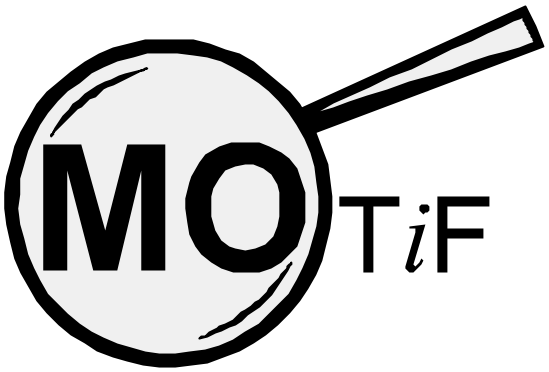

MOT*i*F - Market Orientated Transport in Focus

Contract No. UR-97-SC.1149

Final Report for Publication

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Final Report for Publication (Deliverable 5)

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Executive Summary

Introduction

In all European countries personal mobility has increased tremendously during the past decades due to economical and political changes. Economic wealth made travelling affordable to the majority of European citizens. Reduced working hours resulted in higher time budgets for leisure time activities. Suburbanisation and higher housing standards reduced the density of European cities, which led to an increase of travelling distances. Improved traffic means (e.g. vehicles, roads) were at the same time a necessary condition for absorbing the increased traffic loads and a cause of a further rise of traffic demand, since people tend to make longer journeys as soon as travelling becomes faster and more comfortable.

The increase of mobility was mainly realised by the use of the private car. This has resulted in traffic problems that threaten the quality of life: air pollution, traffic congestion, accidents, noise, and fragmentation of the landscape. The capacities of the road networks have reached their limits, a further expansion of private car use would result in reduced mobility and economic damage due to increasing congestion problems.

These problems are most serious in urban areas because of the density of the population and have been aggravated by deficiencies of city planning in the past. City functions like dwelling, work, shopping, leisure and recreation have been separated. Industrial and commercial centres, shopping malls and residential areas have been built in the periphery of the cities. As a consequence the number and average length of everyday trips is increasing.

A higher modal share of collective transport systems at the expense of individual motorised traffic would be an important contribution to alleviating traffic problems. To achieve this goal public transport systems will have to become more market orientated. In recent years, operators have gradually evolved from product orientation towards market orientation. A number of initiatives searched to improve transport systems or to introduce new systems. However, in many cases these initiatives were not based on a solid knowledge of market requirements. Therefore these initiatives were not as successful as they could have been.

The objective of **MOT*i*F** was to research this problem and to find solutions to improve the market orientation of public transport. The project concentrated on urban transport. **MOT*i*F** was funded as a research project under the Transport RTD Programme of the European Commission Directorate General VII.

MOT*i*F background and approach

From the point of view of operators, the demand side of the transport market consists of two customer groups: passengers and authorities.

- Requirements of **passengers** are diverse and constantly evolving.
- **Authorities** articulate societal needs and express passenger and citizen needs that are not sufficiently expressed by direct market relations.

MOT*i*F presents current strategies and tools for tailoring the mass product "urban public transport" to the needs and requirements of the ever more diversifying market. The following research questions were addressed:

- How can user groups with similar requirements on urban transport systems be identified?
- What are the requirements of the different user groups on public transport?
- What kind of products are offered to them?
- Do these products satisfy user needs currently, how can they be improved?

The basic project structure of **MOT*i*F** reflects these research questions:

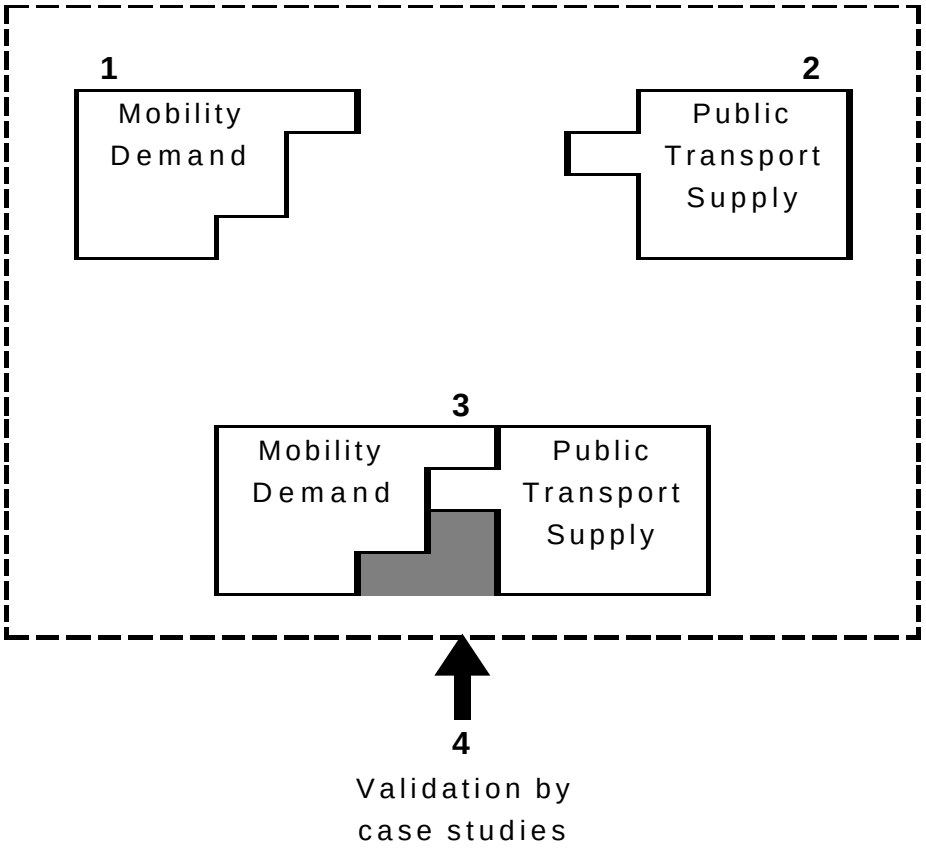


Figure 1: MOT*i*F work packages

MOT*i*F based its findings mainly on the analysis and results of former and current research work throughout Europe. This approach incorporated one of the most challenging requirements for the consortium: drawing general conclusions from heterogeneous data sources. The chosen approach is twofold: to present detailed single results of the studies and to compare on a much more aggregated level.

Due to the available source studies, the focus of **MOT*i*F** was on the requirements that are researched most frequently and on the requirements of present users, as they are the most surveyed target group. Of course, this approach confines the validity of the conclusions somewhat. This should be no problem, as long as decision makers in the transport sector are aware of the bias when interpreting the conclusions. The negligence of the point of view of choice riders might lead to underestimation of information and communication needs as well as of other aspects that are especially important for less frequent users.

MOT*i*F work package objectives

The main objective of the **first work package** of the **MOT*i*F** project was to

> *analyse the structure of the demand side of the urban transport market (market segmentation) and determine the user requirements on urban public transport for every market segment.*

Special attention was given to

- special needs, mainly requirements of the motor and sensorial disabled and passengers travelling at night, and
- the requirements of the authorities.

The crucial step in the study of the demand side of public transport was the determination of **importance factors** and above all the analysis of factors that influence them. This is the key to segmentation of the market, aiming at the isolation of user groups with similar requirements inside any group but different requirements compared to all other groups.

The main objective of the **second work package** was

> *to define transport products and product groups and to assess their specific performance by means of indicators.*

A key task was the development by the consortium of a standardised set of factors for measuring the performance of transport products. These performance factors measure all supply features of public transport products such as availability, travelling speed, security, comfort, etc.

The main objective of the **third work package** was

> *to make a cross comparison between the demand and supply sides of the urban public transport market, thus identifying suitable products for different market segments.*

An inverted form of the benefit segmentation approach was applied, i.e. the focus was on unmet expectations or attribute deficiencies. The basic principle is, that the user chooses the product with minimum deficiencies.

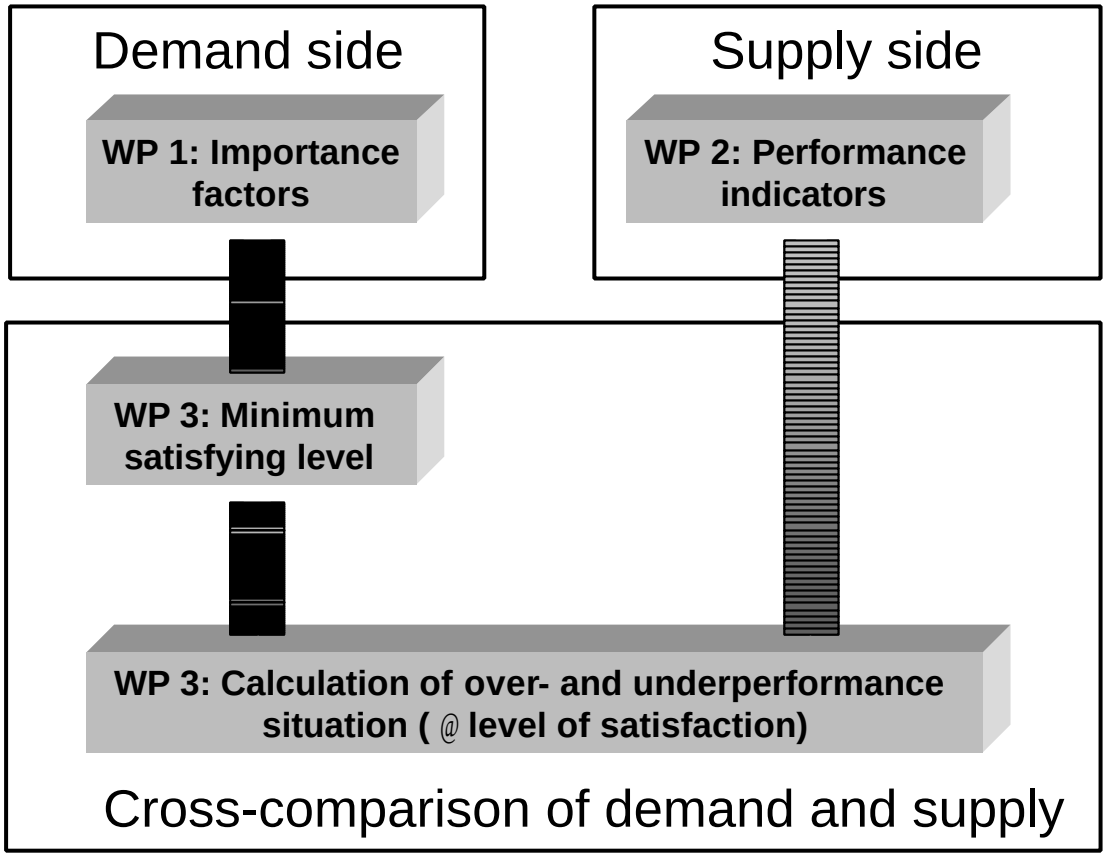


Figure 2: Cross-comparison of demand and supply

The demand data (importance factors) and the supply data (performance indicators) served as input for the calculation of underperformance. The level of underperformance determines the attractiveness of a product for its users.

The entire process of under- or overperformance calculation is briefly illustrated hereafter:

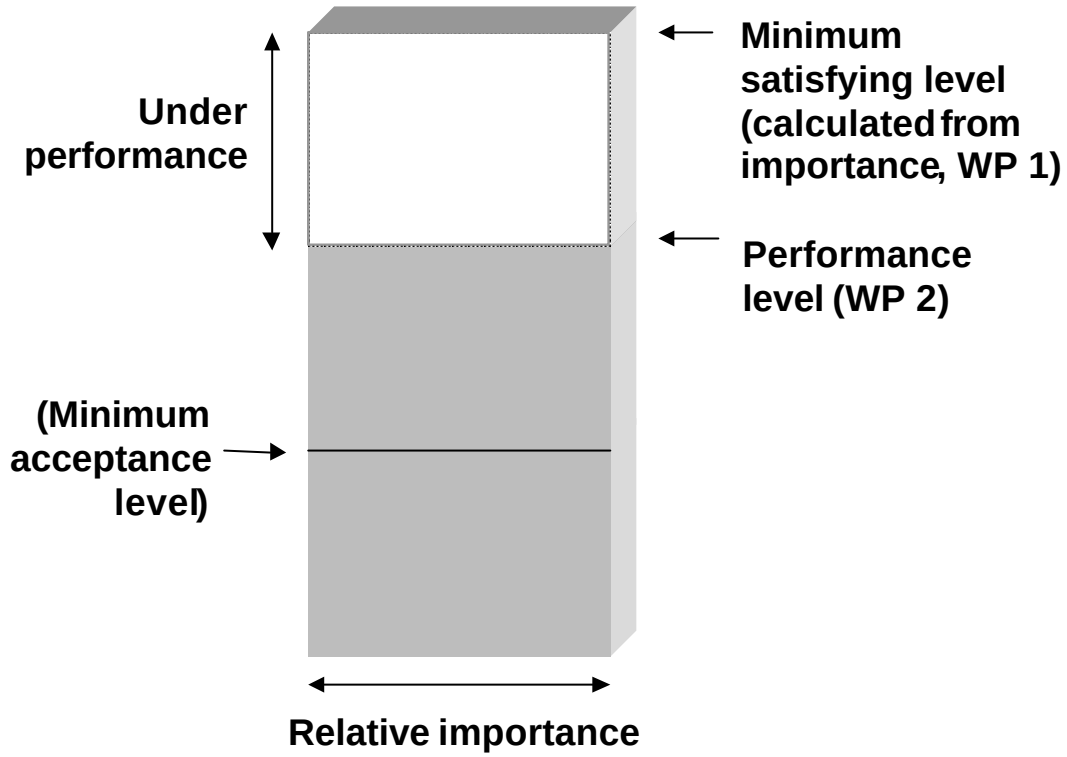


Figure 3: Calculation of underperformances

The main objective of the **fourth work package** of the **MOT*i*F** project was

> *to examine the results of work packages 1 to 3 in practice through case studies.*

The case study descriptions comprise basic data, demand and supply data, traffic related and financial data and legal aspects.

Requirements of users and authorities

The data source for the demand side analysis consisted of different forms of previously conducted studies and literature, all of them dealing with detailed passenger requirements, passenger satisfaction and reasons for modal choice. On this basis, most objectives formulated for the demand analysis within **MOT*i*F** could be reached.

User requirements

A categorised **set of requirements** on public transport of users and potential users based on an extensive survey of European public transport studies was developed.

No.	Category of requirements	No.	Category of requirements
1	availability, connections	10	pre-trip information
2	number of transfers	11	on-trip information
3	punctuality, reliability	12	customer orientation
4	travelling speed	13	price, fare level
5	regularity	14	tariff system
6	accessibility of stops & vehicles	15	possibilities to obtain tickets
7	frequency of departures	16	safety
8	security (in vehicles, at stops)	17	social prestige
9	comfort (in vehicles, at stops)	18	environmental friendliness

Table 1: Categorisation of passenger requirements

The set of categories of passenger requirements was used as a general framework for unification of the results from local surveys. By matching the requirement definitions from the case study with the general **MOT*i*F** requirements, comparison with the results from other case studies became possible. European tendencies regarding passenger requirements were developed on a general level.

This kind of general analysis should be seen as the starting point for further research. The results are not representative due to their **heterogeneity in terms of objectives, methodologies, researched target groups etc.** In field work, the local specifics should determine the selection of an appropriate categorisation of requirements that enables detailed analysis of passenger demand.

At the core of marketing studies are passenger satisfaction and / or importance with regard to these product features. The focus in **MOT*i*F** was on importance, since satisfaction data from different locations are of course dependent on the

locally different service levels and therefore cannot be compared. Importance of different aspects of public transport products could in principle be uniform across Europe. This hypothesis was tested. A comparison of results from studies carried out in different European countries shows, that not only satisfaction with service aspects but also their relative importance varies.

	Dutch	French	German	Portuguese	Spanish
most important	Price	travelling speed	price	safety	safety
second most important	Security	regularity	connections	punctuality, reliability	security
third most important	punctuality, reliability	punctuality, reliability	punctuality, reliability	frequency of departures	punctuality, reliability

Table 2: Most important passenger requirements

The surveyed studies show passenger priorities that are quite different. Only punctuality / reliability ranks among the most important requirements of users in the studies from all five countries.

Though every study delivers another importance ranking, some **general trends** can be observed. The importance of travel speed, according to popular opinion decisive for modal choice, seems to be somewhat exaggerated. Availability, connections, punctuality and frequency are just as or even more important. The influence of car ownership on passenger requirements has proven to be less than expected.

In many studies frequent travellers have been asked to rank, evaluate or mention most and least important requirements. Not only **potential passengers** e.g. with a higher need for information and without subscriptions are neglected through this process but also frequent travellers who may take a rarely used route. Other strategies for assessment of qualities and importances of ‘soft’ criteria such as security, information, comfort etc. should then be considered.

When preparing a customer satisfaction study, the survey design (inquiry method and technique, sample composition, themes) must be chosen carefully depending on the **objectives**. I. e. an inappropriate selection of the research methods and

techniques could lead to doubtful results. Figure 4 presents an overview over research methods and techniques.

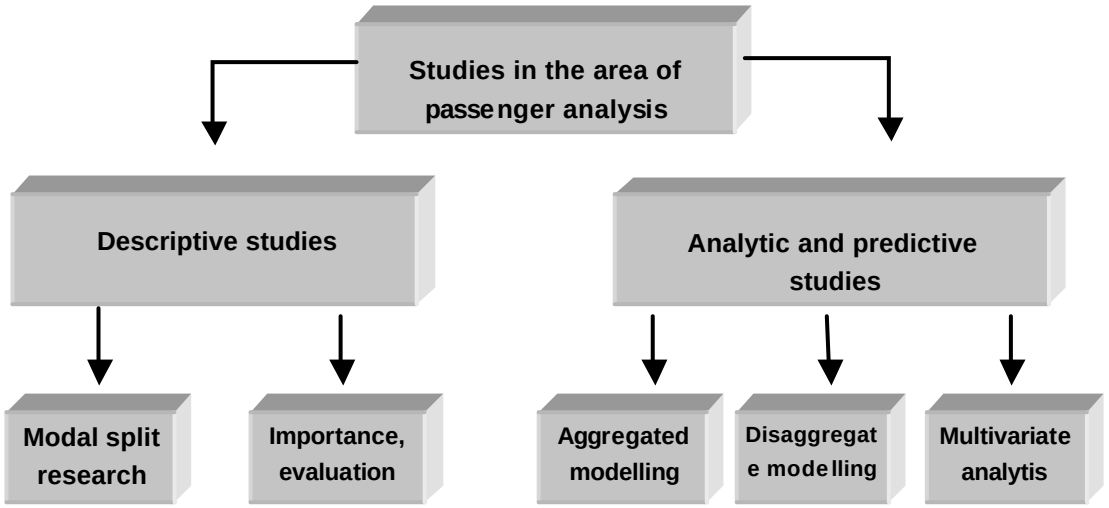


Figure 4: Categorisation of studies in the area of passenger analysis

General quality monitorings or task-specific surveys e.g. on security require different approaches. Gathering all information about the requirements of all passengers is not possible for reasons of feasibility. A conscious **trade-off** between the number of aspects, level of detail, specification of the market segmentation and more or less sophisticated techniques is necessary.

In some studies, all requirements unveil nearly the same level of importance or degree of satisfaction from the passenger's point of view. Since not all studies come to this result, **methodical or systematic weaknesses** might well be the cause (e. g. if "requirement inflation", i. e. assignment of high importance to all aspects of service, is not anticipated). The planner who is responsible within the transport company or at the authority cannot prioritise decisions on infrastructure, operational or marketing investments on this basis.

Taking the (potential) customer serious does not mean taking all of his answers for granted. The importance of information according to customer survey results can be very low whilst at the same time factual information deficits prevent public transport use. The example of Roissy demonstrated such an interesting **paradox** regarding the **importance of information** according to car drivers. Serious

underestimation of the importance of this aspect would have occurred if figures had been taken for granted without sufficient reflection.

The perceived qualities of transport supply, such as punctuality, journey speed, comfort etc. influence the attractiveness of public transport compared to other modes. **Habits**, **image** (prestige) of transport products, **cultural background** and **education** also play an important role. The question to be answered by future research will therefore be, to what extent decision makers within the public transport sector will be able to positively influence the image / prestige of public transport and the mobility habits of (potential) passengers with different cultural backgrounds.

The attractiveness of public transport seems to depend both on its own quality features and on **additional measures** in the field of inner city access and parking facilities for motor cars. Pull measures only will thus have only moderate success.

Market segmentation

Usually, only low importance is attributed on average to pre-trip information and accessibility. Nonetheless, these aspects are very important to smaller, but still considerable groups of users. This fact illustrates, that **market segmentation is a prerequisite for meaningful conclusions**. If relevant discriminative user and journey characteristics are neglected by the researcher, crucial information disappears in the average values.

The literature survey showed that market segmentations are carried out in numerous different ways. Discriminative factors are e. g. socio-economic parameters, number of public transport trips, trip characteristics, quality of individual public transport connection and also concepts that are rooted in psychology and sociology like fundamental principles and attitudes of passengers.

- The majority of studies take **socio-economic** characteristics of the user as a starting point (age, gender, profession, etc.). A sophisticated variant on this discriminative criterion is the **phase of life** (e. g. family situation).
- The socio-economic criterion is regularly combined with **journey purpose**, **frequency of public transport use** and **quality aspects of the journey** such as stop distance, seat availability, and number of transfers.
- Finally, **fundamental convictions and attitudes** of the individual have been

taken as discriminative criteria in more recent work. They are treated as revealed mental (psychological, sociological) structures that influence mobility behaviour and the way transport options are evaluated.

Hypotheses on the criteria that influence passenger requirements are at the core of the **MOT*i*F** methodology. The main factors according to the studies that were included into the **MOT*i*F** survey are presented below:

Category	Selected user and journey characteristics
Journey purpose	**Purpose:** Work (home <> working place) / Education (Home < > school), Business (working place <> other) / Shopping / Recreational / Social
Socio-economic factors	**Income:** low, high **Car ownership:** yes, no **Age:** <16-18, 16-18/65, >65 **Special needs:** disabled (motor, sensorial), people with luggage, babies, etc.
Geographic reference of trips	**Journey length:** short, long
Time-dependent trip factors	Night hours

Table 3: Factors influencing passenger requirements

The following main categories with regard to requirements of special user groups on transport products were identified:

- Requirements of the **motor disabled** (including handicapped, elder people etc.) emphasise accessibility, while
- **sensorial disabled** public transport users (deaf, blind etc.) have higher requirements related to (special) information.
- People travelling with **luggage**, prams, etc. pose additional requirements regarding the accessibility of vehicles and stops, a spacious interior and the supply of direct connections, while
- People **travelling by night** have a strong interest in security, few transfers,

availability / connections, punctuality and pre trip information.

Table 4 summarises the influence of user and journey characteristics on user requirements. A "+"-sign marks characteristics that result in higher requirements. E. g. users older than 65 demand easy access more than average users.

User & journey feature ➔	Journey purpose		Income		Age			Car availa-bility		Journey length	
Passenger requirements ↓	Work/ educa-tion	Recr./ social	High	Low	< 16/ 18	16/ 18-65	> 65	yes	no	short	long
Availability, connections								+			
Number of transfers	+	+ (1)					+	+ (1)		+	
Punctuality, reliability	+							+		+	
Travelling speed	+	+ (2)	+ (3)		+	+		+ (2,3)			
Regularity		+									
Accessibility (vehicle, stop)							+	+		+	
Frequency of departures										+	
Security (vehi-cles, stops)							+	+			
Comfort (vehi-cles, stops)			+				+	+			+
pre-trip information	-	+					+	+			
on-trip information							+				+
Customer orientation							+				
price, fare level			-	+							
tariff system							+				

User & journey feature ➔	Journey purpose		Income		Age			Car availa-bility		Journey length	
Passenger requirements ➔	Work/ educa-tion	Recr./ social	High	Low	< 16/ 18	16/ 18-65	> 65	yes	no	short	long
Possibilities to obtain tickets		+					+				
Safety											
social prestige					+	+		+			
Environmental friendliness											

Table 4: Weighting factors

Some weighting factors are expected to be dependent on more than one user or journey feature. This is indicated by the numbers in the table. For example, the number 2 in the table above indicates that the attribute *travelling speed* is especially important only for users having a car available and travelling for recreational/social purposes.

Using similarity of requirements inside user groups as distinguishing criterion, the following market segmentation was found on the basis of the weighting matrix:

User & journey feature ➔ / Market segment ↓	journey purpose: work/ educ	journey purpose: recr./ social	Income: high	Income: Low	age: < 16/18	age: 16/18 -65	age: > 65	car availability: yes	car availability: no	journey length: short	journey length: long
1	●		▬			●		●		●	
2	●		▬			●		●			●
3	●		▬		▬				●	●	
4	●		▬		▬				●		●
5		●	▬			●		●		●	
6		●	▬			●		●			●
7		●	▬		▬				●	▬	
8		●	▬				●	●		▬	
9		●	▬				●		●	●	
10		●	▬				●		●		●
11	Night travellers										
12	Travellers with luggage, prams etc.										
13	Motor and sensorial disabled users										

Table 5: Segmentation of the urban transport market

Table 5 should be read as follows (example): Market segment 1 comprises users aged between 16/18 and 65, with high or low income, with a car available on a short journey for work / education purposes.

The dependence of passenger requirements on the socio-economic and journey characteristics studied in **MOT*i*F** (journey purpose, income, age, car availability and journey length) is rather small. Importance factors typically vary only between 3 % to 6 % depending on socio-economic and journey characteristics. Other characteristics used in the source studies also yield only small variations in importance factors. Since classical and straightforward socio-economic classifications seem to produce fuzzy market segments with rather similar requirements, it might be useful to consider other approaches as well, despite their higher level of abstraction and complexity.

The postulated influence of socio-economic and trip-related criteria on the relative importance of requirements on transport products was validated. This activity was also based on the available sources, which means that heterogeneous samples, methodologies and specific local contexts have to be taken into account. Therefore the conclusions are restricted to tendencies as to the influence of socio-economic and trip-related criteria on passenger requirements. Nevertheless, some assumptions were validated also on a general level. Examples of this are

- the fact that senior and male customers generally give higher notes in satisfaction surveys,
- the high importance attributed by seniors to accessibility and
- the relatively high importance of accessibility, pre-trip information and possibilities to obtain tickets for recreational and social trips.

Only in few cases, empirical results were totally conflicting with the assumptions in the weighting matrix.

Complex interrelations between the parameters that influence passenger requirements sometimes complicated the analyses. The influence of gender is considered as a distinguishing parameter in some studies (e. g. case studies from Rotterdam and Madrid). Other authors think that the differences between the level of requirements of women and men must be interpreted in terms of mediating variables. This means that gender at first sight seems to influence user requirements, but actually other characteristics that are distributed unevenly between men and women (like car ownership or profession) are responsible for the differences.

Evidence suggests that regional differences (e.g. size and structure of the urban region, transport system and also differences between the countries and regions etc.) influence passenger requirements. The general recommendation yielded by the validation of **MOT*i*F** work package 1 is therefore to verify the hypotheses regarding influence of journey and user characteristics on the user requirements with regard to public transport on a local level.

Authority requirements

Authorities lend force to stated requirements regarding public transport by enacting legislation or providing funding. **MOT*i*F** identified four main areas where authority requirements most directly influence public transport service.

- Establishment of financial constraints
- Requirements regarding the organisation of public transport
- Environmental requirements
- Requirements of people with special needs

Performance of public transport products

Based on extensive documentation of transport products and systems, 24 different product categories were specified according to technical and operational features that are relevant for the users:

No.	Transport Product	No.	Transport Product
1	Train	13	Shared taxi (door to door service)
2	Metro	14	Shared taxi (linebound)
3	Light rail	15	Shared taxi (special services)
4	Monorail	16	Coach – Regular services
5	Tram – free track	17	Coach – Special services
6	Tram – partly free track / in the road	18	Group Rapid Public Transport
7	Trolley	19	Personal Rapid Public Transport
8	Guided bus	20	Cable car / Suspension railway
9	Bus – Express lines	21	Ferry
10	Bus – Standard service	22	Water taxi
11	Bus – Citybus	23	Automated Guided Vehicles
12	Bus – On-demand service	24	Air vehicles

Table 6: List of product categories

All products were evaluated according to their performance regarding 18 different attributes. These attributes correspond directly to the 18 requirements of the demand side, thus enabling a cross-comparison of the figures from the demand and supply sides of the transport market in the further course of the work (work package 3): Each of these product features is determined by one or more performance indicator(s).

The performance levels describe good practice. Good practice defines a performance level that can be reached by most suppliers, in other words a realistic benchmark.

The general conclusion from the validation of the results of the second work package of **MOT*i*F** reads that a useful definition of good practice operation on a European level is hard to find, if possible at all. The performance indicators as well as the reference levels could not be fully validated by the case studies. The source of observed differences could be inappropriateness of the scales as well as genuine gaps between delivered and perceived quality. As long as the source of the difference remains unknown, the difference provides hardly any inferences as to the correctness of the **MOT*i*F** scales.

In principle, performance indicators can be used to substitute satisfaction indices. This option is especially interesting if performance can be measured by using available data from Vehicle Location Systems, etc. Calibration towards customer requirements of all physically measurable performances (punctuality, reliability, connections) is then recommended, although evidence suggests a rather weak correlation between delivered and perceived quality. Therefore direct satisfaction measurement will remain the more reliable indicator of product quality as seen by the customer.

Cross-comparison of demand and supply

Bringing the demand and supply analyses together involved the development of a two step methodology:

- Calculation of underperformances for unsatisfactory aspects of the public transport service based on a benefit segmentation approach. The main advantage of this model is that deficiencies of products can be identified in a simple and comprehensive way, indicating those features that should be

improved. The results are different for all combinations of user groups and products, since every product has specific strengths and weaknesses with regard to the requirements of a certain user group.

- Determining product ranks for all user groups based on lexicographic and limited compensatory ranking algorithms (selection rules based on the values of the underperformances).

The theoretical foundation of the Benefit Segmentation Model as applied in **MOT*i*F,** namely the calculation of performance deficiencies, was validated through case studies across Europe. The model correctly predicts the product features with insufficient quality, but exaggerates the level of underperformance. This evidence suggests that expert opinion tends to exaggerate variations in performance. In other words: experts probably observe differences in performance more than customers.

In the large majority of cases, transport products perform more or less under the users' expectations, sometimes in several aspects. The possibility to develop multi-product solutions, combining products with mutually compensating weaknesses is a solution for this problem.

Common sense is needed for the creation of sensible "product packages", since the possibilities of compensating weaknesses are often limited: People with restricted mobility who are not able to climb stairs in order to get on or off a vehicle, will not use any public transport at all if just one product inside the journey chain does not allow an easy boarding. This example is quite obvious, but the same statement holds also for other requirements such as journey time, security, comfort etc. The planner must assess if usage will depend on the weakest link of the journey chain or if compensation between products is possible.

Additional fail and success factors

The surveys and case studies have shown that the satisfaction level is an important but not the only variable which is necessary to explain modal choice. Various additional aspects were identified in the case studies, e. g.:

- Traffic situation for competing modes; not only the private car but also other urban public transport products,
- Public awareness campaigns that "place public transport on the map of the potential user",

- Resistence of other service providers or cooperation with them.

Recommendations and further research needs

Recommendations based on research findings

- If a detailed market segmentation covering consumer preferences and choices has to be developed, a survey of the influences of socio-economic and journey features on a **local basis** should be carried out.
- Market segmentations based on car availability, journey purpose, etc. often do **not** yield very **discriminative results**. Yet refraining from developing new or improved market orientated services would probably not be the best strategy for public transport companies. Case studies clearly indicated that targeted improvements at the supply side do have effect in terms of ridership and choice rider share.
- The **number of market segments** depends on the number of discriminative factors that are included in the model. For feasibility reasons both on the level of market research and the follow-up marketing activities, the number should be limited. Most studies distinguish between four and approximately eight or ten market segments.
- **Pretests** can help improve the quality of inquiries, e. g. in order to avoid stereotype requests for lower prices, higher availability and higher service frequencies that can be identified in some studies. Furthermore, state-of-the-art survey techniques such as conjoint measurement, regression analysis etc. can achieve more meaningful results.
- Market segmentation methodologies should consciously **distinguish primary and secondary requirements**. Otherwise, secondary requirements on public transport such as passenger information and orientation, possibilities to obtain tickets, design, service orientation etc. can easily be underestimated.
- Fare level is important, but **users are prepared to pay for good quality** on important features. Survey set up should be geared towards quantification of the willingness of the customer to pay for certain improvements. This enables cost benefit analyses and thus efficient design (in the broadest sense) of public transport products.

- A general rejection of parallel services is too dogmatic. A clear **division of tasks** between products in the same service area is of course crucial.

Detailed consumer research using classical and innovative marketing research tools will be essential for the competitiveness of transport companies:

> „*Managers who believe that marketing has no place in the provision of accessible transit service often do not understand that marketing is a systematic, continuous management system that places riders at the forefront of all activities of the service. The needs and demands of riders are the foundations around which the service is designed, operated and evaluated. If there are problems with service delivery, they are not caused by the riders, but by limited knowledge on the part of transit management of what riders need and expect from the service.“ (Cyra, Schauer, 1995)*

Recommended further research activities

- Comparability of user surveys could be improved by developing a standardised set of dimensions. The choice of detailed dimensions should remain the responsibility of the local actors and not be included in the standard. The **MOT*i*F** list of user requirements / product features and / or the QUATTRO / CEN draft quality matrix could be taken as a starting point for further development.

- Market researchers follow many different approaches to segment the market. This variety could be taken as a starting point for a comparison or benchmarking project. The general research question would be: “What segmentation method and technique is most useful in supporting the development of customer orientated products”. The distinguishing power with regard to the segmentation of the market would be a criterion for evaluating the different approaches. Asking practitioners about their experience with the results would also be essential, e.g. if service improvement or communication activities could be focused on specific target groups on the basis of the results.

- In many cases, it was hard to decide if observed differences (in satisfaction or importance) are “real”, or if they only result from different methods, techniques, sample compositions, etc. A “method assessment” would diminish this kind of

interpretation difficulties. Method assessment could be carried out by application of different methods for importance measurement (e. g. ranking, direct scaling, stated preference, regression or variance analysis of satisfaction data, qualitative methods) on one sample in order to compare the validity and limitations of the methods with regard to measuring passenger requirements.

- Closing the gap between delivered and perceived quality would be another field where further research would be very useful. This would imply a validation of the relationships that are postulated in the quality loop under careful consideration of local circumstances and expected quality levels.
- One step further, the relationship between perceived quality and modal choice could be assessed. The question if and how much the patronage of public transport depends on its performance is extremely complex. The best approach is probably to carry out real time research accompanying major changes in supply quality (detailed case study basis).
- Some contributions might also come from new scientific approaches that start to enter the realm of traffic marketing and mobility research, e. g. the theory of planned behaviour and social milieu analysis. These methods require more in terms of abstraction level and interpretation effort. On the other hand they could possibly show valuable new ways of developing the public transport product mix and adjusting it better towards user needs.

1 Introduction

In all European countries personal mobility has increased tremendously during the past decades due to economical and political changes.

- Economic wealth made travelling affordable to the majority of European citizens.
- Reduced working hours resulted in higher time budgets for leisure time activities.
- Suburbanisation and higher housing standards reduced the density of European cities, which led to an increase of travelling distances.
- Improved traffic means (e.g. vehicles, connections) were at the same time a necessary condition for absorbing the increased traffic loads and a cause of a further rise of traffic demand, since people tend to make longer journeys as soon as travelling becomes faster and more comfortable.

The increased mobility was realised mainly by the use of the private car. The urge behind the preference of the car has been manifold.

- The private car and road network has improved much more than public transport networks.
- A sharp decrease of prices in real terms for car ownership and use (contrary to what is sometimes claimed by road lobby organisations) reduced the number of "captive riders" in public transport.
- Financing schemes that lacked revenue based incentives probably did not stimulate operators enough to observe customer requirements, therefore the old production based financing schemes are now being replaced.
- Ever growing congestion problems in urban areas, although mainly caused by excessive use of private cars, were especially detrimental to public transport, since delays result in increased operation costs and missed connections.

The sharp increase of car mobility resulted in traffic problems that threaten the quality of life: air pollution, traffic congestion, accidents, noise, and fragmentation of the landscape. The capacities of the road networks have reached their limits, a

further expansion of private car use would result in reduced mobility and economic damage due to increasing congestion problems.

These problems are most serious in urban areas because of the density of the population and have been aggravated by deficiencies of city planning in the past. City functions like dwelling, work, shopping, leisure and recreation have been separated. Industrial and commercial centres, shopping malls and residential areas have been built in the periphery of the cities. As a consequence mobility and the average length of everyday trips increased.

An increase of the modal split of collective transport systems at the expense of individual motorised traffic would be an important contribution to alleviating traffic problems. To achieve this goal public transport systems have to become more market orientated. In recent years, operators have gradually evolved from product orientation towards market orientation. A number of initiatives searched to improve transport systems or to introduce new systems. However, in many cases these initiatives were not based on a solid knowledge of market requirements. Therefore these initiatives were less successful than they could have been.

The objective of **MOT*i*F** was to research this problem and to find solutions to improve the market orientation of transport systems. The project concentrated on urban transport. **MOT*i*F** was funded as a research project under the Transport RTD Programme of the European Commission Directorate General VII.

What is needed are strategies and tools for tailoring the mass product “urban public transport” to the needs and requirements of an ever more diversifying market. At the same time, economies of scale and other advantages of high capacity transport systems (such as short headways) should be maintained; product diversification is therefore limited. **MOT*i*F** presents current strategies and tools needed for this difficult balancing act between responding to diversifying requirements and maintaining the irrefutable advantages of mass urban public transport.

Market demands are twofold: Transport operators have to focus on the diverse and constantly evolving requirements of passengers. Furthermore, authorities define guidelines for the development of public transport and order transport services that are needed for securing mobility. Authorities are therefore also an important factor on the demand side of the public transport market, articulating needs of

passengers and citizens that are not sufficiently expressed by direct market relations. (The DG VII sponsored project ISOTOPE analysed the actors and their different roles in the public transport market in detail).

Goals that have been formulated by transport operators and authorities are:

- Raising passenger satisfaction,
- increasing ridership and
- lowering deficits (down to zero).

Steps that are necessary to reach these goals are demonstrated by the major competitor of public transport, the automotive industry. The automotive industry in particular seeks to 'seduce' its customers to feel more comfortable, to drive more often and to spend more money on the automobile.

Behind this tactic, a certain marketing strategy can be observed: Whereas in the 1980s the rational factor was in the foreground (speed, horse power, fuel consumption, available space, technical specifics etc.), nowadays specialised marketing tools emphasising emotional attributes are employed to attract new customers: the family-friendly van, the sporty compact-car, the technically superb limousine, the 'female' second car and the 'no-limit' off-road car.

These very different product categories apparently correspond to certain life-styles and images of consumers. It is interesting to know, how these life-styles and images of consumers have been identified in the automobile industry - and other important branches such as furnishing and interior design. Are these just sophisticated assumptions of marketing experts, or are detailed analyses running in the background? Articles in trade journals[1] indicate the last: extensive research on life-styles and social milieus[2] is a common prerequisite for launching new products or modifying existing ones.

[1] W&V, Milieu-Strategien, 47/98, 1998

[2] The concept of "social milieu" is used for segmentation of markets based on fundamental attitudes and convictions of consumers rather than on socio-demographic characteristics (Wohnwelten in Deutschland 2).

The public transport sector (i.e. transport companies, manufacturing industry, universities and consultants) should transfer these new marketing approaches from other innovative, customer oriented branches to urban public transport. The basis for this development is a better understanding of the requirements of different user groups and above all the adjustment of supply towards these requirements.

The following questions are addressed in **MOT*i*F**:

- How can users be categorised?
- What are their needs in terms of (public) transport?
- What kind of products are offered to them?
- How do these products satisfy user needs currently and can they be improved?

These questions are reflected by the basic project structure of **MOT*i*F**. The project work is divided into four main work packages:

- *Analysis of the demand side of public transport,*
- *analysis of the supply side of public transport,*
- *cross-comparison of demand and*
- *supply* and *analysis of case studies.*

The following figure presents the relationships between the four **MOT*i*F** work packages.

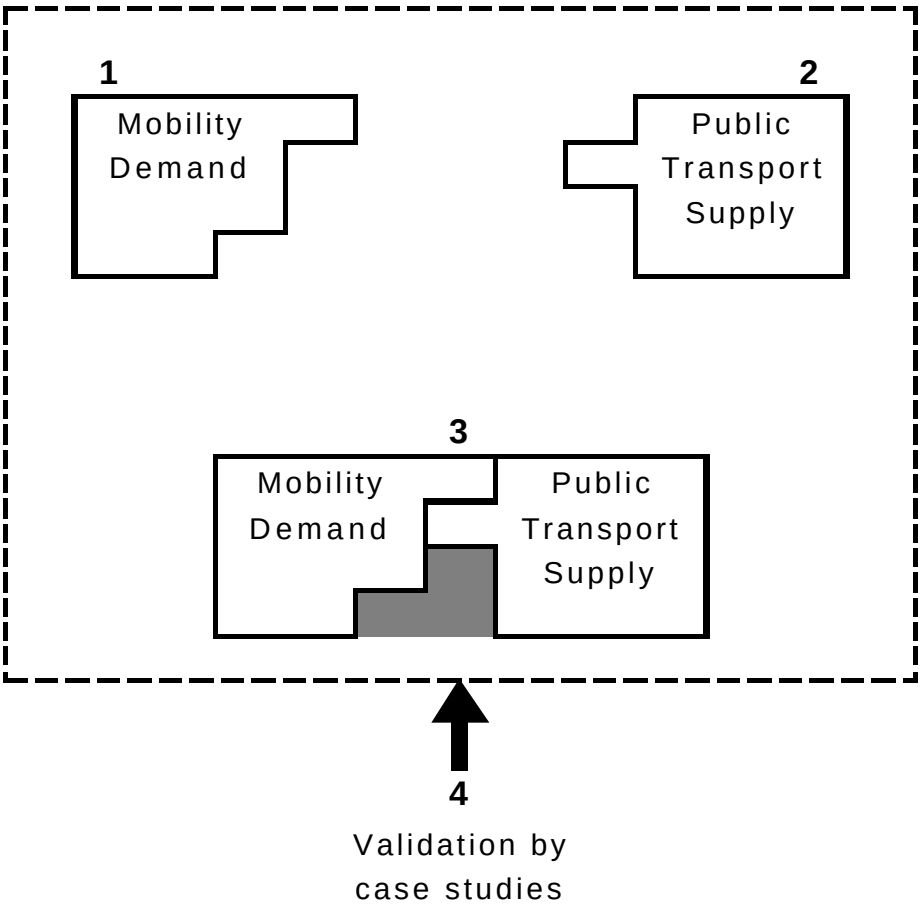


Figure 5: MOT*i*F work packages

The **MOT*i*F** project structure is based on a theoretical approach for the first three work packages and a practice-related component in the fourth work package. The case studies enable the examination and verification of the results of the other work packages. In order to enable the reader to evaluate the theoretical approaches on the basis of case study results, the case study results are integrated in each chapter of the other three work packages.

1.1 MOT*i*F Objectives

Given the **MOT*i*F** goals and project structure illustrated above the objectives of the single work packages can be summarised as follows:

The main objective of the **first work package** of the **MOT*i*F** project was to

> ***analyse the structure of the demand side of the urban transport market (market segmentation) and determine the requirements on urban public transport of users from different market segments.***

From this main objective the following intermediate objectives were derived:

- identification and categorisation of passenger requirements,
- identification of characteristics of potential and existing public transport users that influence their requirements and modal choice behaviour,
- analysis of the influence of these user and journey characteristics on the level of the identified passenger requirements and
- deduction of market segments.

Special attention was given to the requirements of people with special needs: mainly the motor and sensorial disabled as well as people travelling at night.

Authorities are also important actors on the demand side of the public transport market. They define environmental and safety standards as well as guidelines for the development of public transport. Furthermore, they articulate needs of passengers and citizens that are not sufficiently expressed by direct market relations.

The **MOT*i*F**-consortium is aware that authorities act also on the supply side of public transport: They provide infrastructure and are often (partially) responsible for service definition at a strategic and tactical level, integration of services and information. However, the focus within **MOT*i*F** is on the requirements of authorities and not on their role as supplier. Consequently, we treated authorities similarly to the passengers. The following intermediate objectives were pursued:

- Specification of the different ways in which authorities pose requirements on the transport supply and
- Analysis of social, environmental and organisational requirements as well as financial constraints imposed by authorities.

The main objective of the **second work package** was

to define transport products and product groups and to assess their specific performance by means of indicators.

From this main objective the following intermediate objectives were derived:

- Selection of current transport products and promising transport solutions for the (near) future,
- Categorisation of transport products according to operational features that are relevant for passengers and authorities,
- Development of a standardised set of indicators for the assessment of performance of transport products
- Assessment of good practice performance levels of all selected products (reference levels)

Work package 3 aimed at

a cross comparison between the demand and supply sides of the urban public transport market, thus identifying suitable products for different market segments.

The following intermediate questions were answered by this cross comparison:

- How does each transport product fulfil the requirements in each market segment?
- How does each transport product fulfil the authorities' requirements?
- Which transport product is appropriate for which market segment (overall rank)?
- Where (in what features) lie the weaknesses of transport products, compared to other products?
- What are the potential good "transport packages" (combinations of transport products that mutually compensate their respective weaknesses) for each market segment?

The main objective of the **fourth work package** of the **MOT*i*F** project was

> ***to examine the results of work packages 1 to 3 in practice through case studies.***

To reach this objective the following intermediate tasks were carried out:

- selection of appropriate case studies,
- analysis of quantitative and qualitative data from all selected case studies,
- examination of corresponding and conflicting findings of the case studies and general **MOT*i*F** results,
- identification of additional success and fail factors of products, and
- formulation of conclusions and guidelines for the different actors of the transport market.

To verify the results of the previous work packages a large range of research questions were formulated. The most important ones are listed below:

- How are passenger requirements for a public transport product influenced by socio-economic features of (potential) riders? Does this correspond with the assumptions developed in the weighting matrix (see results of work package 1)?
- Do (objective) performance levels of products correspond with good practice (as defined in work package 2), or is still much potential for improvement left?
- Does objective performance correspond with the marks that riders give to public transport product performance (satisfaction levels)?
- To what extent can the **MOT*i*F** methodology predict success or failure of public transport products (e.g. regarding satisfaction with public transport or patronage)?
- Can additional success and fail factors be found that are not covered by the **MOT*i*F** methodology?

1.2 Concepts and terminology

1.2.1 The demand and supply sides of the public transport market

The relationships between the demand and supply sides of public transport are more complicated than in most other branches. There are more stakeholders than just producers and buyers of transport services. Especially the authorities play a significant role, which cannot simply be reduced to either the demand or the supply side.

The following figure, developed from the results of the ISOTOPE project, helps to understand the triangular relationships between stakeholders and above all their role in determining demand and supply better:

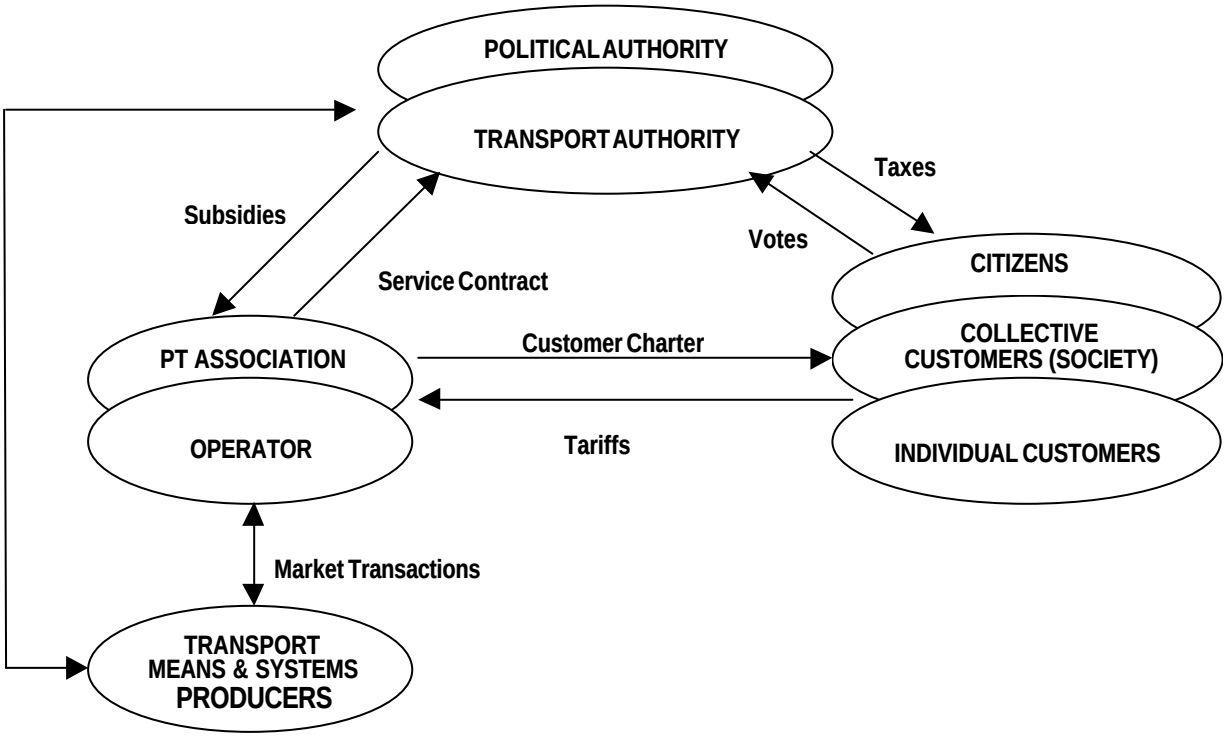


Figure 6: Stakeholders relationships in the public transport market (source: ISOTOPE, modified)

The scheme shows four groups of stakeholders:

i) public authorities (political and transport authorities),

ii) operators / public transport authorities,

iii) citizens / customers (individual as well as collective) and

iv) producers of transport means and systems.

The arrows represent elementary relationships between these groups of stakeholders. These relationships are described in basic terms:

In modern democracies citizens influence the government through the voting process. This influence is usually very general – determining the composition of the local government at each election but not influencing the single decisions taken by politicians (apart from referenda, that are exceptional). Governments have the power to levy taxes on their citizens to finance public transport expenditures.

Not all citizens are customers of local public transport (as a matter of fact in many towns the majority of them use the private car) and, moreover, not all the local public transport (LPT) customers are citizens, because a number of them happen to live outside the municipal boundaries and use LPT to go to work, shopping, etc. inside the town area.

Operators (sometimes together with public transport authorities) deliver the public transport service to their customers, and the latter pay a price that, for a variety of reasons, usually does not cover the total cost of the service. In most cases authorities entrust operators of transport services with delivery instead of producing service themselves, as it is the case in old “non triangular” organisation of public service production. They use taxes levied from citizens to finance the service costs which are not covered by fares.

Finally, a market relation links the operators directly with the suppliers of transport means and systems. The latter have obviously an important effect on the costs and quality of LPT delivered to the customers, but they can be isolated from the triangular relation among authorities, operators and citizens / customers. Formal interactions are reasonably limited to market exchanges with operators and increasingly also with authorities, as they will have to take more responsibility for

rolling stock, maintenance and buildings due to shortening of contract periods (tendering).

Therefore, the main emphasis can remain on the authority and operator side, and on their relation with the citizens and customers (the so called “triangular relation”).

1.2.2 Approach to the analysis of transport demand

The demand side of the transport market consists of two main groups: the passengers and the authorities (who also act partially as suppliers; as discussed before, we have focused on the demand role of the authorities).

- **Passengers** are not only current passengers, but also *potential* passengers of public transport.
- **Authorities** are primarily public entities responsible for establishing national, regional, and local transport policies and/or providing funds for the urban transport system.

The determination of the actors on the demand side was followed by further specification of the requirements regarding availability, travelling speed, security, comfort etc. Preparing the list of requirements was no straightforward task. Analysis of numerous available studies on passenger requirements (see references) showed, that every research institute uses its own list of requirements. In order to compare the results from these different studies, they had to be transferred into a uniform scheme. For this purpose, a list of eighteen requirement categories was developed. The eighteen **MOT*i*F** categories cover all requirements that were listed frequently in the studies we had at our disposal. Section 11.1 of the annex shows, how all requirements in the original studies were allocated to the eighteen **MOT*i*F** categories.

An important methodological decision was to focus the analysis of the demand side on “generic expectations” which are identical to so-called **importance factors** from the point of view of passengers and authorities:

> *“Is punctuality*
> *very – rather important– rather – very unimportant*
> *for you”.*

Importance factors allow for meaningful comparisons between studies from

different locations.

The level of importance assigned to certain requirements has to be distinguished from **satisfaction factors:**

> *"Are you*
> *very – rather satisfied – rather – very unsatisfied*
> *regarding punctuality".*

Satisfaction factors incorporate not only the requirements of the user but also the quality of supply, which is location specific. Therefore, comparison of results from studies carried out in different cities does not enable conclusions regarding passenger requirements. Satisfaction factors were taken into account in a later stage during the research, namely in the comparison of demand and supply.

The crucial step in the study of the demand side of public transport is the determination of generic expectations and above all the analysis of factors that influence these generic expectations. This is the key to segmentation of the market, aiming at the isolation of user groups with similar requirements inside any group but different requirements compared to all other groups.

The study of generic expectations and market segmentation was carried out by surveying available marketing studies on passenger requirements. We analysed both results and methodology:

- Results: importance factors and rankings, number of market segmentations, differences of importance factors depending on market segments.
- Methodology: sample composition, method for the determination of importance factors, kind of characteristic used to discriminate between market segments.

Finally, a theoretical approach towards market segmentation on the basis of socio-demographic (age, car availability, income etc.) and trip-related (journey purpose and distance) features was developed. The resulting market segments were compared with clusters derived from on-site surveys in the course of work package 4.

1.2.3 Approach to the analysis of transport supply

At the beginning of the research project the **MOT*i*F** consortium agreed on a consistent terminology regarding transport modes, transport products and transport systems:

- **Transport modes** are defined by their technical aspects, mainly the type of vehicle and infrastructure; e.g. bus, car, train.
- **Transport products** are characterised by the transport mode as well as the way the mode is operated; e. g. high-speed buses, standard buses, on-demand buses, etc.
- **Transport systems** refer to the total of all transport products in an urban area that form a network and can be used to complete a journey chain.

A key effort was the development by the consortium of a standardised set of factors for measuring the performance of transport products. These performance factors measure all supply features of public transport products such as availability, travelling speed, security, comfort, etc. Through the standardised set of factors, objective service levels can be quantified and compared independent of location and / or personal convictions of the researcher.

The supply factors correspond to the eighteen requirements of the demand side. This 'synchronised' approach allowed for a better cross-comparison of the demand and supply side.

The scales developed by the consortium to measure performance were calibrated. Correspondence of the quantified performance level with the level of performance as seen by the customer was the criterion. In other words, the appropriateness of the scales was tested by referring to customer satisfaction (work package 4).

Many features of supply had to be detailed in order to allow for objective quantification of performance. For example: "comfort" is hardly measurable by a single indicator. Rather, one needs to differentiate between comfort of stops and vehicles. Furthermore, availability and quality of weather protection, seats and illumination at stops have to be considered separately. For all features that are evaluated with more than one indicator, weights were set according to the relative importance as perceived by the consortium members during interactive workshops.

1.2.4 Approach to the cross-comparison of demand and supply

The approach followed for the third major task of the **MOT*i*F** project, the cross-comparison between demand and supply, is summarised in the figure below. The demand data (importance factors) and the supply data (performance indicators)

served as input for the calculation of underperformance. Overperformance can occur as well, at least in theory. The level of underperformance determines the attractiveness of a product for its users.

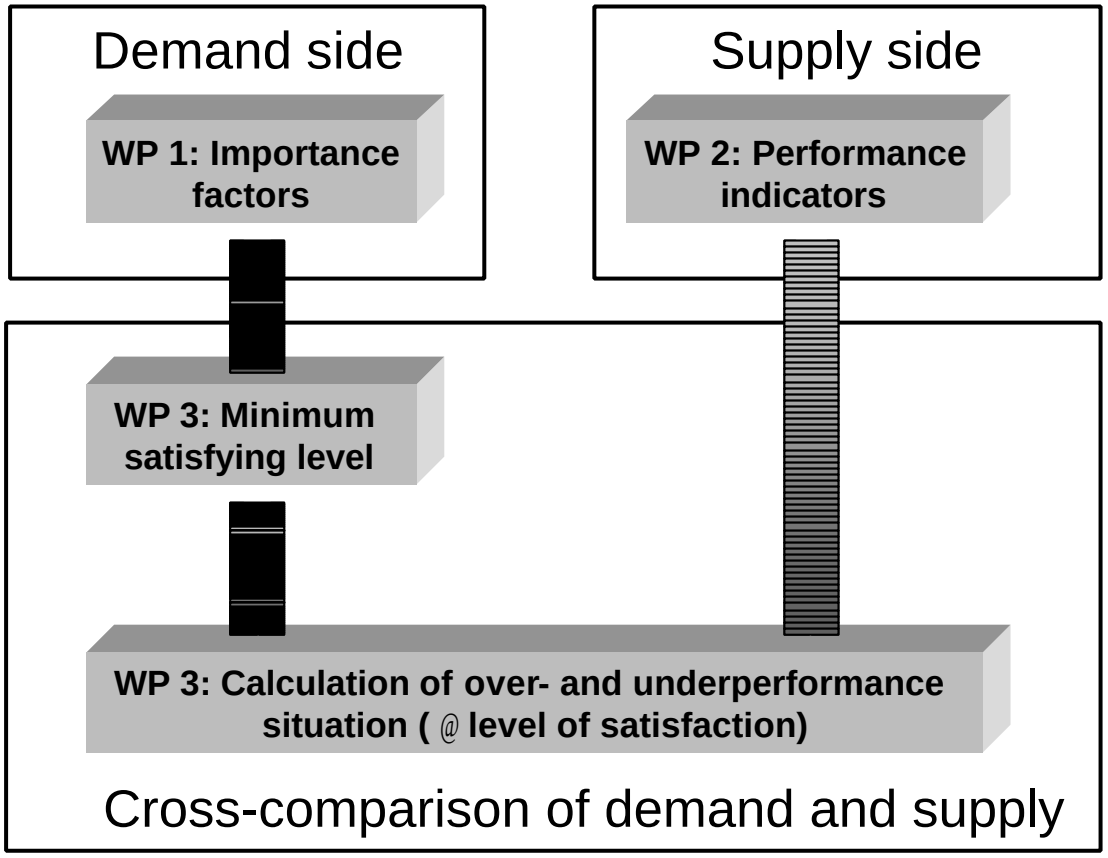


Figure 7: Cross-comparison of demand and supply

Before the approach used to calculate underperformance can be explained, the key-expressions need to be explained.

- **Expectation:** the performance level that the passenger expects from the service.

  Expectation is a concept applied in many studies, namely those using the so-called benefit or needs-based segmentation approach. The basic principle of these approaches is, that the user defines "benefit" as the difference between expected and perceived performance levels. He is expected to choose the product with maximum benefits.

  Within the **MOT*i*F** project this approach was inverted, i.e. the focus was set on

unmet expectations or attribute deficiencies. The basic principle is, that the user chooses the product with minimum deficiencies. This inversion has already been used in other transport market segmentation studies (e. g. Buspower 2000 and TCRP Report 36).

The concept of "expectation" is related with the "minimum satisfying level" and "minimum acceptence level":

- **Minimum satisfying level:** the performance level with regard to a certain transport product feature under which the user's expectations are not fulfilled. Nevertheless, the product can still be chosen if other features are satisfactory.

  The minimum satisfying level is related with the relative importance of a product feature. The relationship was studied in the course of work package 3.

- **Minimum acceptence level:** the transport product performance level under which the user will reject usage altogether, regardless of the quality of other features of the product.

- **Underperformance / overperformance:** Difference between the transport product performance and the minimum satisfying level (for a given attribute). Low underperformance is a measure for the attractiveness of a product for users according to the benefit or needs-based segmentation approach.

The entire process of under- or overperformance calculation is briefly illustrated hereafter:

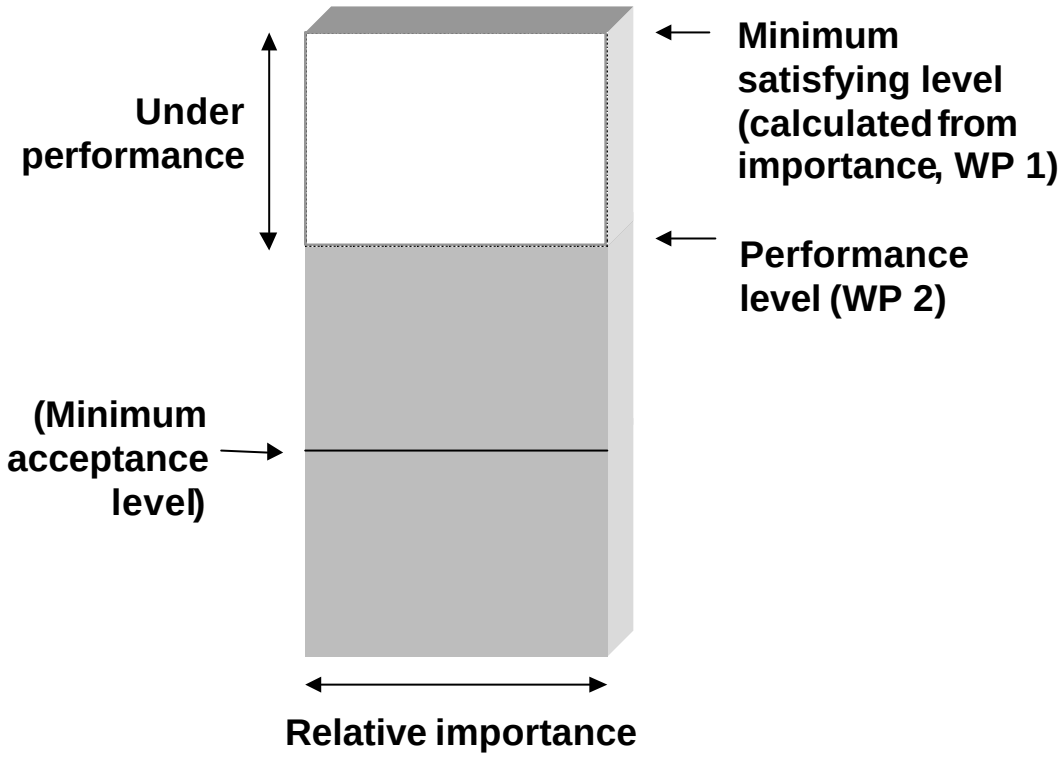
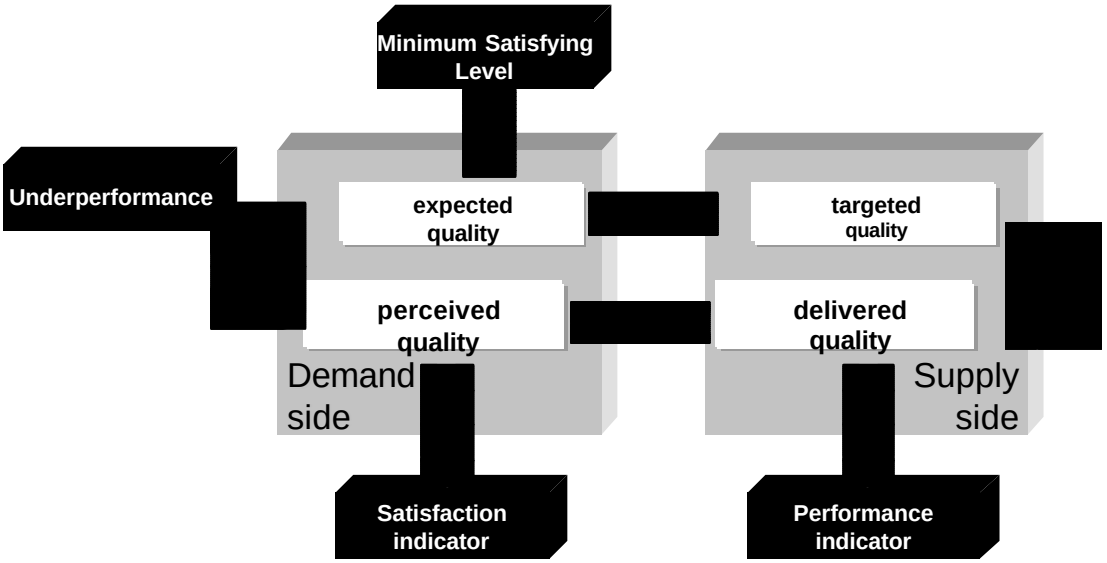


Figure 8: Calculation of underperformances

The following figure illustrates the interdependencies of the **MOT*i*F** approach with the quality loop that has been a cornerstone of the QUATTRO research project:



Source: QUATTRO (modified)

Figure 9: Quality levels and corresponding indicators

The performance level (measured by performance indicators) corresponds to delivered quality. The level of satisfaction corresponds to perceived quality. The minimum satisfying level corresponds to expected quality. Finally, the underperformance connects the perceived and expected quality levels.

The relative Importance of product features does not fit well in the context above as derived from QUATTRO. One might imagine importance as a value describing the size of a quality loop belonging to one aspect (compared to the size of loops belonging to other aspects).

1.2.5 Approach to the case studies

Case studies were selected from all European member countries. The selection of the case studies served for the validation of the results of the previous work packages.

Every partner of the consortium proposed about five case studies, from which the following cases were selected (see Table 7). The last column of the table shows which case studies were integrated into the main report of work package 4 and which ones were integrated into the Annex.

Product	Case study	Country	Main / Annex
Transport systems	Madrid	ES	M
	Barcelona	ES	A
	Roissy	FR	M
	Hanover	DE	A
	London	UK	A
Train	Urban rail lines Rotterdam / The Hague	NL	A
Metro	Metro Rotterdam	NL	M
Light rail	Metrolink Manchester	UK	M
Trolley	Trolley Arnhem	NL	A
Bus express lines	Expressbus Münster	DE	M
	Expressbus Eindhoven	NL	A

Product	Case study	Country	Main / Annex
Bus standard service	Bussystem Dordrecht	NL	M
	Standard bus Rotterdam	NL	A
	Bus Power Birmingham, Andover	UK	A
	Bus Lisbon	PT	M
	Bus (3 cities)	FR	A
Night bus	After-hour bus Lisbon	PT	A
Bus on demand service	Night bus Reggio Emilia	IT	A
	Freebus Imola	IT	A
	Videobus Bologna	IT	A
Shared taxi door-to-door	Special system Reggio Emilia	IT	A
	PickUp Hanover	DE	A
	Shared taxi The Hague	NL	A
	Shared taxi Maastricht	NL	A
Shared taxi linebound	Collective Taxi Linz	AT	A
	Collective Taxi Graz	AT	A
Coach regular services	Coach Eindhoven	NL	A
Coach special services	Amsterdam airport	NL	A
Group rapid public transport	POMA Laon	FR	A
	Park Shuttle	NL	A
	Minisubway in Serfaus	AT	A
Water taxi	Teleboat Venezia	IT	A
Norwegian trial scheme	7 Norwegian cities	NO	M

Table 7: Selected case studies for MOT*i*F

Analysis of qualitative and quantitative data

The transport products were described in detail and data about demand collected. An “open approach”, allowing for additional explanations for success or failure was chosen.

Information included

- use of market and / or product research / surveys and
- interviews with authorities and transport companies.

The gathering of data was structured by means of an open questionnaire. The case studies were all set up along the following structure.

Basic data

Basic data should help to understand the context of the product:

- short description of the product / the user group that will be surveyed
- structure of the urban region
- total population and population served by the product
- transport companies involved
- network / line length
- function of the product in the whole transport system / in the urban region
- co-operation or competition with other products

Demand data

- importance of service frequency, regularity, punctuality etc.
- importance of safety, security, information etc.
- differentiated for age, car availability, income, journey length and purpose and eventually also other features that can influence user requirements

Supply data

- product performance regarding service frequency, regularity, punctuality etc.
- product performance regarding safety, security, information, friendliness etc.
- tariff-related co-operations
- satisfaction levels according to identified user requirements

Traffic related data

- transport volume and performance (passenger-km, vehicle-km, passengers per vehicle-km etc.)
- modal split (in % of passenger-km or % of trips)
- seat utilisation degree (passenger-km in % of seat-km)

Financial data

These data can serve as a measure for the fulfilment of authority requirements or success in terms of productivity:

- operational costs
- investment costs
- revenues
- subsidies
- data about productivity

Legal base

The legal structure around the product, determining the prerequisites of the operation:

- degree of market regulation, market access
- labour legislation

Additional aspects

More aspects were added if they seemed relevant for success / failure, e. g. marketing activities.

2 The requirements of public transport users

Politicians, administrative bodies, transport companies, consultants as well as researchers all have a certain conception about the users of public transport and their requirements. They decide in favour of “their” clients on the definition of transport products and systems, their spatial and time-based availability and price.

These conceptions are ideally based on studies and literature on passenger requirements, passenger satisfaction and studies on the choice of transport products. The main source of data for the **MOT*i*F** research project was an extensive amount of studies of this kind, all with a focus on collective transport systems. Basically individual transport modes such as walking, cycling or car-pooling were not included. The data were used in work package 1 for an analysis of passenger demand. This analysis delivered the following results:

- An inventory of classical and innovative research methods and techniques that are currently applied in market studies on urban public transport. The fields of application of the methods and techniques were assessed in order to improve the interpretation of the results.
- Data about user requirements. This includes both the relative importance of the different aspects of the transport service as seen by the customer and his / her satisfaction with these aspects.
- A uniform scheme used for the categorisation of user requirements, consisting of eighteen requirement categories. This tool enabled comparisons between the results of different studies in spite of the inhomogeneous data base.
- A set of hypotheses on user and journey characteristics (e. g. passenger age, trip purpose) which influence user requirements.
- A basic approach to market segmentation based on the identification of user groups. User groups are characterised by similarity of requirements inside the group, whilst at the same time requirements between user groups are different.

2.1 Categorisation of passenger requirements

2.1.1 Different categorisations of passenger requirements

Not surprisingly, the survey of existing studies and literature made clear that almost every researcher uses his own categorisation of passenger requirements. The project consortium developed a list of 18 categories of requirements, covering all aspects encountered in the body of literature on passenger demand. This characterisation of demand according to 18 categories of requirements is presented in Table 8.

This list was used as a common framework for comparison: requirements that are phrased somewhat differently or studied in more detail in original surveys could be translated into the categories of the **MOT*i*F** list presented above. The price for comparability is of course loss of detail as well as a bias due to rephrasing of requirement descriptions.

The way the slightly different aspects and definitions were matched with the main categories presented in table 1 is shown in section 11.1 of the Annex. This section also clarifies the exact meaning behind the short descriptions of each requirement category. This annex will enable the reader to estimate how much information is lost and biased due to application of the standard categories.

No.	Category of requirements	No.	Category of requirements
1	Availability, connections	10	pre-trip information
2	Number of transfers	11	on-trip information
3	Punctuality, reliability	12	customer orientation
4	Travelling speed	13	price, fare level
5	Regularity	14	tariff system
6	Accessibility of stops & vehicles	15	possibilities to obtain tickets
7	Frequency of departures	16	safety
8	Security (in vehicles, at stops)	17	social prestige
9	Comfort (in vehicles, at stops)	18	environmental friendliness

Table 8: Categorisation of passenger requirements

The following case study from the city of Münster in Germany exemplifies how the categories of passenger requirements can be used as a general framework, unifying the results from local surveys. By matching the requirement definitions from the case study with the general **MOT*i*F** requirements, comparison with the results from other case studies becomes possible.

2.1.2 Case study Münster (Germany)

Introduction

The city of Münster is the centre of the region Münsterland, which is situated in the northern part of the federal state of North Rhine-Westphalia, Germany. The SchnellBus is particularly interesting from the perspective of **MOT*i*F**, since the main target group are commuters to and from the city of Münster. Commuter traffic is a major problem in urban transport and at the same time a tough challenge for public transport. Ever increasing motorization, disperse population structures and high time values of professionals make commuters a target group that is hard to reach for public transport. On the other side, commuter traffic is of course characterised by high and relatively constant passenger flows at regular times, thus offering also favourable conditions for public transport.

Base data

Product type:	Express bus (maximum speed: 100 km/h)
Specifics:	4 radial lines serving the city of Münster, Germany with 270,000 inhabitants

Demand data

The demand data resulted from a postal interview with regular users and on-vehicle inquiries to assess choice riders' opinions in 1996. The surveys should help to analyse the success of quality improvements on existing "Schnellbus-lines" as well as on two new lines. Success, in this case, was defined as the impact on ridership (quantity) and on the customer satisfaction (quality).

Comparison of MOT*i*F and case definitions of passenger requirements

Selected quality features which were surveyed in Münster and the way they are matched with the general categories of **MOT*i*F** are presented hereafter:

SchnellBus surveys		**MOT*i*F** approach
Main category	*Quality feature*	*Passenger requirement*
Supply	Supply Monday – Friday	Frequency of departures
	Supply Saturday	
	Supply Sunday	
	Number of departures	
	Travel time	Travelling speed
	Punctuality	Punctuality, Reliability
Passenger information	Regional/city time table	Pre-trip info
	Tariff info	
	Time table info	
Boarding stop	Weather protection	Comfort (stops and vehicles)
	Illumination	
	Seat availability	
	Time tables at stop	On-trip info
	Feeling of security	Security (stops and vehicles)
	Cleanness	Comfort (stops and vehicles)

Table 9: Excerpt of quality features of the Münster case study matched to the MOT*i*F categories

Evaluation and recommendation

The table above clearly shows the differences between the Münster study and the **MOT*i*F** research project: **MOT*i*F** defined general categories of passenger requirements in order to allow for comparisons on a European level.

In contrast to the general approach of **MOT*i*F**, the Münster study focused on more detailed quality features and their evaluation by the SchnellBus users. Not generalised knowledge (i. e. relative importance of quality features) but the evaluation and actual needs for improvement are important.

2.1.3 Conclusions regarding categorisation of passenger requirements

The **MOT*i*F** study presents an overview of passenger requirements that have been analysed in numerous surveys within Europe (see section 11.1 in the annex). The listed requirements as well as the corresponding categories can serve as a starting point for further specification and analysis. Relevant requirements influencing the level of satisfaction and modal choice behaviour must be selected at the relevant site.

Selection can be done for instance by means of qualitative inquiries among actual and / or potential passengers. In-depth analysis could cover on-site interviews with multiple choice lists or group discussions with potential and existing passengers.

Group discussions can put non-conventional requirements in the foreground. Examples are prestige and image that are usually not explicitly mentioned as influential factors or disappear in the category of “unexplained variation of the dependent variable” (being satisfaction with or usage of public transport). Conventional research methods focusing on explicit, stated opinions with regard to predefined aspects of urban public transport can neglect their influence.

Both qualitative and quantitative researches have to be carefully prepared and professionally conducted, since there is much that can go wrong in market research. Straightforward questions tend to lead to “demand inflation” (all requirements are important) or strategic answers (prices are always too high). In conjoint or regression analysis, selection of aspects whit highly unequal importance will yield few meaningful results. Without sufficient experience in moderating group discussions, unbalanced and incomplete results due to dominant personalities can occur, etc.

During the analysis of the primary studies a certain unbalance in the **MOT*i*F** definition of the 18 requirements became apparent: “comfort” comprises a vast variety of aspects related to both stops and vehicles like neatness, cleanness, way of driving, furniture, air conditioning equipment etc., whereas e.g. “passenger information” is divided into pre-trip and on-trip information. In most studies, comfort aspects are dealt with in a more differentiated manner.

A useful approach is the design and validation of a two- or three layer model:

Various studies apply a theoretical model consisting of general quality, quality on main dimensions and finally sub-dimensions that really go into detail. Such models are firstly used for analyses on different levels. Secondly, they enable the application of statistical methods, e.g. regression analysis for deducting importance factors. In regression analyses, the contribution of e.g. “aspect-satisfaction” to “overall satisfaction” is measured.

Though the basic structure behind the studies often is more or less similar (e.g. “two- or three layer model”), the choice and definition of relevant features on the different levels varies greatly between studies. Comparisons therefore only make sense on a rather general level, as performed in this chapter.

Comparability could be improved by developing standardised dimensions for user surveys. Nevertheless, it would probably be very difficult to take the needs and interests of various operators and transport authorities in different countries into consideration in such an effort. Standardisation on the level of main dimensions might offer a way out of the dilemma. Comparability at the general level is guaranteed by these identical main dimensions (e. g. when “comfort” is used as a standard category), while at the same time, the detailed choice of dimensions (e. g. “ventilation”, “seat quality”, etc.) can be fitted to local needs.

A proposal in this direction was made by the QUATTRO team and CEN working group CEN TC 320 WG5. Their joint effort resulted in a draft “Public Transport Quality Matrix” with eight main categories of public transport quality.

2.2 Importance and satisfaction

At the core of practically all marketing studies are passenger satisfaction and / or importance with regard to various product features. The approach followed in the **MOT*i*F** project was to build on results from different locations that are comparable. Satisfaction indices do not fulfil this requirement: satisfaction will normally be higher if service is better. Only by statistical operations on the data source, importance factors can be deduced.

Local dependency of results might exist in the case of measurement of **importance factors** as well. In principle though, the importance attached to various aspects of the service could be similar everywhere. Verifying this hypothesis was one of the research tasks.

A big share of descriptive surveys focus on satisfaction and similar issues that are dependent on the local circumstances. Very often the respondents are asked to evaluate, to classify or to rank current products on the background of their experience with the service. Some studies did try to deduct importance factors without bias of the present quantitative or qualitative service level, though. These studies were taken as the basis of the analysis.

2.3 Research methods and techniques

2.3.1 State of the art in market research

The data source for the demand analysis consisted of previously conducted studies and literature dealing with detailed passenger requirements, passenger satisfaction and reasons for the choice of a transport product.

Research on passenger requirements, passenger satisfaction and reasons for modal choice can be further specified into different categories according to the illustration below:

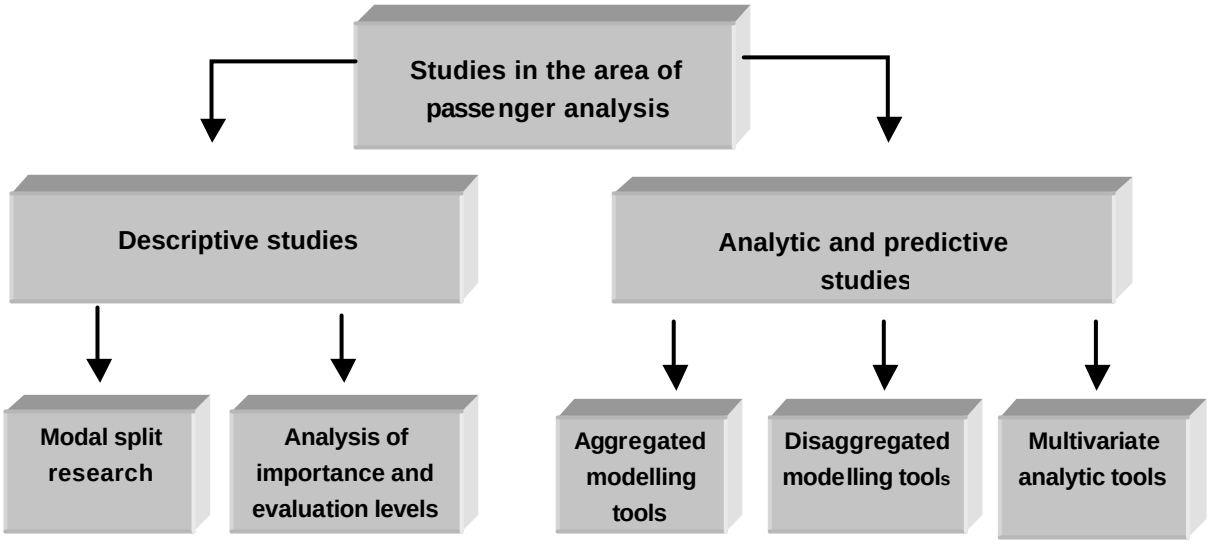


Figure 10: Categorisation of studies in the area of passenger analysis

All partners and subcontractors contributed studies and literature for use in this

project. Brief summaries of the surveyed studies are contained in a separate appendix to the work package 1 report. They can be used as a starting point for further in-depth analyses of passenger behaviour and causal interrelations.

In the following sections the two major groups of analytic / predictive as well as descriptive surveys are discussed:

2.3.2 Descriptive research

The main focus of (commercial) research in the transport field can be seen in the assessment of descriptive data (transport volumes, revenues, costs) and the evaluation of qualitative judgements made by consumers. The main applied techniques are census and inquiry.

In many cases the respondents are asked e.g. to name numbers of journeys per day, the average journey length or journey times. Together with socio-economic data (age, gender, occupation etc.) key-figures are yielded. The methods used mirror the status-quo of the transport market offering useful quantitative data about

- modal split in urban areas (referring to number of trips per day, the travel distances or times),
- number of passengers or vehicles on sections of the network, on lines etc.,
- origin-destination-relations of trips,
- satisfaction level of the offered products or services and the
- importance of different product features.

2.3.3 Predictive and analytic modelling

Within the last decades three major modelling techniques have been developed. These are (in chronological order):

- **aggregated** modelling tools,
- **disaggregated** modelling tools and
- **behavioural** models, often developed by use of multivariate analysis.

Especially the aggregated (known as the 4-step-model) and the disaggregated modelling techniques are the common mid- and long-term traffic predicting tools. They yield statistical relationships between data on population, car availability, working sites etc. and traffic flows.

Behavioural models usually serve for short-term assessments. In contrast to the predictive tools, behavioural models enable conclusions with regard to the reasons for modal choice. Surveys carried out with the help of multivariate methods help to infer the utility associated with each level of each attribute of a transport product. In other words this technique helps to identify consumer requirements, their relative and absolute importance as well as their valuation.

Surveys of this kind deliver more than a description of modal choice. Modal choice can be explained as well since not only socio-economic factors (age, gender etc.) of individuals but also their personal requirements are surveyed.

Stated preference and revealed preference

An important distinction exists between **stated preference and revealed preference methods**. Roughly speaking, revealed preference methods base on observation of actions whereas stated preference methods record statements about these actions. The distinction between revealed and stated is analogous to recording mileage from the odometer and asking a person how much he or she drives.

Direct observation of actions can be advantageous since statements can be biased or incomplete. On the other hand, it is usually hard to infer from observation anything about the motives behind the observed actions.

Stated preference methods are employed often in marketing research. The applications of stated preference methods can be summarised as follows:

- to evaluate products, services or situations with different attributes and
- to study utility functions for individuals and for specific geographic areas.

The most simple technique for a stated preference study is to simply ask the passenger about his satisfaction with various aspects of public transport service, and how important these aspects are for him.

More sophisticated stated preference methods like e. g. variance / regression

analysis and conjoint measurement in particular are increasingly being applied for market research in the field of public transport. The basic principle of the most common methods is presented below, details can be found in the literature on market research and statistics.

Regression and variance analysis

Multi-variate analysis like regression and variance analysis measure the relationship between a dependent variable y and a number of independent variables x_n influencing y (more sophisticated variants, e. g. with more than one dependent variable are treated in the literature):

$$y = f(x_1, x_2, \ldots, x_n)$$

Therefore, regression and variance analysis can be applied to verify numerous interesting relationships, e. g. those between:

Y	$x_1, x_2, \ldots, x_n$
Overall satisfaction with public transport	Satisfaction with various facets of public transport
Intention to use public transport more often	Satisfaction with various facets of public transport
Overall satisfaction with public transport	Socio-economic characteristics of users
Number of trips made	Satisfaction with various facets of public transport
etc.	etc.

Table 10: Applications of regression and variance analyses

In fact, various passenger studies apply theoretical models consisting of general quality of public transport and quality-dimensions that go into detail. By verifying the model relationships, regression and variance analysis give insight into the importance of the single facets of public transport. The passenger is not asked directly if friendly drivers are important, this is inferred from the relative contribution of the satisfaction with driver friendliness to the overall satisfaction with public transport.

Conjoint/ Stated Preference (SP) analyses

Conjoint or Stated Choice analysis is based on hypothetical choices. To make the situation as realistic as possible, the method uses a customised design based on a specific journey made by the respondent. The respondent is then given a choice between various "service packages" relating to that journey.

The persons interviewed make several choices between different packages. In each package different standards of public transport are described. The choices made between the packages provide a basis for determining which factors are considered most important. On the basis of the choices, it is possible to calculate how much for instance the price and the travel time means in the modal choice. This gives us information of the passengers willingness to pay for a certain service or improvement, measured in ? / hour, ? / journey, ? / bus shelter etc. This knowledge can then be used when evaluating the economic effects of improvements. The analysis also gives information about the passengers' priorities.

2.4 Passenger requirements

2.4.1 Study findings; examples

The **MOT*i*F** consortium surveyed approximately 80 studies with quantitative demand data during the first research stage. Results that were found in the surveys were transformed in comparable scales with the aim to set up and test a methodology of market segmentation during the research process.

The following table from a study carried out in Rotterdam (Netherlands) is typical for the kind of results in many studies. Empty cells in al tables below indicate the requirements for which no results are available.

user requirement	RET bus	RET tram	RET metro	MOT*i*F average
1. punctuality	5	3.1	4	4.8
2. friendliness of staff	2.3	1.1	3.1	3.0
3. security in the vehicles	1.6	1.0	2.4	5.0
4. comfort of the vehicle	1.6	2.4	0.9	3.5
5. cleanness of the vehicle/seats	1.6	2.5	0.7	-
6. ventilation of the vehicles	3.8	-	-	-
7. sufficient staff (for information etc.)	1.1	1.0	2.0	2.5
8. neatness of the stops/platforms	-	2.1	1.4	-
9. way of driving	-	1.2	1.7	-
10. audibility of messages	2.8	-	-	-
11 .security at the stops	-	2.5	-	5.0
12. neatness of the vehicle	1.6	-	0.6	-
13. travelling speed	1.3	0.8	-	4.5

Table 11: Importance figures per consumer requirement (Source: RET 1996)

Interviews with commuters in the Roissy area (France) yielded importance ranks instead of exact values:

No.	Requirement	Bus users' rank	Train users' rank	Private car users' rank
1	Availability, connections	1	6	1
2	Number of transfers	9	10	
3	Punctuality	3	3	
4	Travel speed	6	5	4
5	Regularity			
6	Accessibility			
7	Frequencies	2	4	
8	Security	4	1	5
9.1	Comfort at stops	8	7	
9.2	Comfort of vehicles	10	8	2
10	Pre-trip information	13	13	
11	On-trip information	11	9	
12	Customer orientation	8	11	
13	Price, fare level	5	2	3
14	Tariff system	12	12	
15	Distribution of tickets			
16	Safety			6
17	Social prestige			
18	Environmental friendliness			
	Average:			
	Image of P.T:			

Table 12: Transversal Analysis Roissy (bus, train, private vehicles)

In Dordrecht (Netherlands), importance was measured. The survey was related to the introduction of a totally new bus system with three different products:

	User requirement	Importance (former situation)	Importance (present situation)
1	availability, connections	4.4	4.4
2	number of transfers	4.4	4.7
3	punctuality. Reliability	5.0	4.7
4	travelling speed	4.6	4.2
5	Regularity	3.4	3.4
6	accessibility stop/vehicle	3.9	4.2
7	frequency departures	4.1	4.1
8	Security	4.8	5.0
9	comfort stops/vehicle	3.3	3.5
10	pre-trip information	2.3	2.6
11	on-trip information	3.4	3.7
12	customer orientation	2.9	3.1
13	price .fare level	5	5
14	tariff system	3.9	4.2
15	possibilities to obtain tickets	2.4	2.6
16	Safety		
17	social prestige		
18	environmental friendliness		

Table 13: Importance factors (Dordrecht)

An example from Norway shows yet another way to measure importance:

Improvement	Willingness to pay for improvements (NOK/journey)		
	5 towns	Drammen	Oslo
Avoid standing for 15 minutes	4-11	11	4
5 minutes shorter walking time	2-4	4	3
15 minutes shorter intervals between departures	2-5	5	7
Avoid transfers	3-8	2	2
Avoid 10-minute wait for transfer	5-15	20	4
Avoid unexpected 5 minute delay			6.80

Table 14: Relative valuation of various improvements in standards, in terms of ticket prices (NOK/journey, 1 ?˜ 10 NOK).

TØI assessed the relative importance of various improvements in standards by calculating passengers' willingness to pay for the measures (Table 14). The highest willingness to pay relates to having a seat and avoiding waiting when transferring from one means of transport to another.

When comparing the importance data from the various studies, one is struck by the fact that the importance of various aspects is hardly different in some studies, whereas importance scatters over almost the full scale according to other research. Obviously, this has to do with the research method and technique chosen. If interviewing passengers, it seems advisable to force them to choose, since this will yield better articulated results. On the other hand, exaggeration of differences if these really are small should be avoided. The researcher could e. g. ask the passenger being interviewed to divide a limited number of “importance points” over the aspects of service, rather then give importance marks for every feature separately.

2.4.2 Comparing results

The consortium attempted to cluster comparable studies, thus enabling comparison of absolute values. The level of heterogeneity of the available data was such that this attempt has failed. The main sources of heterogeneity and therefore incomparability include:

- Differences in the size and composition of sample surveys: Inclusion of potential passengers, inclusion of young passengers, focus on specific target groups, etc..
- Divergence of surveyed regions in size, structure, transport supply etc.: Different importance factors regarding travel speed might be explained by a genuinely different valuation of travelling time as well as by different origin-destination patterns due to denser city structures (common sense predicts, that trip length will influence the importance attributed to travel speed).
- Different and incomplete selections of passenger requirements: Focus on e. g. security aspects only.
- Different methodologies and inquiry techniques: As described before.
- Divergent methods of statistical analysis: Regression analysis yields results that are related with e. g. correlation factors, but the results are not identical.
- Different interpretations by respondents of seemingly identical scales: Assigning numerical values to requirements leads to a local or national bias, e. g. due to different school systems: Marks in the Netherlands vary between 1 (worst) and 10 (best achievable result). Marks on the lower half of the scale (below 6) are insufficient. The scale that is used at German universities is asymmetric, insufficient results cover only a small proportion. Direct transformation between numerical scales will therefore lead to misinterpretations.

Since all these factors are at work simultaneously, comparison of figures derived from the various sources must remain course. Comparisons of absolute values might lead to unfounded conclusions.

Nonetheless, comparisons of importance factors at aggregate levels are possible, and they do yield interesting results. Importance rankings are an example of high aggregation. Detailed results can easily be transformed into this form (e. g.

calculation of rankings from exact importance levels). Thus the use of rankings enables the comparison of a great number of studies, as shown in the following section.

2.4.3 Importance ranking of product features

Based on several studies, importance rankings were derived and compared. In some of the studies, results were available for different user groups. This enabled comparisons between the requirements of bus and light rail users (e. g. Manchester) and between bus users, RER users and car drivers (e. g. Roissy). The following studies could be considered:

Study and user group	Remark	Abbreviation
Manchester bus users		Man bus
Manchester Metrolink users		Man metro
Rotterdam bus users	Repeated in regular intervals	Rot bus
Rotterdam tram users	Repeated in regular intervals	Rot tram
Rotterdam metro users	Repeated in regular intervals	Rot metro
Madrid	Generally minor differences	Madrid
Norway Trial Scheme		Nor TS
Münster Express Bus		Mün Ex
Roissy Bus users		Roi bus
Roissy RER users		Roi RER
Roissy Car drivers		Roi car

Table 15: Studies used for the comparison of importance factors

The following table summarises the results of the comparison. The product features ranking in the “top three” are formatted in inverse mode. Aspects defined somewhat differently than the **MOT*i*F** categories (first column) are given in parantheses.

Study	Man bus	Man metro	Rot bus	Rot tram	Rot metro	Madrid	Nor TS	Roi bus	Roi RER	Roi car
Methodology	Direct ranking		Regression analysis				Conjoint M	Ranking		
Availability, connections						5	7	1	6	1
Number of transfers						7	3 (change cond.)	9	10	
Punctuality, reliability	1	1	1	1	1	2		3	3	
Travel speed	6	3	9	10	--	6	6	6	5	4
Regularity										
Accessibility of stops and vehicles	4 (stops)	4								
Frequency of departures	2	2				1	2	2	4	
Security (vehicles, stops)			5-8, --	8-9, 2-3	3, --	3		4	1	5
Comfort (vehicles, stops)	8	8	5-8 (vehicles)	4	7	8	4 / 5 / 8 (shelter / seat / clean veh.)	8, 10	7, 8	2 (veh.)
Pre-trip information						11		13	13	
On-trip information	5	6						11	9	
Customer orientation			4 (friendliness of staff)	7	2	10		8	11	
Price, fare level	3	5					1	5	2	3
Tariff system								12	12	
Possibilities for obtaining tickets						9				
Safety										6
Social prestige	7	7								
Environmental friendliness						4				

Table 16: Ranking of attribute importance factors; comparison of studies

"Punctuality" and "frequency" are found to be very important in almost every study. These aspects seem to be hard prerequisites for market orientated transport products.

The results with regard to the other product features vary significantly depending on study sample, methodology and location. All other top positions on the importance scale are not consistent over the range of studies compared in the tables above. "price / fare level" for example can be found on first as well as on fifth place. Basically the same conclusion holds for "security" and "availability, connections".

It is interesting to note, that "travel speed" is not of outstanding importance, as is often assumed in political and other general debates. Rather punctuality, availability, connections and frequency, in other words aspects that define the total travel time from door to door as well as the predictability of travel time, are decisive. Security and fare level are also ranking on the top positions.

MOT*i*F further verified the hypothesis, that passenger requirements vary significantly in different European countries. The headings in the following table express the fact that results are deduced from studies carried out **in** a certain country. The conclusions are not valid **for** this country in general, since importance rankings also vary between different studies in one country, as shown before in Table 16. Therefore, the following tables present general trends rather than exact results.

	Dutch	**French**	**German**	**Portuguese**	**Spanish**
most important	price	travelling speed	price	safety	safety
second most important	security	regularity	connections	punctuality, reliability	security
third most important	punctuality, reliability	punctuality, reliability	punctuality, reliability	frequency of departures	punctuality, reliability

Table 17: Most important passenger requirements

The priorities concerning the passenger requirements according to the researched European studies differ to a certain extent: Within the analysed Spanish and Portuguese studies, safety is most important. Interestingly, the requirements on safety were not even measured in the studies from both France and Germany. Punctuality / reliability ranks among the most important requirements of users in all five countries. Within the French studies the focus was put exclusively on what could be named primary, operational aspects, whereas the results in other countries cover other aspects as well.

	Dutch	**French**	**German**	**Portuguese**	**Spanish**
third least important	customer orientation	possibilities to obtain tickets	On trip information	accessibility (stops, vehicles)	pre trip information
second least important	pre-trip information	on trip information	Comfort (vehicles, stops)	possibilities to obtain tickets	comfort (vehicles, stops)
least important	possibilities to obtain tickets	pre trip information	Accessibility (stops, vehicles)	pre trip information	accessibility (stops, vehicles)

Table 18: Least important passenger requirements

According to the selected studies, 'pre-trip information' is clearly at the bottom of the table with two last positions, and is brought up two more times. Possibly, this result is caused by overrepresentation of present users in the sample. For the average user the need for accessibility of stops and vehicles is also negligible. Again, the need for careful and specific interpretation is apparent: a study by the Norwegian Institute for Transport Economics revealed, that the unimportant – on average - aspect of vehicle accessibility is decisive for 12 % of the public transport passengers.

Comparing the tables with most and least important passenger requirements, it becomes clear that the stated importance of secondary or quality features (like comfort and customer orientation) is relatively small. None of the features occur in both tables, so a clear distinction between important and less important features seems to exist.

2.5 Criteria influencing the level of passenger requirements

Fast and comfortable SchnellBuses drive commuters into the city of Münster (Germany) on direct routes. The success of this new product was evaluated by a user survey.

The **MOT*i*F** consortium differentiated the evaluations of the quality features for the SchnellBus users groups. The numerical results (see appendix in the report of work package 4) are condensed and presented in Table 19. A „+“ means: this user group has higher requirements regarding this aspect.

SchnellBus		**User group dependent results:**
Main category	***Quality feature***	
Supply	Supply Monday – Friday	
	Supply Saturday:	+ Long journeys + Low age
	Supply Sunday	
	Number of departures	
	Travel time	+ Long journeys
	Punctuality	
Passenger information	Regional/city time table	+ Short journeys
	Tariff info	+ Short journeys
	Time table info	
Boarding stop	Weather protection	+ Long journeys
	Illumination	+ Long journeys
	Seat availability	+ Long journeys + Low age
	Time tables at stop	+ High age + Car availability
	Feeling of security	+ Women
	Cleanness	+ Low age

SchnellBus		User group dependent results:
Main category	*Quality feature*	
Vehicle exterior	Vehicle design	+ Long journeys
	Environment (exhaust gases, noise)	+ High age
	Cleanness	+ Long journeys
Vehicle interior	Padding of seats	+ Long journeys + High age
	Seat quality / leg space	+ Long journeys + Men + High age
	Air quality / climate / air supply	+ Long journeys + Men
	Colour	
	Information prospects	
	Stop announcement	
	Suitability for the handicapped	
	Luggage storing room	
	Cleanness	
Personnel / service	Friendliness	+ Long journeys
	Competence	
	Driving manner	

Table 19: SchnellBus survey results

Other studies come to inconsistent conclusions regarding the dependence of importance figures on the modes being used. The researchers of a customer monitoring study in Rotterdam (Netherlands) conclude, that “importance figures are higher if the performance levels [of a product in comparison with another product] are lower”. Stated in terms of the quality loop: importance is positively correlated with delivered quality. According to the Manchester Metrolink study (England), hardly any relation between importance figures and modes with different quality levels exists at all.

Rotterdam rankings are highly mode-dependent, Manchester rankings are not. It seems quite unlikely, that these findings originate from genuine differences between Dutch and English customers. The implication could rather be, that different survey techniques and methodologies (in this case: regression analysis versus direct ranking) lead to different results.

2.5.1 Selection of the key criteria

The survey of the available studies yielded highly diverse results. Nonetheless, the consortium developed a general methodology for market segmentation which includes the discriminative factors used most often in the available studies. It is meant to be a starting point for application in field research. Furthermore, this methodology shall demonstrate common principles of market segmentation.

Hypotheses on the criteria that influence passenger requirements are the core of the methodology. The main factors according to the studies that were researched in the course of **MOT*i*F** are:

- socio-economic characteristics of the users and
- journey features that include journey purposes, time-depending factors and geographic references of trips.

The importance of the discriminative factors was estimated on the basis of the number of studies that include these factors in their model. By very nature, sophisticated and non-standard approaches using concepts like “social milieu”, “fundamental convictions” and “attitudes” are neglected in this procedure. Their qualitative, individual and complex approach yields meaningful results but comparison of discriminative factors is not as straightforward as with journey length, age, etc. Therefore we focused on classical ways to segment markets.

In 18 studies the following criteria were identified to be influential in terms of modal choice or satisfaction with the service:

- age (14 out of 18 studies)
- gender (13 / 18)
- car ownership or availability (11 / 18)

- income or occupancy (11 / 18)
- journey purpose (9 / 18)
- geographic references (5 / 18)
- time-depending factors (5 / 18)

Gender is one of the most surveyed criteria, yet we did not use gender as a discriminative factor for market segmentation. The reason is, that the influence of gender on passenger requirements is mainly a “second order effect”: Gender seems to be highly influential at first sight, but the influence is actually caused by gender specific differences in education, income and position in business life. Therefore, gender itself is not as significant as it seems, but becomes important on the background of societal roles and interrelations (see KEUCHEL, 1994, p. 39).

The selected categories and discriminative criteria are listed below:

Category	Selected user and journey characteristics
Journey purpose	**Purpose:** Work (home <> working place) / Education (Home < > school), Business (working place <> other) / Shopping / Recreational / Social
Socio-economic factors	**Income:** low, high **Car ownership:** yes, no **Age:** <16-18, 16-18/65, >65 **Special needs:** disabled (motor, sensorial), people with luggage, babies, etc.
Geographic reference of trips	**Journey length:** short, long
Time-dependent trip factors	Night hours

Table 20: Factors influencing passenger requirements

Already this small set of discriminative factors yields a high number of possible “trip

types" (combinations of user and journey characteristics):

Selected user and journey characteristics	No. of variations
Purpose: Work (home <> working place) / Education (Home <> school), Business (working place <> other) / Shopping / Recreational / Social	2
Income: low, high	2
Car ownership: yes, no	2
Age: <16-18, 16-18/65, >65	3
Special needs: disabled (motor, sensorial), people with luggage, babies, etc.	2
Journey length: short, long	2
Night hours	1

Table 21: Number of variations of factors influencing passenger requirements

The variations yield 2*2*2*3*2*2 = 48 trip types. These trip types are the basis for the deduction of market segments with similar requirements. An example of trip type is "a short recreational trip by a middle aged car owner with high income".

The direction and extent of the influence of discriminative factors on passenger requirements was estimated in an intermediary step: the development of a **weighting matrix**. This matrix contains qualitative assessments that were partially derived on the basis of expert judgement and partially from the surveyed studies:

- People with journey purposes such as "***work***" and "***education***" travel regularly and are often bound by tight time schedules. Therefore quality aspects of supply (like number of transfers, punctuality, reliability and travelling speed) are relatively important (KEUCHEL 1994). Since working people, pupils and students travel on regular lines pre-trip information should be less important than any other requirement.
- In general, journeys with ***recreational***, ***social*** and ***shopping*** purposes as well as for ***business*** reasons are made less regularly. It has been shown that for non-routine movements, the Movement Factor Value (that is: the quotient of travelling time per car and travelling time with public transport) does not play a dominant role. Other factors such as convenience, costs, comfort and attitude towards

public transportation play an important role (HAGEN & VAN WISSEN 1993). Examples are information before the trip, good possibilities to obtain tickets and regularity. If a car is available, travelling speed and number of transfers are important factors as well because choice possibilities exist.

- ***Older people*** attach importance to many of half of the listed requirements. These include among others door-to-door supply, security and comfort of stops and vehicles, pre- and on-trip information, customer orientation and an easy tariff system and possibilities to obtain tickets (KÖHLER, FLEISCHER 1994).
- People with ***low income*** desire low prices. This obvious correlation was found for example in a study on requirements on public transport that was carried out last year among teenagers, who usually have a low income (SCHMIDT-FREITAG 1996).
- People with ***high income*** and a car available have many possible choices. In this group travelling speed and comfort play a dominant role. In contrast to these two aspects the requirement 'price' is less important than any other demand if the quality of supply and service is guaranteed.
- When ***trip length*** is ***short***, poor connections will affect mode choice because access and waiting times dominate the total journey-time. The same argument holds for stop accessibility and frequency of departures. Comfort on the other hand only plays a minor role because the time spent in vehicles or at stops is short. Fare level especially forms a barrier for short trips due to the tariff system.
- Travellers who have ***a car at their disposal*** have a special interest in the primary functions of transport products such as availability, connections, number of transfers, punctuality and travelling speed. Since the car is the biggest competitor of any public transport product the importance of comfort, security, information and social prestige should not be underestimated.
- Especially for ***younger customers***, the image attributed to different transport products influences modal choice. This life style aspect not only plays a role for the category under 16 or 18. The intermediary group (up to 65) must be included as well (e.g. the car as a status symbol).

These findings are summarised in the matrix below. A “+“ sign indicates a higher importance for a particular passenger requirement than the average. Correspondingly, the “-“ sign indicates a lower importance (the distortion of the results due to the dominance of positive influences is resolved by the calculation

methodology and can therefore be ignored).

User & journey feature ➔	Journey purpose		Income		Age			Car availa-bility		Journey length	
Passenger requirements ⬇	work/ edu-ca-tion	Recr./ social	High	Low	< 16/ 18	16/ 18-65	> 65	yes	no	short	long
Availability, connections								+			
Number of transfers	+	+ (1)					+	+ (1)		+	
Punctuality, reliability	+							+		+	
Travelling speed	+	+ (2)	+ (3)		+	+		+ (2,3)			
Regularity		+									
Accessibility (vehicle, stop)							+	+		+	
Frequency of departures										+	
Security (vehi-cles, stops)							+	+			
Comfort (vehi-cles, stops)			+				+	+			+
pre-trip information	-	+					+	+			
on-trip information							+				+
Customer orientation							+				
price, fare level			-	+							
tariff system							+				
Possibilities to obtain tickets		+					+				

User & journey feature ➔	Journey purpose		Income		Age			Car availa-bility		Journey length	
Safety											
social prestige					+	+		+			
Environmental friendliness											

Table 22: Weighting factors

Some weighting factors are expected to be dependent on more than one user or journey feature. This is indicated by the numbers in the table. For example, the number 2 indicate that the attribute *travelling speed* is more important than average only for users having a car available and travelling for recreational/social purposes.

2.5.2 Passengers with special needs

In addition to the main user groups who were defined by socio-economic and journey features (see above), special attention was given to public transport users with special needs. These users cannot be categorised by their socio-economic and journey features, but were treated separately.

A first important group are **disabled users**. Their importance as a consumer group is generally underestimated. In a wide sense, if all people with motor or sensorial disabilities (incl. e.g. difficulties to use stairs) are taken into account, approximately 33% of the Spanish population belongs to this group (1989 data from the Social Services National Institute of Spain).

Requirements	**Motor disabled**	**Sensorial disabled**
1. Availability, connections	+	+
2. Number of transfers		
3. Punctuality, reliability		
4. Travelling speed		
5. Regularity		
6. Accessibility of vehicles and stops	+	

7. Frequency of departures		
8. Security (vehicles, stops)	+	+
9. Comfort (vehicles, stops)	+	
10. Pre-trip information		+
11. On-trip information		+
12. Customer orientation	+	+
13. Price, fare level		
14. Tariff system		
15. Possibilities to obtain tickets	+	+
16. Safety		
17. Social prestige		
18. Environmental friendliness		

Table 23: Higher requirements of disabled public transport users

With regard to requirements on transport products, two main categories can be discerned:

- Requirements of the motor disabled (including handicapped, elder people etc.) emphasise accessibility, while
- sensorial disabled public transport users (deaf, blind etc.) have higher requirements related to information (based on Spanish studies on requirements of disabled public transport users).

The table above shows in what respect these two groups of disabled users pose increased requirements.

Not all special needs are related to physical disabilities. People travelling with **luggage**, prams, etc. have additional requirements as well. Requirements like the accessibility of vehicles and stops, a spacious interior and the supply of direct connections will be especially important for them.

People **travelling by night** were considered separately as well. This group can of course be very heterogeneous with regard to socio-economic features etc.. Increased interest lies in the security at nightly travel times. In order to reduce long waiting times and walks in the dark, number of transfers, availability, connections and punctuality are more important as well. Special requirements regarding pre trip

information are caused by the fact, that supply is often different compared to day-times.

The assessments articulated in the weighting matrix and above must be interpreted as a summary of hypotheses. These hypotheses were validated through case studies, for example the Metrolink Customer Monitoring study.

2.5.3 Case study: Manchester Metrolink (UK)

Base data

Product type:	*Light rail system (1992)*
Track length:	*30.9 km with 26 stops*
Passengers per year:	*13 million*

Demand data

Information about the Metrolink users was collected as part of the Metrolink Monitoring study[3].

Table 22 shows the priority attached to different consumer requirements by bus, rail and Metrolink passengers (1 = highest priority, 9 = lowest priority).

Consumer Requirement	Importance of Attribute for Passengers			
	Bus Users 1991	Bus Users 1993	Rail Users 1991	Metrolink Users 1993
punctuality / reliability	2	1	1	**1**
travelling speed	6	6	5	**3**
accessibility of stops	4	4	6	**4**
frequency of departures	1	2	2	**2**
comfort	9	8	9	**8**
on-trip information	3	5	3	**6**

[3] Oscar Faber (1996).

price / fare level	5	3	4	**5**
social prestige	7	7	7	**7**

Source: Oscar Faber 1996, Tables B2, B4.

with 1=highest priority, 9=lowest priority

Table 24: Importance attached to different transport attributes

MOT*i*F hypotheses and Metrolink data

The monitoring study surveyed journey purposes for bus, car and rail. The following general patterns were observed:

- Metrolink tends to have a larger proportion of work trips than either rail or bus;
- rail and Metrolink have a larger proportion of education trips to Central Manchester than bus, but the situation is reversed for trips within the corridor;
- bus has the largest proportion of shopping trips.

In work package 1, the **MOT*i*F** study has conjectured that 'punctuality / reliability', 'travel speed' and 'regularity' are important consumer features for work /education trips. Table 22 confirmed the first two to be important to passengers of all modes. Metrolink is more punctual and reliable than bus or rail, and quicker than bus, therefore the **MOT*i*F** study correctly predicts that Metrolink is relatively more attractive to those working.

MOT*i*F postulates the corresponding important consumer features for recreation / social journey purpose to be 'number of transfers', 'accessibility of stops', 'security', 'comfort', 'pre-trip information', and 'possibilities to obtain tickets'. Bus service offers a greater stop accessibility because of its wider network, but the other attributes are not clearly superior for either bus or Metrolink. Therefore, the correct prediction by **MOT*i*F** that bus service has a higher proportion of recreational trips provides little inferences as to the validity of these **MOT*i*F** hypotheses.

2.5.4 Validation of the influence of socio-economic and journey features on passenger requirements

A key result from the first **MOT*i*F** work package is the weighting matrix (Table 22). This matrix was used as a first approximation for market segmentation purposes by evaluating the influence of socio-economic and journey features on passenger requirements. In the course of the project, the consortium reviewed several public transport market studies. On the basis of these analyses, the hypotheses in the weighting matrix were validated. The following questions were answered:

- Do general influences of socio-economic and journey features on passenger requirements exist, i. e. independent of local circumstances?
- If so, do the hypotheses of the weighting matrix predict these general influences correctly?
- Is the assumption regarding the amount of influence exerted by socio-economic and journey features on passenger requirements correct ("magnitude")?

Table 25 to Table 29 summarise results from the case studies that answer the above questions. In order to facilitate comparison, the presentation of the results is standardised. If a certain product feature is especially important to a user group, this is marked with a **"+"**. If the requirement regarding a certain product feature in this group equals the average value, the corresponding sign is **"o".**

Influence of journey purpose on passenger requirements

The influence of journey purpose could be tested to a large extent. Table 25 shows the results of several field studies and compares them with **MOT*i*F**.

Journey purpose:		**Influence:**
w	work	**+** requirement (importance) above average
e	education	**o** no unambiguous influence of journey purpose
r	recreation	no data or incomparable results
so	social	() conjecture rather than conclusion
sh	shopping	

MOT*i*F assumptions	**MOT*i*F**	**Manchester Metrolink**	**Madrid bus users**	**Madrid Underground**	**Madrid Suburban Bus**	**Lisbon bus users**	**Norway Trial Scheme**
Availability, connections	**o**		**+** w/e		**o**	**o**	**+** w/e
Number of transfers	**o**		**+** w/e		**o**	**o**	
Punctuality, reliability	**+** w/e	**+** w/e	**+** w/e	**o**	**o**		**+** r/so
Travel speed	**o**	**+** w/e	**+** w/e	**o**	**o**	**o**	**+** w
Regularity	**+** r/so				**o**		
Accessibility of stops and vehicles	**o**	**(+)** sh		**+** r/so/sh	**+** r/so/sh	**o**	
Frequency of departures	**o**		**o**	**o**	**o**	**o**	**+** w
Comfort (vehicles, stops)	**o**		**o**	**+** r/so/sh	**+** r/so/sh	**o**	
Pre-trip information	**+** r/so		**+** r/so		**+** r/so/sh		
On-trip information	**o**			**+** r/so/sh		**o**	
Customer orientation	**o**		**+** r/so	**+** r/so/sh	**+** r/so/sh	**+** w/e	
Possibilities for obtaining tickets	**+ r/so**		**o**	**+** r/so/sh	**+** r/so/sh	**o**	
Safety	**o**			**o**	**+** r/so/sh	**o**	
Environmental friendliness	**o**		**+** w/e		**o**		

Table 25: Influence of journey purpose on passenger requirements; Comparison of studies

The assumptions with regard to "Availability, connections" and "Number of transfers" are correct. Only a slightly higher requirement level seems to exists for work and educational trips. "Punctuality, reliability" is more important during work and educational trips, as predicted by **MOT*i*F** theory.

The higher importance of "Travel speed" for work and educational journey purposes was not predicted. The weighting matrix should be completed accordingly. Other modifications would be to increase the importance of "Accessibility of stops and vehicles", "Comfort (vehicles, stops)" and "Customer orientation" for recreational, social and shopping trips.

The weighting matrix is again correct in its prediction of the influence of journey purpose on "Frequency of departures", "Pre-trip information", "On-trip information", "Customer orientation", "Possibilities for obtaining tickets", "Safety", and "Environmental friendliness".

Requirements on "Regularity", "Security (vehicles, stops)" and "Price, fare level" are mostly in correspondence with the weighting matrix. Hard conclusions can not be drawn due to the small number of observations for these three aspects.

Influence of income level on passenger requirements

Table 26 summarises case study results regarding the influence of income level on passenger requirements.

Income: l low m middle h high		**Influence:** **+** requirement (importance) above average **o** no unambiguous influence of income on requirement no data or incomparable results () conjecture rather than conclusion	
MOT*i*F assumptions	**MOT*i*F**	**Norway Trial Scheme**	**Lisbon bus customers**
Availability, connections	**o**		**o**
Number of transfers	**o**		**o**

Travel speed	**+** h		**o**
Accessibility of stops and vehicles	**o**		**o**
Frequency of departures	**o**	**+** h	**o**
Security (vehicles, stops)	**o**		**o**
Comfort (vehicles, stops)	**+** h		**o**
On-trip information	**o**		**o**
Customer orientation	**o**		**+** h
Price, fare level	**+** l		**o**
Possibilities for obtaining tickets	**o**		**o**
Safety	**o**		**o**

Table 26: Influence of income level on passenger requirements; Comparison of studies

Results are few, due to the fact that income level is often not included in questionnaires because of privacy reasons. The few results that are available are not corresponding very well with the assumptions in the weighting matrix. More research would be necessary on this aspect.

Influence of age on passenger requirements

Age has been studied in many surveys in order to discriminate between user groups, as Table 27 shows.

Age: l low, e.g. <18 m middle, e.g. 18 – 65 h high, e.g. >65		**Influence:** + requirement (importance) above average o no unambiguous influence of age on requirement no data or incomparable results () conjecture rather than conclusion					
MOT*i*F assumptions	**MOT*i*F**	**Madrid bus customers**	**Madrid Underground**	**Madrid Suburban Bus**	**Lisbon bus**	**Norway Trial Scheme**	**Münster Express Bus**

Age: l low, e.g. <18 m middle, e.g. 18 – 65 h high, e.g. >65		**Influence:** + requirement (importance) above average o no unambiguous influence of age on requirement no data or incomparable results () conjecture rather than conclusion					
MOT*i*F assumptions	**MOTiF**	**Madrid bus customers**	**Madrid Underground**	**Madrid Suburban Bus**	**Lisbon bus**	**Norway Trial Scheme**	**Münster Express Bus**
Availability, connections	**o**	**o**		**o**	**+** l/m		
Number of transfers	**+** h	**o**		**o**	**+** m		
Punctuality, reliability	**o**	**o**	**+** h	**o**			
Travel speed	**+** **l**/m	**o**	**o**	**+** h	**+** m		**+** m/h
Regularity	**o**	**o**		**o**			
Accessibility of stops and vehicles	**+** h	**o**	**+** h	**+** h	**+** m/h	**+** h *	
Frequency of departures	**o**	**o**		**o**	**+** m		
Security (vehicles, stops)	**+ h**	**o**	**O**		**+** m		
Comfort (vehicles, stops)	**+ h**	**+** m/h	**+** h	**+** h	**+** m		**+** h
Pre-trip information	**+ h**	**o**		**+** h			**+** h
On-trip information	**+ h**	**+** h	**+** h		**+** m		**+** h
Customer orientation	**+ h**	**o**	**+** h	**+** h	**+** l/m		**+** h
Price, fare level	**o**	**o**			**+** m		

Age: l low, e.g. <18 m middle, e.g. 18 – 65 h high, e.g. >65		**Influence:** + requirement (importance) above average o no unambiguous influence of age on requirement no data or incomparable results () conjecture rather than conclusion					
MOT*i*F assumptions	**MOTiF**	**Madrid bus customers**	**Madrid Underground**	**Madrid Suburban Bus**	**Lisbon bus**	**Norway Trial Scheme**	**Münster Express Bus**
Tariff system	**+ h**	**o**					
Possibilities for obtaining tickets	**+ h**	**o**	**O**	**+** h	**+** m		
Safety	**o**	**o**	**O**	**o**	**+** m		
Social prestige	+ l/m	o					
Environmental friendliness	**o**	**o**		**o**			

Table 27: Influence of age on passenger requirements; Comparison of studies

Differentiation of passenger requirements in dependence of age categories does show some conflicting results. For example in Madrid, senior users value travel speed higher, whereas in Lisbon the mid age group stresses this aspect more. **MOT*i*F** theory held, that low and mid age groups would consider travel speed to be relatively important.

Mainly in conformity with the weighting matrix are the results with regard to “Availability, connections”, “Punctuality, reliability”, “Regularity”, “Accessibility of stops and vehicles”, “Frequency of departures”, “Comfort (vehicles, stops)”, “Pre-trip information”, “On-trip information”, “Customer orientation”, “Price, fare level”, “Possibilities for obtaining tickets”, “Safety” and “Environmental friendliness”.

Modifications of the weighting matrix might be useful on the following dimensions: “Number of transfers” and “Security (vehicles, stops)”.

The small number of data on the importance of “Tariff system” and “Social prestige” does not allow for well-founded conclusions.

Influence of car availability on passenger requirements

The assumed influence of car availability on passenger requirements seems to have been somewhat exaggerated during the demand analysis (first work package):

Car availability: N no car Y car available		**Influence:** + requirement (importance) above average o no unambiguous influence of car availability on requirement no data or incomparable results () conjecture rather than conclusion		
MOT*i*F assumptions	**MOT*i*F**	**Rotterdam monitor**	**Münster Express**	**Lisbon Bus**
Availability, connections		Generally: hardly any difference		**o**
Number of transfers	**+** Y			**o**
Punctuality, reliability			**+** Y	
Travel speed	**+** Y		**+** Y	**o**
Accessibility of stops and vehicles	**+** Y			**o**
Frequency of departures	**+** Y			**o**
Security (vehicles, stops)	**+** Y			**o**
Comfort (vehicles, stops)	**+** Y			**o**
Pre-trip information	**+** Y		**+** Y	
On-trip information	**+** Y		**+** Y	**o**
Customer orientation	**+** Y			**o**
Price, fare level				**o**
Possibilities for obtaining tickets				**o**
Safety				**o**
Social prestige	+ Y			
Environmental friendliness	**+** Y			

Table 28: Influence of car availability on passenger requirements; Comparison of studies

If increased importance attributed depending on car use could be proven (Münster case), it was for the attributes anticipated by **MOT*i*F** theory.

Influence of journey length on passenger requirements

The last journey feature that was included into the **MOT*i*F** market segmentation methodology is journey length.

Journey length: s short m mid l long		**Influence:** + requirement (importance) above average o no unambiguous influence of journey length on requirement level no data or incomparable results () conjecture rather than conclusion	
MOT*i*F assumptions	**MOT*i*F**	**Norway Trial Scheme**	**Münster Express**
Number of transfers	**+** s		
Punctuality, reliability	**+** s		**+** s
Travel speed		**+** m/l	
Accessibility of stops and vehicles	**+** s		
Frequency of departures	**+** s		**+** s
Comfort (vehicles, stops)	**+** l		**+** l
On-trip information	**+** l		**+** l

Table 29: Influence of journey length on passenger requirements; Comparison of studies

The conformity between the weighting matrix and the Münster case study results is striking. Complementing the weighting matrix according to the suggestion from the Norwegian case study might be considered, since time restrictions of low and mid age groups are probably somewhat higher than for senior customers.

Concluding remarks to the validation of the weighting matrix

A general observation is, that the studies often come to results that differ somewhat from those in **MOT*i*F**, but seldom to really conflicting statements. Furthermore, the adjustments that would be needed to the weighting matrix developed in **MOT*i*F** are not unequivocal, since the results of the field work are not consistent either.

This conclusion should not necessarily be seen as a problem, though. Local and methodological influence accounts for many of the observed differences. A small example will illustrate this.

The higher importance of short travel times and high frequency for working trips as found in Norwegian studies is related to the higher income of working passengers (importance factors have been derived from "value of time", which is higher for this group). Therefore, the influence of journey purpose on the importance of frequency and travel time is partially a second order effect. If respondents had been asked to score importance e. g. directly on a point-scale, the difference between working and recreational trips might possibly be non existent. This is one of many examples, how survey methods influence results. Such methodological biases should be kept in mind when interpreting the tables.

2.5.5 Magnitude of the influence of socio-economic and journey features

In general, the dependence of passenger requirements of the socio-economic and journey characteristics studied in **MOT*i*F** (journey purpose, income, age, car availability and journey length) seems to be rather small. Importance factors typically vary only between 3 % to 6 % depending on socio-economic and journey characteristics. This result corresponds very well with the first approximation made in the first **MOT*i*F** work package (5% difference). Further reinforcement comes from Portuguese results on the difference between market segments (**Error! Not a valid bookmark self-reference.**).

The same magnitude can be observed from studies that were specified according to consumer and journey features. Table 30 contains some key results of three studies on the importance attributed to public transport features by riders in the Madrid area. Importance factors were differentiated for gender, age, occupation,

kind of ticket (e.g. subscription, ten-journey-ticket) and time of travel (see Nortconsult 1993, INECO 1995 and Intergallup 1993).

	Madrid Underground	Madrid Interurban bus	Madrid City bus
greatest positive difference	11,7%	5,6%	8,5%
greatest negative difference	2,4%	6,4%	11,9%
2x standard deviation	2,9%	3,9%	4,5%

Table 30: Deviation from average importance factors depending on consumer and journey features

Also more detailed results from Portugal confirm this part of the **MOT*i*F** methodology, as the following table shows.

	Market segment*							
User requirement	**1**	**3**	**5**	**7**	**8**	**9**	**11**	**MOTiF user requirement**
Operating hours	2%	2%	2%	1%	-7%	-8%	6%	Availability, connections
Route speed	2%	0%	2%	-1%	5%	-7%	-1%	Travel speed
External cleanness	3%	1%	2%	2%	-6%	-4%	2%	
Price	1%	1%	2%	1%	-5%	-5%	3%	Price, fare level
Frequency	2%	1%	1%	0%	1%	-5%	2%	Frequency of departures
Stops location	2%	0%	1%	0%	0%	-3%	1%	Accessibility (stops, vehicles)
Information on stops	1%	1%	1%	1%	-3%	-5%	3%	On-trip information
Possibilities to obtain tickets	1%	1%	1%	0%	0%	-6%	1%	Possibilities for obtaining tickets
Information on vehicles	3%	2%	3%	0%	-6%	-5%	3%	On-trip information
Personal Safety	1%	1%	1%	0%	0%	-3%	0%	Security (vehicles, stops)
Inside Vehicle Safety	1%	1%	1%	1%	1%	-4%	-1%	Comfort (vehicles, stops)
Recent age of vehicles	2%	1%	1%	-1%	2%	-6%	2%	Comfort (vehicles, stops)
Vehicle conservation	1%	1%	1%	1%	1%	-6%	2%	Comfort (vehicles, stops)
Waiting time	0%	1%	0%	1%	3%	-7%	3%	Number of transfers
Easy transfers	1%	1%	0%	1%	2%	-7%	2%	Number of transfers
Waiting conditions	2%	1%	2%	0%	-3%	-3%	2%	Comfort (vehicles, stops)
Public transports transit conditions	1%	1%	0%	1%	2%	-6%	2%	
Existence of Bus lanes	0%	2%	-1%	1%	3%	-6%	1%	Travel speed; punctuality, reliablility
Vehicle accessibility	-1%	-1%	-3%	0%	7%	1%	-1%	Accessibility (stops, vehicles)
Number of seated places	0%	-1%	0%	-1%	3%	1%	0%	Comfort (vehicles, stops)
Internal cleanness	1%	0%	1%	0%	2%	-5%	1%	Comfort (vehicles, stops)
Internal temperature	1%	1%	1%	0%	0%	-5%	2%	Comfort (vehicles, stops)
Air circulation	2%	2%	2%	0%	-2%	-6%	3%	Comfort (vehicles, stops)

Source: Carris client profile study results (case study by TiS), TransTeC calculation.

* Description of market segments: Table 32.

Table 31: Variation of passenger requirements dependent on market segments

2.6 Segmentation of the market

A major goal of the demand analysis in the first **MOT*i*F** work package was the identification of market segments through a survey of available studies. As far as possible, conclusions relating to the 'European' character of these market segments had to be drawn.

Principles of market segmentation are given by GREEN and KRIEGER, marketing researchers:

- Market segmentation presupposes heterogeneity in buyers' preferences for products or services.
- Companies can react to (or possibly produce) preference heterogeneity by modifications of their current product or service attributes (including price), distribution, and advertising / promotion.
- A firm's modification of its product and marketing mix includes product line addition or deletion decisions as well as the repositioning of current offerings.

These principles have increasingly been adopted by actors in the public transport market as well. By its nature as a large scale mass product, possibilities to tailor public transport to individual user needs are limited. Nonetheless, "one size fits all" does not seem to be the most promising marketing strategy in an environment where ever more users can choose freely between public and private means of transport.

The challenge is to design and combine a limited number of transport products that are tailored to the needs of the most important market segments, but without giving up too much of the advantages of high capacity, high frequency mass public transport. This balancing act can only be achieved by profound knowledge of passenger requirements, followed by the identification of market segments with comparable and mutually different requirements.

Thus, the basic principle reads: market segments can be distinguished in the fields of public transport when certain user groups have similar requirements on a transport product or a group of products.

2.6.1 Segmentations used in available studies

In the reviewed literature, several market segmentation approaches were identified:

- The majority of studies take **socio-economic** characteristics of the user as a starting point (age, gender, profession, etc.). A sophisticated variant on this discriminative criterion is **phase of life**: The idea is, that e. g. family situation will influence the requirements on public transport and modal choice more than age as such.
- The socio-economic criterion is regularly combined with **journey purpose**. Other criteria related to journey and mobility patterns are the individuals **frequency of use** of public transport, **quality aspects of the journey** such as stop distance, seat availability, and number of transfers.
- Finally, **fundamental convictions and attitudes** of the individual have been taken as discriminative criteria in more recent work. Users of such approaches search for revealed structures influencing mobility and the way transport options are evaluated.

Further work in the course of the project builds upon a general approach to segment the demand side of urban public transport. This approach is related with the market segmentation techniques presented above.

As socio-economic characteristics of users as well as their journey features play a key role in modal choice behaviour, the definition of market segments was based mainly on these aspects [see BAMBERG and BIEN, 1995]. 48 trip types resulting from the combination of socio-economic characteristics and journey features are the starting point for a systematic market segmentation.

Some less probable trip types were excluded, such as people older than 65 travelling to work or people younger than 18 with a car available or high income. 28 realistic trip types remained for further analysis:

		Journey purpose Work/ Educational				*Journey purpose* Business/ Shopping/ Recreational/Social			
Income		**high**		**low**		**high**		**low**	
car ownership		**yes**	**no**	**yes**	**no**	**yes**	**no**	**yes**	**no**
long *journey*	**> 65**					4	4	4	4
	16/18-65	4	4	4	4	4	4	4	4
	<16/18				4				4
short *journey*	**> 65**					4	4	4	4
	16/18-65	4	4	4	4	4	4	4	4
	<16/18				4				4

Figure 11: Selection of relevant trip types

2.6.2 Special needs

The general market segmentation was complemented by separate consideration of special user groups. For example, the requirements of people with reduced mobility would have been neglected by the general market segmentation. The special user groups that were considered are: night travellers, people travelling with luggage, prams etc. and disabled people. This extension increased the number of trip types to 31.

2.6.3 Basic Market Segmentation

Of course, the 31 trip types that were identified never perfectly fit the criteria for market segmentation used in the available data base: existing studies on traveller requirements. Therefore, the results from existing studies were “translated” into the **MOT*i*F**-segmentation. Of course, the price for comparability is a loss of detail.

Since none of the reviewed studies differentiates such a high number (31) of segments as defined in this study, the consortium applied the weighting matrix: The qualitative hypotheses of the weighting matrix (see table 6) were ‘translated’ into

numerical values in order to spread the average data from the available studies.

The application of the hypotheses in the weighting matrix with respect to the influence of user and journey features on importance resulted in 31 different importance values (one for every trip type). In this manner, all passenger requirements were differentiated. By numerical comparison of the results, the following 13 market segments were finally developed:

User & journey feature → / Market segment ↓	journey purpose		Income		age			car availability		journey length	
	work/ educa-tion	recr./ social	high	Low	< 16/18	16/18 -65	> 65	yes	no	short	long
1	●		▬			●		●		●	
2	●		▬			●		●			●
3	●		▬		▬				●	●	
4	●		▬		▬				●		●
5		●	▬			●		●		●	
6		●	▬			●		●			●
7		●	▬		▬				●	▬	
8		●	▬				●	●		▬	
9		●	▬				●		●	●	
10		●	▬				●		●		●
11	Night travellers										
12	Travellers with luggage, prams etc.										
13	Motor and sensorial disabled users										

Table 32: Segmentation of the urban transport market

Table 32 should be read as follows: Market segment 1 embraces users aged between 16/18 and 65, with high or low income, with a car available on a short journey for work / education purposes.

The market segments presented are virtual clusters derived from the hypothetical values of the weighting matrix. The segments are derived on the basis of homogeneity of requirements; these requirements depend on user and journey characteristics.

The following case study enables a comparison of the theoretical approach with the results of field research:

2.6.4 Case study: Madrid suburban buses

Base data

Product type:	Suburban Buses
Specifics:	186 lines with 950 vehicles
	14,000 trips per day serving 11,061 stops

Demand data

The study was carried out in 1995 on 28 main suburban lines by INECO. 3,680 passengers were interviewed on week-days with the objective of studying importance factors for different passenger requirements and to allow for market segmentation on the basis of similar satisfaction levels.

Comparison of the MOT*i*F and the Madrid approach

A market segmentation was carried out by applying cluster techniques to the data obtained in the survey undertaken. This method enabled grouping of those individuals that have stated similar satisfaction values for each of the requirements. Thus, similar degrees of satisfaction (not importance) were used for clustering.

The following clusters were obtained:

	Satisfaction	Cluster composition (groups represented above average)	Nº of indiv.
1	Very satisfied	People older than 45, housewives, retired people, 10 journey and single tickets users travelling between 7:00 and 13:00	953 (26%)
2	Enough satisfied	Men, people between 25 and 44, workers and retired people, single tickets users travelling between 7:00 and 13:00	565 (16%)
3	Almost satisfied	Men, people between 16 and 34, students and retired people, monthly tickets users travelling between 13:00 and 22:00	344 (9%)
4	Slightly dissatisfied	Women, people between 16 and 24, students, single and 10 journey tickets users	675 (18%)
5	Very dissatisfied	Women, people between 35 and 55, students and housewives, single and monthly tickets users	338 (9%)
6	Dissatisfied, especially with the most important product features	Women, people between 16 and 55, workers and monthly tickets users	185 (5%)
7	Just satisfied, except with environmental friendliness, frequency of departures	People between 16 and 24 as well as older than 45, students, retired people, monthly tickets users	620 (17%)
Total			3.680

Table 33: Market segmentation of suburban bus users

The seven customer groups obtained (clusters) are described according to the socio-economic variables considered in the survey: gender, age, time of day, occupation and kind of ticket. As far as these characteristics correspond with the ones considered in **MOT*i*F**, the results can be validated. In this manner, conclusions with regard to age (corresponding characteristic: also “age”) and journey purpose (corresponding characteristic: “occupation”) are possible.

The socio-economic composition of the clusters found in the Madrid survey varied

only slightly. These small variations of socio-economic variables were compared with the market segmentation found by application of the **MOT*i*F** methodology.

- **Journey purpose:** In contrast to the prerequisites of **MOT*i*F**, none of the clusters in the Madrid case includes workers and students together. Students are grouped either with housewives (cluster 5), retired people (cluster 3) or in a single segment (cluster 4). The market segmentation made in work package 1 of **MOT*i*F** postulated the hypothesis that journeys undertaken for work and education purposes would have similar requirements. From the Madrid case study this hypothesis cannot be validated. Interestingly, in all clusters with a higher percentage of students, environmental friendliness appears as the main requirement.

- **Age:** A deviation from the **MOT*i*F** results in terms of the socio-economic factor "age" can also be stated for people older than 65. In the Madrid case the highest age category is grouped together with people between 45 and 55 (clusters 7 and 1). This result indicates that requirements are not only resulting from retirement or professional activity. Age as such can be a discriminative factor.

- **Other user characteristics:** Gender and type of ticket used (as an indicator to discriminate between regular and non regular user) seem to be characteristics that are influential in terms of market segmentation in Madrid. These discriminative factors were not found in the 18 segmentation studies reviewed for **MOT*i*F**.

- On the other hand, **gender** can be interpreted as a mediating variable, as shown before.

- Also, the **type of ticket** (discriminative factor in Madrid) and car availability (discriminative factor in the **MOT*i*F** approach) are both correlated with the number of trips made by a person. These two indicators are therefore probably related, though not enough to compare them directly.

These examples show that not all incompatibility problems encountered during the comparison of results from studies with different designs can be solved.

3 Authority requirements

Besides the requirements of the users the requirements of the authorities do substantially shape and influence the transport market as well. Authority requirements were reviewed and the influence of these requirements on the transport market analysed.

In addition to requiring a minimum level of transport service for passengers, authorities are also interested in ensuring that transport service contributes to over-arching, societal goals, such as providing mobility for people without other alternatives and improving environmental standards in a city or region. The legal tools, like laws, guidelines, plans, contracts, subsidies or taxes, used to move toward such goals are different in every country. Examples of requirements that **public authorities** have for public transport include, for example, limitations on funding, provision of service to particular social groups (even when this is not economically efficient) and environmental requirements.

3.1 The European Framework for Authority Requirements

The Citizens' Network Green Paper (EU 1996) emphasises that citizens should be at the centre of the public transport planning processes, that systems must be seamlessly co-ordinated, and that systems must be highly developed so that public transport can be a reasonable alternative to the automobile. The Green Paper offers the following checklist for ensuring that public transport meets citizens' needs. This can be seen as a summary of the Commissions' ideal requirements on public transport (although no concrete goals were actually defined).

Quality Checklist for the Citizens' Network	
System Accessibility	Needs of mobility impaired passengers Conception of transport vehicles Design at stops (including intermodal features) Connections to important destinations in the local public transport system Integration of rural and outlying areas
Affordability	• Ticket price • Provision of social service (reduced tariffs)
Personal and Operational Security	• Safety standards • Lighting • Qualification of personnel • Number of personnel available or security systems in place
Travel Comfort	• Trip length • Reliability • Number of trips offered • Cleanliness • Comfort • Passenger information • Integrated tariff system • Flexibility
Environmental Standards	• Noxious emissions • Noise • Infrastructure

Table 34: The Citizen's Network, European Commission Green Paper (1996)

Although the European Commission can do a great deal to increase communication across Europe and to support innovative research, implementing

specific regulations at the local level is not one of the Commission's roles. It is still the responsibility of individual countries to move from policy to concrete realisation of goals.

3.2 National authority requirements

Although public authorities often describe a wide variety of goals which public transport can fulfil, only a subset of these goals is actually directly influenced by the requirements of authorities. Authorities can lend force to their stated requirements by enacting legislation or providing funding only when specific standards are met. We have identified four main areas where authority requirements most directly influence public transport service:

- the establishment of financial constraints,
- requirements regarding the organisation of public transport,
- environmental requirements,
- requirements of people with special needs.

Financial constraints

Because public authorities have an interest in maintaining a public transport network, they allocate funding to cover both infrastructure and operating costs. The way funding is distributed influences the type of service provided. When, for example, extensive funding is available for infrastructure and little for operating costs, then transport operators will be directly persuaded to implement systems which are infrastructure intensive, but require less personnel.

Organisational requirements

In attempting to get optimum utility from the funds provided, authorities sometimes impose regulations on the organisation of public transport designed to increase the efficiency of transport systems. The most important types of „organisational requirements" are requirements regarding the level of competition, the market orientation of the transport service providers and requirements for co-operation among transport providers.

In the future, the influence of the authorities on public transport will be more based

on financial instruments and contracts about public transport services then on the ownership of a transport company. At the same time, the authorities get more important roles in network planning, timetable co-ordination and joint tariff systems and generally co-ordinating the public transport.

Only the Netherlands provide the users of public transport a nation-wide tariff system. Region wide joint tariff system for the most urban or for all transport companies exists in some of the urban regions in the other countries.

Environmental requirements

As long as the external costs of emissions, energy consumption, noise and land use are not part of the enterprise or individual calculation because of missing „ecological taxes“, the ecological advantage of public transport leads to no economical incentive. Environmental guidelines, laws and taxes are today so weak, that they will not affect the modal split significantly.

Only in France and the Netherlands, instruments which may lead to a small modal shift towards public transport do exist. In France, the local authorities are forced to define urban mobility goals and air quality goals. In the Netherlands, the authorities tries to influence the modal split and the environmental effects of traffic through two coherent plans (Structure Scheme for Traffic and Transport, National Environmental Policy Plan Plus).

The vehicles used in public transport normally have to fulfil the same environmental requirements as other vehicles (e.g. EURO II, III).

Requirements of people with special needs

In order to enable people with special needs to use public transport, the stations and vehicles have to allow access without steps. To make stations suitable for blind people, the stations need special information equipment (e.g. information in Braille). The degree of low floor buses and trams and of stations in the underground or at the surface which allow access without steps mark the success of regulation and funding in this field. The consortium members interviewed representatives from different European cities regarding the conditions for people with special needs in their respective public transport systems. This small survey of course does not give an exhaustive overview. It does show, that people with special needs travel under highly different conditions.

Degree of accessibility / information (% of all vehicles / stations)	Madrid	Barcelona	Germany	Hanover (üstra)	Vienna (Wiener Verkehrs-betriebe)	Lisbon
Low floor busses	10,3 %	22,5%	19,9%	44,4%	31,4%	10,9%
Low floor trams	-	-	9,0%	-	0,3% (test)	16,7%
(Tunnel)-station without steps	2,9%	6,3%		26,5%	majority	-
Information for blind passengers	100% of under-ground stations	6,3% of under-ground stations		no	several stations	25% of under-ground stations
Data from	1996	1996	1995	1995	1996	1997

- = no information available or not relevant

Table 35: Degree of accessibility and information supply for people with special needs

The joint consideration of points of view of authorities and users is an important step in the process of definition of transport solutions for the various market segments in each country. The preferences of these two groups are not expressed in identical terms, both in time and in decision power. By virtue of their funding and regulative powers, authorities enable or prevent transport products to enter the market prior to customer decisions.

The analytical process chosen in **MOT*i*F** permits consideration of the point of view of authorities as a filter that limits the field of solutions susceptible of being offered to consumers. This process introduces a necessary element of pragmatism on this study about preferences and provision of transport products to the various market segments.

4 Performance of public transport products

The objective of the analysis of the supply side of the urban public transport market was to evaluate the performance of transport products (second work package). The following results are presented hereafter:

- List of transport products
- Standardised evaluation scheme including relevant aspects of service
- Specification of good practice for different products
- Calculation of performance indicators

4.1 Transport products

4.1.1 Product categories

In all source studies and articles about transport products, the physical aspects of the transport product are the central distinguishing factors. These physical aspects are mainly the vehicle and the infrastructure. Another main distinguishing factor is the legal framework e.g. regulations about public and non-public transport and about licensing.

Indeed these factors are of main importance for the operational and quality features of transport products. Therefore also in the **MOT*i*F** study the same factors were used for distinguishing transport products. Other factors lead to further specifications of the transport products, such as operational aspects.

With respect to technical or operational aspects one can distinguish almost numberless transport products, e.g. on the basis of type and size of the vehicle, type and size of the track, type of the engine, type of energy, etc. These features are only important for the consumer as far as they influence his preference for a transport product.

Therefore these technical and operational aspects were only taken into account in relationship with the consumers' and authorities' requirements that were defined in work package 1. This means that the background and the frame of reference in

making the inventory was restricted to the product features that are relevant for the consumer or for the authorities.

The following product features influence the level of the quality, the costs, the environmental aspects and other performances of the transport products on which the consumers and the authorities base their decisions with regard to the use or the support of the products.

No.	Criteria	No.	Criteria
1	public access / limited access	7	seat guarantee
2	linebound / 'optional' / free	8	need for reservations
3	time scheduled / unscheduled	9	Technical reliability
4	main (backbone) system / feeder system	10	driver / automatically driven
5	density of stops	11	Operation expenses
6	type of infrastructure	12	Investment expenses

Table 36: Criteria for categorising transport products

The criteria 11 and 12 cover mainly the interests of authorities whereas the other criteria are perceived features of transport products from the consumer point of view.

Based on documentation of transport products and systems, 24 different products were specified according to the relevant features we have just referred to. A complete inventory of the products is shown in section 11.2 of the annex.

No.	Transport Product	No.	Transport Product
1	Train	13	Shared taxi (door to door service)
2	Metro	14	Shared taxi (linebound)
3	Light rail	15	Shared taxi (special services)
4	Monorail	16	Coach – Regular services
5	Tram - free track	17	Coach – Special services
6	Tram - partly on free track, partly in the road	18	Group Rapid Public Transport
7	Trolley	19	Personal Rapid Public Transport
8	Guided bus	20	Cable car / Suspension railway
9	Bus - Express lines	21	Ferry
10	Bus - Standard service	22	Water taxi
11	Bus – Citybus	23	Automated Guided Vehicles
12	Bus - On-demand service	24	Air vehicles

Table 37: List of public transport product categories

Most products are certainly well known. Some of the more innovative products that were considered during the research are described and illustrated hereafter:

Monorail

The monorail is comparable with metro and light rail but is constructed above ground, not being impeded by other traffic. The infrastructure consists of one rail. Field applications are in Japan, Germany, USA etc.

Guided bus

Guided bus systems employ an infrastructure consisting of guideways carrying electric, hybrid or diesel buses. The buses also drive on normal streets where necessary. Field applications are in Adelaide (Australia) and Essen (Germany).

Bus - on demand service

Bus services, linebound and according to a timetable, operated only on (telephonic) request of one or more passengers. There are many field applications.

Taxi - shared taxi door to door service

Differently from the regular street taxi, the operator tries to combine more than one individual (group) of passenger(s) in one taxi trip. Many field applications and variations exist.

Group Rapid Public Transport (Group Rapid Transit, GRT)

Group Rapid Public Transport systems are efficient transport products for high volume passenger transport. The vehicles are mostly rubber-wheel-driven, powered by an electric engine. A computer system controls the vehicles, no driver is necessary. GRT systems can be operated scheduled or on demand.

Personal Rapid Public Transport (Personal Rapid Transit, PRT)

Personal Rapid Public Transport systems are advanced shuttle services providing direct non-stop service for passengers between desired stations. They can be compared with a simple elevator, but working horizontally.

Cable car/suspension railway

The best known example for cable cars is the tram like cable cars operating in the hilly city of San Francisco. Modern cable cars operate without drivers guided by a computerised system. They are able to stop on request of individual passengers.

Automated guided vehicle systems (AGVS)

Automated guided vehicles are smaller means of transport using conventional streets. Due to an additional on board electronic system and specific construction details more AGVS can be grouped together and use special lanes or tracks with a smaller distance in between the vehicles. In addition common energy supply is possible on the tracks. On the network of tracks the vehicles are automatically driven. If a vehicle leaves the common track system it has to be self driven and relies on the energy supply on board.

4.2 Evaluation of product performance

Performance indicators measure quantity and quality aspects of the service. No differentiation was made as to the responsibility for service aspects of the operator on the one hand and of the authority related aspects on the other. These questions

have been covered in other EU funded research, namely the QUATTRO and ISOTOPE studies.

Within the second work package of **MOT*i*F** all 24 products were evaluated according to their overall performance, divided into 18 different attributes. These attributes correspond to the 18 requirements of the demand side, thus enabling a cross-comparison of the figures from the demand and supply sides of the transport market in the further course of the work (third work package).

Most features of supply had to be detailed in order to allow for objective quantification of performance. For example: “comfort” is hardly measurable by a single indicator. Rather, one needs to differentiate between comfort of stops and vehicles and even further between availability and quality of weather protection, seats and illumination at stops. For all features that are evaluated with more than one indicator, relative weights were estimated by the consortium members during interactive workshops according to the relative importance. The weighting factors (presented in brackets after each indicator) were estimated on the basis of the partners’ knowledge of the performance of transport products in different countries throughout Europe.

This process is demonstrated for one requirement (accessibility of stops and vehicles) in Table 38 and Table 39.

Description of product aspect **In brackets (..): weighting factor representing relative importance of single aspects**	**Quantification** **10 = very good performance** **1 = very bad performance**
6. Accessibility of stops and vehicles	
a. Area covered by the transport product (0.6) % of the urban area covered by a 400 metre radius circle around each stop	100% = 10 90% = 9 : : < 20% = 1
b. Availability of bike & ride facilities (0.1) % of the stops with good facilities for parking bicycles	> 50 % of stops = 10 40 - 50 % of stops = 9 : : 0 - 5 % of stops = 1
c. Availability of park & ride facilities (0.1) % of the stops with good facilities for parking cars	> 25% of stops = 10 20 - 25% of stops = 9 etc.
d. Access to the stop (0.1) % of the stops with stairless access	90 - 100% of stops = 10 80 - 90% of stops = 9 etc.
e. Access to the vehicle e.g. plane level boarding (0.1)	90 - 100% of vehicles = 10 80 - 90% of vehicles = 9 etc.

Table 38: Set of indicators for product performance calculation

Based on the performance indicators and relative weights the overall accessibility indicator can be calculated (weighted average). This approach was applied on all products. Table 39 summarises the result: indicators regarding the service aspect “accessibility” for all products.

Product aspect: 6. Accessibility of stops and vehicles							
		Performance indicator and weight					
Transport product		0.6 Area covered	0.1 B&R facilities	0.1 P&R facilities	0.1 Stop access	0.1 special needs	Total
1	Train	1.0	10.0	6.0	7.0	8.0	3.7
2	Metro	6.5	3.5	4.0	8.0	6.0	6.1
3	Light rail	4.0	5.0	4.0	3.0	6.0	4.2
4	Monorail	4.0	5.0	4.0	3.0	6.0	4.2
5	Tram partial free track	6.0	2.0	2.0	2.0	1.0	4.3
6	Tram free track	6.0	2.0	2.0	2.0	1.0	4.3
7	Trolley	6.0	1.0	1.0	1.0	3.0	4.2
8	Guided bus	6.0	1.0	1.0	1.0	3.0	4.2
9	Bus express service	4.0	2.0	1.0	1.0	3.0	3.1
10	Bus standard service	7.5	2.0	2.0	1.0	3.0	5.3
11	Bus city	3.0	1.0	1.0	1.0	3.0	2.4
12	Bus on demand	7.5	2.0	1.0	1.0	3.0	5.2
13	Shared taxi door-to-door	n.a.	n.a.	n.a.	10.0	8.0	9.0
14	Shared taxi linebound	n.a.	1.0	1.0	10.0	4.0	4.0
15	Shared taxi special service	n.a.	1.0	1.0	10.0	4.0	4.0
16	Coach regular service	3.0	1.0	1.0	1.0	1.0	2.2
17	Coach special service	n.a.	1.0	6.0	1.0	1.0	2.3
18	People mover	1.0	1.0	1.0	10.0	10.0	2.8
19	Horizontal lift	1.0	1.0	1.0	10.0	10.0	2.8
20	Cable car	1.0	1.0	1.0	7.0	10.0	2.5
21	Ferry	1.0	5.0	10.0	10.0	8.0	3.9
22	Water taxi	2.0	1.0	1.0	1.0	1.0	1.6
23	Automatic guided vehicle	1.0	n.a.	n.a.	10.0	10.0	3.3
24	Air vehicle	1.0	10.0	10.0	10.0	10.0	4.6

Table 39: Calculation of performance indicators (example)

The scales in Table 39 are based on good practices identified by the participating consortium partners for each of the chosen products. After a first iteration and once the values were calculated for each transport product, the results were distributed among the partners in order to calibrate the scales through a comparison with other examples for the same and / or for other products.

Good practice is not necessarily best practice, since it is often impossible to transfer exceptionally good performance (like the area coverage of the Paris metro) to other locations. Furthermore, all target levels cannot simultaneously be realised by the transport product for all passenger and authority requirements. Classical examples of conflicting requirements are punctuality and connection guarantee, travel speed and short ways to stops etc. Therefore it is better to speak about “good practice” instead of targets or benchmarks.

Finally the performance level (good practice) of the transport products (24) with respect to all (18) attributes was thus evaluated. 18 tables with specifications of the performance of the 24 products were produced as a result of this work package. This general approach for the analysis of supply was validated by case study results, a. o. from Madrid.

4.2.1 Case study: Madrid urban buses

Introduction

The urban bus network of Madrid is composed of 178 lines, among which 177 belong to the Integrated Network - in the sense that they belong to the Integrated Tariff System- and one line providing service to the route Airport-City Centre, which has a special tariff.

The network is served by a fleet of 1,835 vehicles. In the last few years, the trend has been towards low-floor and natural gas vehicles. The average vehicle age is 6.4 years.

Demand data and study objectives

A study was carried out in 1993 on 28 main suburban lines by INECO. 3,680 passengers were interviewed on week-days with the objective to study importance factors for different passenger requirements and to allow for market segmentation on the basis of similar satisfaction levels.

Validation of the MOT*i*F approach

The validation of the performance factors derived from the second **MOT*i*F** work package was based on the analysis and comparison of three values:

1. Satisfaction with the bus service in Madrid
   Satisfaction Indexes S.I. derived from the survey undertaken in 1993,
2. Objective performance of the bus service in Madrid
   Madrid Urban Buses Performances Indicators (M.U.B.P.I.) obtained by applying the scales proposed in work package 2 to the real data corresponding to the operator in 1993.
3. Good practice of bus performance in general
   Transport Product Performance Indicators proposed in work package 2 (WP2 P.I.) for "bus standard services".

The comparison of the three indices aimed at

1. **Validation of relationships between delivered and perceived quality** by comparing Madrid urban buses performance indicators (applying the scales produced in work package 2 on the actual bus service) with the satisfaction indices and
2. **Benchmarking**
   by comparing transport product performance indicators for "bus standard services" (good practice results produced in work package 2) with Madrid urban buses performance indicators.

Validation of relationships between delivered and perceived quality

consumer requirements	M.U.B.P.I. (A)	S.I. (B)	Difference A-B
1. Availability, connections	8.68	5.00	3.68
2. Travel Speed	4.00	5.57	-1.57
3. Frequency of departures	8.00	4.88	3.12
4. Comfort at stops	5.4	5.83	- 0.43
5. Comfort in vehicles	5.1	5.48	- 0.38
6. Pre-trip information	6	5.35	0.65
7. Possibilities to obtain tickets	7.59	6.26	1.33

Table 40: Validation of scales

The satisfaction indices of 1993 (B) are hardly comparable with the performance indicators (A) derived from the application of the **MOT*i*F** work package 2 methodology, i.e. the difference in the right-hand column of the table is not equal to zero in most cases. The source of the difference could be inappropriateness of the scales as well as genuine gaps between delivered and perceived quality. As long as the source of the difference remains unknown, the difference provides hardly any inferences as to the correctness of the **MOT*i*F** scales.

Benchmarking:

By comparing the performance measured in **MOT*i*F** standard indicators (A) with the good practice values for buses (C), the following differences resulted:

consumer requirements	M.U.B.P.I. (A)	WP2 P.I. (C)	A-C
Availability, connections	8.68	9.3	-0.62
Travel speed	4	6,5	-2.5
Regularity	9	4	5
Accessibility of vehicles and stops	7.3	5.3	2
Frequency of departures	8	6	2
Comfort of stops	5.4	5.4	0
Comfort of vehicles	5.1	5.1	0
Pre-trip information	6	7	-1
On-trip information	5	4.8	0.2
Price, fare level	8.5	5	3.5
Tariff system	8.58	7	1.58
Cost effectiveness	9	9	0

Table 41: Validation of performance indicators

If the **MOT*i*F** results had been generally valid and the Madrid service level had been on the level of “good practice”, the differences in the table above had been equal to zero. This is three times the case; for one attribute (availability, connections) it is close to zero.

For the other seven attributes the **MOT*i*F** results are refuted, especially by the fact that good practice is exceeded in several aspects. For this reason, the performance indicators should be carefully checked and the corresponding weights of the second work package should be refined.

To this aim, similar analyses like the one in Madrid were carried out on the basis of data from other cities as well. The comparisons and conclusions are summarised in the following sections.

4.2.2 Benchmarking (comparison)

The performance of real public transport products was compared with good practice as defined in work package 2. Checking the reference levels by integrating various product data is the first step. Subsequently, the improved definition of good practice can be used again to evaluate the single products.

The scaling of criteria is open to challenge if:

- scores of actual products are much better than “good practice” as defined in work package 2, except if the product is clearly an exception or if
- application of the developed **MOT*i*F**-scales leads to results that are apparently unrealistic or unfair (e.g. if all products end up performing extremely badly).

The following table summarises the analytical framework used to compare results from different case studies. The focus is on deviations of product performance from good practice as defined in work package 2. Comparability is achieved by transformation of the various numerical results into five broad categories:

<<	Product performance much lower (> 1,5 on 10 point scale) than good practice
<	Product performance somewhat lower (between 0,5 and 1,5) than good practice
o	Product performance equals quality assessment by experts (difference < 0,5)
+	Product performance somewhat higher (between 0,5 and 1,5) than good practice
++	Product performance much higher (> 1,5 on 10 point scale) than good practice

Table 42: Categories used to bring different comparisons between delivered quality and good practice together

If necessary or appropriate, the results are commented briefly. Results that seem

to challenge the performance scales are shaded:

The general conclusion from the tables presented below is, that a useful definition of good practice on a European level is hard to find, if possible at all. Although researchers from several European countries have been involved in the definition of performance scales, considerable deviations still occur.

This problem cannot be solved by a simple adaptation of scales, since positive and negative deviations from good practice (depending on the study) exist simultaneously. Therefore, the only useful and practical implication is to consider very carefully local circumstances when comparing performance levels of transport products.

The considerable differences between the Roissy Bus Service and **MOT*i*F** good practice are partly explained by the fact that this service is running in a special metropolitan area, namely the surroundings of Charles de Gaulle Airport. Therefore performance is bound to deviate from the inner city focused standards. As can be seen, they are sometimes substantially higher, sometimes substantially lower. Most of the differences are comprehensible: e. g. availability is rather low compared to dense public transport networks in cities. On the other hand, punctuality is of course much better than for inner city good practice.

+ good practice surpassed o correspondence < performance less then good practice not assessed or no data	**Madrid Urban Bus**	**Madrid Underground**	**Madrid Sub-urban Rail**	**Madrid Sub-urban Bus**
Availability, connections	<	<	<<	++
Number of transfers		<		<
Travel speed	<< due to con-gestion	<	+	<
Regularity	++ very regular timetable	<<	<<	<
Accessibility of stops and vehicles	++	<	<	++
Frequency of departures	++	<	<<	++
Comfort (vehicles, stops)	o	o	o	+ (veh.) < (stops)
Pre-trip information	<	o	o	<<
On-trip information	o	o	o	<
Price, fare level	++ Low costs of living and cost coverage degree	++ Low costs of living and cost coverage degree	++ Low costs of living and cost coverage degree	
Tariff system	++	+	<<	o
Possibilities for obtaining tickets	+	<	<	o

Table 43: Comparison of product performance with good practice (1)

+ good practice surpassed o correpondence < performance less then good practice not assessed or no data	**Lisbon Bus**	**Roissy Bus Service**	**Metrolink**
Availability, connections	+	<<	<< due to low coverage
Number of transfers		<	+
Punctuality, reliability		++	o
Travel speed	<<	<<	+
Regularity	+	o	++ very regular timetable
Accessibility of stops and vehicles	++	<<	o
Frequency of departures	o	<	+
Security (vehicles, stops)		++	
Comfort (vehicles, stops)	o	o	
Pre-trip information	o	<	o
On-trip information	o	++	+
Customer orientation		+	
Price, fare level	++ (local circumstance)	<<	<< Fares exceed “normal” level
Tariff system	<	o	<
Possibilities for obtaining tickets	o	++	<
Safety		<	
Social prestige		+	++ Author suspects relation with high price level
Environmental friendliness		+	<< Low score, “only” 10% former car users

Table 44: Comparison of product performance with good practice (2)

4.2.3 Relationship between delivered quality and perceived quality

The performance scales defined during the supply analysis (second work package) reflect expert opinions about what "good", "medium" and "bad" performance means. The following results from the case studies give an impression if users share these experts' ideas. One of the very few possibilities to verify the relationship between delivered and perceived quality directly existed in Madrid. For eleven Madrid operators, the relationship between performance and user satisfaction regarding regularity and frequency was investigated in detail (see case study description in work package 4 for details). Since the study was performed at only one location by one research institute, methodological and site-specific biases will have been small. The following table compares delivered and perceived quality:

Operator		Frequency	Performance	Satisfaction
ARGABUS	Peak	5-10 min.	5.5	5.5
	Off -peak	15-20 min.		
AUTOPERIFERIA	Peak	30 min.	2	5.85
	Off -peak	30 min.		
CONTINENTAL	Peak	10 min.	5.5	4.31
	Off -peak	15 min.		
LLORENTE	Peak	5-10 min.	5.5	6.29
	Off -peak	20 min.		
MARTIN	Peak	10-15 min.	5	6.1
	Off -peak	17-18 min.		
T. CERCANIAS	Peak	5-10 min.	7	5.56
	Off -peak	5-10 min.		
TRAPSA	Peak	10-15 min.	5	5.75
	Off -peak	24 min.		
URBANOS DEL SUR	Peak	10 min.	6.5	5.33
	Off -peak	15 min.		

Table 45: Delivered and perceived quality: Example "frequency of departures"

Clearly, the correlation is rather weak.

MOT*i*F verified the relation between delivered and perceived quality further on a much broader (but also less homogeneous) basis. Since the comparison of standardised delivered quality levels with subjective satisfaction indices is not at all unproblematic from a methodological point of view, the results will again only be interpreted on a general level. This is done by transformation of the various numerical results into five broad categories:

<<	user satisfaction much lower (> 1,5 on 10 point scale) than expert quality assessment
<	user satisfaction somewhat lower (between 0,5 and 1,5) than expert quality assessment
o	user satisfaction equals quality assessment by experts (difference < 0,5)
+	user satisfaction somewhat higher (between 0,5 and 1,5) than expert quality assessment
++	user satisfaction much higher (> 1,5 on 10 point scale) than expert quality assessment

Table 46: Categories used for the survey of delivered quality and perceived quality relationships

+ users overvalue performance o correspondence < evaluation below performance not assessed or no data	**Madrid Urban Bus**	**Madrid Under ground**	**Madrid Sub-urban Rail**	**Madrid Sub-urban Bus**	**Dordrecht Express Bus**	**Dordrecht City & Service Bus**
Availability, connections	<<		o (oper. hours)	<<		
Number of transfers			+ (transfer time)	++		
Travel speed	++	+		o	<	++
Regularity				o		

+ users overvalue performance o correspondence < evaluation below performance not assessed or no data	**Madrid Urban Bus**	**Madrid Under ground**	**Madrid Sub-urban Rail**	**Madrid Sub-urban Bus**	**Dordrecht Express Bus**	**Dordrecht City & Service Bus**
Accessibility of stops and vehicles		++	<< (P+R) ++ (stops) << (veh.)	++		
Frequency of departures	<<	o		<	+	
Comfort (vehicles, stops)	o	++ (only veh.)	< (stops) + (veh.)		o	+
Pre-trip information	<		<	<		
On-trip information		++	o		+	
Price, fare level			<<		<<	
Tariff system			o			
Possibilities for obtaining tickets	<	++		+		

Table 47: Comparison of product performance with user satisfaction

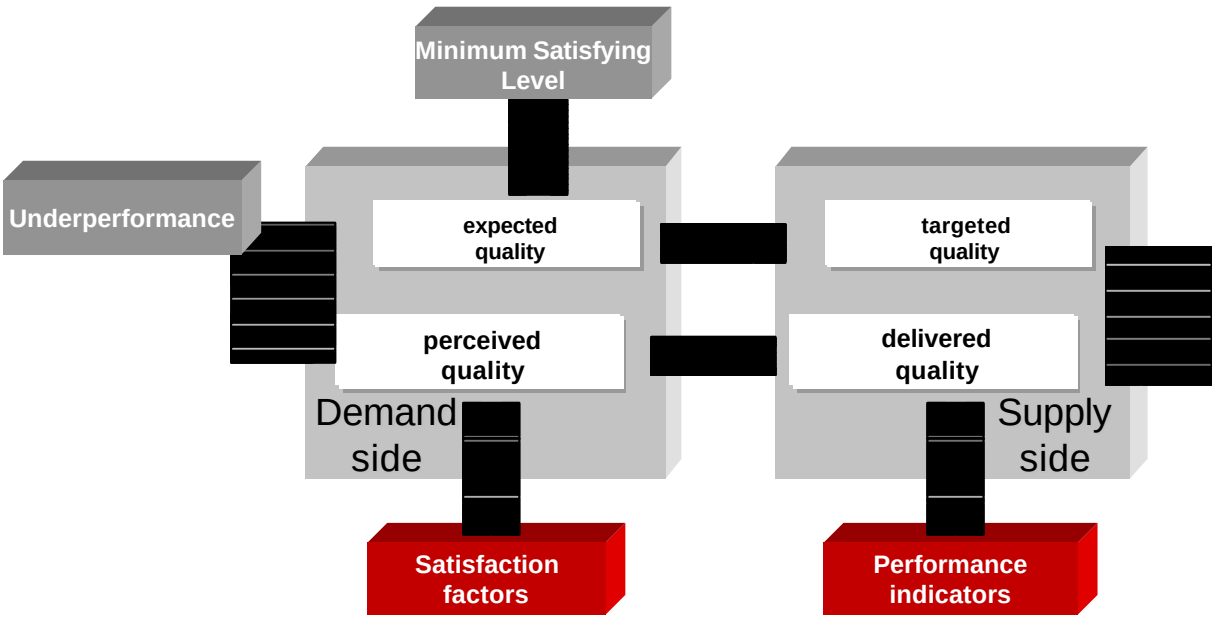


Figure 12: Satisfaction or performance factors?

The results in Table 47 show a rather weak correlation between delivered and perceived quality as well. Of course, some differences between figures might have been influenced by differences in survey methods and geographical regions. These disturbances were absent in the case study of Madrid Suburban Buses, still identical conclusions could be drawn, as shown before. Therefore, the general conclusion that perceived quality seems to be dependent on more factors besides delivered quality, is enforced further.

This raises the question, how (with which indicator) performance should be measured. Focusing on satisfaction indices for measuring performance would put the user in the foreground. Despite the lack of objectivity, this might be a good strategy since satisfaction indices are decisive in terms of travel intention and behaviour. Performance indicators can sometimes replace perceived quality, especially if the target is related with customer satisfaction (calibration of objective targets against user expectations). Of course, possible biases and “blind spots” related with the use of the methods for measuring perceived and delivered quality have to be considered.

5 Evaluation of public transport products from the user perspective

The core objective of the **MOT*i*F** research project was to establish a cross-comparison between the demand and the supply side of the urban public transport. This cross-comparison should lead to conclusions regarding the best products for different market segments.

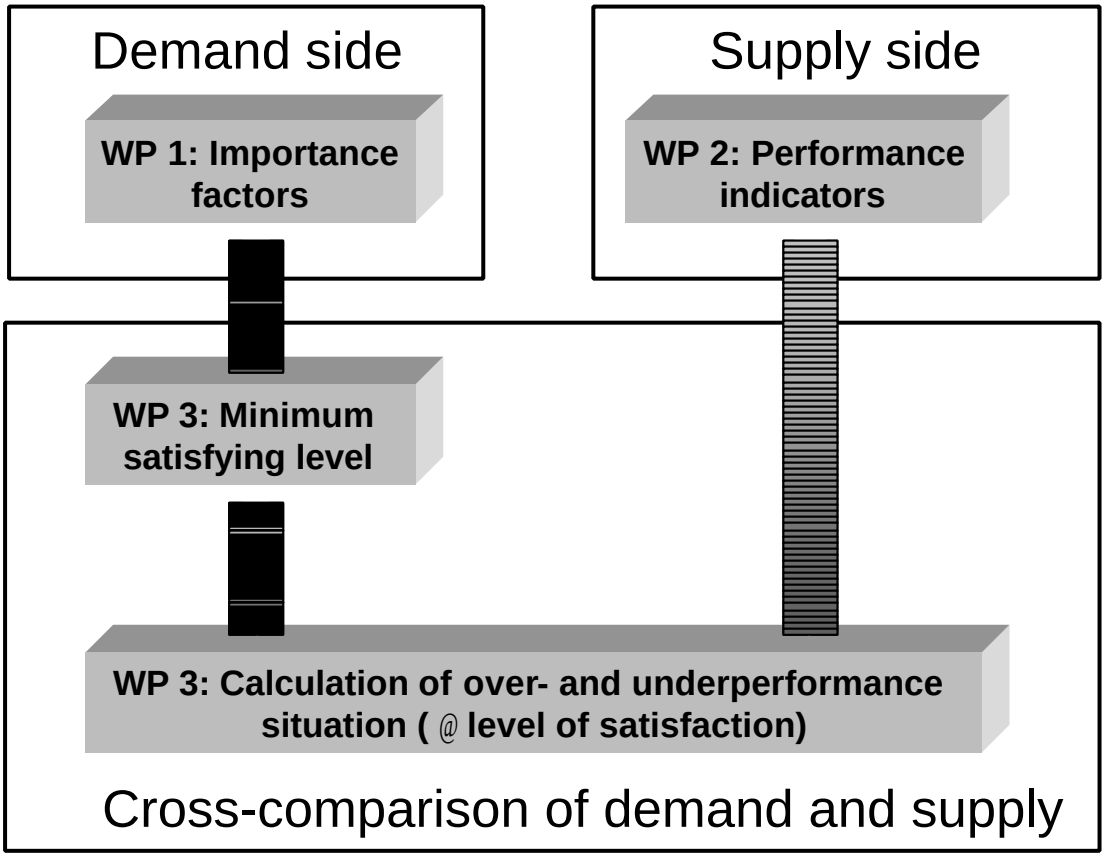


Figure 13: Work package 3 methodology scheme

The consortium set out to reach the following intermediary objectives:

- identifying in how far each different market segment's specific requirements are fulfilled by the transport products,
- setting up an overall ranking of the transport products in the analysis according

to their ability to satisfy the different requirements for each market segment and

- finding product combinations that mutually compensate each others weaknesses In case of serious deficiencies of single products.

To perform the cross-comparison between the demand and supply of the urban public transport market an approach derived from the general marketing theory was adopted: benefit segmentation of the market.

The benefit segmentation approach assumes that the main reason that leads a person to consume a product is the range of benefits he expects to obtain by doing so. These benefits correspond to the product features for which the performance meets or exceeds the individual needs (or expectations).

Following this basic principle (maximisation of benefits), the **MOT*i*F**-consortium chose an inverse approach. This means that a consumer will choose the product with the fewest deficiencies. The inverse benefit segmentation approach has already been used in several other transport market segmentation studies (e.g. Buspower 2000 and TCRP Report 36).

Deficiencies can sometimes be compensated by a quality surplus in other areas - but certainly not always ("limited compensatory rule"). This corresponds with daily experience of transport planners and operators who know that e. g. area coverage and fast "backbone" products can complement each other to a certain extent; but features such as speed and comfort will not increase public transport usage as long as security cannot be guaranteed.

The method used for cross-comparing demand and supply identifies the main weak points of the 24 transport products defined in the supply analysis (work package 2) against the 13 market segments' requirements studied in the analysis of demand (work package 1).

Determining the gap between demand and supply

In order to enable a better understanding of the **MOT*i*F** methodology of cross-comparison a simplified example is presented with three products, characterised by ten attributes and used by consumers from three imaginary market segments:

3 products:

P1 - train

P2 - metro

P3 - light rail

10 attributes:

A1 - punctuality/reliability

A2 - travel speed

A3 - regularity

A4 - accessibility

A5 - frequency of departures

A6 - comfort of stops

A7 - comfort of vehicles

A8 - price/fare

A9 - tariff system

A10 - possibility to obtain tickets

3 well differentiated market segments:

MS1 - price orientated

MS2 - time orientated

MS3 - comfort orientated

A scale from 1 to 10 is used to measure the performance levels as well as the importance values.

Table 48 shows the performance levels for each product. These performance levels were taken directly from work package 2 values.

	ATTRIBUTES	Train	Metro	Light rail
1	Punctuality/ reliability	9,0	9,0	8,5
2	Travel speed	10,0	9,0	8,0

3	Regularity	8,0	6,0	6,0
4	Accessibility	3,7	6,1	4,2
5	Frequency of departures	6,5	9,0	8,0
6	Comfort of stops	7,9	8,1	6,1
7	Comfort of vehicles	7,3	5,7	5,2
8	Price/fare	5,2	5,0	5,0
9	Tariff system	8,0	7,1	7,7
10	Possibility to obtain tickets	5,0	6,0	5,3

Table 48: Performance levels of the three products

Table 49 shows the importance values (≅ generic expectations) given in each market segment to each attribute. The three different market orientations (price, time, comfort) can easily be identified. The right hand side of this table shows the corresponding relative importance indices.

	ATTRIBUTES	Importance Factors			Relative Importance Indices		
		MS 1	MS 2	MS 3	MS 1	MS 2	MS 3
1	Punctuality/ reliability	6,8	9,8	6,7	8,8%	11,9%	8,9%
2	Travel speed	6,4	9,9	6,1	8,2%	12,0%	8,1%
3	Regularity	6,3	9,8	6,5	8,1%	11,9%	8,7%
4	Accessibility	6,3	9,7	6,8	8,1%	11,8%	9,1%
5	Frequency of departures	6,4	9,7	7,1	8,2%	11,8%	9,5%
6	Comfort of stops	8,0	7,6	9,9	10,3%	9,2%	13,2%
7	Comfort of vehicles	8,1	7,2	9,9	10,4%	8,7%	13,2%
8	Price/fare	9,9	6,4	6,5	12,7%	7,8%	8,7%
9	Tariff system	9,8	6,2	6,2	12,6%	7,5%	8,3%
10	Possibility to obtain tickets	9,7	6,2	9,3	12,5%	7,5%	12,4%

Table 49: Importance factors (@ generic expectations) and their relative importance indices for the 3 market segments

The method of benefit segmentation requires the calculation of the minimum satisfying level of each attribute for each market segment. Minimum satisfying levels are needed to determine if underperformance reduces the attractiveness of

the product, and especially which performance attributes lead to user dissatisfaction.

No specific surveys to measure the minimum satisfying levels were carried out. Therefore the minimum satisfying levels were obtained through indirect information, namely from the ”generic expectation“. The two variables are not identical, but common sense and marketing literature[4] point in the same direction: they are positively related. A higher generic expectation will imply a higher value of the minimum satisfying level.

This positive correlation can easily be identified in the following figure in which three alternatives for modelling the relationship are shown (details about the Constant Difference, Constant Ratio and Exponential model are presented in section 11.3 of the annex):

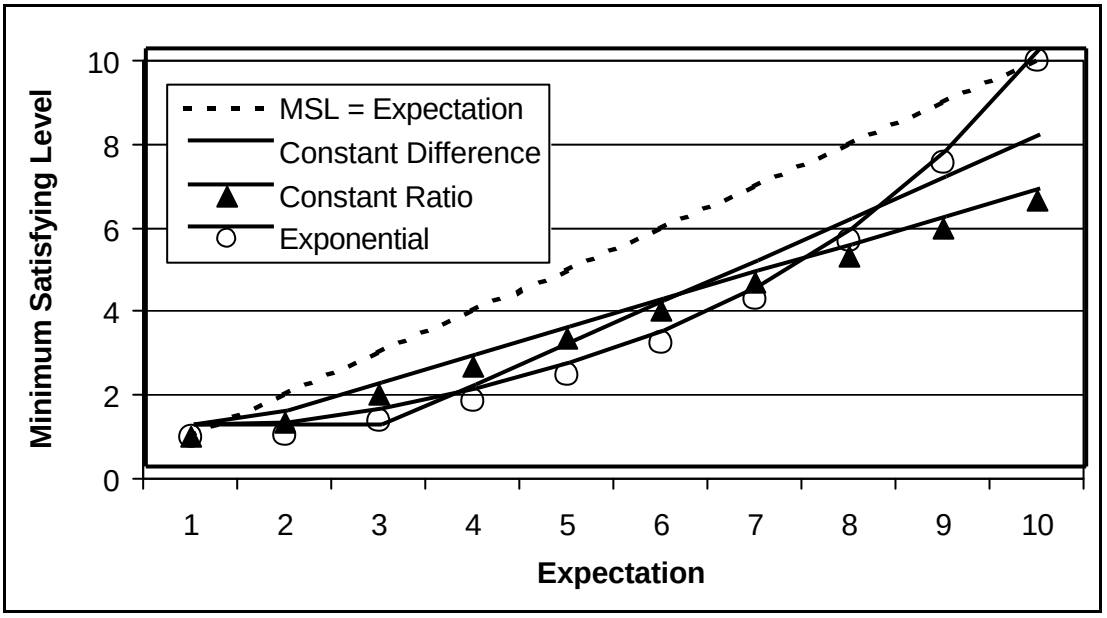


Figure 14: Alternative models for estimation of minimum satisfying levels

The Constant Difference Model is the most straightforward alternative. The idea is,

[4] Schiffman, L. & Kanuk, L.(1987), Consumer Behavior, Prentice-Hall

Howard, J. (1989), Consumer Behavior in Marketing Strategy, Prentice-Hall

that the customer is prepared to tolerate a fixed deviation of the service quality from what he is expecting. The customer perceives underperformance if the performance falls below this level.

This model was applied for the calculation of the minimum satisfying level for each attribute and market segment:

Step 1: Calculation of the Minimum Satisfaction Level

Applying the Constant Difference Model to the importance values in Table 49 yields the following minimum satisfying levels:

	ATTRIBUTES	MS 1	MS 2	MS 3
1	Punctuality/ reliability	4,75	7,75	4,65
2	Travel speed	4,35	7,85	4,05
3	Regularity	4,25	7,75	4,45
4	Accessibility	4,25	7,65	4,75
5	Frequency of departures	4,35	7,65	5,05
6	Comfort of stops	5,95	5,55	7,85
7	Comfort of vehicles	6,05	5,15	7,85
8	Price/fare	7,85	4,35	4,45
9	Tariff system	7,75	4,15	4,15
10	Possibility to obtain tickets	7,65	4,15	7,25

Table 50: Minimum satisfying levels (Constant Difference Model)

Step 2 - Calculation of the underperformance Values

An underperformance situation occurs when the performance level of an attribute is lower than the correspondent Minimum Satisfaction Level. The basic principle can best be understood from the figure below:

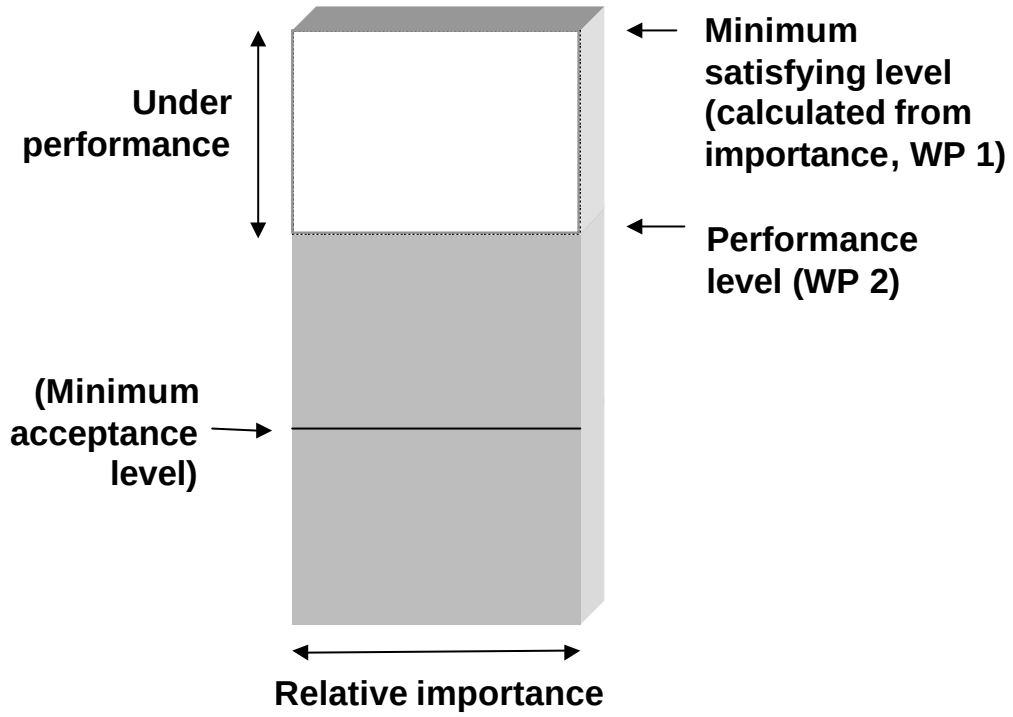


Figure 15: Calculation of underperformance

The total underperformance of each product for each market segment is calculated from the underperformance values per attribute. They are weighted by the relative importance of the attributes (right-hand side of Table 49):

	ATTRIBUTES	MARKET SEGMENT 1			MARKET SEGMENT 2			MARKET SEGMENT 3		
		Train	Metro	Light rail	Train	Metro	Light rail	Train	Metro	Light rail
1	Punctuality/ reliability									
2	Travel speed									
3	Regularity					-1,75	-1,75			
4	Accessibility	-0,55		-0,05	-3,95	-1,55	-3,45	-1,05		-0,55
5	Frequency of departures				-1,15					

	ATTRIBUTES	MARKET SEGMENT 1			MARKET SEGMENT 2			MARKET SEGMENT 3		
		Train	Metro	Light rail	Train	Metro	Light rail	Train	Metro	Light rail
6	Comfort of stops									-1,75
7	Comfort of vehicles		-0,35	-0,85				-0,55	-2,15	-2,65
8	Price/fare	-2,65	-2,85	-2,85						
9	Tariff system		-0,65	-0,05						
10	Possibility to obtain tickets	-2,65	-1,65	-2,35				-2,25	-1,25	-1,95

Table 51: underperformance calculation

Step 3 - Ranking the products

The underperformance values for all attributes does not automatically infer any conclusion as to the best transport product. Some rule is needed to deduct a choice from the figures, especially if the situation becomes more complex. Two common decision rules are presented:

Lexicographic Ranking

The (purely noncompensatory) lexicographic ranking is obtained as follows:

In market segment 1, the most important attribute is “price/fare”, and the train has the smallest underperformance, so it gets rank 1. Since the two other products are equal in this attribute, the next important attribute “tariff system” is decisive. Here, light rail has a smaller underperformance than the metro, so it gets rank 2. Metro then gets rank 3.

The proceeding for the second and third market segments is identical.

Limited Compensatory Ranking

The Limited Compensatory Ranking takes not only the lowest underperformance, but also the sum of the underperformances times their relative weights (s. Table 49) into account.

	ATTRIBUTES	MARKET SEGMENT 1			MARKET SEGMENT 2			MARKET SEGMENT 3		
		Train	Metro	Light rail	Train	Metro	Light rail	Train	Metro	Light rail
	Lexicographic Rank	*1*	*3*	*2*	*1*	*2*	*3*	*1*	*2*	*3*
	Weighted underperformance (WUP)	*-0,71*	*-0,69*	*-0,75*	*-0,60*	*-0,39*	*-0,61*	*-0,45*	*-0,44*	*-0,87*
	Limited Compen-satory Rank	*2*	*1*	*3*	*2*	*1*	*3*	*2*	*1*	*3*

Table 52: Two different product rankings based on underperformance

The following two case studies from Lisbon (Portugal) and Münster (Germany) validate the concept of the minimum satisfying level. They also investigate the relationship between underperformance and improvement proposals of consumers.

5.1.1 Case study Lisbon (Portugal)

Base data

The Lisbon bus network, operated by Carris, has a total length of 595 km, from which 41,1 are dedicated bus lanes (6,9%). The network reaches a coverage rate of approximately 7 km /km2. The company has a fleet of 779 vehicles from which 30 are mini buses, 40 medium buses, 61 articulated buses and 648 standard buses.

Demand data

Included in the new company approach to the public transport concept, the bus service provider carried out a “client profile” study in 1996. The objective of the study was to characterise the clients, evaluate their opinion on some quality and service features, to investigate ways of improving the service and assess what the strong and weak points of the bus service are as compared to other modes.

The relationship between underperformance of the Carris buses (calculated with

the methodology developed in work package 3) and the situations in which bus users of different market segment were dissatisfied is shown in the table below. Results that are shaded or inverted correspond to higher degrees of underperformance. The results were made comparable by adaptation of the scales:

MOTiF		Under performance (WP3)							Under performance (from survey)						
Market segments		1	3	5	7	8	9	11	1	3	5	7	8	9	11
1	Availability														0
2	Change Frequency	-1,4	-1,5	-1,4	-1,4	**-1,8**	-0,1	**-1,8**	**-0,6**	**-0,7**	**-0,8**	**-0,6**	-0,2	-0,5	**-1**
4	Travel speed	**-3,9**	**-3,8**	**-3,9**	**-3,6**	**-4,8**	**-2,5**	**-3,6**	-0,1	-0,1	-0,2	0			-0,2
6	Accessibility	-0,1				-0,6		-0,1							
7	Frequency of departures	**-2,3**	**-2,1**	**-2,3**	**-2,1**	**-2,3**	-1,1	**-2,4**	**-1,1**	**-1,3**	**-1,2**	**-1,3**	**-1,1**	-0,5	**-1,3**
8	Security	**-1,9**	**-1,8**	**-2**	**-1,8**	**-1,8**	-1	**-1,8**	-0,2	0	-0,4	-0,2		-0,2	-0,2
9.1	Comfort of stops	**-2,6**	**-2,4**	**-2,6**	**-2,3**	**-1,9**	**-1,9**	**-2,7**	**-0,6**	-0,5	**-0,6**	-0,4	-0,1	-0,5	**-1**
9.2	Comfort of vehicles	**-2,2**	**-2**	**-2,1**	**-1,9**	**-2,2**	-1,2	**-2,2**	-0,4	-0,2	-0,4	-0,1		-0,1	-0,4
11	On-trip information	**-2**	**-2,1**	**-2,1**	**-2**	-1,2	-1,2	**-2,2**							-0,1
13	Price/fare								-0,2		-0,3	-0,1			-0,2
15	Possibility to obtain tickets	0													
16	Safety	-0,2	-0,2	-0,2	-0,2	-0,3					0				

,

Table 53: Cross-comparison of MOTiF versus Survey results

Clearly the theory is incorrect in its prediction of serious underperformance regarding travel speed and on-trip information. In general, the theory predicts more and also more serious shortcomings than justified on the basis of user surveys (of course apparent “misfits” might just as well result from really existent differences between delivered and perceived quality). The exception is frequency: for this aspect, the prediction is slightly too optimistic.

The small degree of underperformance for market segment 9 is adequately anticipated by the theory. Also correct is the prediction what product features are satisfying at all, as can be seen from the high number of corresponding blank and filled lines between the left and right hand sides of the table, respectively.

5.1.2 Case study Münster (Germany)

Base data

Product type:	Express bus (maximum speed: 100 km/h)
Specifics:	4 radial lines serving the city of Münster, Germany with 270,000 inhabitants

Demand data

The demand data resulted of a postal interview with regular users and on-vehicle inquiries to assess choice riders' opinions in 1996. The surveys should help to analyse the success of quality improvements on existing "SchnellBus-lines" as well as on two new lines. Success, in this case, was defined as a research on the impact on ridership (quantity) and on the customer satisfaction (quality).

Validation of MOT*i*F methodologies

Within **MOT*i*F** it is assumed that underperformance situations occur when actual performance falls markedly below the expected performance level. The calculation process depends on the assumption, that the expected performance level is dependant on the importance.

This assumption can be verified by interpreting the **proposals for improvement** as underperformance situations. The following improvement options were proposed to the SchnellBus customers:

- More departures (working days)
- More departures (evening)
- More departures (Saturday)
- More departures (Sunday)
- Reduction of travel time
- Improvement of time table information
- Improvement of stop provisions
- Improvement of vehicle comfort
- Raising environmental standards of the vehicles

- Bus acceleration programmes (e.g. Bus lanes)
- Higher quality personnel service

The „top five“ options mentioned by the subscribers were, by order of frequency: 2. more departures (evening), 10. bus acceleration programmes (e.g. bus lanes), 4. more departures (Sunday), 3. more departures (Saturday) and 5. reduction of travel time.

Comparing these results with the general quality evaluation by the users (not differentiated for user groups) yielded the following results:

The request for more Saturday and Sunday departures corresponds very well with the quality evaluation. While the working day supply was evaluated as very good (rank 5 out of 30), Saturday and Sunday supply ranked only on 26th and 30th place, respectively. The proposal that was mentioned most often (expansion of evening supply) does not correspond to any of the quality features in the evaluation (the list of quality features evaluated in the first part did not contain evening supply, since the service only runs until 20:00). Expanding evening supply does fit in the general formulation, to increase the number of off-peak departures.

The general assumption that the improvement proposals of passengers can be used as a synonym for underperformance situations of products is validated on the basis of this case study. Conclusions as to the validity under other circumstances and at different locations would require additional cross-checks.

5.1.3 Intermediate conclusions from Lisbon, Roissy and other case study results

The overall impression from the Lisbon and Roissy case studies is, that the approach of underperformance calculation generally leads to appropriate results, although deviations on detailed level do exist.

Support also comes from the Dordrecht case study: Satisfaction surveys carried out in this medium sized Dutch city indicate that the basic approach (calculating performance deficiencies) seems to have been correct. The calculation of minimum satisfying levels in work package 3 was too severe, though. The relation

between importance and minimum satisfying levels is not as strong as assumed. Underperformances calculated according to the theory correspond well with low report marks from the user survey.

In short: the theory developed in work package 3 correctly predicts the product features with insufficient quality, but exaggerates the level of underperformance.

The theory might be changed in such a way as to produce less underperformance, since Lisbon and also Dordrecht results indicate that underperformance calculation rules are too strict.

The Madrid cases presented in the report on work package 4 clearly underline an assumption made in the third work package: standardised product performance scales vary much more than user satisfaction and importance of product features attributed by users (requirements). To ensure a useful comparison, the scales on which performance levels and satisfaction levels are scored should be appropriate. The problem is of course the definition of appropriateness. Should performance levels vary less, just as much or more than satisfaction levels? It would be hard to find a solid criterion to answer this question.

Instead of trying to find a scientifically indisputable answer to this question, the **MOT*i*F**-Consortium states its impression that expert opinion tends to amplify variations in performance. In other words: experts probably observe differences in performance more than customers. Nevertheless, it would be incorrect to conclude that customers do not observe quality differences at all. Several examples have underlined the success of improvement or extension of supply in terms of e.g. increased ridership or attraction of non-captive passengers.

Rather, profound research on the relationship between delivered and perceived quality levels and on the relationship between perceived quality and mobility behaviour is necessary. This kind of research could help finding conclusions regarding the range in which variations of performance are relevant from the point of view of users, transport operators and politicians.

6 Conclusions

MOT*i*F based its findings mainly on the analysis and results of former and current research work throughout Europe. This approach incorporated one of the most challenging requirements: deriving general conclusions from heterogeneous data sources. The chosen approach is twofold: to present detailed single results of the studies and to compare on a much more aggregated level.

Due to the available source studies, the focus of **MOT*i*F** was on the requirements that are researched most frequently and on the requirements of present users, as they are the most surveyed target group. Of course, this approach confines the validity of the conclusions somewhat. This should be no problem, as long as decision makers in the transport sector are **aware of the bias** when interpreting the conclusions. The negligence of the point of view of choice riders might lead to underestimation of information and communication needs as well as of other aspects that are especially important for less frequent users.

The delivered qualities of transport supply, such as punctuality, journey speed, comfort etc. influence the attractiveness of public transport compared to other modes. Still, these features are not the only factors that are important. **Habits**, **image** (prestige) of transport products, **cultural background** and **education** also play an important role. The question to be answered by future research will therefore be, to what extent decision makers within the public transport sector will be able to positively influence the image / prestige of public transport and the mobility habits of (potential) passengers with different cultural backgrounds.
Besides these more general conclusions which are the basis for the recommendations in the next chapter, specific conclusions could be drawn from the results of each of the work packages:

6.1 Conclusions derived from the analysis of demand

The objectives of the demand analysis within **MOT*i*F** could partially be reached:

- A categorised **set of passenger requirements** on public transport based on an extensive survey of European public transport studies was developed. This set of categories of passenger requirements can be used as a general framework for unification of the results from local surveys. By matching the requirement definitions from the case study with the general **MOT*i*F** requirements, comparison with the results from other case studies became possible. European tendencies regarding passenger requirements could be developed on a rather general level.

- This kind of general analysis should be seen as the starting point for further research. The results are not representative due to their **heterogeneity in terms of objectives, methodologies, researched target groups etc.** In field work, the local specifics should determine the selection of an appropriate categorisation of requirements that enables detailed analysis of passenger demand.

- Though every study delivers another importance ranking, some **general trends** can be observed. The importance of travel speed, according to popular opinion decisive for modal choice, seems to be exaggerated. Availability, connections, punctuality and frequency are just as or even more important. The influence of car ownership on passenger requirements has proven to be less than expected.

- In many studies frequent travellers were asked to rank, evaluate or mention most and least important requirements. Not only **potential passengers** e.g. with a higher need for information and without subscriptions are neglected through this process but also frequent travellers who may take a rarely used route. Other strategies for assessment of qualities and importances of 'soft' criteria such as security, information, comfort etc. should then be considered.

- The survey design (inquiry method and technique, sample composition, themes) must be chosen carefully depending on the **objectives**. I. e. an inappropriate selection of the methodology could lead to doubtful results. General quality monitorings or task-specific surveys e.g. on security require different

approaches. Gathering all information about the requirements of all passengers is not possible for reasons of feasibility. A conscious **trade-off** between the number of aspects, level of detail, specification of the market segmentation and more or less sophisticated techniques is necessary.

- The seemingly low importance of pre-trip information and accessibility illustrate, that **market segmentation is a prerequisite for meaningful conclusions**. If relevant discriminative user and journey characteristics are neglected by the researcher, crucial information disappears in the mean values.

- In some studies, all requirements unveil nearly the same level of importance or degree of satisfaction from the passenger's point of view. Since not all studies come to this result, **methodical or systematic weaknesses** might well be the cause (e. g. if "requirement inflation", i. e. assignment of high importance to all aspects of service, is not anticipated). The responsible planner within the transport company or at the authority cannot prioritise decisions on infrastructure, operational or marketing investments on this basis.

- Taking the (potential) customer serious does not mean taking all of his answers for granted. The importance of information according to customer survey results can be very low whilst at the same time factual information deficits prevent public transport use. The example of Roissy demonstrated such an interesting **paradox** regarding the **importance of information** according to car drivers. Serious underestimation of the importance of this aspect would have occurred if figures had been taken for granted without sufficient reflection.

- **Socio-economic and trip-related criteria** influencing the levels of importance of the above mentioned requirements were analysed. This activity was based on the same heterogeneous samples, methodologies and specific local contexts. Therefore the conclusions are restricted to tendencies as to the influence of socio-economic and trip-related criteria on passenger requirements.

- Nevertheless, some assumptions were validated also on a **general level**. Examples of this are the high importance of frequency and punctuality, the fact that senior and male customers give higher notes in satisfaction surveys, the high importance attributed by seniors to accessibility and the increased importance of accessibility, pre-trip information and possibilities to obtain tickets for recreational and social trips.

- Complex **interrelations** between the parameters that influence passenger requirements make the analyses rather difficult. The influence of gender is sometimes considered as a distinguishing parameter (e. g. case studies from Rotterdam and Madrid). Other authors think that the differences between the level of requirements of women and men must be interpreted in terms of mediating variables.

- The **magnitude** of differences in importance factors is not very large: Importance factors typically vary only between 3 % to 6 % depending on socio-economic and journey characteristics.

- A general conclusion resulting from the validation of **MOT*i*F** work package 1 is, that the general weighting matrix as well as other assumptions must be **verified on a local level**. Evidence suggests that regional differences (e.g. size and structure of the urban region, transport system and also differences between the countries and regions etc.) influence passenger requirements.

- Only in few cases, empirical results were totally conflicting with the **assumptions in the weighting matrix**.

- The literature survey showed that market segmentations are carried out in numerous different ways. Discriminative factors are e. g. socio-economic parameters, number of public transport trips, trip characteristics, quality of individual public transport connection and also concepts that are rooted in psychology and sociology like fundamental principles and attitudes of passengers.

  Since classical and straightforward socio-economic classifications seem to produce fuzzy market segments with highly similar requirements, it might be useful to **consider other approaches** as well, despite their higher level of abstraction and complexity.

6.2 Conclusions derived from the analysis of supply

The main objectives of the analysis of the supply side were firstly to define transport products and product groups and secondly to assess their specific performance by means of standardised indicators. The research concluded with

the following results:

- A set of eighteen **product features** was defined in analogy with the findings of the demand side. Thus it was guaranteed, that the data could serve as an input for the cross-comparison of demand and supply. Each of these product features is determined by one or more **performance indicator**(s).
- In order to evaluate the performances of each product, **reference levels** were introduced. These "quasi-benchmarks" are based on good practice of current operation in Europe. If data were not available, e.g. for products under development, the missing figures were assessed through expert knowledge.
- In analogy with the QUATTRO research, **MOT*i*F** distinguished between delivered quality as described by objective performance indicators and perceived quality as described by the subjective level of satisfaction of the passengers. The latter is influential regarding modal choice and consequently also regarding patronage of public transport.
- The general conclusion from the validation of the results of the second work package of **MOT*i*F** should be, that a useful **definition of good practice** operation on a European level is hard to find, if possible at all.
- The performance indicators as well as the reference levels could not be fully validated by the case studies researched. The source of observed differences could be inappropriateness of the scales as well as genuine gaps between delivered and perceived quality. As long as the source of the difference remains unknown, the difference provides hardly any inferences as to the correctness of the **MOT*i*F** scales.
- In principle, **performance indicators can be used to substitute satisfaction** indices. This option is especially interesting if performance can be measured by using available data from Vehicle Location Systems, etc. Calibration towards customer requirements of all physically measurable performances (punctuality, reliability, connections) is then recommended, although evidence suggests a rather weak correlation between delivered and perceived quality.

6.3 Conclusions derived from the cross-comparison of demand and supply

- A **Benefit Segmentation Model** was developed and applied in **MOT*i*F.** The main advantage of this model is that deficiencies of products can be identified in a simple and comprehensive way, indicating those features that should be improved.
- The theoretical foundation of the Benefit Segmentation Model as applied in **MOT*i*F,** namely the calculation of performance deficiencies, was validated through case studies across Europe. The model correctly predicts the product features with insufficient quality, but exaggerates the level of underperformance.
- In the large majority of cases, transport products perform more or less under the users' expectations, sometimes in several aspects. The possibility to develop **multi-product solutions,** combining products with mutually compensating weaknesses is a promising solution for this problem.

  Common sense is needed for the realisation of sensible "product packages", since the **possibilities of compensating weaknesses are often limited**: People with restricted mobility who are not able to climb stairs in order to get on or off a vehicle, will not use any public transport at all if just one product inside the journey chain does not allow an easy boarding. This example is quite obvious, but the same statement holds also for other requirements such as journey time, security, comfort etc. The planner must assess if usage will depend on the weakest link of the journey chain or if compensation between products is possible.
- Evidence suggests that **expert opinion tends to amplify variations in performance**. In other words: experts probably observe differences in performance more than customers.

7 Recommendations and further research needs

7.1 Recommendations based on research findings

The main findings of the research work throughout **MOT*i*F** and the conclusions derived before result in the following recommendations:

- If a detailed market segmentation covering consumer preferences and choices has to be developed, a survey of the influences of socio-economic and journey features on a **local basis** should be carried out. The **MOT*i*F** weighting matrix, after improvement in accordance with the conclusions of the case studies (work package 4), can be used as a first approximation for market segmentation purposes. Passenger requirements in any real context will differ depending on the location specific size and structure of the urban region, transport system, cultural differences between the countries and regions as well as actual problem perceptions.
- Market segmentations based on car availability, journey purpose, etc. often do **not** yield very **discriminative results**. Yet refraining from developing new or improved market orientated services would probably not be the best strategy for public transport companies. Case studies clearly indicate that targeted improvements at the supply side do have effect in terms of ridership and choice rider share.
- Depending on the objectives, other fundamentally **different ways to segment** the market might be superior to classical methods if the corresponding level of abstraction and complexity can be controlled. The **MOT*i*F** methodology, demonstrating the use of classical segmentation criteria, represents one common way, not the only way to carry out a market segmentation.
- The **number of market segments** depends on the number of discriminative factors that are included in the model. For feasibility reasons both on the level of market research and the follow-up marketing activities, the number should be limited. Most studies distinguish between four and approximately eight or ten market segments. A detailed modal choice analysis (which is outside the scope of **MOT*i*F**) also forces the researcher to confine himself to a manageable number of explanatory variables. For example [KEUCHEL, 1994] researched

only five requirements of commuters on transport in order to increase the feasibility of the experiment.

- The **possibilities for clustering** are determined in an early phase of the research, namely by the decision on the survey design: Only discriminative factors that are included in the questionnaire can be used later to segment the market. Therefore, at least a qualified guess of the relevant factors should precede the formulation of a questionnaire.
- **Pretests** can help to improve the quality of inquiries, e. g. in order to avoid stereotype requests for lower prices, higher availability and higher service frequencies that can be identified in some studies. Furthermore, state-of-the-art survey techniques such as conjoint measurement, regression analysis etc. are recommended in order to achieve more meaningful results.
- Market segmentation methodologies should consciously **distinguish primary and secondary requirements**. Secondary requirements on public transport such as passenger information and orientation, possibilities to obtain tickets, design, service orientation etc. can easily be underestimated. This is caused by lack of comparability regarding secondary requirements (most passengers do not have a clear picture of the performance level that could be reached) or by unconscious influences (which passenger will know exactly about the role design plays with regard to feeling unpleasant or “at home” whilst using public transport).
- **Correspondence between stated and revealed preferences** should not be taken for granted. The quality of forecasting highly depends on this factor that is still insufficiently mirrored in models of planned behaviour. Future research needs in this area are clear at hand.
- **Isolating results** from their context easily leads to mistakes regarding market orientation. A clear example is, that security seems to be hardly a problem for senior riders – at least at first sight. In-depth analysis shows, that senior customers generally give higher notes. Without knowledge of this relevant interrelationship, the comparison of security satisfaction indices for different age groups leads to misinterpretations.
- Fare level is important, but **users are prepared to pay for good quality** on important features. Survey set up should be geared towards quantification of the

willingness of the customer to pay for certain improvements. This enables cost benefit analyses and thus efficient design (in the broadest sense) of public transport products.

- A general rejection of parallel services is too dogmatic. This is proven by e. g. the experiences gathered with on-demand systems and Express Buses in Münster. A clear **division of tasks** between products in the same service area is of course crucial.

Detailed consumer research covering classical marketing research tools will be essential for the competitiveness of transport companies:

„*Managers who believe that marketing has no place in the provision of accessible transit service often do not understand that marketing is a systematic, continuous management system that places riders at the forefront of all activities of the service. The needs and demands of riders are the foundations around which the service is designed, operated and evaluated. If there are problems with service delivery, they are not caused by the riders, but by limited knowledge on the part of transit management of what riders need and expect from the service.*“ *(Cyra, Schauer, 1995)*

7.2 Recommended further research activities

7.2.1 Standard set of dimensions

- Comparability of user surveys could be improved by developing a standardised set of dimensions. The choice of detailed dimensions should remain the responsibility of the local actors and not be included in the standard. The **MOT*i*F** list of user requirements / product features and / or the QUATTRO / CEN draft quality matrix could be taken as a starting point for further development.

7.2.2 Benchmarking

- Marketing companies and the transport companies they work for deploy a huge variety of different approaches to segment markets. This variety could be taken as a starting point for a comparison or benchmarking project. A possible research question would be: "What segmentation method and technique is most useful in supporting the development of customer orientated products?". In order to ensure feasibility, **MOT*i*F** experience would suggest the following:

- Market segmentation studies are rather complex and use vast data bases. In-depth analysis is necessary to explore this rich source. The number of cases should therefore not exceed approximately four or five.

- Furthermore it is crucial to observe how results can be used to improve existing or implement new transport products. For this reason, public transport companies that use market surveys for their strategic planning should be principal project partners rather than marketing companies (that are needed as well, of course).

- Segmented results about passenger requirements, especially in connection with company supply data, are usually confidential. A research project as suggested here can only succeed if a limited number of competitors can be won over for a benchmarking project that is focused on mutual interest and learning. Detailed project descriptions as well as clear agreements concerning usage grants and confidentiality from the beginning are hard prerequisites.

- As far as possible, available reports and ongoing research should be taken as the basis for any further study. Nevertheless, careful and extensive literature surveys are necessary to evaluate in how far available studies really can contribute to achieving own research goals. Primary surveys focused on specific research questions can sometimes be more efficient than broad secondary surveys.

7.2.3 "Method assessment"

- In many cases, it was hard to decide, if observed differences (in satisfaction or

importance) are “real”, or if they only result from different methods, techniques, sample compositions, etc. A “method assessment” would diminish this kind of interpretation difficulties. Method assessment could be carried out by application of different methods for importance measurement (e. g. ranking, direct scaling, stated preference, regression or variance analysis of satisfaction data, qualitative methods) on one sample in order to compare the validity and limitations of the methods with regard to measuring passenger requirements.

7.2.4 Closing the gap between delivered and perceived quality

- Another field where further research would be useful is the gap between delivered and perceived quality. In more general terms, this means validating the relationships that are postulated in the quality loop under careful consideration of local circumstances and expected quality levels.

  In order to fill this gap between experimental circumstances and real-life decisions of respondents, more than one method with the same reference group could be conducted simultaneously. Since the surveys will influence the behaviour (e. g. make modal choice more conscious) an alternative would be to initiate two parallel target groups, the first one co-operating during the experimental phase and the other one as a reference group with the aim of a cross-check.

7.2.5 Relevance of quality and satisfaction for modal choice

- One step further, the relationship between perceived quality and modal choice could be assessed. The question if and how much the patronage of public transport depends on its performance is extremely complex. Many modal choice studies have been carried out during the last few years, but a comprehensive model explaining the influence of specific features of public transport and other modes as well as of disturbances (influences from outside the transport system) on both short and long term could not be developed so far. Local circumstances, expected quality levels and additional influencing factors should be considered. The best approach is probably to carry out real time research accompanying major changes in supply quality (detailed case study basis).

- Some contributions might also come from new scientific approaches that start to enter the realm of traffic marketing and mobility research. These (relatively) new approaches, e. g. the theory of planned behaviour and social milieu analysis lead to recommendations that are less straightforward as e. g. studies measuring the satisfaction of product features and using segmentation principles that everybody understands immediately (like gender and age). Methods like the theory of planned behaviour and social milieu analysis promise to deliver more meaningful results, e. g. better articulated market segments. On the other hand, their recommendations are less accessible, and market segments are harder to address. The reason is that membership of e. g. social milieus is not administered like socio-economic data. Thus on the one hand these sophisticated methods require a lot more in terms of abstraction level and interpretation effort, on the other hand they could possibly show valuable new ways of developing the public transport product mix and adjusting it better towards user needs.

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Annex

Elements of passenger requirements

No.	Category	requirements
1	availability, connections	❑ supply in general ❑ connections ❑ interchange possibility ❑ integration with other transport means ❑ 24-hours supply
2	number of transfers	❑ supply of direct connections ❑ change frequency ❑ transfer time/waiting period
3	punctuality, reliability	❑ reliability ❑ punctuality
4	travelling speed	❑ running time ❑ travel speed
5	Regularity	❑ constant regular intervals
6	accessibility (vehicles, stops)	❑ supply at place of residence ❑ distance to departure stop ❑ distance to destination stop ❑ possibility to reach stop on foot ❑ route network/density of network ❑ B&R places ❑ P&R places ❑ usability by disabled ❑ stairless boarding ❑ door for prams etc.
7	frequency of departures	❑ frequency ❑ quick succession of trains
8	security (vehicles, stops)	❑ pestering protection ❑ physical safety ❑ personal and property security

No.	Category	requirements
		❑ clear lay-out of stops at stops as well as in vehicles: ❑ by day ❑ in the evening ❑ at night
9	**comfort (vehicles, stops)**	at stops: ❑ comfort ❑ equipment ❑ shaping/design ❑ weather protection ❑ illumination ❑ technology of stop/station ❑ warning streak/guiding signalisation ❑ seating capacity ❑ usability by disabled ❑ cleanness ❑ temperature ❑ not too crowded ❑ surroundings in vehicles ❑ equipment ❑ comfort ❑ vehicle technology ❑ air-conditioning ❑ heating ❑ storeroom ❑ seating capacity ❑ seat comfort ❑ possibility to hold on ❑ possibility to take bikes ❑ cleanness ❑ no bad smells ❑ not too crowded ❑ temperature

No.	Category	requirements
		❑ shaping/design
10	**pre-trip information**	written information ❑ availability of info-brochures ❑ shaping of info-brochures ❑ comprehensibility of road network map ❑ time table information ❑ availability of time tables ❑ comprehensibility of time tables personal information ❑ telephone information ❑ information desk/office ❑ personal advice ❑ comprehensibility of advice ❑ advertising/promotion
11	**on-trip information**	at stops ❑ information at stops ❑ announcements/displays at stops ❑ road network map at stops ❑ information about interruptions ❑ information system for disabled/blind persons ❑ signs at stops in vehicles ❑ information in vehicles ❑ reliable announcements/displays in vehicles in time ❑ road network map in vehicle
12	**customer orientation**	service (in general) ❑ total public transport staff ❑ friendliness of staff ❑ lockers for luggage ❑ salespersons ❑ advice ❑ appearance

No.	Category	requirements
		❑ way to treat complaints ❑ vigilant friendliness drivers and conductors ❑ friendliness ❑ patience ❑ advice ❑ helpfulness ❑ willingness to give information ❑ reliable information ❑ time for customers ❑ pleasant way of driving ❑ safe way of driving punctuality guarantying order and cleanliness ❑ additional friendliness of staff ❑ lockers for luggage ❑ salespersons ❑ advice ❑ appearance ❑ way to treat complaints ❑ vigilantes friendliness drivers and conductors ❑ friendliness ❑ patience ❑ advice ❑ helpfulness ❑ willingness to give information ❑ reliable information ❑ time for customers ❑ pleasant way of driving ❑ safe way of driving ❑ punctuality ❑ guarantying order and cleanliness additional service

No.	Category	requirements
		❑ newspapers etc. in vehicles ❑ restaurants at stations
13	**price, fare level**	❑ fare level ❑ cost effectiveness ❑ lower fares ❑ special offers ❑ short distance tariff
14	**tariff system**	❑ tariff supply ❑ tariff system ❑ comprehensibility of the tariff system ❑ range of ticket-supply
15	**possibilities to obtain tickets**	❑ possibilities to buy tickets ❑ number of ticket offices ❑ business hours of ticket offices ❑ location of the ticket offices ❑ number of ticket machines ❑ reliability of ticket machines ❑ simplification of ticket machines ❑ kind of payment ❑ ticket sale by the driver
16	**safety**	❑ traffic safety
17	**social prestige**	❑ general opinion on public transport ❑ sympathy with other passengers
18	**environmental friendliness**	❑ ecological commitment/habitat attention ❑ reduction of congestion

Table 54: Categorisation of passenger requirements

Inventory of transport products

	Category of product	product
1	**Train**	❑ first class urban train with higher than average comfort: seat availability, space per seat ❑ second class urban train with average comfort
2	**Metro**	❑ urban light rail, (partially) underground, with driver ❑ urban light rail, (partially) underground, without driver (VAL)
3	**Light rail**	❑ urban light rail, (mainly) on the ground
4	**Monorail**	❑ urban monorail above ground
5	**Tram - free track**	❑ urban tram, (mainly) free track
6	**Tram - partially free track**	❑ urban tram, partly free track, partly rails in the street
7	**Trolley**	❑ trolley, no free lane ❑ trolley, (mainly) free lane
8	**Guided bus**	❑ guided bus
9	**Bus - express services**	❑ bus on fast, direct connections, (partially) free lanes
10	**Bus - standard services**	❑ bus services - opening city quarters ❑ bus services - connecting city quarters
11	**Bus - city bus**	❑ high frequent bus services in city centre
12	**Bus - on demand services**	❑ bus services operated on demand of passengers
13	**Taxi - shared taxi door-to-door (dtd)**	❑ shared taxi dtd limited for certain categories of passengers ❑ shared taxi dtd open for all passengers
14	**Taxi - shared taxi linebound**	❑ shared taxi linebound, timetable

	Category of product	product
		❑ shared taxi linebound, flexible ❑ shared taxi linebound, on demand
15	**Taxi - shared taxi special services**	❑ shared taxi theatre, disco, etc. ❑ shared taxi for employees and school children
16	**Coach - regular services**	❑ coach services for employees ❑ coach services for school children
17	**Coach - special services**	❑ coach - city tour ❑ coach - hotel services
18	**Group Rapid Transport**	❑ people mover
19	**Personal Rapid Transport**	❑ horizontal lift
20	**Cable car/suspension car**	❑ cable car - across height or water barriers ❑ cable car - in built-up area ❑ suspension car
21	**Ferry**	❑ ferry carrying all vehicles and pedestrians ❑ ferry carrying only bicycles and pedestrians
22	**Water taxi**	❑ water taxi for individual (groups) of passengers ❑ shared water taxi
23	**Automatic guided vehicle systems (AGVS)**	❑ AGVS - public vehicles ❑ AGVS - private owned vehicles
24	**Air vehicles**	❑ airship ❑ helicopter

Table 55: Transport Products

Estimation of the minimum satisfying level

On the basis of the results of work packages 1 and 2 (expectations and actual satisfactions with the products) that are scaled from 1 to 10, and having obtained through surveys the "general expectation"[5] with regard to each of the attributes considered, it is necessary to choose a procedure for estimation of the minimum satisfying level of each of those attributes.

The minimum satisfying levels were obtained through indirect information. The best support seemed to come from the "general expectation". On the basis of common sense and supported by marketing literature[6] we postulated that the two variables are strongly (positively) related, in the sense that a higher general expectation will imply a higher value of the minimum satisfying level.

Since no clear support was found to estimate which is the best method to determine the minimum satisfying level, 3 different models for this estimation were considered and tested:

1 A Constant Difference model, i.e. the minimum satisfying level is a constant difference from the general expectation obtained for any attribute;

$$\mathbf{MSL = GE - Constant}$$

2 A Constant Ratio model, i.e. the minimum satisfying level is a constant ratio of the general expectation obtained for any attribute;

$$\mathbf{MSL = GE * Constant} \text{ (Constant smaller or equal to 1)}$$

3 An Exponential model, i.e. the minimum satisfying level can be obtained as an exponential expression (with constant parameters, a and b) based on the general expectation obtained for any attribute;

$$\mathbf{MSL = a * e^{b * GE}}$$

[5] In the above mentioned sense of "importance"

[6] Schiffman, L. & Kanuk, L.(1987), Consumer Behavior, Prentice-Hall

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A useful auxiliary concept in this respect is that of **tolerance**, defined as the difference between generic expectation and Minimum Satisfaction Level.

The physical interpretations of these models are more easily understood in terms of the variation of the tolerance along the axis of general expectation values:

- In the Constant Difference model, tolerance is constant, with the exception of the values close to the lower limit, since by definition no satisfaction can be expressed with a value lower than 1. So, in relative terms, tolerance decreases as a percentage of general expectations when these are higher.
- In the Constant Ratio model, tolerance increases with the general expectation, but keeping a constant value as a percentage of the general expectations.
- In the Exponential model, tolerance is smaller in the extreme zones of the expectation axis and greater in the middle. In the lower extreme, due to the fact that 1 is the lowest possible value, tolerance is low because there is little to lose; in the higher extreme, tolerance is low because the user does not want to abdicate anything on really important things; and in the middle zone the user is more willing to compromise, tolerating some losses because those attributes are not so relevant for his / her choice.

Since there is no theoretical or empirical evidence to support the universal choice of one of these models over the others, it was decided to retain all three and base the choice of which to apply in a particular case on the results they produce when applied to the data of that particular case. This selection process will be described below.

Figure 5 presents the type of curve obtained for each of these models. In addition to the three curves corresponding to the three models, a fourth curve serving as a reference is added for greater ease of perception of the concept of tolerance. This one (the highest of the four curves) is a curve of satisfaction equal to the general expectation. The value of tolerance for any of the models at a certain point can easily be perceived by the difference of ordinates between the curve of that model and the reference curve.

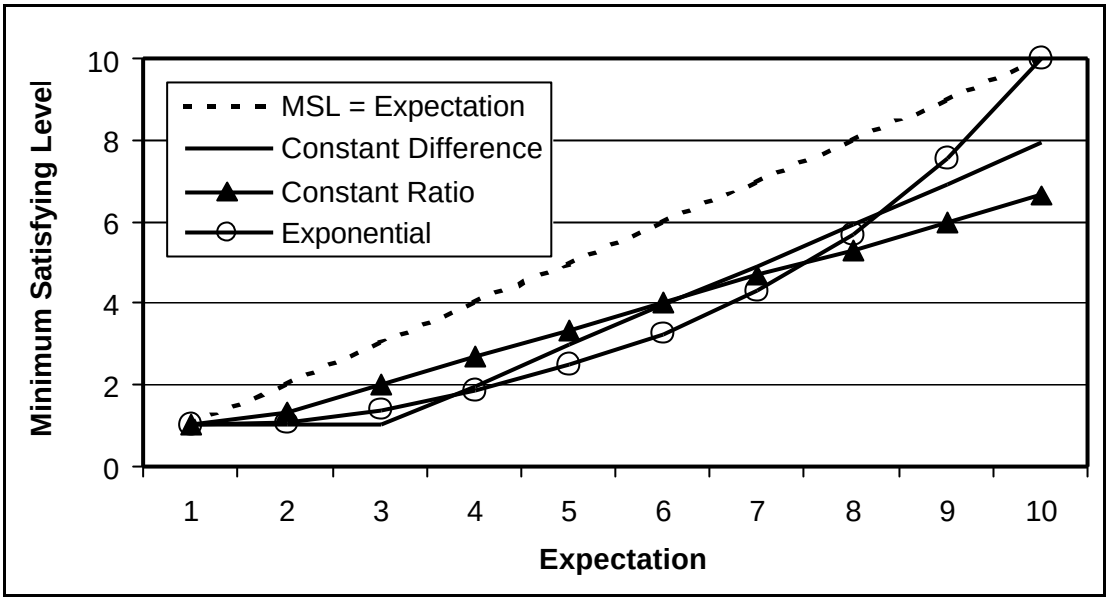

Figure 16: Alternative models for estimation of minimum satisfying levels

Having specified the types of models that can be applied, the corresponding parameters must be chosen. If one wants to base the selection of the model for each case on the results obtained for the separation of the alternative transport products, and not so much of the parameters of the models, these have to be chosen interdependently.

To guarantee this interdependency, a procedure was developed which forces the ”tolerance areas“, i.e. the area between the highest curve (expectations) and the curve corresponding to each of the models, to have the same value for all 3 models. This has to be made in order to avoid any bias in the choice of the model on the basis of their separation capabilities. Given the simple expression of the curves, this can easily be done analytically as well as numerically.

The curves shown in the graph, which are those applied in the remainder of the computations, correspond to a constant ratio of 2/3, i.e. a minimum satisfying level on any attribute that is equal to 2/3 of the general expectation with respect to that attribute.

Minimum satisfying level = 2/3 * General expectation

If we force the “tolerance areas” of the two other models to be the same as the tolerance area obtained for this constant ratio model, the corresponding parameters are the following:

- Constant Difference Model: Constant = 2.051
- Exponential model, a = 0.6091; b = 0.2798