increase of congestion.

It should be noted that the above two-fold classification can be verified by means of a further analysis able to investigate also the interdependencies among all the attributes such as the Multicriteria Approach. This analysis will be developed in the next Section 5. However, from this first study we can assume that for each of the two groups of corridors, significant differences both in the potential of ATT introduction (as well as of other European resolutions) and the related behavioural responses will be likely to emerge.

5. A TWO-FOLD CLASSIFICATION OF INTER-URBAN CORRIDORS BY MEANS OF MULTICRITERIA ANALYSIS

5.1 THE METHODOLOGY ADOPTED

In the previous section we have shown how the investigation of the corridors on the basis of data collected has led to a preliminary typology, clustering the corridors in TWO MAIN 'structural' groups (central and peripheral corridors).

The above typology derives from the analysis of two-dimensional diagrams connecting the following types of variables for the corridors:

a) Socio-economic attributes
b) Transport supply attributes
c) Transport demand attributes

However it should be noted that all these indicators constitute a **multi-dimensional profile** of the corridors which provides different aspects of the 'socio-economic traffic' value of the corridors in relation to the potential introduction of ATT.
This implies that the corridors can also be valued by a multi-attribute utility approach, by considering the previous attributes a), b), c) as a basis for 'socio-economic traffic' evaluation of the corridors which is useful for an assessment of the ATT potential market.

In this context, a multidimensional approach such as Multicriteria Analysis (MCA) seems suitable for designing a ranking scheme of corridors in relation to their 'compound value', determined by the interdependencies of the various attributes.

TABLE 5.1: CRITERIA UTILIZED IN THE MCA ANALYSIS.

a.	**Socio-economic profile**	**c.**	**Transport-demand profile**
a1	Population density	c1	Private car ownership
a2	(Total) GVAMP (*)	c2	Road traffic accidents
a3	GVAMP of industrial sectors	c3	NOx pollutions
a4	GVAMP of market services	c4	Vehicles flows
a5	Employment	c5	Growth of vehicle flows
a6	Industrial branches employm.	c6	Heavy vehicle flows
a7	Market services br. employm.	c7	Traffic flows smoothness
a8	Stock of dwellings		

b. Transport-supply profile
b1 Motorway density
b2 Accessibility of cities
b3 Large agglomeration on corridor
b4 Crossed EC member states

(*) GVAMP Gross Value Added at Market Prices

MCA has become a popular tool in policy evaluation studies in many countries (see, e.g., Nijkamp, 1979 and Nijkamp et al., 1990), not only in the case of 'hard' (quantitative) information but also in the case of 'soft' (qualitative) information. In this framework, a corresponding suitable multiple criteria method, such as the 'Regime Method' meeting methodological soundness, mathematical and statistical accessibility and easy computer use can be identified (Hinloopen et al., 1983 and Hinloopen and Nijkamp, 1990) and used in the present study.

In particular, by means of MCA, we assume **three main evaluation criteria**, viz. the Socio-Economic Profile, the Transport Supply Profile and the Transport Demand Profile. Each of these main judgment profiles is composed of observable attributes, based on the data collected, as shown in Table 5.1.

Nineteen indicators, grouped in the three main criteria categories, are used. The resulting impact matrix is shown in Table 5.2.

The appliance of the Regime Method finds place by considering five different weighting sets A, B, C and D. Table 5.3 shows for each of these five weighting Scenarios an ordinal ranking of attributes according to their expected relevance, utilized in the MCA.

TABLE 5.2.: THE IMPACT MATRIX (AC).

	SOCIO-ECONOMIC PROFILE								TRANSPORT SUPPLY PROFILE			
	a1	a2	a3	a4	a5	a6	a7	a8	b1	b2	b3	b4
AMSTERDAM-UTRECHT	12	8	6	11	12	10	12	12	12	10	1	1
AMSTERDAM-MILAN	11	12	11	12	10	11	10	11	11	12	6	10
LONDON-BERLIN	10	9	8	8	11	12	11	10	10	11	2	9
ROTTERDAM-VERONA	9	10	12	9	9	9	9	9	9	9	5	6
AMSTERDAM-ATHENS	7	6	9	5	7	7	6	7	7	4	11	11
LONDON-ATHENS	8	5	7	6	8	8	8	8	8	7	12	12
GLASGOW-MARSEILLE	6	7	5	7	6	5	7	6	4	6	8	2
AMSTERDAM-MADRID	3	4	3	4	3	4	4	3	3	5	9	5
AOSTA-ATHENS	5	1	1	1	4	3	3	4	5	3	3	3
TRIESTE-LISBON	2	2	2	3	2	2	2	2	2	2	10	7
STUTTGART-MADRID	1	3	4	2	1	1	1	1	1	1	4	8
VIENNA-NANTES	4	11	10	10	5	6	5	5	6	8	7	4

	TRANSPORT DEMAND PROFILE						
	c1	c2	c3	c4	c5	c6	c7
AMSTERDAM-UTRECHT	12	12	12	12	1	2	12
AMSTERDAM-MILAN	11	10	10	11	3	1	10
LONDON-BERLIN	10	11	11	8	4	5	4
ROTTERDAM-VERONA	9	4	9	10	2	4	11
AMSTERDAM-ATHENS	7	6	7	6	11	8	9
LONDON-ATHENS	8	9	8	5	10	7	8
GLASGOW-MARSEILLE	6	7	6	9	9	11	6
AMSTERDAM-MADRID	3	5	4	7	7	10	5
AOSTA-ATHENS	4	8	3	3	12	12	7
TRIESTE-LISBON	2	3	2	2	5	9	2
STUTTGART-MADRID	1	1	1	4	8	6	3
VIENNA-NANTES	5	2	5	1	6	3	1

TABLE 5.3: ORDINAL RANKING OF THE ATTRIBUTES IN FIVE WEIGHTING SETS A, B, C, D AND E

SCENARIO A	c7 c4 c5 c6 b3 b4 c3 b1 c2 b2 c1 a1 a8 a2 a5 a3 a4 a6 a7
SCENARIO B	a7 a6 a4 a3 a5 a2 a8 a1 c1 b2 c2 b1 c3 b4 b3 c6 c5 c4 c7
SCENARIO C	c4 c3 c7 c5 c6 c2 c1 b2 b4 b3 b1
SCENARIO D	b1 b3 b4 b2 c1 c2 c6 c5 c7 c3 c4
SCENARIO E	a1 a8 a2 a5 a3 a4 a6 a7

In the Scenarios A and B, relevance is given to the attributes related to the 'traffic' criteria (both supply and demand) and to 'socio-economic' criteria respectively. In the Scenarios C and D the 'socio-economic' criteria are not taken into account, so the corridors can be classified in the sole context of transport characteristics. In Scenario C more relevance is given to the 'demand-side' attributes, in Scenario D to 'supply-side' attributes. Finally, in Scenario E the relevance is given only to socio-economic data, in order to evaluate the relation between 'transport data' and 'socio-economic' characteristics. For each Scenario a Regime analysis is carried out. The results are presented in the next subsection.

5.2 RESULTS OF MULTICRITERIA ANALYSIS AND ASSESSMENT OF REPRESENTATIVE CORRIDORS

The results of a MCA (by applying a Regime Method) within the framework of the 'complex' evaluation of twelve European inter-urban corridors for the ATT introduction are presented in Table 5.4.

From these results we can draw the conclusion that the **two-fold classification constructed in Section 4 seems fairly robust when seen against changes in the Scenarios: this is also the case for MCA.** In other words the Multicriteria analysis displays the highest scores for the central (C) group of the corridors in light of all the 'socio-economic-traffic' aspects. Thus a clearly subdivision between C and (Q)P corridors again emerge.

We remind that the rationale behind the definition of such a classification is the hypothesis that **differences in the impact of the corridors with ATT (or other European policies) introduction are dependent upon hierarchical levels based on 'socio-economic-traffic' characteristics.**

TABLE 5.4: THE RESULTS OF MULTICRITERIA ANALYSIS

A	B	C	D	E
AMSTERDAM-UTRECHT	AMSTERDAM-UTRECHT	AMSTERDAM-UTRECHT	AMSTERDAM-MILAN	AMSTERDAM-UTRECHT
AMSTERDAM-MILAN	AMSTERDAM-MILAN	AMSTERDAM-MILAN	LONDON-BERLIN	AMSTERDAM-MILAN
LONDON-BERLIN	LONDON-BERLIN	LONDON-BERLIN	AMSTERDAM-UTRECHT	LONDON-BERLIN
ROTTERDAM-VERONA	ROTTERDAM-VERONA	ROTTERDAM-VERONA	LONDON-ATHENS	ROTTERDAM-VERONA
LONDON-ATHENS	LONDON-ATHENS	LONDON-ATHENS	AMSTERDAM-ATHENS	LONDON-ATHENS
AMSTERDAM-ATHENS	AMSTERDAM-ATHENS	AMSTERDAM-ATHENS	ROTTERDAM-VERONA	AMSTERDAM-ATHENS
GLASGOW-MARSEILLE	GLASGOW-MARSEILLE	GLASGOW-MARSEILLE	GLASGOW-MARSEILLE	GLASGOW-MARSEILLE
AOSTA-ATHENS	WIEN-NANTES	AOSTA-ATHENS	AOSTA-ATHENS	WIEN-NANTES
AMSTERDAM-MADRID	AMSTERDAM-MADRID	AMSTERDAM-MADRID	AMSTERDAM-MADRID	AOSTA-ATHENS
WIEN-NANTES	AOSTA-ATHENS	TRIESTE-LISBON	WIEN-NANTES	AMSTERDAM-MADRID
TRIESTE-LISBON	TRIESTE-LISBON	STUTTGART-MADRID	TRIESTE-LISBON	TRIESTE-LISBON
STUTTGART-MADRID	STUTTGART-MADRID	WIEN-NANTES	STUTTGART-MADRID	STUTTGART-MADRID

Some examples in this context can be also provided by two recent studies displaying respectively the impact of TGV and the impact of Channel Tunnel on European Network. In particular, similar (negative) behavioural responses seems to emerge in the peripheral areas (see Figure 5.1 and 5.2) by showing the necessity of a stronger integration with the core of Europe and hence the necessity of constructing a further hierarchy within the peripheral corridors in order to identify more 'unfavourable' characteristics of integration (as in the case of peripheral islands).

The classification of corridors which results from this multicriteria analysis can be further detailed by not only considering their geographical positions relative to the core of Europe, but also their easterly and westerly dimensions relative to this core. By synthesizing these dimensions, a **five-cluster typology** of inter-urban corridors, which show similar profiles in particular with respect to their transport demand attributes, emerges as follows:

1C	central located corridors
2E	semi-peripheral, easterly corridors
2W	semi-peripheral, westerly corridors
3E	peripheral, easterly corridors
3W	peripheral, westerly corridors.

The 1, 2, 3 codes in this classification reflects the geographical position of the corridors with respect to the «core» of Europe (respectively central, semi-peripheral and peripheral) and the E, W code reflects westerly and easterly positions relative to this core. In Table 5.5 the resulting hierarchy of corridors from the multicriteria analysis is shown again, preceeded by the respective clusters they belong to.

- The (C) group is composed of the central corridors (Amsterdam-Utrecht, Amsterdam-Milan, Rotterdam-Verona, London-Berlin), i.e. corridors characterized by a high density of infrastructure and accessibility degree and by a low growth rate of total flows as well as the share of freight transport. However they are rather insufficient in satisfying the total traffic needs owing to the high level of congestion and pollution emissions (see, related Figures in MARTA Working Paper n° 12);
- The (E) group is composed of central-peripheral corridors in an East direction (Amsterdam-Athens, London-Athens and Aosta-Athens): they show high to medium congestion levels and growth rates, and the necessity of infrastructure investment in order to avoid a rapid increase of congestion;
- The (W) group is composed of central-peripheral corridors in a Westerly direction (Glasgow-London-Paris-Marseille, Amsterdam-Madrid, Stuttgart-Madrid, Lisbon-Trieste and Nantes-Vienna), i.e. corridors that denote medium congestion levels and low growth rates by showing the incapability of exploiting the infrastructure network.

The mapping of the clusters, showing similar transport demand profiles, results in a set of centric zones, called the **Euregg** model (see Figure 5.3).

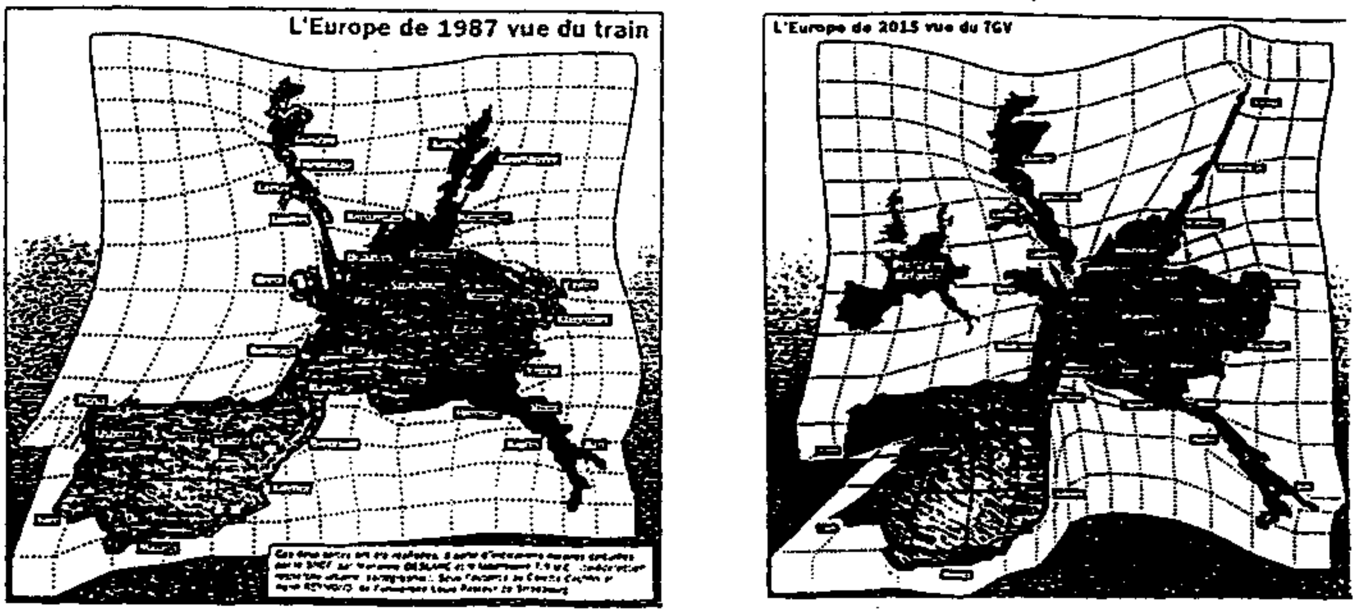

FIGURE 5.1: IMPACT OF THE TGV ON EUROPEAN NETWORK
(source: Wegener, 1992)

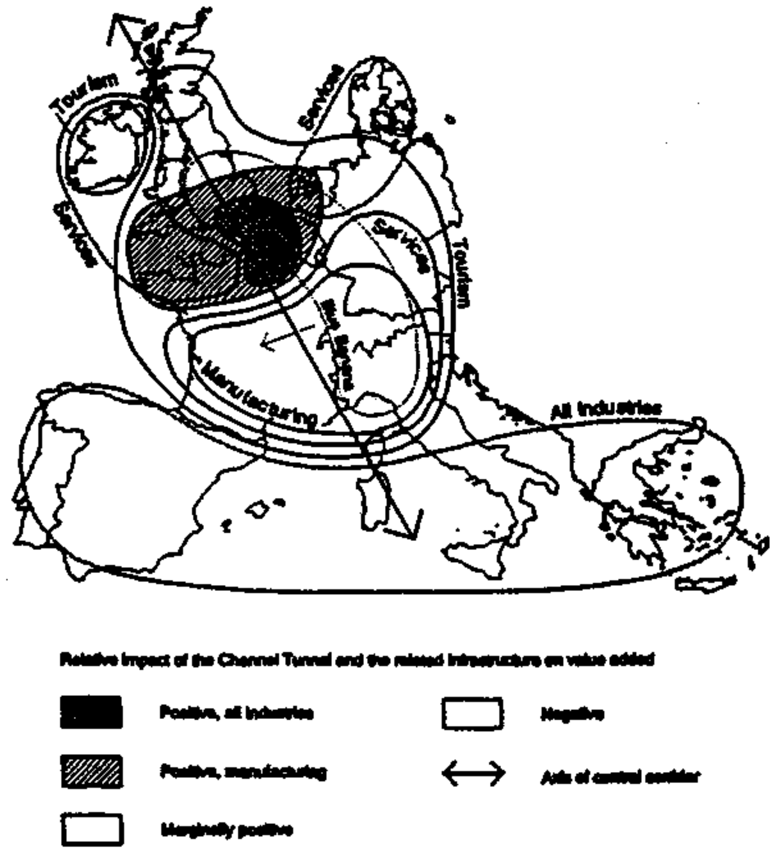

FIGURE 5.2:IMPACTS OF THE CHANNEL TUNNEL AND THE RELATED TRANSPORT INFRASTRUCTURE ON ECONOMIC DEVELOPMENT (Source: Wegener et al., 1992).

TABLE 5.5: FIVE-CLUSTER TYPOLOGY OF CORRIDORS

A	B	C	D	E
1C AMSTERDAM-UTRECHT	1C AMSTERDAM-UTRECHT	1C AMSTERDAM-UTRECHT	1C AMSTERDAM-MILAN	1C AMSTERDAM-UTRECHT
1C AMSTERDAM-MILAN	1C AMSTERDAM-MILAN	1C AMSTERDAM-MILAN	1C LONDON-BERLIN	1C AMSTERDAM-MILAN
1C LONDON-BERLIN	1C LONDON-BERLIN	1C LONDON-BERLIN	1C AMSTERDAM-UTRECHT	1C LONDON-BERLIN
1C ROTTERDAM-VERONA	1C ROTTERDAM-VERONA	1C ROTTERDAM-VERONA	2E LONDON-ATHENS	1C ROTTERDAM-VERONA
2E LONDON-ATHENS	2E LONDON-ATHENS	2E LONDON-ATHENS	2E AMSTERDAM-ATHENS	2E LONDON-ATHENS
2E AMSTERDAM-ATHENS	2E AMSTERDAM-ATHENS	2E AMSTERDAM-ATHENS	1C ROTTERDAM-VERONA	2E AMSTERDAM-ATHENS
2W GLASGOW-MARSEILLE	2W GLASGOW-MARSEILLE	2W GLASGOW-MARSEILLE	2W GLASGOW-MARSEILLE	2W GLASGOW-MARSEILLE
3E AOSTA-ATHENS	3W WIEN-NANTES	3E AOSTA-ATHENS	3E AOSTA-ATHENS	3W WIEN-NANTES
2W AMSTERDAM-MADRID	2W AMSTERDAM-MADRID	2W AMSTERDAM-MADRID	2W AMSTERDAM-MADRID	3E AOSTA-ATHENS
3W WIEN-NANTES	3E AOSTA-ATHENS	3W TRIESTE-LISBON	3W WIEN-NANTES	2W AMSTERDAM-MADRID
3W TRIESTE-LISBON	3W TRIESTE-LISBON	3W STUTTGART-MADRID	3W TRIESTE-LISBON	3W TRIESTE-LISBON
3W STUTTGART-MADRID	3W STUTTGART-MADRID	3W WIEN-NANTES	3W STUTTGART-MADRID	3W STUTTGART-MADRID

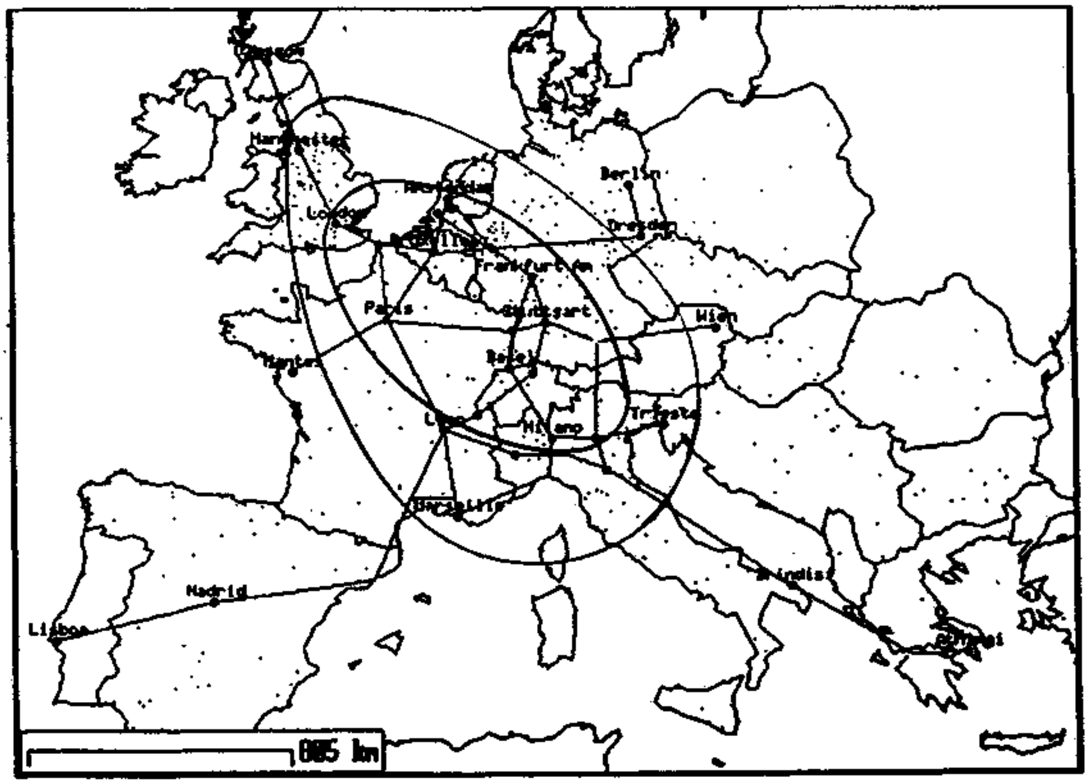

FIGURE 5.3: THE DESIGN OF AN INTER-URBAN CORRIDOR TYPOLOGY IN FIVE CLUSTERS: THE EUREGG MODEL

An examination of each cluster based on the corridor rankings resulting from the multicriteria analysis shows in particular that some pilot projects in the new DRIVE programme can be chosen as representative of each category illustrated in Table 5.6.

TABLE 5.6: REPRESENTATIVE CORRIDORS

TYPOLOGY	SAMPLE CORRIDOR	PILOT PROJECT
1C	Rotterdam-Verona	COMBICOM
2E	London-Athens	METAFORA
2W	Glasgow-Marseille	PLEIADES(*)
3E	Aosta-Athens	ADS
3W	Stuttgart-Madrid	MELYSSA(*)

(*) The pilot projects PLEIADES and MELYSSA examine a part of the corridors investigated, viz. London-Paris and Stuttgart-Barcelona respectively.

A further monitoring of this preliminary result will also be the investigation of all the specific segments in order to identify - within each corridor - the range values of the attributes which could be significant for the behavioural responses to potential ATT implementation. In helping to achieve this, appropriate methods are required to visualize for each corridor under investigation its specific socio-economic, transport supply and

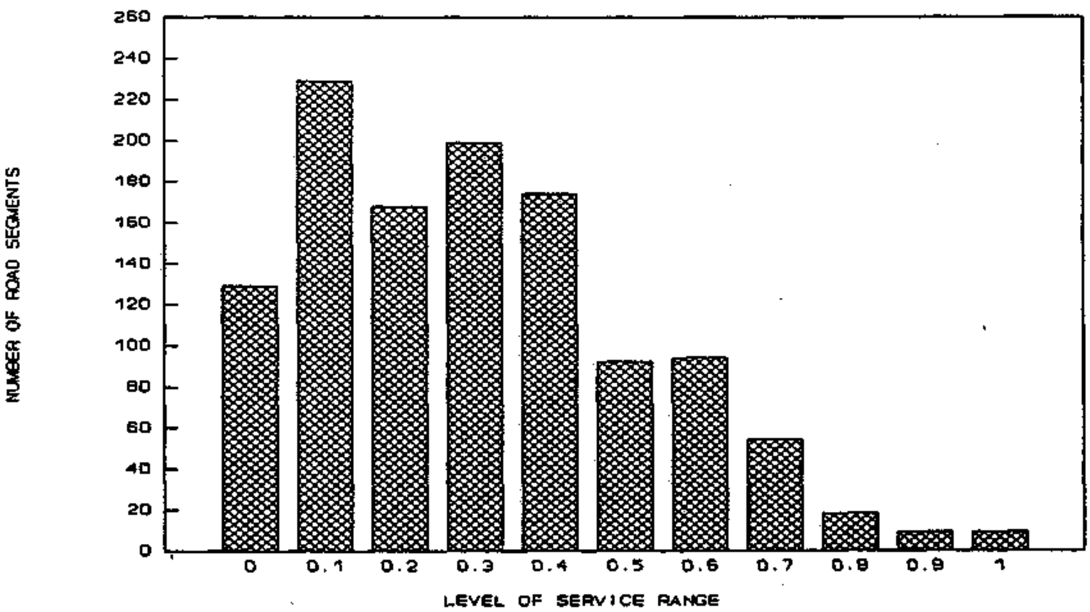

FIGURE 5.4 FREQUENCY PROFILE OF LEVEL OF SERVICE VALUES OF THE MELYSSA CORRIDOR NETWORK

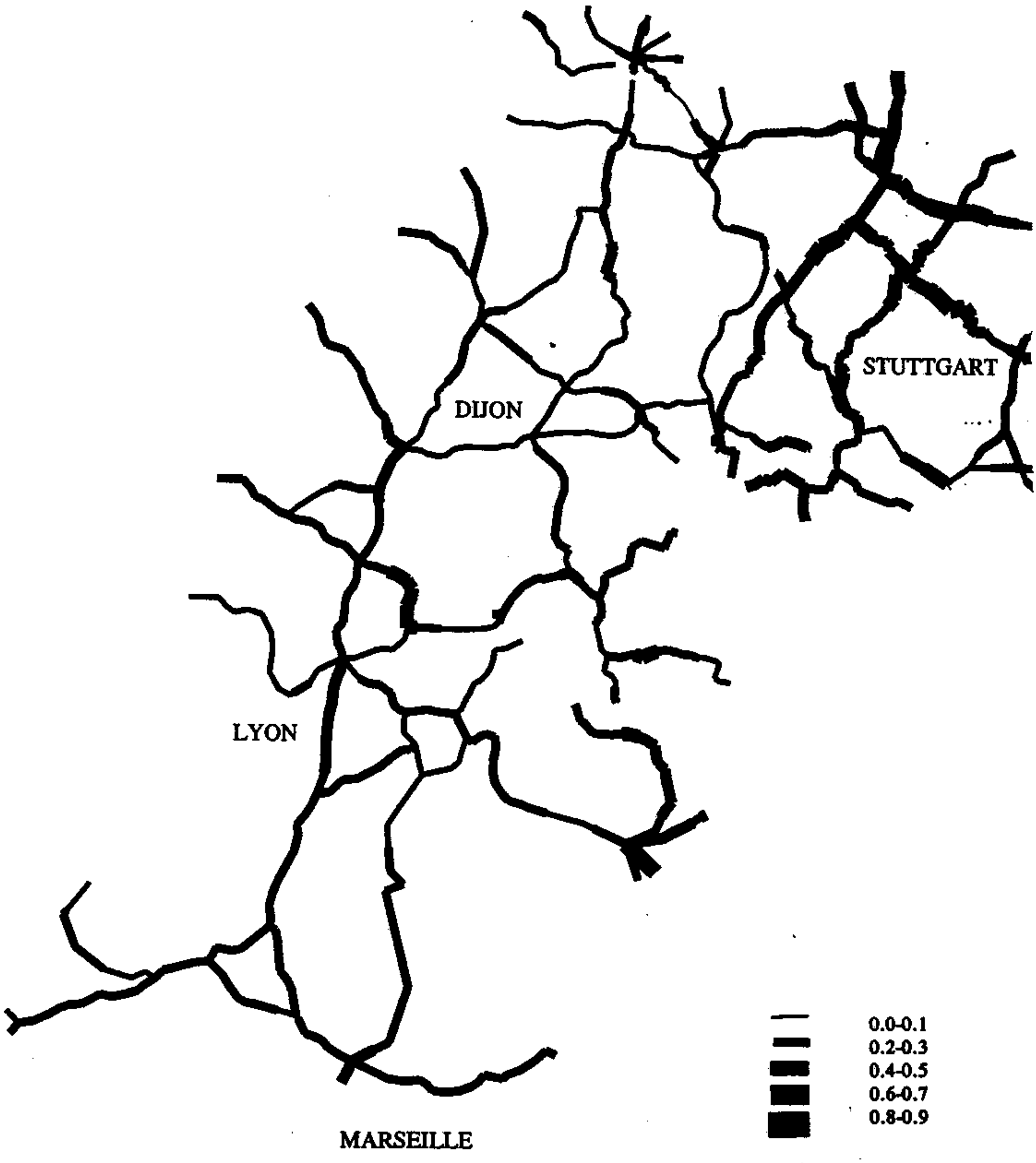

FIGURE 5.5 LEVEL OF SERVICE PROFILE OF THE MELYSSA CORRIDOR ROAD NETWORK

transport demand attributes profiles. One such method is based on Geographical Information System (GIS) techniques. By using ARC/INFO, a computer program being able to create a spatial information system[2], the geodemographic features of the European road network can be fully utilized, for example, to create spatial congestion profiles. In Figure 5.5 an example is shown in the case of the corridor test area of the MELYSSA project, for which traffic measurements on road segments in 1985 are used (see also the related frequency Diagram 5.4 with level service value ranges). Because the use of ATT is expected to vary with the local traffic situations, such maps help to understand in which areas ATT applications could be of high importance or under which corridor traffic circumstances ATT could lead to successful results.

[2] Environmental Systems Research Institute (1992).

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